# SOUTH ASIAN UNIVERSITY

**Akbar Bhawan, Chanakyapuri, New Delhi**

Construction of South Asian University Campus at Maidan Garhi, New Delhi. Package-III: (i) Administration Building (ii) Library Building (iii) Institute of South Asian Studies and Interdisciplinary Research (iv) Faculty of Law and Humanities (v) Faculty of Physics, Chemistry, Maths and I.T. (vi) Faculty of Art & Design and Convention Centre (vii) Utility Building: Including Basements, Superstructures, Interior Finishes, Internal Water Supply, Sanitary Installations, Drainage, Internal Electrical Installations, HVAC, Lifts, Fire Fighting System, Low Voltage System ; PA System, Solar Water Heating System etc. External Site Development and Infrastructure; Roads, Street Lighting, Sewerage, Storm Water Drainage, STP, WTP, Water Supply, HT & LT Power Distribution, Electrical Substation, Chiller Plant, Pump House, D.G. Sets, Rainwater Harvesting, Hardscaping etc.

**Percentage Rate Tender for Works**

**PART A**
**Technical / Eligibility Bid**
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**September 2016**

# NIT

**N.I.T. No. : 09/NIT/SAU-9A/2016**

**Name of work :** Construction of South Asian University Campus at Maidan Garhi, New Delhi. Package-III: (i) Administration Building (ii) Library Building (iii) Institute of South Asian Studies and Interdisciplinary Research (iv) Faculty of Law and Humanities (v) Faculty of Physics, Chemistry, Maths and I.T. (vi) Faculty of Art & Design and Convention Centre (vii) Utility Building: Including Basements, Superstructures, Interior Finishes, Internal Water Supply, Sanitary Installations, Drainage, Internal Electrical Installations, HVAC, Lifts, Fire Fighting System, Low Voltage System ; PA System, Solar Water Heating System etc. External Site Development and Infrastructure; Roads, Street Lighting, Sewerage, Storm Water Drainage, STP, WTP, Water Supply, HT & LT Power Distribution, Electrical Substation, Chiller Plant, Pump House, D.G. Sets, Rainwater Harvesting, Hardscaping etc.

**Estimated Cost : Rs. 638,89,18,337/-**

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| **Earnest Money** | **Rs 6,48,90,000/-** |
| **Performance Guarantee** | **5% of tendered value.** |
| **Security Deposit** | **2.5% of tendered value.** |
| **Time For Completion** | **36 Months** |

Certified that this NIT contains Part-A from Page 1 to Page 69. & Part-B from Page 1 to Page 1087 and Part-C from Page 1 to Page 481 and Part-D CPWD GCC2014 with modifications and corrections up to date of uploading the tender by SAU.

Prepared By Vetted By :

PA: PMC:

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# SOUTH ASIAN UNIVERSITY
## Akbar Bhawan, Chanakyapuri, New Delhi-110021

## 2.0 NOTICE INVITING E-TENDER ( Press Notification )

Registrar, South Asian University ( SAU ), on behalf of the President, SAU, Delhi invites online percentage rate bids from eligible firms/contractors in two bid system for the following work: –

**NIT NO**: 09/NIT/SAU-9A/2016

**Name of work**:- Construction of South Asian University Campus at Maidan Garhi, New Delhi. Package-III: (i) Administration Building (ii) Library Building (iii) Institute of South Asian Studies and Interdisciplinary Research (iv) Faculty of Law and Humanities (v) Faculty of Physics, Chemistry, Maths and I.T. (vi) Faculty of Art & Design and Convention Centre (vii) Utility Building: Including Basements, Superstructures, Interior Finishes, Internal Water Supply, Sanitary Installations, Drainage, Internal Electrical Installations, HVAC, Lifts, Fire Fighting System, Low Voltage System ; PA System, Solar Water Heating System etc. External Site Development and Infrastructure; Roads, Street Lighting, Sewerage, Storm Water Drainage, STP, WTP, Water Supply, HT & LT Power Distribution, Electrical Substation, Chiller Plant, Pump House, D.G. Sets, Rainwater Harvesting, Hardscaping etc.

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| Estimated Cost | Rs. 638,89,18,337/- |
| Earnest Money | **Rs 6,48,90,000/-** |
| Time for Completion | 36 Months |
| Last Date and Time for Submission of Bids | **4th November 2016 (3:00 PM)** |

For detailed NIT/ Tender Documents/ Details / downloads and for any other correction/ amendments/ modification / extension till the last date of submission of bids, please visit websites: www.sau.int or www.eprocure.gov.in or www.tenderwizard.com/SAU

Tender submissions can only be made through online mode at www.tenderwizard.com/SAU

**Registrar**

# 3.0 PART-A

# TECHNICAL / ELIGIBILITY BID

## 3.1 INFORMATION AND INSTRUCTIONS FOR BIDDERS FOR E-TENDERING FORMING PART OF BID DOCUMENT AND TO BE POSTED ON WEBSITE.

**(APPLICABLE FOR INVITING TWO BID SYSTEM)**

Registrar, South Asian University (SAU), on behalf of the President, SAU, Delhi invites online Percentage rate bids from eligible firms/contractors in two bid system for the following work :-

### 3.1.1 Details of work for which tender has been invited:

| S. No. | NIT No. | Name of work & Location | Estimated Cost put to Tender | Earnest Money | Period for Completion | Date of pre-bid meeting | Last date & time for submission of bid, EMD, e-tender processing fee and other documents online as specified in the press notice | Date and time of opening of Technical / Eligibility bid |
|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 1 | 09/NIT/SAU-9A/2016 | Construction of South Asian University Campus at Maidan Garhi, New Delhi. Package-III: (i) Administration Building (ii) Library Building (iii) Institute of South Asian Studies and Interdisciplinary Research (iv) Faculty of Law and Humanities (v) Faculty of Physics, Chemistry, Maths and I.T. (vi) Faculty of Art & Design and Convention Centre (vii) Utility Building: Including Basements, Superstructures, Interior Finishes, Internal Water Supply, Sanitary Installations, Drainage, Internal Electrical Installations, HVAC, Lifts, Fire Fighting System, Low Voltage System ; PA System, Solar Water Heating System etc. External Site Development and Infrastructure; Roads, Street Lighting, Sewerage, Storm Water Drainage, STP, WTP, Water Supply, HT & LT Power Distribution, Electrical Substation, Chiller Plant, Pump House, D.G. Sets, Rainwater Harvesting, hardscaping etc. | **Rs. 638,89,18,337/-** | Rs 6,48,90,000/- | 36 Months | 7.10.2016 at 2:30 PM | **04.11.2016 at 3:00 PM** | **04.11.2016 at 3:30 PM** |

## 3.1.2 Eligibility Criteria:

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| **1** | Contractors/ bidders who fulfill the following minimum criteria shall be eligible to apply. **Joint ventures shall not be accepted.** |
| a) | Should have satisfactorily completed the works as mentioned below during the last (7) seven years ending previous day of last date of submission of bids: |
| i) | Three similar completed works each costing not less than **Rs. 255 Crores** or two similar completed works each costing not less than **Rs. 383 Crores** or one similar completed work costing not less than **Rs. 511 Crores.**<br><br>Similar work shall mean "Construction of Five or more (15 meter or more above ground level) storied RCC framed structure including internal water supply, sanitary installation, Electrical Installation all executed under one agreement |
| ii) | The Bidder should have completed at least one Institutional building such as Hospital/Academic Institution/ Hotel/ Scientific Research and Development Centre of value not less than **Rs.120 Crore.** |
| iii) | The Bidder should have executed the following works either as part of any composite work listed in above (i) or other or under any independent packages in his own name during the last seven years. The agency shall have to deposit the documentary proof of this effect: |
| | a. One HVAC work of value not less than **Rs. 23.0 Crore**. |
| | b. One firefighting work of value not less than **Rs. 7.3 Crore.** |
| b) | Should have had average annual financial turnover of at least **Rs. 319 Crores** on construction works during the immediate last three consecutive financial years ending 31st March 2016 (Scanned copy of Certificate from CA to be uploaded.). |
| c) | The bidder Should not have incurred any loss in more than two years during the last five years ending 31st March 2016. Consecutive **financial statements** duly certified and audited by the Chartered Accountant to be uploaded. |
| d) | Should have a solvency **Rs. 255 Crores** certified by his banker (Scanned copy of original solvency to be uploaded). The solvency certificate should be addressed to the Registrar, SAU. |
| e) | The bidding capacity of the contractor should be equal to or more than the estimated cost of the work put to tender. The bidding capacity shall be worked out by the following formula:<br>Bidding Capacity = [(AxNx2)-B] Where:<br>A= Maximum value of construction works executed in any one year during the last seven years taking into account the completed as well as works in progress.<br>N= Number of years prescribed for completion of work for which bids have been invited.<br>B= Value of existing commitments and ongoing works to be completed during the period of completion of work for which bids have been invited.<br>***The applicant shall submit the calculation sheet of Bid Capacity and also indicate value of balance work in hand certified by a Chartered Accountant***. |

| 2 | For components of E&M works, the eligibility criteria for the bidder or the Associate Agencies will be as detailed below: | | | |
|---|---|---|---|---|
| | **S.No.** | **Component of E&M Works** | **Estimated cost (Rs in crores)** | **Eligibility** |
| | i. | Providing, Installing, Testing and Commissioning of Electrical and LV works | **79** | i a) Should have completed during last 7 years upto previous day of last date of submission of tender one similar work costing not less than 80% of estimated cost or two similar works each costing not less than 60% of estimated cost or three similar works each costing not less than 40% of estimated cost.<br>i b) Note : Similar work(s) means internal electrical installation work. |
| | ii. | Providing, Installing Testing and Commissioning of Lifts | **8.4** | The associate agency shall be as per approved list of makes. |
| | iii | Providing, Installing Testing and Commissioning of Fire Fighting System | **18.4** | iii a) Same as above i a)<br>iii b) Similar work shall mean SITC of firefighting system. |
| | iv | Providing, Installing Testing and Commissioning of HVAC Works | **57.6** | iv a) Same as above i a)<br>iv b) Similar work shall mean SITC of individual chiller of minimum capacity of 800 TR . |
| | v | Providing, Installing Testing and Commissioning of DG Sets | **4.7** | v a) Same as above i a)<br>v b) Similar work shall mean SITC of individual DG of minimum capacity of 1200 kva . |
| | vi | SITC of electrical sub station | **11.9** | vi a) Same as above ia<br>vi b) Similar work shall mean SITC of 66 Kv GIS Substation and individual transformer of minimum capacity of 4Mva. |

The main contractor should either himself meet the eligibility criteria as defined in the bid document (para above) or he will have to Associate with an Agency for E&M package after award of work and has to submit details of at least three such agencies conforming eligibility condition to Engineer-in-charge within 60 days after award of work. Name of the agency(s) to be associated shall be approved by Engineer-in-charge.

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| 3 | i) | Components of work executed other than those included in definition of similar work shall be deducted while calculating cost of similar work. Bidder shall submit abstract of cost of work in support of this. |
| | ii) | For the purpose, “Cost of work” shall mean gross value of the completed work including the cost of materials supplied by the Government/Client, but excluding those supplied free of cost. This should be certified by an officer not below the rank of Executive Engineer / Project Manager or equivalent |
| | iii) | The value of executed works shall be brought to current costing level by enhancing the actual value of work at simple rate of 7% per annum; calculated from the date of completion to last date of submission of bids. |
| 4 | The intending bidder must read the terms and conditions of NIT carefully. He should only submit his bid if he considers himself eligible and he is in possession of all the documents required. | |

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| 5 | Information and Instructions for bidders posted on website shall form part of the bid document. |
| 6 | The bid document consisting of plans, specifications, the schedule of quantities of various types of items to be executed and the set of terms and conditions of the contract to be complied with and other necessary documents can be seen and downloaded from website www.sau.int/ www.eprocure.gov.in/ and www.tenderwizard.com/SAU free of cost. |
| 7 | The bid can only be submitted after depositing e-tender Processing Fee in favour of ITI Limited through their e-gateway by credit/debit card/Internet banking facility and uploading the mandatory scanned documents such as Demand Draft or Pay order or Banker`s Cheque or Deposit at call Receipt or Fixed Deposit Receipts and Bank Guarantee of any Scheduled Bank against EMD in favour of South Asian University, New Delhi and other documents as specified |
| 8 | Bidders not registered on the website www.tenderwizard.com/SAU, are required to get registered beforehand. If needed they can be imparted training on online bidding process as per details available on the website. |
| 9 | The intending bidder must have valid class-III digital signature to submit the bid. |
| 10 | The bidders can login and see the competitor financial bid sheets after opening of the financial bid on the bid opening date. |
| 11 | The bidder can upload documents in JPG format or PDF format. |
| 12 | Certificate of Financial Turnover: At the time of submission of bid contractor may upload Affidavit/ Certificate from CA mentioning Financial Turnover of immediate last 3 years ending previous day of last date of submission of bids or for the period as specified in the bid document and further details if required may be asked from the contractor after opening of technical bids. There is no need to upload entire voluminous balance sheet. |
| 13 | **The part-c of tender documents contains BOQ Consisting of four Schedules, as under;**<br>**1) Schedule-A, DSR 2014 items**<br>**2) Schedule-B, Non DSR items**<br>**3) Schedule-C, BMS items**<br>**4) Schedule-D, Operation and maintenance Items**<br><br>**Contractor shall quote definite percentage, above, below or at par for each of above parts of BOQ separately at the designated place. If any Part of BOQ is left blank by the bidder, the bid shall be considered as invalid.** |
| 14 | The Technical/Eligibility bid shall be opened first on due date and time as mentioned above. The time and date of opening of Financial bid of contractors qualifying the Technical/ Eligibility bid shall be communicated to them at a later date. |
| 15 | Pre-Bid conference shall be held in the office of the Registrar, South Asian University, Akbar Bhawan, Chanakyapuri, New Delhi - 110021 at **2:30 PM on date 07.10.2016** to clear the doubts of intending bidders, if any. The tenderers are requested to submit their questions/ queries in writing in the name of Registrar, SAU or e-mail to registrar@southasianuniversity.org to reach the employer not later than two days before the date of pre-bid conference. |
| 16 | If any information furnished by the applicant is found incorrect at a later stage, he shall be liable to be debarred from tendering/ taking up of works in **South Asian University (SAU)**. The tender shall be cancelled and EMD shall be forfeited. The SAU reserves the right to verify the particulars furnished by the applicant independently. |

**3.2 <u>List of Documents to be filled in by the bidders</u> in various forms as indicated in Section III, to be scanned and uploaded in JPG format or PDF format within the period of bid submission:**

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| 1. | Demand draft/Pay order or Banker's Cheque/Fixed Deposit Receipt of a Scheduled Bank/ Bank Guarantee of any Scheduled Bank against EMD |
| 2. | Letter of transmittal |
| 3. | Certificate of Financial Turnover from Chartered Accountant (Form 'A'). |
| 4. | Bank Solvency Certificate (Form 'B'). |
| 5. | Integrity Pact |
| 6. | Integrity Agreement |
| 7. | Certificates of Works Experience (Form 'C', 'D' & 'E'). |
| 8. | Structure & Organization (Form 'F'). |
| 9. | Details of Technical & Administrative Personnel (Form 'G'). |
| 10. | Details of Construction Equipment (Form 'H'). |
| 11. | List of similar past works and performance on these works. |
| 12. | Calculation of bidding capacity along with CA Certificate. |
| 13. | Certificate of Registration for Sales Tax/VAT and Service Tax and acknowledgement of up to date filed return |
| 14. | Affidavit as mentioned under Para 1.2 ( B) of Eligibility Criteria in NIT Form CPWD 6. |
| 15. | Affidavit as mentioned under 4.0 Eligibility Criteria Section-II, Sl.No. 1.7 |

## 3.3 NOTICE INVITING E-TENDER – NIT FORM CPWD-6

The Registrar, **South Asian University (SAU)**, New Delhi on behalf of The President, SAU invites percentage rate bids for the work "Construction of South Asian University Campus at Maidan Garhi, New Delhi. Package-III(i) Administration Building (ii) Library Building (iii) Institute of South Asian Studies and Interdisciplinary Research (iv) Faculty of Law and Humanities (v) Faculty of Physics, Chemistry, Maths and I.T. (vi) Faculty of Art & Design and Convention Centre (vii) Utility Building: Including Basements, Superstructures, Interior Finishes, Internal Water Supply, Sanitary Installations, Drainage, Internal Electrical Installations, HVAC, Lifts, Fire Fighting System, Low Voltage System ; PA System, Solar Water Heating System etc. External Site Development and Infrastructure; Roads, Street Lighting, Sewerage, Storm Water Drainage, STP, WTP, Water Supply, HT & LT Power Distribution, Electrical Substation, Chiller Plant, Pump House, D.G. Sets, Rainwater Harvesting, Hardscaping etc.

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| 1 | 1.1 | **Joint ventures are not accepted.**<br>The work is estimated to cost **Rs. 638,89,18,337/-**The estimated cost is based on CPWD DSR 2014 (civil and E&M) and Non-DSR items based on prevailing market rates. This estimated cost, however, is given merely as a rough guide.<br>Intending bidders may submit the bid after satisfying themselves that they fulfill the following eligibility criteria:- |
| | 1.2 | **Eligibility Criteria** |
| | (A) | Same as described in **INFORMATION AND INSTRUCTIONS FOR BIDDERS FOR e-TENDERING,** 3.1.2 Eligibility Criteria (serial No.1, 2 & 3 ). |
| | (B) | The bidder shall have to furnish an affidavit as under:<br>I / We undertake and confirm that eligible similar work(s) has / have not been got executed through another contractor on back to back basis. Further that, if such a violation comes to the notice of SAU, then I / we shall be debarred for bidding in SAU in future forever. Also, if such a violation comes to the notice of SAU before date of start of work, the Engineer-in-Charge/SAU shall be free to forfeit the entire amount of Earnest Money Deposit / Performance Guarantee. |
| 2. | | Agreement shall be drawn with the successful bidders on prescribed Form No. CPWD 7 as amended up to the date of uploading of tender by SAU, which is available as a Govt. of India Publication and also available on website www.cpwd.gov.in and the format in practice in SAU. Bidders shall quote his rates as per various terms and conditions of the said form, which will form part of the agreement. |
| 3 | | The time allowed for carrying out the work will be from the date of start as defined in schedule 'F' or from the first date of handing over of the site, whichever is later, in accordance with the phasing, if any, indicated in the bid documents. |
| 4 | (i) | The site for the work is available. |
| | (ii) | The working architectural and structural drawings shall be made available in phased manner as per requirement of the same as approved program of construction submitted by the contractor after award of work. |
| 5 | | The bid document consisting of plans, specifications, schedule of quantities of items to be executed and the set of terms & conditions of the contract to be complied with and other necessary documents can be seen free of cost from website www.southasianuniversity.org, www.eprocure.gov.in and www.tenderwizard.com/SAU. Plans can also be seen in the office of the Executive Engineer, South Asian University, Akbar Bhawan, Chanakyapuri, New Delhi – 110021<br>The CPWD standard publications like General Conditions of Contract, Delhi schedule of rates 2014 (for civil and Electrical ), Specifications for Civil and Electrical works and Delhi analysis of rates 2014 (for civil and electrical) with amendments / correction slips up to the date of uploading the tender by SAU can be seen free of cost from website www.cpwd.gov.in. |

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| | | Those bidders not registered on the website www.tenderwizard.com/SAU, are required to get registered beforehand. If needed they can be imparted training on online tendering process as per details available on the website. The intending bidder must have valid class-III digital signature to submit the bid. |
| 6 | | After submission of the bid, the tenderer can re-submit revised bid any number of times but before last time and date of submission of bid as notified. |
| 7 | | While submitting the revised bid, tenderer can revise the quoted rates any number of times but before last time and date of submission of bid as notified. |
| 8 | | Earnest Money of Rs 6,48,90,000/-in the form of Demand Draft or Pay Order or Banker's Cheque or Fixed Deposit Receipt of a scheduled bank drawn in favour of South Asian University, New Delhi, shall be scanned and uploaded to the e-Tendering website within the period of tender submission.<br><br>A part of earnest money is acceptable in the form of bank guarantee also. In such case, 50% of earnest money or Rs. 20 lakh, whichever is less, shall have to be deposited in the shape prescribed above and balance may be deposited in shape of Bank guarantee of any scheduled bank in accordance with the Form available in Tender Document having validity for 6 months or more from the last date of receipt of tenders which is to be scanned and uploaded by the interested bidders.<br><br>The original physical EMD (of the scanned copy uploaded) shall be deposited by the bidder before opening of Eligibility/ Technical Bid in the office of the Registrar, SAU, failing which the tender shall be rejected.<br>The bank details of SAU are as follows:<br>1. Beneficiary Name : South Asian University<br>2. Name of Bank : State Bank of India<br>3. Bank Address : Old JNU Campus New Delhi<br>4. Beneficiary A/C No. : 31238978138<br>5. IFSC Code/ RTGS No. : SBIN0001624<br>6. MICR Code : 110002056<br>7. PAN Number : Not Applicable in view of tax exemption.<br>Interested bidders who wish to participate in the bid has to also make the following payments within the period of tender submission: |
| | (i) | e-Tender Processing Fee shall be payable to ITI Limited through their e-gateway by credit/debit card/internet banking facility. |
| | (ii) | Copy of Enlistment Order and certificate of work experience and other documents as specified in the tender document for eligibility shall be scanned and uploaded to the e-tendering website within the period of tender submission. However, certified copy of all the scanned and uploaded documents as specified in tender document shall have to be submitted by the lowest bidder within a week physically in the office of tender opening authority. Online tender documents submitted by interested bidders shall be opened of those bidders only, who have deposited e-Tender processing fee with I T I Limited and Earnest Money Deposit. |
| 9 | | The bid submitted shall become invalid if : |
| | (i) | The bidder is found ineligible. |
| | (ii) | The bidder does not upload all the documents including service tax registration, VAT registration/ sales tax registration as stipulated in the tender document including the undertaking, if any. |
| | (iii) | If Any discrepancy is noticed between the documents as uploaded at the time of submission of bid and hard copies as submitted physically by the lowest bidder in the office of tender opening authority. |
| | (iv) | If the bidder does not deposit physical EMD before opening of technical bid. |
| | (v) | In any case the e-tender processing fee shall not be refunded. |

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| | 9.1 | After opening of the technical bid/ eligibility bid , SAU shall prepare a list of deficiencies found in the bids of each bidder vis a vis requirements as per NIT within one week and send these lists to individual bidders by Speed Post **and Email** with a request to furnish required documents within one week of receipt, failing which it will be presumed that the individual bidder do not have any further documents to furnish and decision on bids will be taken accordingly. |
| 10. | | The tenderer whose bid is finally accepted, will be required to furnish performance guarantee of 5% (Five Percent) of the bid amount within the period specified in schedule F or Banker's cheque of any scheduled bank / Demand Draft of any scheduled bank / Pay order of any Scheduled bank or Fixed Deposit Receipts of a Scheduled bank or an irrevocable bank Guarantee Bonds of any Scheduled Bank or the State Bank of India in accordance with the prescribed form. In case the contractor fails to deposit the said performance guarantee within the period as indicated in schedule 'F' including the extended period if any, the Earnest Money deposited by the contractor shall be forfeited automatically without any notice to the contractor. The Earnest Money deposited along with tender shall be returned after receiving the aforesaid performance guarantee.<br><br>The contractor whose bid is accepted will also be required to furnish either copy of applicable license/ registrations or proof for applying for obtaining labour licenses, registration with EPFO, ESIC and BOCW welfare board and programme chart (Time and progress within the period specified in Schedule 'F'. |
| 11. | | Intending Bidders are advised to inspect and examine the site and its surroundings and satisfy themselves before submitting their bids as to the nature of the ground and sub-soil (so far as is practicable), the form and nature of the site, the means of access to the site, the accommodation they may require and in general shall themselves obtain all necessary information as to risks, contingencies and other circumstances which may influence or affect their bid. A bidders shall be deemed to have full knowledge of the site whether he inspects it or not and no extra claims / payments consequent on any misunderstanding or otherwise shall be allowed. The bidders shall be responsible for arranging and maintaining at his own cost all materials, tools & plants, water, electricity, access, facilities for workers and all other services required for executing the work unless otherwise specifically provided for in the contract documents. Submission of a bid by a bidder implies that he has read this notice and all other contract documents and has made himself aware of the scope and specifications of the work to be done and of conditions if any, in this tender document and local conditions and other factors having a bearing on the execution of the work. |
| 12 | | The competent authority on behalf of SAU does not bind itself to accept the lowest or any other bid and reserves to itself the right to reject any or all the bids received without assigning any reason. All bids in which any of the prescribed conditions is<br>not fulfilled or any condition including that of conditional rebate is put forth by the bidders shall be summarily rejected. |
| 13 | | Canvassing whether directly or indirectly, in connection with bids is strictly prohibited and the bids submitted by the tenderers who resort to canvassing will be liable to rejection. |
| 14 | | The competent authority on behalf of SAU reserves to himself the right of accepting the whole or any part of the bid and the bidders shall be bound to perform the |

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| 15 | | The tenderer shall not be permitted to bid for works in SAU responsible for award and execution of contracts, in which his near relative is posted as an officer in any capacity ( (Grade IV or above ) in SAU. He shall also intimate the names of persons who are working with him in any capacity or are subsequently employed by him or are subsequently employed by him and who are near relatives to any officer in the SAU or in the Ministry of External Affairs. Any breach of this condition by the tenderer would render him liable to be debar red from future contracts . |
| 16 | | No Engineer of Gazetted rank or other Gazetted Officer employed in Engineering or Administrative duties in an Engineering department of the Government of India is allowed to work as a contractor for a period of one year after his retirement from Government service, without the prior permission of the Government of India in writing. This contract is liable to be cancelled if either the contractor or any of his employees is found any time to be such a person who has not obtained the permission of the Government of India as aforesaid before submission of the bid or engagement in the contractor's service. |
| 17 | | The tender for the works shall remain open for acceptance for a period of One Hundred Twenty (120) days from the date of opening of **Technical** bid. In case the tenderer withdraws his tender before the said period or issue of letter of acceptance, whichever is earlier, or makes any modifications in the terms and conditions of the tender which are not acceptable to the SAU, then the SAU shall, without prejudice to any other right or remedy, be at liberty to forfeit 50% of the said earnest money as aforesaid. Further the tenderer shall not be allowed to participate in the re-tendering process of the work. |
| 18 | | This notice inviting tender shall form a part of the contract document. The successful bidder / tenderer, on acceptance of his bid by the Accepting Authority shall within 15 days from the letter of acceptance, sign the agreement consisting of :- |
| | a) | The Notice Inviting Bid, all the documents including special conditions, additional conditions, particular specifications and drawings, if any, forming part of the bid as uploaded at the time of invitation of bid and the rates quoted online at the time of submission of bid and acceptance thereof together with any correspondence leading thereto. |
| | b) | Standard C.P.W.D. Form 7 (GCC for CPWD works 2014) amendments up to date of uploading the tender by SAU. |
| | c) | An agreement on standard SAU Format on a non-judicial Stamp paper of appropriate value.( format attached ) |
| | d) | Integrity Pact and Agreement as per attached format. |
| 19. | 19.1 | The bid document will include following three components: |
| | 19.1.1 | **For Composite Bids**<br>**Part A :**<br>Information and Instructions to bidder, eligibility criteria, CPWD-6, CPWD-7 including schedule A to F,<br>General Conditions of Contract for CPWD 2014 or latest edition as applicable with all amendments / modifications as amended / modified up to date of uploading the tender by SAU.<br>**Part B :**<br>Special, Additional Conditions & Particular Specifications for Civil, Electrical & Mechanical Components and Tender Drawings.<br>**Part C :**<br>Schedule of Quantities applicable to Civil, Electrical & Mechanical components. |
| | 19.1.2 | After acceptance of the bid by competent authority, SAU shall issue letter of award on behalf of the president SAU. After the work is awarded, the main contractor will have to enter into an agreement with SAU. |
| | 19.1.3 | Entire work under the scope of composite bid shall be executed under one agreement. |

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|---|---|---|
| | 19.1.4 | The main contractor should either himself meet the eligibility criteria as defined in the bid document or he will have to associate with an agency for E&M package after award of work and has to submit details of at least three such agency(s) confirming eligibility condition as defined in the bid document, within prescribed time. Name of the agency(s) to be associated shall be approved by Engineer-in-charge. |
| | 19.1.5 | In case the main contractor intends to change any of the above approved agency / agencies during the operation of the contract, he shall obtain prior approval of Engineer-in-charge. The new agency /agencies shall also have to satisfy the laid down eligibility criteria in bid document. In case Engineer-in-charge is not satisfied with the performance of any agency, he can direct the contractor to change the agency executing such items of work and this shall be binding on the contractor. |
| | 19.1.6 | The main contractor has to enter into agreement with contractor(s) associated agency by him for execution of E&M work. This agreement must contain terms and conditions of payment between the main contractor and associate contractor. Copy of such agreement shall be submitted to Engineer-in-Charge. In case of change of associate contractor, the main contractor has to enter into agreement with the new contractor associated by him with prior approval of Engineer-in-charge. |
| | 19.1.7 | Running payment for the work shall be made by SAU to the main contractor. In case main contractor fails to make the payment to contractor associated by him for E&M component within 15 days of receipt of each running account payment then on the written complain of the contractor associated for such E&M component , SAU shall serve show cause notice to main contractor and after considering the reply of the same he may make payment directly to the contractor associated for E&M component as per terms and conditions of the agreement drawn between main contractor and the associated contractor for the minor component. |
| | 19.1.8 | The work shall be treated as complete when all the components of the work are complete, commissioned and handed over to SAU. The Completion Certificate of the work shall be recorded by Engineer in charge of the rank not less than Executive Engineer. |
| | 19.1.9 | The agency must read carefully Section I: Brief Particulars of work and Section II: Guideline for bidders. |
| | 19.1.10 | The contract has a portion of operation and maintenance up to 5 years as detailed in the tender documents: After successful completion of construction work, the main agreement shall be closed and a supplementary agreement will be executed between the bidder and SAU for operation and maintenance work. |
| | 19.1.11 | SAU has already awarded the construction of Package-II buildings at Maidan Grahi. The High side works of Package-II are included in this Package. The bidder has to coordinate with package-II contractor for integrating these services. |

## 3.4 Form of Earnest Money Deposit (Bank Guarantee Bond)

WHEREAS, contractor..... (**Name of contractor**) (hereinafter called "the contractor") has submitted his tender dated ..... (date) for the construction of ..... (**name of work**) (hereinafter called "the Tender")

KNOW ALL PEOPLE by these presents that we ..... registered office at ..... (hereinafter called "the Bank") are bound unto **South Asian University , New Delhi** in the sum of Rs. ..... (Rs. in words .....) for which payment well and truly to be made to the said **SAU, New Delhi** the Bank binds itself, his successors and assigns by these presents.

SEALED with the Common Seal of the said Bank this ..... day of ..... 20.... THE CONDITIONS of this obligation are:

(1) If after opening of tender; the Contractor withdraws, his tender during the period of validity of tender (including extended validity of tender) specified in the Form of Tender;

(2) If the contractor having been notified of the acceptance of his tender by the **SAU, New Delhi**

(a) fails or refuses to execute the Form of Agreement in accordance with the Instructions to contractor, if required;

OR

(b) fails or refuses to furnish the Performance Guarantee, in accordance with the provisions of tender document and Instructions to contractor,

OR

(c) fails or refuses to start the work, in accordance with the provisions of the contract and Instructions to contractor,

OR

(d) fails or refuses to submit fresh Bank Guarantee of an equal amount of this Bank Guarantee, against Security Deposit after award of contract.

We undertake to pay to the **SAU, New Delhi** either up to the above amount or part thereof upon receipt of his first written demand, without **SAU, New Delhi** having to substantiates his demand, provided that in his demand **SAU, New Delhi** will note that the amount claimed by him is due to him owing to the occurrence of one or any of the above conditions, specifying the occurred condition or conditions.

This Guarantee will remain in force up to and including the date* ..... after the deadline for submission of tender as such deadline is stated in the Instructions to contractor or as it may be extended by **SAU, New Delhi**, notice of which extension(s) to the Bank is hereby waived. Any demand in respect of this Guarantee should reach the Bank not later than the above date.

DATE ..... SIGNATURE OF THE BANK

WITNESS ..... SEAL

(SIGNATURE, NAME AND ADDRESS)

*Date to be worked out on the basis of validity period of 6 months from last date of receipt of tender.

# 3.5 INTEGRITY PACT

To,

M/s XXX
( Name and Address of Contractor)

Sub: **NIT No. 09/NIT/SAU-9A/2016 for the work of Construction of South Asian University Campus at Maidan Garhi New Delhi. Package-III, (i) Administration Building (ii) Library Building (iii) Institute of South Asian Studies and Interdisciplinary Research (iv) Faculty of Law and Humanities (v) Faculty of Physics, Chemistry, Maths and I.T. (vi) Faculty of Art & Design and Convention Centre (vii) Utility Building: Including Basements, Superstructures, Interior Finishes, Internal Water Supply, Sanitary Installations, Drainage, Internal Electrical Installations, HVAC, Lifts, Fire Fighting System, Low Voltage System ; PA System, Solar Water Heating System etc. External Site Development and Infrastructure; Roads, Street Lighting, Sewerage, Storm Water Drainage, STP, WTP, Water Supply, HT & LT Power Distribution, Electrical Substation, Chiller Plant, Pump House, D.G. Sets, Rainwater Harvesting, Hardscaping etc.**

Dear Sir,

It is here by declared that South Asian University is committed to follow the principle of transparency, equity and competitiveness in public procurement.

The subject Notice Inviting Tender (NIT) is an invitation to offer made on the condition that the Bidder will sign the integrity Agreement, which is an integral part of tender/bid documents, failing which the tenderer/bidder will stand disqualified from the tendering process and the bid of the bidder would be summarily rejected.

This declaration shall form part and parcel of the Integrity Agreement and signing of the same shall be deemed as acceptance and signing of the Integrity Agreement on behalf of the SAU.

Yours faithfully

The Registrar,
South Asian University
Akbar Bhawan, Chanakyapuri,
New Delhi – 110021

# 3.6 INTEGRITY PACT

To,
The Registrar,
South Asian University
Akbar Bhawan, Chanakyapuri,
New Delhi – 110021

Sub: **NIT No. 09/NIT/SAU-9A/2016, Submission of Tender for the work of Construction of South Asian University Campus at Maidan Garhi New Delhi. Package-III (i) Administration Building (ii) Library Building (iii) Institute of South Asian Studies and Interdisciplinary Research (iv) Faculty of Law and Humanities (v) Faculty of Physics, Chemistry, Maths and I.T. (vi) Faculty of Art & Design and Convention Centre (vii) Utility Building: Including Basements, Superstructures, Interior Finishes, Internal Water Supply, Sanitary Installations, Drainage, Internal Electrical Installations, HVAC, Lifts, Fire Fighting System, Low Voltage System ; PA System, Solar Water Heating System etc. External Site Development and Infrastructure; Roads, Street Lighting, Sewerage, Storm Water Drainage, STP, WTP, Water Supply, HT & LT Power Distribution, Electrical Substation, Chiller Plant, Pump House, D.G. Sets, Rainwater Harvesting, Hardscaping etc.**

Dear Sir,

I/We acknowledge that South Asian University is committed to follow the principles thereof as enumerated in the Integrity Agreement enclosed with the tender/bid document.

I/We agree that the Notice Inviting Tender (NIT) is an invitation to offer made on the condition that I/We will sign the enclosed integrity Agreement, which is an integral part of tender documents, failing which I/We will stand disqualified from the tendering process.

I/We acknowledge that THE MAKING OF THE BID SHALL BE REGARDED AS AN UNCONDITIONAL AND ABSOLUTE ACCEPTANCE of this condition of the NIT.

I/We confirm acceptance and compliance with the Integrity Agreement in letter and spirit and further agree that execution of the said Integrity Agreement shall be separate and distinct from the main contract, which will come into existence when tender/bid is finally accepted by South Asian University. I/We acknowledge and accept the duration of the Integrity Agreement, which shall be in the line with Article 1 of the enclosed Integrity Agreement.

I/We acknowledge that in the event of my/our failure to sign and accept the Integrity Agreement, while submitting the tender/bid, South Asian University shall have unqualified, absolute and unfettered right to disqualify the tenderer/bidder and reject the tender/bid is accordance with terms and conditions of the tender/bid.

Yours faithfully
(Duly authorized signatory of the Bidder)

# 3.7 INTEGRITY AGREEMENT

This Integrity Agreement is made at ..... on this ..... day of ..... 20.....

**BETWEEN**

President, South Asian University represented through Registrar, South Asian University, Akbar Bhawan, Chanakyapuri, New Delhi – 110021, SAU, (Hereinafter referred as the **'Principal/Owner',** which expression shall unless repugnant to the meaning or context hereof include its successors and permitted assigns)

**AND**

**M/s XXX,** (name and address of contractor) , through ..... (Hereinafter referred to as the (Details of duly authorized signatory)
**"Bidder/Contractor"** and which expression shall unless repugnant to the meaning or context hereof include its successors and permitted assigns)

**Preamble**

WHEREAS the Principal / Owner has floated the Tender (NIT No. 09/NIT/SAU-9A/2016) (hereinafter referred to as "Tender/Bid") and intends to award, under laid down organizational procedure, contract for Construction of South Asian University Campus at Maidan Garhi, New Delhi. Package-III: (i) Administration Building (ii) Library Building (iii) Institute of South Asian Studies and Interdisciplinary Research (iv) Faculty of Law and Humanities (v) Faculty of Physics, Chemistry, Maths and I.T. (vi) Faculty of Art & Design and Convention Centre (vii) Utility Building: Including Basements, Superstructures, Interior Finishes, Internal Water Supply, Sanitary Installations, Drainage, Internal Electrical Installations, HVAC, Lifts, Fire Fighting System, Low Voltage System ; PA System, Solar Water Heating System etc. External Site Development and Infrastructure; Roads, Street Lighting, Sewerage, Storm Water Drainage, STP, WTP, Water Supply, HT & LT Power Distribution, Electrical Substation, Chiller Plant, Pump House, D.G. Sets, Rainwater Harvesting, Hardscaping etc. hereinafter referred to as the "Contract".

AND WHEREAS the Principal/Owner values full compliance with all relevant laws of the land, rules, regulations, economic use of resources and of fairness/transparency in its relation with its Bidder(s) and Contractor(s).
AND WHEREAS to meet the purpose aforesaid both the parties have agreed to enter into this Integrity Agreement (hereinafter referred to as "Integrity Pact" or "Pact"), the terms and conditions of which shall also be read as integral part and parcel of the Tender/Bid documents and Contract between the parties.

NOW, THEREFORE, in consideration of mutual covenants contained in this Pact, the parties hereby agree as follows and this Pact witnesses as under:

**Article 1: Commitment of the Principal/Owner**
(1) The Principal/Owner commits itself to take all measures necessary to prevent corruption and to observe the following principles:

(a) No employee of the Principal/Owner, personally or through any of his/her family members, will in Connection with the Tender, or the execution of the Contract, demand, take a promise for or accept, for self or third person, any material or immaterial benefit which the person is not legally entitled to.

(b) The Principal/Owner will, during the Tender process, treat all Bidder(s) with equity and reason. The Principal/Owner will, in particular, before and during the Tender process, provide to all Bidder(s) the same information and will not provide to any Bidder(s) confidential / additional information through which the Bidder(s) could obtain an advantage in relation to the Tender process or the Contract execution.

(c) The Principal/Owner shall endeavour to exclude from the Tender process any person, whose

conduct in the past has been of biased nature.

(2) If the Principal/Owner obtains information on the conduct of any of its employees which is a criminal offence under the Indian Penal code (IPC)/Prevention of Corruption Act, 1988 (PC Act) or is in violation of the principles herein mentioned or if there be a substantive suspicion in this regard, the Principal/Owner will inform the Chief Vigilance Officer and in addition can also initiate disciplinary actions as per its internal laid down policies and procedures.

**Article 2: Commitment of the Bidder(s)/Contractor(s)**

(1) It is required that each Bidder/Contractor (including their respective officers, employees and agents) adhere to the highest ethical standards, and report to the Government / Department all suspected acts of fraud or corruption or Coercion or Collusion of which it has knowledge or becomes aware, during the tendering process and throughout the negotiation or award of a contract.

(2) The Bidder(s)/Contractor(s) commits himself to take all measures necessary to prevent corruption. He commits himself to observe the following principles during his participation in the Tender process and during the Contract execution:

(a) The Bidder(s)/Contractor(s) will not, directly or through any other person or firm, offer, promise or give to any of the Principal/Owner's employees involved in the Tender process or execution of the Contract or to any third person any material or other benefit which he/she is not legally entitled to, in order to obtain in exchange any advantage of any kind whatsoever during the Tender process or during the execution of the Contract.
(b) The Bidder(s)/Contractor(s) will not enter with other Bidder(s) into any undisclosed agreement or understanding, whether formal or informal. This applies in particular to prices, specifications, certifications, subsidiary contracts, submission or non-submission of bids or any other actions to restrict competitiveness or to cartelize in the bidding process.

(c) The Bidder(s)/Contractor(s) will not commit any offence under the relevant IPC/PC Act. Further the Bidder(s)/Contract(s) will not use improperly, (for the purpose of competition or personal gain), or pass on to others, any information or documents provided by the Principal/Owner as part of the business relationship, regarding plans, technical proposals and business details, including information contained or transmitted electronically.

(d) The Bidder(s)/Contractor(s) of foreign origin shall disclose the names and addresses of agents/
representatives in India, if any. Similarly Bidder(s)/Contractor(s) of Indian Nationality shall disclose names and addresses of foreign agents/representatives, if any. Either the Indian agent on behalf of the foreign principal or the foreign principal directly could bid in a tender but not both. Further, in cases where an agent participate in a tender on behalf of one manufacturer, he shall not be allowed to quote on behalf of another manufacturer along with the first manufacturer in a subsequent/parallel tender for the same item.

(e) The Bidder(s)/Contractor(s) will, when presenting his bid, disclose any and all payments he has made, is committed to or intends to make to agents, brokers or any other intermediaries in connection with the award of the Contract.

(3) The Bidder(s)/Contractor(s) will not instigate third persons to commit offences outlined above or be an accessory to such offences.

(4) The Bidder(s)/Contractor(s) will not, directly or through any other person or firm indulge in fraudulent practice means a willful misrepresentation or omission of facts or submission of fake/forged documents in order to induce public official to act in reliance thereof, with the purpose of obtaining unjust advantage by or causing damage to justified interest of others and/or to influence the procurement process to the detriment of the Government interests.

(5) The Bidder(s)/Contractor(s) will not, directly or through any other person or firm use Coercive Practices (means the act of obtaining something, compelling an action or influencing a decision through intimidation, threat or the use of force directly or indirectly, where potential or actual

injury may befall upon a person, his/ her reputation or property to influence their participation in the tendering process).

**Article 3: Consequences of Breach**

Without prejudice to any rights that may be available to the Principal/Owner under law or the Contractor its established policies and laid down procedures, the Principal/Owner shall have the following rights in case of breach of this Integrity Pact by the Bidder(s)/Contractor(s) and the Bidder/ Contractor accepts and undertakes to respect and uphold the Principal/Owner's absolute right:

(1) If the Bidder(s)/Contractor(s), either before award or during execution of Contract has committed a
transgression through a violation of Article 2 above or in any other form, such as to put his reliability
or credibility in question, the Principal/Owner after giving 14 days' notice to the contractor shall have powers to disqualify the Bidder(s)/Contractor(s) from the Tender process or terminate/determine the contract, if already executed or exclude the Bidder/Contractor from future contract award processes.

The imposition and duration of the exclusion will be determined by the severity of transgression and determined by the Principal/Owner. Such exclusion may be forever or for a limited period as decided by the Principal/Owner.

(2) Forfeiture of EMD/Performance Guarantee/Security Deposit: If the Principal/Owner has disqualified the Bidder(s) from the Tender process prior to the award of the Contract or terminated/determined the Contract or has accrued the right to terminate/determine the Contract according to Article 3(1), the Principal/Owner apart from exercising any legal rights that may have accrued to the Principal/Owner, may in its considered opinion forfeit the entire amount of Earnest Money Deposit, Performance Guarantee and Security Deposit of the Bidder/Contractor.

(3) Criminal Liability: If the Principal/Owner obtains knowledge of conduct of a Bidder or Contractor, or of an employee or a representative or an associate of a Bidder or Contractor which constitutes corruption within the meaning of IPC Act, or if the Principal/Owner has substantive suspicion in this regard, the Principal/Owner will inform the same to law enforcing agencies for further investigation.

**Article 4: Previous Transgression**

(1) The Bidder declares that no previous transgressions occurred in the last 5 years with any other Company in any country confirming to the anticorruption approach or with Central Government or State Government or any other Central/State Public Sector Enterprises in India that could justify his exclusion from the Tender process.

(2) If the Bidder makes incorrect statement on this subject, he can be disqualified from the Tender process or action can be taken for banning of business dealings/ holiday listing of the Bidder/Contractor as deemed fit by the Principal/ Owner.

(3) If the Bidder/Contractor can prove that he has resorted / recouped the damage caused by him and has installed a suitable corruption prevention system, the Principal/Owner may, at its own discretion, revoke the exclusion prematurely.

**Article 5: Equal Treatment of all Bidders/Contractors/Subcontractors**

(1) The Bidder(s)/Contractor(s) undertake(s) to demand from all subcontractors a commitment in conformity with this Integrity Pact. The Bidder/Contractor shall be responsible for any violation(s) of the principles laid down in this agreement/Pact by any of its Subcontractors/sub-vendors.

(2) The Principal/Owner will enter into Pacts on identical terms as this one with all Bidders and Contractors.

(3) The Principal/Owner will disqualify Bidders, who do not submit, the duly signed Pact between

the Principal/Owner and the bidder, along with the Tender or violate its provisions at any stage of the Tender process, from the Tender process.

**Article 6- Duration of the Pact**
This Pact begins when both the parties have legally signed it. It expires for the Contractor/Vendor 12 months after the completion of work under the contract or till the continuation of defect liability period, whichever is more and for all other bidders, till the Contract has been awarded. If any claim is made/lodged during the time, the same shall be binding and continue to be valid despite the lapse of this Pacts as specified above, unless it is discharged/determined by the Competent Authority, SAU.

**Article 7- Other Provisions**
(1) This Pact is subject to Indian Law, place of performance and jurisdiction is the Headquarters of the Division of the Principal/Owner, who has floated the Tender.

(2) Changes and supplements need to be made in writing. Side agreements have not been made.

(3) If the Contractor is a partnership or a consortium, this Pact must be signed by all the partners or by one or more partner holding power of attorney signed by all partners and consortium members. In case of a Company, the Pact must be signed by a representative duly authorized by board resolution.

(4) Should one or several provisions of this Pact turn out to be invalid; the remainder of this Pact remains valid. In this case, the parties will strive to come to an agreement to their original intensions.

(5) It is agreed term and condition that any dispute or difference arising between the parties with regard to the terms of this Integrity Agreement / Pact, any action taken by the Owner/Principal in accordance with this Integrity Agreement/ Pact or interpretation thereof shall not be subject to arbitration.

**Article 8- LEGAL AND PRIOR RIGHTS**
All rights and remedies of the parties hereto shall be in addition to all the other legal rights and remedies belonging to such parties under the Contract and/or law and the same shall be deemed to be cumulative and not alternative to such legal rights and remedies aforesaid. For the sake of brevity, both the Parties agree that this Integrity Pact will have precedence over the Tender/Contact documents with regard any of the provisions covered under this Integrity Pact.

IN WITNESS WHEREOF the parties have signed and executed this Integrity Pact at the place and date first above mentioned in the presence of following witnesses:

.....
(For and on behalf of Principal/Owner)

.....
(For and on behalf of Bidder/Contractor)

WITNESSES:
1. .....
(signature, name and address)

2. .....
(signature, name and address)
Place:
Dated :

## 3.8 SAU CONTRACT AGREEMENT ( Format )

This agreement made this day of **XX Month XX , Year XXXX**, between the **South Asian University**, established through the South Asian University Act 2008 (No. 8 of 2009 dated 11th January 2009) by the Republic of India, having its office at Akbar Bhawan, Chanakyapuri, New Delhi 110021 (hereinafter referred to as the **"the Employer"** which expression shall include its administrators, successors, executors and assigns) of the one part, and **XXXXX** (hereinafter referred to as the 'Contractor' which expression shall unless the context requires otherwise include its administrators, successors, executors and permitted assigns) of the other part.

WHEREAS, SOUTH ASIAN UNIVERSITY, is desirous of "**Construction of South Asian University Campus at Maidan Garhi, New Delhi. Package-III: (i) Administration Building (ii) Library Building (iii) Institute of South Asian Studies and Interdisciplinary Research (iv) Faculty of Law and Humanities (v) Faculty of Physics, Chemistry, Maths and I.T. (vi) Faculty of Art & Design and Convention Centre (vii) Utility Building: Including Basements, Superstructures, Interior Finishes, Internal Water Supply, Sanitary Installations, Drainage, Internal Electrical Installations, HVAC, Lifts, Fire Fighting System, Low Voltage System ; PA System, Solar Water Heating System etc. External Site Development and Infrastructure; Roads, Street Lighting, Sewerage, Storm Water Drainage, STP, WTP, Water Supply, HT & LT Power Distribution, Electrical Substation, Chiller Plant, Pump House, D.G. Sets, Rainwater Harvesting, Hardscaping etc."** (hereinafter referred to as the "**PROJECT or the WORK**") and has accepted a tender submitted by the contractor for the execution and completion of such work/ Project and the remedying of defects there in as per condition of contract.

This agreement is signed between **Dr. A K Malik, Registrar, SAU** (for and on behalf of the employer ) and **XXXX** (Authorized Signatory of Contractor) for and on behalf of the contractor.

NOW THEREFORE THIS DEED WITNESSETH AS UNDER:

### ARTICLE 1.0 – AWARD OF CONTRACT

### 1.1 SCOPE OF WORK

"**Construction of South Asian University Campus at Maidan Garhi, New Delhi. Package-III: (i) Administration Building (ii) Library Building (iii) Institute of South Asian Studies and Interdisciplinary Research (iv) Faculty of Law and Humanities (v) Faculty of Physics, Chemistry, Maths and I.T. (vi) Faculty of Art & Design and Convention Centre (vii) Utility Building: Including Basements, Superstructures, Interior Finishes, Internal Water Supply, Sanitary Installations, Drainage, Internal Electrical Installations, HVAC, Lifts, Fire Fighting System, Low Voltage System ; PA System, Solar Water Heating System etc. External Site Development and Infrastructure; Roads, Street Lighting, Sewerage, Storm Water Drainage, STP, WTP, Water Supply, HT & LT Power Distribution, Electrical Substation, Chiller Plant, Pump House, D.G. Sets, Rainwater Harvesting, Hardscaping etc."**as per the terms and conditions of the agreement / contract.

In this agreement, words and expression shall have the same meaning as the respectively assigned to them in the condition of contract herein after referred to.

### ARTICLE 2.0 – CONTRACT DOCUMENTS

2.1 The contract shall be performed strictly as per the terms and conditions stipulated herein and in the following documents attached herewith (hereinafter referred to as "Contract Documents").

**a)** Agreement Form
**b)** Letter of Acceptance
**c)** Letter of Commencement of Works duly accepted by the contractor.
**d)** Integrity Pact

**e)** Integrity Agreement

**f)** Tender Document Published on www.tenderwizard.com/SAU,www.sau.int, & www.eprocurement.gov.in .consisting of:

- **PART A : TECHNICAL / ELIGIBILITY BID**
- **PART- B : SPECIAL, ADDITIONAL CONDITIONS AND PARTICULAR SPECIFICATIONS**
- **PART-C - SCHEDULE OF QUANTITIES**
- CPWD GCC 2014 with up to date correction slip issued up to date of uploading the tender by SAU. shall be deemed to be part of agreement. (Term SE, CE, ADG, wherever mentioned in the GCC may be read as "appropriate authority in South Asian University, New Delhi")
- Tender Drawings uploaded on website shall be deemed to be part of agreement.

**g)** Any Corrigendum/amendment issued by SAU

**h)** Minutes of Pre-bid Meeting

**i)** Financial Bid Downloaded from www.tenderwizard.com/SAU

**j)** Documents uploaded by the contractor and other correspondence with SAU.

**k)** Contractors Acceptance/ Performance Bank Guarantee

**l)** Power of Attorney document submitted by contractor

**ARTICLE 3.0 – CONDITIONS & COVENANTS**

3.1 The scope of work shall also include all such items which are not specifically mentioned in the Contract Documents and drawings but which are reasonably implied for satisfactory completion of the entire scope of work envisaged under this contract unless otherwise specifically excluded from the scope of work in the Letter of acceptance and Letter of Commencement.

3.2 Contractor shall adhere to all requirements stipulated in the Contract documents.

3.3 Time is the essence of the Contract and it shall be strictly adhered to. The progress of work shall conform to agreed works schedule/contract documents.

3.4 The rates and prices quoted include all constructional plant, labour, supervision, materials, erection, maintenance, Insurance, profit etc. together with all the general risks, liabilities and obligations set out or implied in the contract.

3.5 The contractor shall adhere to all Labour Laws of Government and as per Contract Documents.

3.6 The total contract price for the entire scope of this contract as detailed in Letter of Acceptance is Rs.XXX (Rupees XXXX only), which shall be governed by the stipulations of the contract documents.

**ARTICLE 4.0 – Settlement of Disputes and Arbitration**

4.1 Settlement of dispute and Arbitration shall be governed as per clause 25 of General Conditions of Contract.

**5.0 Obligation of the Contractor:**

5.1 The contractor shall ensure full compliance with tax laws of India with regard to this contract and shall be solely responsible for the same. The contractor shall submit copies of acknowledgements evidencing filing of returns every year and shall keep the Employer fully indemnified against liability of tax, interest, penalty etc. of the contractor in respect thereof, which may arise.

## 6.0 Notice of Default

6.1 Notice of default given by either party to the other party under the Agreement shall be in writing and shall be deemed to have been duly and properly served upon the parties hereto, if delivered against acknowledgment due or by FAX or by registered mail duly addressed to the signatories at the address mentioned herein above.

IN WITNESS WHEREOF, the parties through their duly authorized representatives have executed this deed (execution whereof has been approved by the Competent Authorities of both the parties) on the day, month and year mentioned in first para above at New Delhi.

| | |
|---|---|
| Binding Signature of the Contractor | Binding signature of the Owner |
| (XXX ) | ( XXX)<br>Registrar |
| For and on behalf of: | For and on behalf of: |
| **(Contractor.)** | **M/s SOUTH ASIAN UNIVERSITY** |
| WITNESS: | WITNESS: |
| 1. | 1. |
| 2. | 2. |

## 3.9 FORM OF SUPPLEMENTARY AGREEMENT

As per APPENDIX – 26 of CPWD manual

This Agreement made this day the …… 20 ….. between…… hereinafter called the First Party which expression shall include his heirs, executors and administrators/their successors and assigns and the President, SAU, hereinafter called the Second Party, which expression shall include his successors and assigns, shown as under :

(1) That this Agreement shall be called as Supplementary Agreement to the Agreement No **09/NIT/SAU-9A/2016** relating to the construction of …... entered into by the parties to this Agreement.

(2) That WHEREAS the First Party has substantially completed the execution of the work described in and covered by the Agreement No. **09/NIT/SAU-9A/2016** except the items mentioned in the Schedule annexed to this Agreement and whereas the items of the work mentioned in the Schedule annexed to this agreement cannot be executed now as it is spread over five years beyond completion date stipulated in main agreement; and whereas both the parties are desirous that the items mentioned in the Schedule annexed to this Agreement should be executed by the First Party in accordance with conditions attached with, it is hereby further agreed as under :

(a) That First Party shall and will execute the work covered by the items mentioned in the Schedule annexed to this Agreement at the rates and as per the terms and conditions of the original Agreement No **09/NIT/SAU-9A/2016** whatsoever called upon to do so by the Engineer-in-charge, within a period of five year from the date hereof.

(b) That the First Party shall have absolutely no claim of whatsoever nature against the Second Party for doing the work mentioned in the Schedule annexed to this Agreement as required under clause (a) above, except that which he would be entitled to under the original Agreement No. **09/NIT/SAU-9A/2016**

(c) That the First Party shall have to execute all the items which the Engineer-in-charge consider necessary for successful completion of this agreement

(d) That the First Party shall start with the work of the remaining items mentioned in the Schedule annexed to this Agreement within 05 days from ….. execution of this contract or from any date fixed in by the Engineer-in-charge and shall complete the said work within the time fixed by the Engineer-in-charge or as extended by him from time to time.

(e) That on the due execution and completion of this Agreement by the parties, the bill of the First Party in relation to the work already done by him under the Original Agreement No. **09/NIT/SAU-9A/2016** shall be provisionally finalized by the Second Party and payment on account, if any amount due, shall be made to the First Party provided that the Second Party shall have a right to retain such amount as is considered reasonable by him **as a security for the execution of the work mentioned in the Schedule annexed to this Agreement** and the Second Party shall have right to deal with the said amount of security as he thinks proper under the terms and conditions of the Original Agreement. Further, on the due execution and original completion of this Agreement, the First Party shall be entitled to claim back his security deposit relating to the work in question as per terms and conditions of contract subject to the right of the Second Party to retain such amount as he thinks reasonable as mentioned above, as the case may be mentioned in clause of the Original Agreement, is over.

(3) That the final bill relating to main work already completed shall be prepared and paid to the First Party as and when submitted and accepted. The bills for items covered under Supplementary Agreement shall be processed and paid separately. Except as modified by this Agreement the said Agreement No. **09/NIT/SAU-9A/2016** Shall remain in full force and effect.

IN WITNESS WHERE OF THE ABOVE MENTIONED PARTIES HAVE PUT THEIR SIGNATURE ON THIS DAY THE…….

| | |
|---|---|
| Binding Signature of the Contractor | Binding signature of the Owner |
| (XXX ) | ( XXX)<br>Registrar |
| For and on behalf of: | For and on behalf of: |
| **(Contractor.)** | **SOUTH ASIAN UNIVERSITY** |
| WITNESS: | WITNESS: |
| 1. | 1. |
| 2. | 2. |

# 4.0 ELIGIBILITY CRITERIA

## 4.1 SECTION-I BRIEF PARTICULARS OF THE WORK

1. Salient details of the work for which bids are invited are as under:

| | | |
|---|---|---|
| **Name of work** | **:** | **Construction of South Asian University Campus at Maidan Garhi, New Delhi. Package-III: (i) Administration Building (ii) Library Building (iii) Institute of South Asian Studies and Interdisciplinary Research (iv) Faculty of Law and Humanities (v) Faculty of Physics, Chemistry, Maths and I.T. (vi) Faculty of Art & Design and Convention Centre (vii) Utility Building: Including Basements, Superstructures, Interior Finishes, Internal Water Supply, Sanitary Installations, Drainage, Internal Electrical Installations, HVAC, Lifts, Fire Fighting System, Low Voltage System ; PA System, Solar Water Heating System etc. External Site Development and Infrastructure; Roads, Street Lighting, Sewerage, Storm Water Drainage, STP, WTP, Water Supply, HT & LT Power Distribution, Electrical Substation, Chiller Plant, Pump House, D.G. Sets, Rainwater Harvesting, Hardscaping etc.** |
| **Estimated Cost** | **:** | **Rs. 638,89,18,337/-** |
| **Period of Completion** | **:** | **36 Months** |

| | | |
|---|---|---|
| 2 | | This tender is invited for the Construction of South Asian University Campus at Maidan Garhi New Delhi, as detailed above in the name of work. The project is planned with modern building concepts and technology and aims to achieve 5 Star GRIHA rating for Large Development (LD). |
| 3 | | The site for South Asian University is located in Maidan Garhi Village, New Delhi near village Rajpur Khurd and is accessed from the Chattarpur-Fatehpur Beri Road. |
| 4 | | Entire campus of South Asian University is planned to be constructed in four packages.<br>Package-I (Boundary wall and temporary office building) has already completed; Construction of Package-2 Buildings is in progress at site of work. The proposed construction is primarily planned to be RCC Framed Structures with AAC Block Masonry Infill walls. |
| 5 | | Particulars of Buildings to be constructed in this Package-III of SAU campus is as under: |

| S. No. | Building | No. of Blocks | Structure | Total Built up Area in Sq. M. (Approx) |
|---|---|---|---|---|
| i) | Administration (AD1) | 1 | RCC Framed Structure, AAC Block Masonry Walls, **B+G+5** | 13,618 |
| ii) | Faculty of Physics Chemistry Maths and I.T. (AC3) | 1 | RCC Framed Structure, AAC Block Masonry Walls, Precast Concrete Elements **B+G+4** | 29,465 |
| iii) | Faculty of Law and Humanities (AC4) | 1 | RCC Framed Structure, AAC Block Masonry Walls, Precast Concrete Elements **B+G+3** | 25764 |
| iv) | Institute of South Asian Studies and Interdisciplinary Research Centre (AC9) - | 1 | RCC Framed Structure, AAC Block ,Masonry Walls **B+G+7** | 9,682 |

| | | | | |
|---|---|---|---|---|
| v) | Faculty of Art & Design and Convention Centre (AC1+C1) | 1 | RCC Framed Structure, AAC Block Masonry Walls **B+G+5** | 36,518 |
| vi) | Library (L1) | 1 | RCC Framed Structure, AAC Block Masonry Walls **B+G+5** | 14,631 |
| vii) | Utility Building (U1) | 1 | RCC Framed Structure, Brick Masonry Walls **B+G** | 3,463 |
| viii) | External Development | | Roads, Street Lighting, Sewerage, Storm Water Drainage, STP, WTP, Water Supply, Rainwater Harvesting and Hardscaping etc. | 42 Acre |
| ix) | High Side work of Package-II buildings: Faculty of Life Science and Earth Science, Faculty Housing, Faculty Club and Guest House and Package III Buildings | | HT & LT Power Distribution, Fire Fighting System ,Electrical Substation, HVAC-Chiller Plant, Pump House, D.G. Sets, etc. | |

| | | |
|---|---|---|
| 5.1 | | **The general features and components of composite work are as under: These are indicative, the bidder must see the complete tender document for complete scope of work -** |
| | i) | RCC Frame Structure with AAC Block masonry infill Walls. |
| | ii) | External finishing is combination of stone cladding , cement plaster and textured paint. |
| | iii) | Structural glazing with double glass. |
| | iv) | External/ Internal glazing with extruded Aluminum. |
| | v) | Factory Fabricated Metal Fire Doors and Metal Doors. |
| | vi) | Combination of granite, kota, vitrified tiles, CC Flooring. |
| | vii) | False ceiling of gypsum, mineral fiber, Metal etc. |
| | viii) | Finishing with premixed formulated gypsum lightweight plaster/ Cement Plaster |
| | ix) | Wall painting with premium acrylic emulsion paint of interior grade, having Low VOC |
| | x) | GRC work |
| | xi) | Plumbing Works |
| | xii) | Internal Electrical Installation including light fittings |
| | xiii) | HVAC – Internal Ducting, Piping, AHU |
| | xiv) | HVAC – VRF System |
| | xv) | Fire Fighting & Fire alarm system |
| | xvi) | Lifts |
| | xvii) | Conduits for Data Network and telephones/ TV etc. |
| | xviii) | Solar water heating system |
| | xix) | HVAC Water Cooled Chiller Plant |
| | xxii) | DG Sets |
| | xxiii) | Water Pumping Station |
| | xxiv) | External Chilled Water Piping, MS Fire Header Piping, Water Supply Piping, LT & HT Cabling, LV Network Cabling and Wiring, Sewerage & Storm Water Piping, Rainwater Harvesting, STP, WTP, ETP etc. |
| | xxv) | Electrical Substation ( 66 Kv ) |
| | xxvi) | External Development like Road work, Drainage, Hard Paving etc. |

| | | |
|---|---|---|
| | 5.2 | Work shall be executed according to General Conditions of Contract for Central PWD works (CPWD, GCC 2014) available separately at printer's outlets. The bidder may obtain the address of the outlets from the Engineer-in-Charge. |
| | 5.3 | The Soil report, location plan, plans & elevations are available for inspection in the office of the Executive Engineer, South Asian University, Akbar Bhawan New Delhi-21 on any working day between 10 AM to 4 PM and main architectural drawings are part of tender document uploaded in two websites as specified. |
| | 5.4 | The employer reserves the right to increase or decrease the scope of work before or after the award of work without assigning any reason to the bidder/ contractor. No claim on any account whatsoever in this regard shall be entertained by the employer. |

## 4.2 SECTION II GUIDELINES FOR BIDDERS ( Information and instruction to the bidder)

| | | |
|---|---|---|
| 1.0 | | **GENERAL:** |
| | 1.1 | Letter of Transmittal and forms for deciding eligibility are given in Section III. It should be uploaded along with all other tender documents. |
| | 1.2 | All information called for in the enclosed forms should be furnished against the relevant columns in the forms. If for any reason, information is furnished on a separate sheet, this fact should be mentioned against the relevant columns. Even if no information is to be provided in a column, a "nil" or "no such case" entry should be made in that column. If any particular/query is not applicable in case of the bidder, it should be stated as "not applicable". The bidders are cautioned that not giving complete information called for in the application forms or not giving it in clear terms or making any change in the prescribed forms or deliberately suppressing the information may result in the bid being summarily rejected. Bids made by telegram or telex and including those received late will not be entertained. |
| | 1.3 | References, information and certificates from the respective clients certifying suitability, technical knowledge or capability of the bidder should be signed by an officer not below the rank of Executive Engineer. |
| | 1.4 | The bidder may furnish any additional information which he thinks is necessary to establish his capabilities to successfully complete the envisaged work. **He is, however, advised not to furnish superfluous information**. No information shall be entertained after uploading of eligibility criteria document unless it is called for by SAU. |
| | 1.5 | The applicant must submit information of on-going litigations and litigations he has had in the past seven years. In the event that the applicant has no litigations either in process or in the past seven years, an affidavit to this effect, duly notarized must be submitted in original. |
| | 1.6 | **The credentials submitted in respect of prequalification for tender by the bidder may be verified if necessary, before opening of the financial bid. Any information furnished by the bidder found to be incorrect either immediately or at a later date, would render him disqualified and liable for forfeiture of Earnest Money Deposit/ Performance Guarantee and shall be debarred from tendering/taking up of works in SAU.** |
| | 1.7 | The bidder should not have been black listed by any State/Central Government Department or PSU or Autonomous bodies. The applicant must submit a duly notarized affidavit to this effect. Applications received without this declaration shall stand automatically rejected. |
| | 1.8 | Overwriting should be avoided. Correction, if any, should be made by neatly crossing out, initiating, dating and rewriting, pages of the technical bid document are numbered. Additional sheets, if any added by the contractor, should also be numbered by him. They should be submitted as a package with signed letter of transmittal.<br>After opening of the Technical bids, Engineer-in-Charge/SAU shall prepare a list of deficiencies found in the bids of each bidder vis-à-vis requirements as per NIT within one week and send these lists to individual bidders by Speed Post/ e mail with a request to furnish required documents within one week of receipt, failing which it will be presumed that they do not have any further documents to furnish and decision on bids will be take accordingly. |
| **2.0** | | **DEFINITIONS:** |
| | 2.1 | In this document the following words and expressions have the meaning hereby assigned to them: |
| | 2.2 | **EMPLOYER:** Means the SAU, acting through the Engineer-in-Charge, **SAU, New Delhi or successor thereof.** |
| | 2.3 | **BIDDER:** Means the individual, proprietary firm, firm in partnership, limited company (private or public) or corporation. Joint ventures, consortium and Special Purpose Vehicles are not accepted as bidders. |

| | | |
|---|---|---|
| | 2.4 | **"Year"** means "Financial Year" unless stated otherwise. |
| | 2.5 | **"SAU"** means South Asian University, New Delhi |
| | 2.6 | **"Engineer - in - charge" means authorized representative of SAU or his successor thereof.** |
| | 2.7 | "PMC" means Project Management Consultant appointed by SAU for the above work. |
| | 2.8 | "PA" means Principal Architect appointed by SAU for the above work. |
| 3.0 | | **METHOD OF APPLICATION:** |
| | 3.1 | If the bidder is an individual, the application shall be signed by him above his full type written name and current address. |
| | 3.2 | If the bidder is a proprietary firm, the application shall be signed by the proprietor above his full typewritten name and the full name of his firm with its current address. |
| | 3.3 | If the bidder is a firm in partnership, the application shall be signed by all the partners of the firm above their full typewritten names and current address, or, alternatively, by a partner holding power of attorney for the firm. In the later case a certified copy of the power of attorney should accompany the application. In both cases a certified copy of the partnership deed and current address of all the partners of the firm should accompany the application. |
| | 3.4 | If the bidder is a limited company or a corporation, the application shall be signed by a duly authorized person holding power of attorney for signing the application accompanied by a copy of the power of attorney. The bidder should also furnish a copy of the Memorandum of Articles of Association duly attested by a Public Notary. |
| 4.0 | | **FINAL DECISION MAKING AUTHORITY** |
| | | The employer reserves the right to accept or reject any bid and to annul the process and reject all bids at any time without assigning any reason thereof or incurring any liability to the bidders. |
| 5.0 | | **PARTICULARS ARE PROVISIONAL** |
| | | The particulars of the work given in Section-I (Brief Particulars of work) are provisional. They are liable to change and must be considered only as advance information to assist the bidders. |
| 6.0 | | **SITE VISIT** |
| | | The bidder is advised to visit the site of work, at his own cost, and examine it and its surroundings to satisfy himself and collect all information that he considers necessary for proper assessment of the prospective assignment and for quoting his rates judiciously. |
| 7.0 | | **ELIGIBILITY CRITERIA (TECHNICAL / ELIGIBILITY BID)**<br>As per Para 3.1.2 (Eligibility Criteria) serial no. 1,2,3 . |
| 7.1 | | The bidder shall have to furnish an affidavit as under :<br>"I/We undertake and confirm that eligible similar work(s) has/have not been got executed through another contractor on back to back basis. Further that, if such a violation comes to the notice of SAU, then I/we shall be debarred from biding in SAU in future forever. Also, if such a violation comes to the notice of SAU before date of start of work, the Engineer-in-Charge shall be free to forfeit the entire amount of Earnest Money Deposit/Performance Guarantee." |
| 7.2 | | The main contractor should either himself meet the eligibility criteria as defined in the bid document (Same as described in 3.1 INFORMATION AND INSTRUCTIONS FOR BIDDERS FOR e-TENDERING (serial No.2) or he will have to Associate with an Agency for E&M package after award of work and has to submit details of at least three such agencies conforming eligibility condition to Engineer-in-charge within 60 days after award of work. Name of the agency(s) to be associated shall be approved by Engineer-in-charge. |

| | | |
|---|---|---|
| 7.3 | (i) | Components of work executed other than those included in definition of similar work shall be deducted while calculating cost of similar work. Bidder shall submit abstract of cost of work in support of this. |
| | (ii) | For the purpose, "Cost of work" shall mean gross value of the completed work including the cost of materials supplied by the Government/Client, but excluding those supplied free of cost. This should be certified by an officer not below the rank of Executive Engineer / Project Manager or equivalent. |
| | (iii) | The value of executed works shall be brought to current costing level by enhancing the actual value of work at simple rate of 7% per annum; calculated from the date of completion to last date of submission of bids. |
| 7.4 | | The bidder should own construction equipments as per list required for the proper and timely execution of the work. Else, he should certify that he would be able to manage the equipment by hiring etc., and submit the list of firms from whom he proposes to hire. |
| 7.5 | | The bidder's performance only for each eligible works completed in the last 7 (seven) years and in hand should be certified by an officer not below the rank of Executive Engineer or equivalent. |
| 7.6 | | The bidder should have sufficient number of Technical and Administrative employees for proper execution of the contract. The bidder should submit a list of these employees stating clearly how these would be involved in this work. |
| 8.0 | | **Evaluation Criteria for Eligibility (Technical Bid)** |
| | 8.1 | The Eligibility details submitted by the bidders will be evaluated in the following manner:- |
| | 8.1.1 | The criteria for eligibility prescribed in para 3.1.2 ( Eligibility Criteria) serial no. 1,2,3 in respect of experience of similar class of works completed, bidding capacity and financial turn over etc. will be first scrutinized and the bidder's eligibility for the work be determined. |
| | 8.1.2 | The SAU, however, reserves the right to restrict the list of bidders qualifying in technical bid evaluation to any number, as deemed suitable by it. |
| | 8.2 | Even though any bidder may satisfy the above requirements, he would be liable to disqualification if he has: |
| | 8.2.1 | Made misleading or false representation or deliberately suppressed the information in the forms, statements and enclosures required in the eligibility criteria document. |
| | 8.2.2 | Record of poor performance such as abandoning work, not properly completing the contract, or financial failures / weaknesses etc. |
| 9.0 | | **FINANCIAL INFORMATION**<br>Bidder should furnish the following financial information: |
| | a) | Annual financial statement for the last five years in (Form "A"). This should be supported by audited balance sheets and profit and loss accounts duly certified by a chartered accountant, as submitted by the applicant to the income tax department. |
| | b) | Solvency certificate in (Form "B"). Name and address of the bankers, identification of individuals familiar with the applicant's financial standing and a banker's statement on availability of credit. |
| 10.0 | | **EXPERIENCE IN WORKS HIGHLIGHTING EXPERIENCE IN SIMILAR WORKS**<br>Bidder should furnish the following: |
| | a) | List of all works of similar nature successfully completed during the last seven years (in form "C"). |
| | b) | List of the projects under execution or awarded (in Form "D"). This information should be complete and no work should be left out. |
| | 10.1 | Particulars of completed works and performance of the applicant duly authenticated/ certified by an officer not below the rank of Executive Engineer or equivalent should be furnished separately for each eligible work completed (in Form "E"). |
| | 10.2 | Information in Form "D" should be complete and no work should be left out. |

| | | |
|---|---|---|
| 11.0 | | **ORGANISATION INFORMATION**<br>Bidder is required to submit the information in respect of his organization (in forms 'F" & "G"). |
| 12.0 | | **CONSTRUCTION PLANT & EQUIPMENT**<br>Bidders should furnish the list of construction plant and equipment including steel shuttering, centering and scaffolding to be used in carrying out the work (in Form "H"). Details of any other plant & equipment required for the work not included in form "H" and available with the bidder may also be indicated. |
| 13.0 | | **LETTER OF TRANSMITTAL**<br>The bidder should submit the letter of transmittal attached with the document. |
| 14.0 | | **OPENING OF FINANCIAL BID**<br>After evaluation of eligibility documents (technical bid), a list of short listed agencies qualified in eligibility criteria will be prepared. Thereafter, the financial bids of only the qualified and technically acceptable bidders shall be opened at the notified time, date and place in the presence of the qualified bidders or their representatives who desire to be present. **The bids shall remain valid for 120 days from the date of opening of the Technical Bids.** |
| 15.0 | | **AWARD CRITERIA** |
| | 15.1 | The employer reserves the right, without being liable for any damages or obligation to inform the bidder, to: |
| | a) | Amend the scope and value of contract. |
| | b) | Reject any or all of the applications without assigning any reason. |
| | 15.2 | Any effort on the part of the bidder or his agent to exercise influence or to pressurize the employer would result in rejection of his bid. Canvassing of any kind is prohibited. |
| 16.0 | | **ESSENTIAL SUBMISSIONS AND INFORMATION** |
| | 16.1 | The bidder shall provide copies of work orders as well as completion certificates from the past Employer as documentary proof for having executed similar works. However, decision with regard to eligibility of the applicant will be taken by the Engineer in charge, SAU, only after necessary documents provided by the applicant have been examined. |
| | 16.2 | The applicant's performance for each eligible work completed in the last seven years shall be certified by an officer not below the rank of Executive Engineer or equivalent. |
| | 16.3 | The applicant must submit an undertaking that up to date tax returns have been filed along with copies of such returns submitted to the concerned IT department/ Commercial Tax department. |
| | 16.4 | The applicant shall own construction equipment as per list required for the proper and timely execution of the work. Else, he shall certify that he would be able to manage the equipment by hiring etc. and submit the list of firms from whom he proposes to hire. |
| | 16.5 | The applicant shall have sufficient number of Technical and Administrative employees for the proper execution of the contract work. The applicant shall submit a list of the employees stating clearly how they would be involved in this work. |
| | 16.6 | Minimum requirement of Technical Staff for this work is given in clause 36 of schedule F. |
| | 16.7 | Credentials for the works submitted by the bidder for qualifying the eligibility criteria, if required, may be **verified** by the Engineer - in - Charge or his authorized representative and the bidder will make necessary arrangement for arranging meeting with client department, etc. |

## 4.3 SECTION III INFORMATION REGARDING ELIGIBILITY CRITERION

### 4.3.1 Letter of Transmittal

From:
……..
……
……

To,

**The Registrar,**
**South Asian University**
**Akbar Bhawan,**
**Chanakyapuri,**
**New Delhi - 110021**

Sub: Construction of South Asian University Campus at Maidan Garhi, New Delhi. Package-III: (i) Administration Building (ii) Library Building (iii) Institute of South Asian Studies and Interdisciplinary Research (iv) Faculty of Law and Humanities (v) Faculty of Physics, Chemistry, Maths and I.T. (vi) Faculty of Art & Design and Convention Centre (vii) Utility Building: Including Basements, Superstructures, Interior Finishes, Internal Water Supply, Sanitary Installations, Drainage, Internal Electrical Installations, HVAC, Lifts, Fire Fighting System, Low Voltage System ; PA System, Solar Water Heating System etc. External Site Development and Infrastructure; Roads, Street Lighting, Sewerage, Storm Water Drainage, STP, WTP, Water Supply, HT & LT Power Distribution, Electrical Substation, Chiller Plant, Pump House, D.G. Sets, Rainwater Harvesting, Hardscaping etc.

Sir,
Having examined the details given in **Press Notice and Detailed Bid** document available on designated websites for the above work, I /we hereby submit the relevant information.

1. I/We hereby certify that all the statement made and information supplied in the enclosed forms A to H and accompanying statement are true and correct.
2. I/We have furnished all information and details necessary for eligibility and have no further pertinent information to supply.
3. I/We submit the requisite certified solvency certificate and authorize **SAU, New Delhi** to approach the Bank issuing the solvency certificate to confirm the correctness thereof. I/We also authorize **SAU, New Delhi** to approach individuals, employers, firms and corporation to verify our competence and general reputation.
4. I/We submit the certificates as per the form "E" in support of our suitability, technical knowledge and capability for having successfully completed the following works:-

| S.N. | Name of work | Amount | Certificate issued by |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |

5. Technical / Eligibility bid documents are submitted online and Earnest **money amounting to Rs 6,48,90,000/-** in the prescribed form is submitted herewith under sealed envelope.

6. Financial bid is submitted online.

Enclosures:

Seal of bidder

Date of submission **SIGNATURE(S) OF BIDDER(S)**

**FORM 'A'**

## 4.3.2 FINANCIAL INFORMATION

**Name of the firm / contractor…….:**

I. Financial Analysis-Details to be furnished duly supported by figures in balance sheet / profit & loss account for the last five years duly certified and audited by the Chartered Accountants, as submitted by the applicant to the Income Tax SAU (Copies to be attached).

**Figures in Lakhs Rs.**

| Sl. No. | Particulars | Financial Years | | | | |
|---|---|---|---|---|---|---|
| | | 2011-2012 | 2012-2013 | 2013-2014 | 2014-2015 | 2015-2016 |
| i) | Gross Annual turnover | | | | | |
| ii) | Turnover on construction works | | | | | |
| iii) | Profit / Loss | | | | | |

II. Financial arrangements for carrying out the proposed work.

III. Solvency Certificate from Bankers of bidder in the prescribed Form "B"

**SIGNATURE OF BIDDER(S)**

**Signature of Chartered Accountant with Seal**

**FORM 'B'**

### 4.3.3 FORM OF BANKERS' SOLVENCY CERTIFICATE FROM A SCHEDULED BANK

This is to certify that to the best of our knowledge and information that M/s./Shri…… having marginally noted address, a customer of our bank are / is respectable and can be treated as good for any engagement up to a limit of Rs…… (Rupees……..…).

This certificate is issued without any guarantee or responsibility on the bank or any of the officers.

(Signature) For the Bank NOTE:

1. Bankers certificate should be on letter head of the Bank, sealed in cover addressed to the **Registrar, SAU, New Delhi - 110021** tendering authority.

2. In case of partnership firm, certificate should include names of all partners as recorded with the Bank.

3. The certificate should not be more than 6 months old.

**FORM 'C'**

**4.3.4 DETAILS OF ALL WORKS OF SIMILAR NATURE COMPLETED DURING THE LAST SEVEN YEARS**

Name of the firm / contractor…….

| Sl. No. | Name of work / project and location | Owner or sponsoring organization | Cost of work in crores | Date of commencement as per contract | Stipulate date of completion | Actual date of completion | Litigation/ arbitration cases pending / in progress with details* | Name and Address (Postal & E-mail) / telephone number of officer to whom reference may be made | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |

Certified that the above list of works is complete and no work has been left out and that the information given is correct to the best of my / our knowledge and belief.

**SIGNATURE OF BIDDER(S)**

WITH STAMP

*indicate gross amount claimed and amount awarded by the Arbitrator.

**FORM 'D'**

## 4.3.5 PROJECTS UNDER EXECUTION AND AWARDED

| Sl. No. | Name of work / project and location | Owner or sponsoring organization | Cost of work | Date of commencement as per contract | Stipulated date of completion | Up to date percentage progress of work | Slow progress if any, and reasons thereof | Name and Address (Postal & E-mail) / telephone number of officer to whom reference may be made | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

Certified that the above list of works is complete and no work has been left out and that the information given is correct to the best of my / our knowledge and belief and if it is found incorrect at any stage, the employer shall have the right to disqualify we/us.

**SIGNATURE OF BIDDER(S) WITH STAMP**

**FORM 'E'**

## 4.3.6 PERFORMANCE REPORT OF WORKS TO BE CONSIDERED FOR ELIGIBILITY

| | | | |
|---|---|---|---|
| 1. | Name of work / Project & Location | | |
| 2. | Agreement No. | | |
| 3. | Estimated Cost | | |
| 4. | Tendered Cost | | |
| 5. | Date of Start | | |
| 6. | Date of completion | | |
| | i) | Stipulated Date of Completion ( as mentioned in work order ) | |
| | ii) | Actual Date of Completion | |
| 7. | i) | Status of Compensation (Not Levied / Levied / Not Decided ) | |
| | ii) | Amount of compensation levied for delayed completion, if any | |
| 8. | Amount of reduced rate items, if any. | | |
| 9. | Whether any litigation / arbitration case pending / in progress in respect of this work. | | |
| 10. | Performance Report | | |
| | 1) Quality of Work | | Very Good/Good/Fair/Poor |
| | 2) Financial Soundness | | Very Good/Good/Fair/Poor |
| | 3) Technical Proficiency | | Very Good/Good/Fair/Poor |
| | 4) Resourcefulness | | Very Good/Good/Fair/Poor |
| | 5) General Behaviour | | Very Good/Good/Fair/Poor |
| 11 | Remarks ( if any ): | | |
| Dated: | | | Engineer-in-Charge<br>Equivalent to EE with stamp |

**FORM 'F'**

**4.3.7 STRUCTURE & ORGANISATION OF THE FIRM / BIDDER**

| | | | |
|---|---|---|---|
| 1. | Name & Address of the bidder | | |
| 2. | Telephone No. /<br>Email id /Telex No./Fax No. | | |
| 3. | Legal status of the bidder<br>(attach copies of original document defining the legal status). | | |
| | a) | An Individual | |
| | b) | A proprietary firm | |
| | c) | A firm in partnership | |
| | d) | A limited company or Corporation | |
| 4. | Particulars of registration with various Government bodies (attach attested photo-copy). | | |
| | **ORGANIZATION/PLACE OF REGISTRATION** | | |
| | 1. | | |
| | 2. | | |
| | 3. | | |
| 5. | Names and Titles of Directors & Officers with designation to be concerned with this work. | | |
| 6. | Designation of individuals authorized to act for the organization. | | |
| 7. | Was the bidder ever required to suspend construction for a period of more than six months continuously after commencing the construction? If so, given the name of the project and reasons of suspension of work. | | |
| 8. | Has the bidder, or any constituent partner in case of partnership firm, ever abandoned the awarded work before its completion? If so, give name of the project and reasons for abandonment. | | |

| | | |
|---|---|---|
| 9. | Has the bidder, or any constituent partner in case of partnership firm, ever been debarred/ black listed for tendering in any organization at any time? If so, give details. | |
| 10. | Has the bidder, or any constituent partner in case of partnership firm, ever been convicted by a court of law? If so, give details. | |
| 11. | In which field of Civil Engineering Construction the bidder has specialization and interest? | |
| 12. | Any other information considered necessary but not included above. | |

Signature of bidder(s) with stamp

**FORM 'G'**

**4.3.8 DETAILS OF TECHNICAL & ADMINISTRATIVE PERSONNEL TO BE DEPLOYED ON THE WORK**

| Sl. No. | Designation | Total Number | Number for this work | Name | Qualifications | Professional/ Construction experience and details of work carried out | How these would be involved in this work | Remarks |
|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

SIGNATURE OF BIDDER(S) WITH STAMP

**FORM 'H'**

**4.3.9 DETAILS OF CONSTRUCTION EQUIPMENT LIKELY TO BE USED IN CARRYING OUT THE WORK**

| Sl. No. | Name of Equipment | Nos. | Capacity or Type | Age | Condition | Ownership status | | | Current location | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Presently Owned | Leased | To be Purchased | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 1. | Power driven mobile roller pan mixer conforming to IS 2438. (Heavy duty Lime mortar Mill ) | | | | | | | | | |
| 2. | Automatic Concrete Batching plants, electrically operated with automatic load cell weigh batching system (minimum capacity 30 cumper hour). | | | | | | | | | |
| 3. | Tower Crane. | | | | | | | | | |
| 4. | Excavator cum loader (JCB 3D model or equivalent). | | | | | | | | | |
| 5. | Compressor machine minimum 200 cfm with rock breaker. | | | | | | | | | |
| 6. | DG set of minimum capacity 62.5 KVA. | | | | | | | | | |
| 7. | Mini batching plant (12 cum./hr.). | | | | | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 8. | Transit mixer. | | | | | | | | | |
| 9. | Concrete pump (minimum capacity 30 cum/hr. & head 90m). | | | | | | | | | |
| 10. | Needle Vibrators. | | | | | | | | | |
| 11. | Plate Vibrators. | | | | | | | | | |
| 12. | Dumper. | | | | | | | | | |
| 13. | Reinforcement bending machine. | | | | | | | | | |
| 14. | Reinforcement cutting machine. | | | | | | | | | |
| 15. | Power driven earth rammer (Soil Compactor). | | | | | | | | | |
| 16. | Total station. | | | | | | | | | |
| 17. | Auto level & staff. | | | | | | | | | |
| 18. | Tractor with trolley. | | | | | | | | | |
| 19. | Water tanker. | | | | | | | | | |
| 20. | Welding machine 400 Ampere | | | | | | | | | |
| 21. | Screener for coarse sand and fine sand | | | | | | | | | |
| 22. | Centrifugal mono block water pump minimum capacity 2 HP | | | | | | | | | |
| 23. | Any other machinery required for completion of the work as per decision of Engineer-in-charge. | | | | | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 24. | Builder's Hoist | | | | | | | | | |
| 25. | Concrete Mixer (Diesel) | | | | | | | | | |
| 26. | Concrete Mixer (Electrical) | | | | | | | | | |
| 27. | Welding Generators | | | | | | | | | |
| 28. | Welding Transformers (10 KVA) | | | | | | | | | |
| 29. | Cube Testing Machines | | | | | | | | | |
| 30. | M.S. Pipes | | | | | | | | | |
| 31. | Steel / Marine Ply shuttering (sqm) | | | | | | | | | |
| 32. | Steel Scaffolding (sqm equivalent) | | | | | | | | | |
| 33. | Grinding / Polishing Machine | | | | | | | | | |
| 34. | Trucks | | | | | | | | | |

I, the undersigned, do hereby undertake that our firm M/s. …… shall deploy all plants, equipment's and machinery required for implementation of the project as per technical specifications. I also undertake to either own or have assured access through hire or lease the key items of the equipment as specified in this form.

…….…….

Signed by an Authorized Signatory of the firm
With stamp

## 5.0 PERCENTAGE RATE TENDER & CONTRACT FOR WORKS (CPWD-7)

**Tender for the work of :**

Construction of South Asian University Campus at Maidan Garhi, New Delhi Package-III(i) Administration Building (ii) Library Building (iii) Institute of South Asian Studies and Interdisciplinary Research (iv) Faculty of Law and Humanities (v) Faculty of Physics, Chemistry, Maths and I.T. (vi) Faculty of Art & Design and Convention Centre (vii) Utility Building: Including Basements, Superstructures, Interior Finishes, Internal Water Supply, Sanitary Installations, Drainage, Internal Electrical Installations, HVAC, Lifts, Fire Fighting System, Low Voltage System ; PA System, Solar Water Heating System etc. External Site Development and Infrastructure; Roads, Street Lighting, Sewerage, Storm Water Drainage, STP, WTP, Water Supply, HT & LT Power Distribution, Electrical Substation, Chiller Plant, Pump House, D.G. Sets, Rainwater Harvesting, Hardscaping etc.

# TENDER

I/We have read and examined the notice inviting tender, schedule, A, B, C, D, E & F Specification applicable, Drawings & Designs, General Rules and Directions, Conditions of Contract, of 2014 with amendments up to, clauses of contract, Special conditions, Schedule of Rate & other documents and Rules referred to in the conditions of contract and all other contents in the tender document for the work "

Construction of South Asian University Campus at Maidan Garhi, New Delhi. Package-III: (i) Administration Building (ii) Library Building (iii) Institute of South Asian Studies and Interdisciplinary Research (iv) Faculty of Law and Humanities (v) Faculty of Physics, Chemistry, Maths and I.T. (vi) Faculty of Art & Design and Convention Centre (vii) Utility Building: Including Basements, Superstructures, Interior Finishes, Internal Water Supply, Sanitary Installations, Drainage, Internal Electrical Installations, HVAC, Lifts, Fire Fighting System, Low Voltage System ; PA System, Solar Water Heating System etc. External Site Development and Infrastructure; Roads, Street Lighting, Sewerage, Storm Water Drainage, STP, WTP, Water Supply, HT & LT Power Distribution, Electrical Substation, Chiller Plant, Pump House, D.G. Sets, Rainwater Harvesting, Hardscaping etc.

I/W e hereby tender for the execution of the work specified for the SAU within the time specified in Schedule 'F' viz., schedule of quantities and in accordance in all respect with the specifications, designs, drawing and instructions in writing referred to in Rule-1 of General Rules and Directions and in Clause 11 of the Conditions of contract of 2014 with amendments up to the date of uploading the tender by SAU. with such materials as are provided for, by, and in respect of accordance with, such conditions so far as applicable.

We agree to keep the tender open for **One Hundred Twenty (120)** days from the date of opening of **Technical** bid and not to make any modification in its terms and conditions.

A sum of **Rs 6,48,90,000/-** is hereby forwarded in cash/receipt / deposit at call receipt of a scheduled bank/fixed deposit receipt of scheduled bank/demand draft of a scheduled bank or Rs. 20 lakh in the shape prescribed above and balance in shape of Bank guarantee of scheduled bank in accordance with the Form available in Tender Document having validity for 6 months or more from the last date of receipt of tenders.

If I/W e, fail to furnish the prescribed performance guarantee within prescribed period, I/W e agree that the said SAU or his successors representatives, in office shall without prejudice to any other right or remedy, be at liberty to forfeit the said earnest money absolutely. Further, if I/W e fail to commence work as specified,

I/W e agree that SAU or the successors representatives in office shall without prejudice to any other right or remedy available in law, be at liberty to forfeit the said earnest money and the performance guarantee absolutely, otherwise the said earnest money shall be retained by him towards security deposit to execute all the works referred to in the tender documents upon the terms and conditions contained or referred to those in excess of that limit at the rates to be determined in accordance with the provision contained in Clause 12.2 and 12.3 of the tender form.

Further, I/W e agree that in case of forfeiture of Earnest Money & Performance Guarantee as aforesaid, I/We shall be debarred for participation in the re-tendering process of the work.

I/W e undertake and confirm that eligible similar work(s) has/have not been got executed through another contractor on back to back basis. Further that, if such a violation comes to the notice of SAU, then I/W e shall be debarred for tendering in SAU in future forever. Also, if such a violation comes to the notice of SAU before date of start of work, the Engineer-in-Charge shall be free to forfeit the entire amount of Earnest Money Deposit/ Performance Guarantee.

I/W e hereby declare that I/W e shall treat the tender documents drawings and other records connected with the work as secret/confidential documents and shall not communicate information/derived there from to any person other than a person to whom I/W e am/are authorized to communicate the same or use the information in any manner prejudicial to the safety of the State.

**Dated: ……..……..……..**** **Signature of Contractor ** Witness: ****

**Address: **** **Postal Address ****

**Occupation: ****

## 5.1 LETTER OF ACCEPTANCE

The above tender (as modified by you as provided in the letters mentioned hereunder) is accepted by me for an on behalf of the SAU for a sum of Rs..……*…….…….. (Rupee……..……*……
…
……....……...).

The letters referred to below shall form part of this contract agreement:-

(a) *
(b) *
(c) *

**For & on behalf of SAU**

**Signature ……..*……**

**Dated: ……*…….. Designation ……*……**

## 5.2 PROFORMA OF SCHEDULES

**SCHEDULE 'A'**

Schedule of quantities as per Part-C from **page 1 to page 481** only

**SCHEDULE 'B'**

Schedule of materials to be issued to the contractor.

| S. No. | Description of item | Quantity | Rates in figures & words at Which the material will be charged to the contractor | Place of issue |
|---|---|---|---|---|
| | | **NIL** | | |

**SCHEDULE 'C'**

Tools and plants to be hired to the contractor

| S. No. | Description | Hire charges per day | Place of Issue |
|---|---|---|---|
| | | **NIL** | |

**SCHEDULE 'D'**

Extra schedule for specific requirements /document for the work, if any. **N I L**

**SCHEDULE 'E'**

Reference to General Conditions of Contract: General Conditions of Contract 2014 with amendments issued up to the date of uploading the tender by SAU.

**Name of Work:** Construction of South Asian University Campus at Maidan Garhi, New Delhi. Package-III: (i) Administration Building (ii) Library Building (iii) Institute of South Asian Studies and Interdisciplinary Research (iv) Faculty of Law and Humanities (v) Faculty of Physics, Chemistry, Maths and I.T. (vi) Faculty of Art & Design and Convention Centre (vii) Utility Building: Including Basements, Superstructures, Interior Finishes, Internal Water Supply, Sanitary Installations, Drainage, Internal Electrical Installations, HVAC, Lifts, Fire Fighting System, Low Voltage System ; PA System, Solar Water Heating System etc. External Site Development and Infrastructure; Roads, Street Lighting, Sewerage, Storm Water Drainage, STP, WTP, Water Supply, HT & LT Power Distribution, Electrical Substation, Chiller Plant, Pump House, D.G. Sets, Rainwater Harvesting, Hardscaping etc.

| | | |
|---|---|---|
| I. | Estimated cost of Work | **Rs. 638,89,18,337/-** |
| ii. | Earnest Money | **Rs 6,48,90,000/-** |
| iii. | Performance Guarantee | 5% of tendered amount |
| iv. | Security Deposit | 2.5% of tendered amount |

## SCHEDULE 'F' (GENERAL RULES & DIRECTIONS)

**Officer inviting tender: SAU, New Delhi – 110021**

**Definitions:**

| | | |
|---|---|---|
| (i) | Engineer-in-Charge | **Authorized representative of SAU, to be decided later** |
| (ii) | Accepting Authority | **Building Works Committee ( BWC ), SAU** |
| (iii) | Percentage on cost of materials and Labour to cover all overheads and profits | **15%** |
| (ix) | Standard Schedule of Rates | **DSR 2014 and DSR (E&M) 2014 with amendments up to date correction up to date of uploading the tender by SAU.** |
| (v) | Department | **South Asian University or its authorized representative.** |
| (vi) | Standard CPWD Contract Form GCC 2014 | **CPWD Form 7 & GCC 2014 modified & Corrected up-to date of uploading the tender by SAU.** |

**Clause 1**

| | | |
|---|---|---|
| (i) | Time allowed for submission of Performance Guarantee from the date of issue of letter of acceptance | **15 (Fifteen) days** |
| (ii) | Maximum allowable extension beyond the period provided in (i) above | **7 (Seven) days with late fee @ 0.1% per day of the PG amount.** |

**Clause 2 (Compensation for Delay)**

| | | |
|---|---|---|
| | Authority for fixing compensation under clause 2 | **President, SAU, New Delhi – 110021 or successor thereof** |

**Clause 2A (Incentive for Early Completion)**

| | | |
|---|---|---|
| | Whether Clause 2A shall be applicable | **Yes** |

**Clause 5 (Time and Extension for Delay)**

| | | |
|---|---|---|
| | Number of days from the date of issue of letter of acceptance for reckoning date of start | **22 (twenty-two) days or date of handing over of site whichever is later** |

**Mile Stones for Works**

| Sl. No. | Description of Milestone (Physical) | | | | | | | | Time allowed in Months from Start | Amount to be withheld if milestone is not achieved |
|---|---|---|---|---|---|---|---|---|---|---|
| | Administrative Building | Library Building | Institute of South Asian Studies | Faculty of Phy/ Chem/ Maths/ IT | Faculty of Law and Humanities | Faculty of Art, Design and Convention Center | Utility Buildings | External Development Works for Package 2 and 3 | | |
| 1 | -- | -- | -- | Structural Works upto Level (00) | Structural Works upto Level (00) | Structural Works upto Level (00) | Structural Works Complete | -- | 7 Months | 0.25% of tendered amount |
| 2 | -- | -- | -- | Structural Works Complete | Structural Works Complete | Structural Works upto Level(04) i/c Auditorium Sloped Slabs | Building Complete and ready for installation of all High Side Equipments | 40% Completion of Road Works and laying of Service lines i/c drainage, all MEPF lines, RWHP, etc. | 14 Months | 0.75% of tendered amount |
| | -- | -- | -- | AAC Block Work upto Level (03) | AAC Block Work upto Level (03) | AAC Block Work upto Level (03) | | | | |
| | -- | -- | -- | Internal MEP Works upto Level (02) | Internal MEP Works upto Level (02) | Internal MEP Works upto Level (02) | | | | |
| 3 | Structural Works upto Level (02) | Structural Works upto Level (02) | Structural Works upto Level (02) | -- | -- | Completion of Structural Works i/c RCC, Structural Steel and Roofing | -- | 80% Completion of Road Works and laying of Service lines i/c drainage, all MEPF lines, RWHP, etc. | 21 Months | 0.75% of tendered amount |
| | -- | -- | -- | External Façade Complete | External Façade Complete | External Façade 50% Complete | -- | | | |
| | -- | -- | -- | Internal Finshing (Flooring, Cladding, etc.) Complete | Internal Finshing (Flooring, Cladding, etc.) Complete | Internal Finshing (Flooring, Cladding, etc.) upto Level (04) | -- | | | |
| | -- | -- | -- | Installation of MEP Fittings and Fixtures, complete with their Testing | Installation of MEP Fittings and Fixtures, complete with their Testing | Installation of MEP Fittings and Fixtures, with their Testing upto Level (03) | -- | | | |

| Sl. No. | Description of Milestone (Physical) | | | | | | | | Time allowed in Months from Start | Amount to be withheld if milestone is not achieved |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Admini-strative Building** | **Library Building** | **Institute of South Asian Studies** | **Faculty of Phy/ Chem/ Maths/ IT** | **Faculty of Law and Humani-ties** | **Faculty of Art, Design and Conven-tion Center** | **Utility Buildings** | **External Develo-pment Works for Package 2 and 3** | | |
| 4 | Structure Works Complete | Structure Works Complete | Structure Works Complete | -- | -- | Audito-rium Ready for operation | -- | 95% Compl-etion of Road Works and laying of Service lines i/c drain-age, all MEPF lines, RWHP, etc. | 28 Months | 0.75% of tendered amount |
| | AAC Block Work upto Level (04) | AAC Block Work upto Level (04) | AAC Block Work upto Level (04) | -- | -- | External Façade Complete | -- | | | |
| | Internal MEP Works upto Level (03) | Internal MEP Works upto Level (03) | Internal MEP Works upto Level (03) | -- | -- | -- | 50% Completion of Overall MEP High Side Testing and Commissioning | | | |
| 5 | Internal Finishing (Flooring, Cladding, Base Coat of Paint, etc.) Complete | Internal Finishing (Flooring, Cladding, Base Coat of Paint, etc.) Complete | Internal Finishing (Flooring, Cladding, Base Coat of Paint, etc.) Complete | -- | -- | -- | 100% Completion of Overall MEP High Side Testing and Commissioning | | 33 Months | 0.75% of tendered amount |
| | Installation of MEP Fittings and Fixtures, complete with their Testing | Installation of MEP Fittings and Fixtures, complete with their Testing | Installation of MEP Fittings and Fixtures, complete with their Testing | -- | -- | -- | -- | 50% Compl-etion of Final Road and 50% Compl-etion of Hards-caping Works | | |
| 6 | External Façade Complete | External Façade Complete | External Façade Complete | -- | -- | -- | -- | 100% Compl-etion of Final Road and 100% Compl-etion of Hards-caping Works | 36 Months | 0.75% of tendered amount |
| | Completion and Handing Over | | | | | | | | | |

Time allowed for execution of work – 36 Months.

**Authority to decide**

| | | |
|---|---|---|
| **(i)** | Extension of Time | **President, SAU or authorized representative** |
| **(ii)** | Rescheduling of Mile Stones | **President, SAU or authorized representative** |
| **(iii)** | Shifting of date of start in case of delay in handing over of site: | **President, SAU or authorized representative** |

| | | |
|---|---|---|
| **Clause 6, 6A** | Clause applicable - (6 or 6A) | **6A ( Computerized Measurement Book )** |
| **Clause 7** | Gross work to be done together with net payment /adjustment of advances for material collected, if any, since the last such payment for being eligible to interim payment | Rs. 10 Crores or part thereof as per the discretion of Engineer in charge. |
| **Clause 7 A** | **Applicable** | No running account bill shall be paid for the work till the applicable labour licenses, registration with EPFO, ESIC and BOCW welfare board whatever applicable are submitted by the contractor to the Engineer In Charge.( This may be relaxed up to certain period by the President, SAU on discretion). |
| **Clause 10A** | Material to be provided by Contractor ( Testing Equipments) | List of testing equipment to be provided by the contractor at site lab as per Annexure-I. For electrical and mechanical part, all measuring and testing equipment for testing during the progress of work and final testing and commissioning shall be provided by the contractor as per relevant CPWD general specifications for Electrical & Mechanical works amended up to date of uploading the tender by SAU. |
| **Clause 10B** | Whether Clause 10 B shall be applicable – Secured Advance and Mobilization Advance | **Yes, Clause 10 B (i) and B (ii) both are applicable** |
| **Clause 10C** | | **Not Applicable as 10 CC is applicable** |

| **Clause 10 CA** | | | **Applicable** | |
|---|---|---|---|---|
| **Sl. No.** | **Material covered under this clause** | **Nearest Materials for which all India Wholesale Price Index to be followed.** | **Base Price per MT of all the materials covered under clause 10 CA (The rates for cement and reinforcement bars are as per DG CPWD circular no. DG/10/CA/37 dated 10/06/16 for the month of March 2016 and for structural steel vide DG/10/CA/28 dated 8/9/2015 for the month of June 2015.)** | |
| 1 | Portland Pozzolana **Cement (PPC)** | | **Rs 5500/- Per MT** | **(1) All India Wholesale Price Index for PPC shall be considered same as Circulated for OPC by DG (W) CPWD.**<br><br>**(4) In case of non-availability of Price Index for structural steel by CPWD, All India Wholesale Price Index issued by Ministry of Commerce shall be applicable** |
| **2** | **OPC Cement** | | **Rs 5700/- Per MT** | |
| 3 | Reinforcement bars TMT-500D (Primary manufacturer) | | **Rs 37300/- Per MT** | |
| 4 | Structural steel (Primary manufacturer) | **Steel Structure** | **Rs 39722/- Per MT (June 2015)** | |

**Note: Please read Clause 10CA of CPWD, GCC 2014 carefully before quoting.**

**Clause 10CC (Payment due to increase/decrease in the prices other than material under 10 CA): Applicable**

Schedule of component of other materials, Labour, POL etc. for price escalation: -

| | |
|---|---|
| Component of civil (Except materials covered under clause 10CA) | 75% minus cement & steel under clause 10CA |
| Component of labour expressed as percent of total value of work | 25% |

| Component of E& M Works ( except E&M item/material covered under clause 10 CA if any) | EI, Street light & cabling etc. | Other E&M works except EI, Street light & cabling etc. |
|---|---|---|
| Value of work - | 75% | 90% |
| Component of Labour | 25% | 10% |

Component of P.O.L. expressed as percent of total value of work Nil

**Clause 11**

| | |
|---|---|
| Specifications to be followed for execution of work | **1)** Civil works; CPWD Specifications 2009 volume- I & II with corrections slips up to the last date of uploading of tender, Manufactures specifications and directions of Engineer in charge.<br><br>**2)** E&M works; CPWD General Specifications for Electrical Works Part I Internal – 2013, Part IV Sub Station–2013, Heating, Ventilation & Air-Conditioning(HVAC)-2004,<br>Part-III-Lifts & Escalators-2003, Wet riser cum Down comer 2006 |

**Clause 12 (Deviation/Variation)**

Type of work : Project & Original work

Maximum percentage for quantity of items of work to be executed beyond which rates are to be determined in accordance with Clauses 12.2, 12.3 : Please refer below

| | | |
|---|---|---|
| 12.2. 12.3 | Deviation limit beyond which clauses 12.2 & 12.3 shall apply for building work | **30% (Thirty percent)** |
| 12.5 | i) Deviation Limit beyond which clauses 12.2 & 12.3 shall apply for foundation work (except earth work)<br>ii) Deviation Limit for items in earth work subhead of DSR or related items | **100% (One Hundred percent)**<br><br>**100% (One Hundred percent)** |

**Clause 16**

| | |
|---|---|
| Competent Authority for deciding reduced rates. | President SAU, New Delhi-110021 or successor thereof. |

**Clause 17**

| | |
|---|---|
| Defects Liability Period | 24 Months |

**Clause 18**

List of mandatory machinery, tools & plants to be deployed by the contractor at site:-

i) **for civil works** ; As per Annexure – I and Annexure – II

ii) **for electrical and mechanical works**; as required for E & M works and as decided by engineer in charge.

**Clause 25**

**Constitution of Dispute Redressal Committee:- SAU (These may however can be changed on the discretion of President, SAU.)**

**(A) Total Claims upto 25 Lacs**

| | |
|---|---|
| Chairman | OSD/Chief Liaison Officer, SAU |
| Member | Director Finance, SAU |
| Member | Executive Engineer, SAU |
| Presenting Office; PMC | Engineer in charge from |

**(B) Total Claims above 25 Lacs**

| | |
|---|---|
| Chairman | Vice President SAU |
| Member | OSD/Chief Liaison Officer, SAU |
| Member | Director Finance, SAU |
| Member | Executive Engineer, SAU |
| Member | One BWC Member shall be Nominated by Chairman of BWC whenever the need arises. |
| Presenting Officer | Engineer in charge from PMC |

**Note: The above constitution of Dispute Redressal Committee is subject to change, for which necessary notification shall be issued by the competent authority of the SAU, if required.**

| Clause 36 (i) | | | | |
|---|---|---|---|---|
| Minimum Requirement of Technical **Staff** and Recovery Rates | | | | |
| Manpower | | Minimum experience (Years) | Designation | Rate at which recovery shall be made from the contractor in the event of not fulfilling provision of clause 36(i) |
| Qualification | Number | | | |
| (For Civil+ E&M Component) | | | | |
| A. Requirement of **Technical Staff** | | | | |
| Graduate Engineer (Civil) | 1 | 20( and having experience of one similar nature of work) | Project Manager | Rs. 1,00,000 per month |
| Graduate Engineer | 2+1 | 15( and having experience of one similar nature of work) | Deputy Project Manager | Rs. 80,000 per month Per Person |
| Graduate Engineer<br>Or<br>Diploma Engineer | 4+4 | 5<br>or<br>10<br>Respectively | Senior<br>Project/Site Engineer | Rs. 40,000 per month Per Person |
| Diploma Engineer | 3+2 | 5( and having experience of one similar nature of work) | Site Engineers | Rs. 30,000 per month Per Person |
| Graduate Engineer | 1 | 8 | Quality Engineer | Rs. 50,000 per month Per Person |
| Diploma Engineer | 1 | 8 | Surveyor | Rs.30,000 per month |
| Graduate Engineer ( Primavera Expert) | 1 | 6 | Project Planning | Rs. 40,000 per month Per Person |
| Graduate Engineer | 1 | 6 | Billing Engineer | Rs. 40,000 per month Per Person |
| B. Requirement of **Safety and Environment Staff** | | | | |
| PG Dip. In Ind. Safety | 1 | 5 Years Exp. of similar nature | Chief SHE Manager | Rs. 60,000 per month Per Person |
| Graduate/ Diploma in Safety | 2 | 2 years Exp. of similar nature | Junior SHE Manager | Rs. 30,000 per month Per Person |
| PG Deg/Dip in Env Engg/ B.tech. Env. | 1 | 2 Years Exp. of similar nature | Environment Manager | Rs. 30,000 per month Per Person |

**Note:**

1. Foremen, Supervisors and Safety Stewards with basic qualification and SHE certificate as per requirement and instruction of Engineer in Charge at site.

2. The above technical representative shall be mobilized at site as per the deployment schedule given in this NIT (Annexure -IV).

Assistant Engineers retired from Government services who are holding Diploma will be treated at par with Graduate Engineers. Diploma holder with minimum 5 year relevant experience with a reputed construction company can be treated at par with Graduate Engineers for the purpose of such deployment subject to the condition that such diploma holders should not exceed 2/3rd of requirement of degree engineers.

The contractor shall submit a certificate of employment of the technical representative(s) (in the form of copy of Form -16 or CPF deduction issued to the Engineers employed by him) along with every account bill/final bill and shall produce evidence if at any times so required by the Engineer-in-charge.

The CV of technical persons shall be presented to Engineer in charge before deployment in above work for approval. Once inducted they will not be transferred or removed without the permission on Engineer in Charge.

**Clause 42**

| | | | |
|---|---|---|---|
| (i) | (a) | Schedule/statement for determining theoretical quantity of cement & bitumen on the basis of Delhi Schedule of Rates | **DSR 2014 with up to date correction slips.** |
| (ii) | | Variations permissible on theoretical quantities: | |
| | (a) | Cement | |
| | | (i) For Design Mix | **Variation should not be less than specified in design mix** |
| | | (ii) For other works | **2% (Two percent) plus / minus .** |
| | (b) | Bitumen for all works | **2.5% (Two point five percent) plus only and nil on minus side.** |
| | (c) | Steel Reinforcement and structural steel sections for each diameter, section and category | **2% (Two percent) plus / minus** |
| | (d) | All other materials | **Nil** |

Registrar

South Asian University

**ANNEXURE I**

## 5.3 Equipment for Testing of Materials & Concrete at Site Laboratory

All necessary equipment for conducting all necessary tests shall be provided at the site in the well- furnished site laboratory of minimum 1000 Square Feet by the contractor at his own cost The following minimum laboratory equipment shall be set up at site office laboratory:-

| Sl. No. | Equipment | Numbers (Minimum) |
|---|---|---|
| 1. | 100MT compression testing machine, electrical-cum-manually operated) | 2 |
| 2. | Slump cone, steel plate, tamping rod, steel scale, scoop | 10 |
| 3. | Vicats apparatus with Desk pot | 2 |
| 4. | Megger & earth resistance tester | 2 |
| 5. | Pumps and pressure gauges for hydraulic testing of pipes | 2 |
| 6. | Weighing scale platform type 300 Kg capacity | 1 |
| 7. | Graduated glass measuring cylinder | As per requirement |
| 8. | Sets of sieves of 450mm internal dia for coarse aggregate [100mm, 80mm, 40mm; 20mm; 12.5mm, 10mm; 4.75mm complete with lid and pan] | 2 |
| 9. | Sets of sieves of 200mm internal dia for fine aggregate [4.75mm; 2.36mm; 1.18mm; 600 microns; 300 microns & 150 micron , with lid and pan] | 2 |
| 10. | Sieve Brushes and sieve shaker capable of 200mm and 300mm dia sieves , manually operated with timing switch assembly | 1 |
| 11. | Cube moulds size 70mmx70mmx70mm | 18 |
| 12. | Cube moulds size 150mmx150mmx150mm | 72 |
| 13. | Ultrasonic Test Equipment (For concrete) | 1 |
| 14. | Hot air oven temp. Range $50^{o}$c to $300^{o}$c- sensivity 1 degree | 1 |
| 15. | Electronic balance 600gx0.1g., 10kg and 50 kg | 2 |
| 16. | Physical balance weight upto 5 kg | 1 |
| 17. | Digital thermometer upto 150oc | 2 |
| 18. | Air Content of concrete testing machine | 1 |
| 19. | Measuring jars 100ml, 200ml, 500ml | 3 nos each size |
| 20. | Gauging trowels 100mm & 200mm with wooden handle | 2 |
| 21. | Spatula 100mm & 200mm with long blade wooden handle | 2 |

| Sl. No | Equipment | Numbers (Minimum) |
|---|---|---|
| 22. | Vernier calipers 12” & 6” size | 2 each |
| 23. | Digital PH meter least count 0.01mm | 1each |
| 24. | Digital Micrometer least count. 0.01mm | 1 each |
| 25. | Digital paint thickness meter for steel 500 micron range | 2 |
| 26. | GI tray 600x450x50mm, 450x300x40mm,300x250x40mm | 2 nos each |
| 27. | Electric Motor mixer 0.25 cum capacity | 2 |
| 28. | Rebound hammer test digital rebound hammer | 2 |
| 29. | Screw gauge 0.1mm-10mm, least count 0.05 | 4 |
| 30. | Water testing kit | 2 |
| 31. | Motorized sieve shaker | 1 |
| 32. | Pruning Rods 2 Kg weight length 40 cm and ramming face 25 mm2 | 2 |
| 33. | Extra Bottom plates for 15 cm cube mould | 10 |
| 34. | Standard Vibration Table for gauging the cubes | 1 |
| 35. | Pocket concrete penetrometer 0 to 50kg/ sq.cm | 1 |
| 36. | Concrete temperature measuring thermometer with Brass protection sheath 0- 100 degree centigrade | 2 |
| 37. | Mortar Cube vibrator | 1 |
| 38. | Dial type spring balance preferable with zero correction knob capacity 100 kgs reading to ½ kg. | 1 |
| 39. | Counter scale capacity 1 kg and 10 kg | 1 |
| 40.a | Iron Weight of 5 kg, 2 kg, 1 kg, 500 gm, 200 gm, 100 gm | 1 each |
| 40 .b | Standard Weights up to 2000 kg for calibration of Batching Plant at site | 1 Set |
| 41. | Brass Weight of 50 gm, 20 gm, 10 gm, 5 gm, 2 gm, 1 gm | 1 each |
| 42. | Measuring cylinder TPX or Poly propylene capacity 100 ml, 500 ml, 250 ml, 100 ml | 1 each |
| 43. | Pyrex, corning or Borosil beakers with cover capacity 500 ml, 200 ml, 50 ml | 2 each |
| 44. | Wash Bottles capacity 500 ml | 3 |
| 45. | Thermometers 1-100 degree centigrades/ max. and Min/ Dry and wet with table | 3 |
| 46. | Set of box spanner ratchet | 2 |
| 47. | Hammer 1lb& 2lb | 2 each |
| 48. | Rubber Hammer | 2 |

| Sl. No | Equipment | Numbers (Minimum) |
|---|---|---|
| 49. | Hacksaw with 6 blades | 2 |
| 50. | Measuring tape 3 mtrs, 5 Mtrs, 15 Mtrs, 30 Mtrs | 5 Nos Each |
| 51. | Depth gauge 20cm | 3 |
| 52. | Shovels& Spade | 3 |
| 53. | Steel plates 5 mm thick 75x75 cm | 4 |
| 54. | Plastic or G.I. Buckets 15 ltr, 10 ltr, 5 ltr | 1 each |
| 55. | Wheel Barrow | 3 |
| 56. | Floor Brushes, hair dusters, scrappers, wire brush, paint brushes, shutter steel plat oil, kerosene with stove etc. | 5 each |
| 57. | Any other equipment for site tests as outlined in BIS codes and as directed by the Engineer-in-charge. | |
| 58. | Equipment for testing of soil compaction by Sand Replacement and Core Cutting Method. | 1 set each |

**ANNEXURE II**

## 5.4 PLANT AND EQUIPMENT REQUIRED TO BE OWNED / TAKEN ON LEASE BY THE CONTRACTOR

| S. No. | Machinery | Nos. |
|---|---|---|
| 1 | Excavator cum loader ( L& T Poclain- PC- 200 or equivalent) with rock breaker arrangement | 3 |
| 2 | Excavator cum loader ( L& T Poclain- PC- 72 or equivalent) | 1 |
| 3 | Excavator cum loader ( JCB 3 D Model or equivalent) | 2 |
| 4 | Tower crane of 45mtr. Ht. | 6 |
| 5 | Builders hoist | 8 |
| 6 | Concrete pump( Minimum capacity 30 Cum Per hour and Head 90 M) | 4 |
| 7 | Boom Placer | 2 |
| 8 | Needle vibrators | 15 |
| 9 | Transit Mixers | 4 |
| 10 | Automatic Concrete Batching plants, **(with silo)** electrically operated with DG Backup, Automatic Load Cell Weigh batching system (Minimum Capacity 30 Cu. M. per hour) | **1** |
| 11 | Earth Compactors | 2 |
| 12 | Total Stations | **4** |
| 12 | Auto Level | 4 |
| 13 | Electric pump/Centrifugal mono block water pump for curing and dewatering | As required on site |
| 14 | Dumpers | 2 |
| 15 | Vibratory Roller(10 T) | 1 |
| 16 | Mini Roller(2T) | 1 |
| 15 | Plate vibrators | 3 |
| 16 | Bar bending machine | 10 |
| 17 | Bar cutting machine | 10 |
| 18 | Water Tanker | 3 |
| 19 | Mortar Mixers | 3 |

**Note : The above list is only indicative and not exhaustive.** The contractor is required to deploy necessary equipment for achieving the progress as per Milestone Schedule given in Schedule F Clause 5 and the completion of Entire Work within 36 Months' time from the start of work. These resources are minimum for peak period of each activity. All plants and equipments need not to be mobilized simultaneously, plants and equipments as required as per the progress of work shall be brought at site in advance as directed by the engineer in charge.

**ANNEXURE III**

## 5.5 RECOVERY RATES FOR QUANTITIES BEYOND PERMISSIBLE VARIATION

| S. No. | Description of Item | Rates in figures and words at which recovery shall be made from the Contractor | |
|---|---|---|---|
| | | Excess beyond permissible variation | Less use beyond permissible variation |
| 1. | Cement PPC Conforming to IS 1489 (Part I) Fly ash based | Nil | **Rs 6000/-** Per MT |
| 2. | Steel Reinforcement TMT Bar of all diameters | Nil | **NA** |
| 3. | Structural Sections | Nil | **NA.** |

**Items which are to be executed through specialized agency: As detailed at clause No. 6.1.44 of special conditions.**

The agency shall be got approved from the Engineer In Charge before start of specialized work.

## 5.6 Deployment Schedule

**Annexure IV**

| | | | | | | Months | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S No. | Designation | Discipline | Qualification | Experience | Total MM | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | | Remarks |
| 1 | Project Manager | Civil | Graduate | 20 years | 36 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 36 | Completion |
| 2 | Dy. PM -1 | Civil | Graduate | 15 years | 31 | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | | 31 | |
| 3 | Dy. PM -2 | Civil | Graduate | 15 years | 32 | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 32 | |
| 4 | Dy. PM -3 | Electrical | Graduate | 15 years | 35 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 35 | Completion |
| 5 | Senior Engineer-01 | Civil( Quality) | Graduate | 8 years | 36 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 36 | |
| 6 | Senior Engineer-02 | Civil(Billing) | Graduate | 6 years | 35 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 35 | Completion |
| 7 | Senior Engineer-03 | Civil(Planning) | Graduate | 6 years | 36 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 36 | Completion |
| 8 | Senior Engineer-04 | Civil | Graduate/D | 5 years/10 | 91 | 1 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 91 | |
| 10 | Senior Engineer-05 | Civil | Graduate/D | 5 years/10 | 34 | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 34 | |
| 11 | Senior Engineer-06 | Mechanical | Graduate/D | 5 years/10 | 59 | | | | | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 59 | |
| 12 | Senior Engineer-07 | Electrical | Graduate/D | 5 years/10 | 62 | | | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 62 | |
| 13 | Junior Engineer-04 | Civil | Diploma | 5 years | 98 | 1 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 1 | 98 | |
| | Junior Engineer-06 | Plumbing | Diploma | 5 years | 66 | | | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 66 | Completion |
| 16 | Junior Engineer-05 | Civil(Survey) | Diploma | 8 years | 36 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 36 | |
| 17 | Chief SHE Manager | Safety | PG Dip in Ind.Saf | 5 years | 36 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 36 | |
| 18 | Junior SHE Manager | Safety | GR/Dip | 2 years | 69 | | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 69 | |
| 19 | Environment Manager | Safety | PG Dip in Env | 2 years | 36 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 36 | Completion |
| | | | | | 828 | | | | | | | | | | | 25 | | | | | | | | | | | | | | | | | | | | | | | | | | 828 | |
| | Note: | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Supervisor | Civil | | | | As per requirement at site | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Safety Steward | Safety | Basic Qual with SHE certificate | | | As per requirement at site | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

# SOUTH ASIAN UNIVERSITY

Akbar Bhawan, Chanakyapuri, New Delhi

**Construction of South Asian University Campus at Maidan Garhi, New Delhi. Package-III: (i) Administration Building (ii) Library Building (iii) Institute of South Asian Studies and Interdisciplinary Research (iv) Faculty of Law and Humanities (v) Faculty of Physics, Chemistry, Maths and I.T. (vi) Faculty of Art & Design and Convention Centre (vii) Utility Building: Including Basements, Superstructures, Interior Finishes, Internal Water Supply, Sanitary Installations, Drainage, Internal Electrical Installations, HVAC, Lifts, Fire Fighting System, Low Voltage System ; PA System, Solar Water Heating System etc. External Site Development and Infrastructure; Roads, Street Lighting, Sewerage, Storm Water Drainage, STP, WTP, Water Supply, HT & LT Power Distribution, Electrical Substation, Chiller Plant, Pump House, D.G. Sets, Rainwater Harvesting, Hardscaping etc.**

**Percentage Rate Tender for Works**

**PART A**
**Technical / Eligibility Bid**
**Notice Inviting Tender, Eligibility Criteria,**
**General Conditions of Contract**

**PART B**
**Special Conditions and Particular Specifications**
**and Tender Drawings**

**PART C**
**Financial Bid**

**September 2016**

# 6.0 PART-B
# SPECIAL CONDITIONS & PARTICULAR / TECHNICAL SPECIFICATIONS

| | | |
|---|---|---|
| **6.0** | **PART – B SPECIAL, ADDITIONAL CONDITIONS & PARTICULAR/ TECHNICAL SPECIFICATIONS** | |
| | **6.1 SPECIAL CONDITIONS - GENERAL** | |
| | **6.1.1** | The Contractors are advised to inspect and examine the site and its surroundings and satisfy themselves with the nature of site, the means of access to the site, the constraints of space for stacking material / machinery, labour etc. constraints put by local regulations, if any, weather conditions at site, general ground / subsoil conditions etc. or any other circumstances which may affect or influence their tenders. The site is available for work. The Contractor shall carry out survey of the work area, at his own cost, setting out the layout and fixing of alignment of the building as per architectural and Structural drawings in consultation with the Engineer-in-Charge and proceed further ensuring full structural continuity and integrated and monolithic construction. Any discrepancy between the architectural drawings and actual layout at site shall be brought to the notice of the Engineer-in-charge. It shall be responsibility of the Contractor to ensure correct setting out of alignment. Nothing extra shall be payable on this account. No claims, whatsoever, shall be entertained at a later date for any errors found, on plea that the information supplied by the SAU in the tender is insufficient or is at variance with the actual site conditions. |
| | **6.1.2** | The Contractor shall, if required by him, before submission of the tender, inspect the drawings in the Office of the Executive Engineer , SAU, Akbar Bhawan, Chanakyapuri, New Delhi-110021. The SAU shall not bear any responsibility for the lack of knowledge and also the consequences, thereof to the Contractor. The information and data shown in the drawings and mentioned in the tender documents have been furnished for general information and guidance only. The Engineer-in-Charge, in no case, shall be held responsible for the accuracy thereof and/or interpretations or conclusions drawn there from by the Contractor and all consequences shall be borne by the Contractor. No claim, whatsoever, shall be entertained from the Contractor, if the data or information furnished in tender document is different or in-correct otherwise or actual working drawings are at variance with the drawings available for inspection or attached to the tender documents. It is presumed that the Contractor shall satisfy himself for all possible contingencies, incidental charges, wastages, bottlenecks etc. likely during execution of work and acts of coordination, which may be required between different agencies. Nothing extra shall be payable on this account. |
| | **6.1.3** | The nomenclature of the item given in the schedule of quantities gives in general the work content but is not exhaustive i.e. does not mention all the incidental works required to be carried out for complete execution of the item of work. The work shall be carried out, all in accordance with true intent and meaning of the specifications and the drawings taken together, regardless of whether the same may or may not be particularly shown on the drawings and/or described in the specifications, provided that the same can be reasonably inferred there from may be several incidental works, which are not mentioned in the nomenclature of each item but will be necessary to complete the item in all respect. All these incidental works / costs which are not mentioned in item nomenclature but are necessary to complete the item shall be deemed to have been included in the rates quoted by the contractor for various items in the schedule of quantities. No adjustment of rates shall be made for any variation in quantum of incidental works due to variation / change in actual working drawings(GFC). Also, no adjustment of rates shall be made due to any change in incidental works or any other deviation in such element of work (which is incidental to the items of work and are necessary to complete such items in all respects) on account of the directions of Engineer-in-Charge. Nothing extra shall be payable on this account. |

| | | |
|---|---|---|
| | | The contractor(s) shall give to the local body, police and other authorities all necessary notices etc. that may be required by law and obtain all requisite licenses for temporary obstructions, enclosures etc. and pay all fee, taxes and charges which may be leviable on account of these operations in executing the contract. He shall make good any damage to the adjoining property whether public or private and shall supply and maintain lights either for illumination or for cautioning the public at night.<br>Proper temporary barricading by fencing with G.I. sheets, shall be carried out by the Contractor at the start of work to physically define the boundaries of the plot for restricted entry to only those involved in the work and also to prevent any accidents, at the same time without causing any inconvenience to the traffic and the users of the buildings in the adjacent plots. It shall be done by providing, erecting, maintaining temporary protective barricading of minimum 3.0 meters in height, made in panels, with each panel having MS frames / MS scaffolding pipes of suitable size and stiffness, with 24 gauge thick GI corrugated sheet or suitably stiffened plain GI sheet fixed on frames. Such panels shall be suitably connected to each other for stability with nuts and bolts, hooks, clamps etc. and fixed firmly to the ground at about 2 meters spacing, for the entire duration till completion of the work. He shall also provide and erect temporary protective barricades within the plot, if required, to prevent any accident. Temporary protective roofing near the Entrance to the building, under construction, shall be made to protect the visiting officials from getting hurt by falling debris etc. Also, one or more coat of enamel paint of shade as approved and directed by the Engineer-in-Charge shall be applied on the panels and "SAU" shall be painted over that in suitable sizes, shapes and numbers as directed by the Engineer-in-Charge. It shall be dismantled and taken away by the Contractor after the completion of work at his own cost with the approval of the Engineer-in- Charge. Nothing extra shall be payable on this account.<br>The contractor shall maintain it during the complete period of execution and realign it if required, for execution of works. A penalty of Rs. 5,000/- per day shall be levied for not maintaining the barricading in good condition or breach of any of the above conditions as per the direction of Engineer-in-charge. |
| | **6.1.4** | The Contractor(s) shall take all precautions to avoid accidents by exhibiting necessary caution boards day and night. In case of any accident of labours/ contractual staffs the entire responsibility will rest on the part of the contractor and any compensation under such circumstances, if becomes payable, shall be entirely borne by the contractor. |
| | **6.1.5** | The work shall generally be carried out in accordance with the "CPWD Specifications 2009 Vol. I & II" with up to date correction slips, additional/Particular Specifications, architectural/Structural drawings and as per instructions of Engineer-in-Charge. Any additional item of the work, if taken up subsequently, shall also conform to the relevant CPWD specifications as mentioned above. |
| | **6.1.6** | The several documents forming the tender are to be taken as mutually complementary to one another. Detailed drawings shall be followed in preference to small scale drawings and figured dimensions in preference to scale dimensions. |
| | **6.1.7** | There be any difference or discrepancy between the description of items as given in the schedule of quantities, particular specifications for individual items of work (including special conditions) and I.S. Codes etc., the following order of preference shall be observed. |
| | **i)** | **Pre-bid clarifications** |
| | **ii)** | Description of items as given in Schedule of quantities |
| | **iii)** | Particular Specifications / Technical Specifications |
| | **iv)** | Special Conditions |
| | **v)** | Tender drawings attached |
| | **vi)** | CPWD Specifications including correction slips issued up to the last date of uploading/submission of tender. |
| | **vii)** | General Conditions of Contract for CPWD works including correction slips issued up to the last date of uploading/submission of tender. |
| | **viii)** | Indian Standards Specifications of B.I.S. |
| | **ix)** | ASTM, BS, or other foreign origin code mentioned in tender document. |

| | | |
|---|---|---|
| | **x)** | Manufacturer's specifications and as decided by the Engineer-in-Charge. |
| | **xi)** | Sound Engineering practices or well established local construction practices |
| | **6.1.8** | The works to be governed by this contract shall cover delivery and transportation up to destination, safe custody at site, insurance, erection, testing and commissioning of the entire works. The works to be undertaken by the contractor shall inter-alia include the following: |
| | **i)** | Preparation of detailed SHOP drawings and AS BUILT drawings wherever applicable. |
| | **ii)** | Obtaining of Statutory permissions where-ever applicable and required. |
| | **iii)** | Pre-commissioning tests as per relevant standard specifications, code of practice, Acts and Rules wherever required. |
| | **iv)** | Warranty obligation for the equipment and / or fittings/fixtures supplied by the contractor. Contractor shall provide all the shop drawings or layout drawings for all the coordinated services before starting any work or placing any order of any of the services etc. These shop drawings/layout drawings shall be got approved from Engineer-in-charge before implementation and this shall be binding on the contractor. The contractor shall submit material submittals along with material sample / mock-ups for approval of Engineer-in-Charge prior to delivery of material at site. |
| | **v)** | All shop drawings submitted by the Contractor as per approved schedule shall be got approved by Engineer In Charge or his authorized representative before start of work. |
| | **6.1.9** | The work shall be carried out in accordance with the approved architectural drawings, structural drawings, service drawings to be issued from time to time, by the Engineer-in-Charge. Before commencement of any item of work the contractor shall correlate all the relevant architectural and structural drawings, nomenclature of items and specifications etc. issued for the work and satisfy himself that the information available from there is complete and unambiguous. The figure and written dimension of the drawings shall be superseding the measurement by scale. The discrepancy, if any, shall be brought to the notice of the Engineer-in- charge before execution of the work. The contractor alone shall be responsible for any loss or damage occurring by the commencement of work on the basis of any erroneous and or incomplete information and no claim whatsoever shall be entertained by the SAU on this account. |
| | **6.1.10** | Unless otherwise provided in the Schedule of quantities vide Part-C, the rates tendered by the contractor shall be all inclusive and shall apply to all heights, lifts, leads and depths of the building and nothing extra shall be payable to him on this account. Payment for centering, shuttering, however, if required to be done for floor heights greater than 3.5m shall be admissible at rates arrived in accordance with clause 12 of the agreement if not already specified. |
| | **6.1.11** | The Contractor(s) shall take instructions from the Engineer-in-Charge regarding collection and stacking of materials at any place. No excavated earth or building rubbish shall be stacked on areas where other buildings, roads, services and compound walls are to be constructed. The stacking shall take place as per stacking plan however, if any change is required, the same shall be done with the approval of Engineer-in-Charge. |
| | **6.1.12** | The contractor shall engage specialized agency for carrying out specialized items mentioned in this document. Before engaging such agency, the contractor shall submit the details for the approval of Engineer-in-charge, the name of the agency along with their working experience, presentation on method statement and materials being used for execution of such items etc. |
| | **6.1.13** | The Contractor shall bear all incidental charges for cartage, storage and safe custody of materials, if any, issued by SAU as well as to those materials also arranged by the contractor. |
| | **6.1.14** | Any cement slurry added over base surface (or) for continuation of concreting for better bond is deemed to have been built in the items and nothing extra shall be payable or extra cement considered in consumption on this account. |
| | **6.1.15** | The contractor shall give performance test of the entire installation(s) as per the specifications in the presence of the Engineer-in-charge or his authorized |

| | | |
|---|---|---|
| | | representative before the work is finally accepted and nothing extra what-so-ever shall be payable to the contractor for such test. |
| | **6.1.16** | Water tanks, taps, sanitary, water supply & drainage pipes, fittings & accessories should conform to bye-laws of local body/corporation, where CPWD specifications are not available. The Contractor should engage approved, licensed plumbers for the work and get the materials (fixtures/fittings) tested, by the municipal Body/ Corporation authorities wherever required at his own cost. The Contractor shall submit for the approval of the Engineer-in- Charge, the name of the plumbing agency (along with their working experience in recent past) proposed to be engaged by him.<br>The contractor shall make his own arrangements for water and for obtaining electric connections if required and make necessary payments directly to the State Govt. SAUs concerned. Contractor shall get the water tested from laboratory approved by the Engineer-in-charge at regular interval as per the CPWD Specifications 2009. All expenses towards collection of samples, packing, transportation etc. shall be borne by the contractor. Agency shall neither be allowed to use existing borewell, if any, nor shall be allowed to dig any borewell in the site premises unless he got permission from the concerned authority. The contractor shall install water treatment plant at site and treat the water to obtain the desired parameter of water quality required for construction as per relevant IS codes. |
| | **6.1.17** | Site test register & **MAS** Registers to be maintained by contractor:<br>All test registers and MAS registers issued by the engineer-in-charge shall be maintained by the contractor which will be reviewed by the officers of **Engineer-in-charge,** or a person authorized by SAU at regular intervals. These may also be reviewed by Engineer in charge, SAU as and when required. Frequency of tests will be governed by the CPWD specifications 2009 Volume I & II with correction slips up to **last date of uploading/ submission of tender by SAU.** |
| | **6.1.18** | **PREVENTION OF NUISANCE AND POLUTION CONTROL**<br>The contractor shall take all necessary precautions to prevent any nuisance or inconvenience to the owners, tenants or occupiers of adjacent properties and to the public in general and to prevent any damage to such properties from pollutants like smoke, dust, noise. The contractor shall use such methodology and equipment so as to cause minimum environmental pollution of any kind during and minimum hindrance to road users and to occupants of the adjacent properties or other services running adjacent/near vicinity. The contractor shall make good at his cost and to the satisfaction of the Engineer-in-Charge, any damage to roads, paths, cross drainage works or public or private property whatsoever caused due to the execution of the work or by traffic brought thereon by the contractor. All waste or superfluous materials shall be carried away by the contractor, without any reservation, entirely to the satisfaction of the Engineer-in-Charge. The contractor shall follow the guidelines of South Delhi Municipal Corporation, Delhi Pollution Control Board, National Green Tribunal and all other concerned government departments and statutory bodies. |
| | **6.1.19** | Utmost care shall be taken to keep the noise level to the barest minimum so that no disturbance as far as possible is caused to the nearby occupants/users of building(s), if any. |
| | **6.1.20** | **SECURITY AND TRAFFIC ARRANGEMENTS**<br>In the event of any restrictions being imposed by the Security agency, SAU, Traffic or any other authority having jurisdiction in the area on the working or movement of labour /material, the contractor shall strictly follow such restrictions and nothing extra shall be payable to the contractor on such accounts. The loss of time on these accounts, if any, shall have to be made up by augmenting additional resources whatever required. |
| | **6.1.21** | SAU will earmark land area about **2500 sqm** within SAU site, free of cost for establishing the labour hut on as is where is basis. The agency may visit the site to ascertain the feasibility with respect to prevailing labour regulations. The labour camp shall be properly isolated with 3 meters high metal barricading and security arrangements acceptable to SAU. The Contractor shall make his own arrangements to provide such accommodation as per the rules of the local bodies. Nothing shall be paid extra on account of such barricading and security of labour camp. |

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| | **6.1.22** | No payment shall be made for any damage caused by rain, snowfall, flood or any other natural calamity, whatsoever during the execution of the work. The contractor shall be fully responsible for any damage to the govt. property and the work for which payment has been advanced to him under the contract and he shall make good the same at his risk and cost. The contractor shall be fully responsible for safety and security of his material, T&P/Machinery brought to the site by him. |
| | **6.1.23** | The contractor shall construct suitable godowns, yard at the site of work for storing all materials so as to be safe against damage by sun, rain, damages, fire, theft etc. at his own cost and also employ necessary watch and ward establishment for the purpose at his cost. Total area of approximately **8000 sqm** shall be earmarked for establishing the batching plant and office of the contractor at above site free of cost. Before starting such office/ yard the agency will submit a layout plan to SAU for approval This shall be maintained as per the prevailing norms of DPCC and NGT failing which a suitable penalty shall be imposed on the agency. The agency will barricade this area at his own cost and nothing shall be paid on this account. |
| | **6.1.24** | All materials brought at site by contractor shall be got checked by the representative of Engineer-in-Charge on receipt of the same at site before use. |
| | **6.1.25** | Royalty at the prevalent rates shall have to be paid by the contractor on all the boulders, metals, shingle sand and bajri etc. collected by him for the execution of the work, direct to the Revenue authority or authorized agent of the State Government concerned or Central Government. |
| | **6.1.26** | The contractor shall be responsible for the watch and ward/guard of the buildings, safety of all fittings and fixtures including all equipment, services provided by him against pilferage and breakage during the period of Installations and thereafter till the building is physically handed over to SAU. No extra payment shall be made on this account and no claim shall be admissible on this account. The Contractor shall keep himself fully informed of all acts and laws of the Central & State Governments, all orders, decrees of statutory bodies, tribunals having any jurisdiction or authority, which in any manner may affect those engaged or employed and anything related to carrying out the work. All the rules & regulations and bye-laws laid down by Collector / DDA / NDMC/SDMC and any other statutory bodies shall be adhered to, by the contractor, during the execution of work. The Contractor shall also adhere to all traffic restrictions notified by the local authorities. The extra sewerage charges (one time charges for commencement of work) required to be paid to the Municipal Corporation/ other statutory bodies shall be paid by the SAU and need not be considered by the contractor. All statutory taxes, levies, charges (including water and sewerage charges, charges for temporary service connections and / or any other charges) payable to such authorities for carrying out the work, shall be borne by the Contractor. The water charges (for municipal water connection as well as tanker water) shall be borne by the contractor. Also, if the contractor obtains water connection for drinking purposes from the municipal authorities or any other statutory body, the consequent sewerage charges shall be borne by the contractor. The clause 31A (Supply of water by department) of the General conditions of contract for CPWD works is not applicable to the tender. The Contractor shall arrange to give all notices as required by any statutory / regulatory authority and shall pay to such authority all the fees that is required to be paid for the execution of work. He shall protect and indemnify the SAU and its officials & employees against any claim and /or liability arising out of violations of any such laws, ordinances, orders, decrees, by himself or by his employees or his authorized representatives. Nothing extra shall be payable on these accounts. The fee payable to statutory authorities for obtaining the various permanent service connections and Occupancy Certificate for the building shall be borne by the SAU. |
| | **6.1.27** | For works below ground level the contractor shall keep that area free from water. If dewatering or bailing out of water is required the contractor shall do the same at his own cost and nothing extra shall be paid except otherwise provided in the items of Schedule of Quantities |

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| | **6.1.28** | The Contractor shall make all necessary arrangements for protecting from rains, fog or likewise extreme weather conditions, the work already executed and for carrying out further work, during monsoon including providing and fixing temporary shelters, protections etc. Nothing extra shall be payable on this account and also no claims for hindrance shall be entertained on this account. |
| | **6.1.29** | In case of flooding of site on account of rain or any other cause and any consequent damage, whatsoever, no claim financially or otherwise shall be entertained notwithstanding any other provisions elsewhere in the contract agreement. Also, the Contractor shall make good, at his own cost, the damages caused, if any. Further, no claims for hindrance shall be entertained on this account. |
| | **6.1.30** | The contractor will take reasonable precautions to prevent his workman and employees from removing and damaging any flora (plant/vegetation) & fauna from the project area. |
| | **6.1.31** | **SETTING OUT** |
| | **i)** | The Contractor shall carry out survey of the work area, at his own cost, setting out the layout of building in consultation with the Engineer -in-Charge & proceed further. Any discrepancy between the Engineer-in-charge, architectural drawings and actual layout at site shall be brought to the notice of the Engineer -in-charge. It shall be responsibility of the Contractor to ensure correct setting out of alignment. Total station survey instruments only shall be used for layout, fixing boundaries, and centre lines, etc., Nothing extra shall be payable on this account. |
| | **ii)** | The Contractor shall establish, maintain and assume responsibility for grades, lines, levels and benchmarks. He shall report any errors or inconsistencies regarding grades, lines, levels, dimensions etc. to the Engineer -in-Charge before commencing work. Commencement of work shall be regarded as the Contractor's acceptance of such grades, lines, levels, and dimensions and no claim shall be entertained at a later date for any errors found. |
| | **iii)** | If at any time, any error appears due to grades, lines, levels and benchmarks during the progress of the work, the Contractor shall, at his own expense rectify such error, if so required, to the satisfaction of the Engineer -in-Charge. Nothing extra shall be payable on this account |
| | **iv)** | Though the site levels are indicated in the drawings the Contractor shall ascertain and confirm the site levels with respect to benchmark from the concerned authorities. The Contractor shall protect and maintain temporary/ permanent benchmarks at the site of work throughout the execution of work. These benchmarks shall be got checked by the Engineer-in-Charge or his authorized representatives. The work at different stages shall be checked with reference to bench marks maintained for the said purpose. Nothing extra shall be payable on this account. |
| | **v)** | The approval by the Engineer-in-Charge, of the setting out by the Contractor, shall not relieve the Contractor of any of his responsibilities and obligation to rectify the errors/ defects, if any, which may be found at any stage during the progress of the work or after the completion of the work. |
| | **vi)** | The Contractor shall be entirely and exclusively responsible for the horizontal, vertical and other alignments, the level and correctness of every part of the work and shall rectify effectively any errors or imperfections therein. Such rectifications shall be carried out by the Contractor at his own cost to the entire satisfaction of the Engineer - in-Charge. |
| | **vii)** | The rates quoted by the Contractor are deemed to be inclusive of site clearance, setting out work (including marking of reference points, center lines of buildings), construction and maintenance of reference bench mark(s), taking spot levels, construction of all safety and protection devices, barriers, barricading, signage, labour safety, labour welfare and labour training measures, preparatory works, working during monsoon, working at all depths, height and location etc. and any other incidental works required to complete this work. Nothing extra shall be payable on this account. |

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| | **6.1.32** | A site laboratory with the minimum equipment as specified in CPWD specifications/in this agreement shall be established, made functional and maintained within one month from the award of work as per Annexure-I without any extra cost to the SAU. In case of non compliance / delay in compliance in this, a recovery @ Rs. 5000/- per day will be imposed which will be recovered from the immediate next R/A Bill of the Contractor. The agency will calibrate all lab equipment as per manufacturers specifications and shall maintain a frequency chart of calibration of various lab equipment. The calibration certificate for equipment used for this project shall not be 3 month older than date of start of work. The agency will maintain a frequency chart for calibration of equipment at laboratory. The frequency of calibration of batching plant shall be one month. Notwithstanding above SAU will have the right to send the samples to independent third party labs to ensure the correctness of the equipment provided in lab. |
| | **6.1.33** | **INTEGRATED SERVICE DRAWINGS**<br>Before taking up the work, the contractor shall be provided progressively with integrated drawings for various civil and electrical services showing details of layout plan including sectional elevations and contractor shall plan and mobilize his resources as per the Integrated drawings and as per the site conditions to facilitate convenient execution, installation as well as maintenance of these services. Nothing extra shall be payable on this account. The contractor shall intimate requirement of additional integrated drawings fifteen days in advance before execution of work. |
| | **6.1.34** | **TOOLS AND PLANTS**<br>The bidder should have own constructions equipment required for the proper and timely execution of the work. Nothing extra shall be paid on this account.<br>No tools and plants including any special T&P etc. shall be supplied by the SAU and the Contractor shall have to make his own arrangements at his own cost. No claim of hindrance (or any other claim) shall be entertained on this account. |
| | **6.1.35** | **SCAFFOLDING**<br>Wherever required for the execution of work, all the scaffolding shall be provided and suitably fixed, by the Contractor. It shall be provided strictly with steel double scaffolding system, suitably braced for stability, with all the accessories, gangways, etc. with adjustable suitable working platforms to access the areas with ease for working and inspection. It shall be designed to take all incidental loads. It should cater to the safety features for workmen. Nothing extra shall be payable on this account unless mentioned in the item. It shall be ensured that no damage is caused to any structure due to the scaffolding. **The contractor shall prepare detailed drawing for all temporary works like scaffolding, centering and shuttering and get it vetted from the third party consultant approved by the Engineer In Charge.** |
| | **6.1.36** | The Contractor shall do proper sequencing of the various activities by suitably staggering the activities within various pockets in the plot so as to achieve early completion. The agency to deploy adequate equipment, machinery and labour as required for the completion of the entire work within the stipulated period specified. Also ancillary facilities shall be provided by contractor commensurate with requirement to complete the entire work within the stipulated period. Nothing extra shall be payable on this account. Adequate number/sets of equipment in working condition, along with adequate stand-by arrangements, shall be deployed during entire construction period. It shall be ensured by the Contractor that all the equipment, Tools & Plants, machineries etc. provided by him are maintained in proper working conditions at all times during the progress of the work and till the completion of the work. Further, all the constructional tools, plants, equipment and machineries provided by the Contractor, on site of work or his workshop for this work, shall be exclusively intended for use in the construction of this work and they shall not be shifted/ removed from site without the permission of the Engineer-in- Charge. |

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| | | The agency shall not use more than 10 year old machinery in the above unless the permission is obtained in special case from SAU and shall keep the valid registration and fitness certificates all the time for inspection. The agency will deploy only certified and competent operator for operation of various machinery. |
| | **6.1.37** | The Contractor shall maintain all the work in good condition till the completion of entire work. The Contractor shall be responsible for and shall make good, all damages and repairs, rendered necessary due to fire, rain, traffic, floods or any other causes. The Engineer-in- Charge shall not be responsible for any claims for injuries to person/workmen or for structural damage to property happening from any neglect, default, want of proper care or misconduct on the part of the Contractor or of any other of his representatives, in his employment during the execution of the work. The compensation, if any, shall be paid directly to the SAU / authority / persons concerned, by the Contractor at his own cost. |
| | **6.1.38** | **ROYALTY**<br>Royalty at the prevalent rates shall be paid by the Contractor or the RMC supplier as per the terms of supply between them, on all materials such as boulders, metals, all sizes stone aggregates, brick aggregates, coarse and fine sand, moorum, river sand, gravels and bajri etc. collected by him for the execution of the work, directly to the revenue authority of the state government concerned. Further, contractor needs to submit proof of submission of full royalty to the state government or local authority. Nothing extra shall be payable on this account |
| | **6.1.39** | **PRESERVATION AND CONSERVATION MEASURES** |
| | **i)** | Existing drains, pipes, cables, over-head wires, sewer lines, water lines and similar services, if any, encountered in the course of the execution of work shall be protected against the damage by the contractor at his own expense. In case the same are to be removed and diverted, expenditure incurred in doing so shall be payable to the contractor. The contractor shall work out the cost, get the same approved by Engineer- in- Charge before taking up actual execution. The contractor shall not store materials or otherwise occupy any part of the site in a manner likely to hinder the operation of such services. |
| | **ii)** | All fossils, coins, articles of value of antiquity, structures and other remains or things of geological or archaeological interest discovered on project location during excavation/construction shall be the property of SAU, and shall be dealt with as per provisions of the relevant legislation. The contractor will take reasonable precaution to prevent his work men or any other persons from removing and damaging any such article or thing. He will, immediately upon discovery thereof and before removal acquaint the Engineer-in-charge of such discovery and carry out the official instructions of Engineer-in- charge for dealing with the same, till then all work shall be carried out in a way so as not to disturb/damage such article or thing. |

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| | **6.1.40** | **RESPONSIBILITY** |
| | **i)** | He shall protect and indemnify SAU and its officials & employees against any claim and /or liability arising out of violations of any such laws, ordinances, orders, decrees, by himself or by his employees or his authorized representatives. Nothing extra shall be payable on these accounts. |
| | **ii)** | The fee payable to statutory authorities for obtaining the various permanent service connections and Building Use Certificate for the building shall be borne by the SAU. |
| | **iii)** | The Contractor shall assume all liability, financial or otherwise in connection with this contract and shall protect and indemnify SAU from any and all damages and claims that may arise on any account. The Contractor shall indemnify the SAU against all claims in respect of patent rights, royalties, design, trademarks- of name or other protected rights, damages to adjacent buildings, roads or members of public, in course of execution of work or any other reasons whatsoever, and shall himself defend all actions arising from such claims and shall indemnify the SAU in all respect from such actions, costs and expenses. Nothing extra shall be payable on this account. |
| | **iv)** | The Contractor shall be responsible for any liability imposed by law for any damage to the Work or any part thereof or to any of the materials or other things used in performing the Work or for injury to any person or persons or any property damage in or based under Work limit. The Contractor shall indemnify, keep indemnified and hold, the SAU, harmless against any and all liability, claims, loss or injury, including costs, expenses, and attorney's fees incurred in the defense of the same, arising from any allegations, whether groundless or not, of damage or injury to any person or property resulting from the performance of the Work or from any material used in the Work or from any portion of the Work or Work site or non- payment of statutory dues of any nature and penalty thereon or from any cause whatsoever during the process of the Work. The Contractor shall provide, during the entire Contract Period, such indemnification in the proforma approved by engineer in charge on a non -judicial stamp paper of appropriate value. |
| | **6.1.41** | **CO-OPERATION WITH OTHER CONTRACTORS/SPECIALIZED AGENCIES / SUB- CONTRACTORS** |
| | **i)** | The Contractor shall take all precautions to abide by the environmental related restrictions imposed by any statutory body having jurisdiction in Delhi as well as prevent any pollution of streams, ravines, river bed and waterways. All waste or superfluous materials shall be transported by the Contractor, entirely to the satisfaction of the Engineer- in-Charge and disposed at designated places only. Utmost care shall be taken to keep the noise level to the barest minimum so that no disturbance as far as possible is caused to the occupants / users of adjoining buildings. No claim what so ever on account of site constraints mentioned above or any other site constraints, lack of public transport, , inadequate availability of skilled, semi-skilled or unskilled workers in the near vicinity, non-availability of construction machinery spare parts and any other constraints not specifically stated here, shall be entertained from the Contractor. Therefore, the Tenderers are advised to visit site and get first-hand information of site constraints. Accordingly, they should quote their tenders. Nothing extra shall be payable on this account. |
| | **ii)** | The Contractor shall cooperate with and provide the facilities to the other agencies working at site for smooth execution of the work. The contractor shall indemnify the SAU against any claim(s) arising out of such disputes. The Contractor shall: |
| | **a)** | Allow use of scaffolding, toilets, sheds etc. |
| | **b)** | Properly co-ordinate their work with the work of other Contractors |
| | **c)** | Provide control lines and benchmarks to his Sub-Contractors and the other Contractors. |
| | **d)** | Provide electricity and water at mutually agreed rates. |
| | **e)** | Provide hoist and crane facilities for lifting material at mutually agreed rates. |
| | **f)** | Co-ordinate with other Contractors for leaving inserts, making chases, alignment of services etc. at site. |

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| | **g)** | Adjust work schedule and site activities in consultation with the Engineer-in-Charge and other Contractors to suit the overall schedule completion |
| | **h)** | Resolve the disputes with other Contractors/ sub-contractors amicably and the Engineer-in-Charge shall not be made intermediary or arbitrator. |
| | **iii)** | The work should be planned in a systematic manner so as to ensure proper co-ordination of various disciplines viz. sanitary & water supply, drainage, rain water harvesting, electrical, firefighting, information technology, communication & electronics and any other services. |
| | **iv)** | Other agencies will also simultaneously execute and install the works of sub- station / generating sets, air-conditioning, lifts, etc. for the work and the contractor shall afford necessary facilities for the same. The contractor shall leave such recesses, holes, openings trenches etc. as may be required for such related works (for which inserts, sleeves, brackets, conduits, base plates, clamps etc. shall be supplied free of cost by the SAU unless otherwise specifically mentioned) and the contractor shall fix the same at time of casting of concrete, stone work and brick work, if required, and nothing extra shall be payable on this account. |
| | **v)** | The contractor shall conduct his work, so as not to interfere with or hinder the progress or completion of the work being performed by other contractor(s) or by the Engineer-In-Charge and shall as far as possible arrange his work and shall place and dispose off the materials being used or removed so as not to interfere with the operations of other contractor or he shall arrange his work with that of the others in an acceptable and in a proper co -ordination manner and shall perform it in proper sequence to the complete satisfaction of others. |
| | **6.1.42** | **SUPERVISION OF WORK** |
| | **6.1.43** | The Contractor shall depute Site Engineer & skilled workers as required for the work. He shall submit organization chart along with details of Engineers and supervisory staff. It shall be ensured that all decision making powers shall be available to the representatives of the Contractor at New Delhi itself to avoid any likely delays on this account. The Contractor shall also furnish list of persons for specialized works to be executed for various items of work. The Contractor shall identify and deploy key persons having qualifications and experience in the similar and other major works, as per the field of their expertise. If during the course of execution of work, the Engineer-in-Charge is of the opinion that the deployed staff is not sufficient or not well experienced; the Contractor shall deploy more staff or better-experienced staff at site to complete the work with quality and in stipulated time limit. Principle Technical representative of the Contractor having minimum twenty years of experience in similar nature of work as mentioned in the clause 36 of the General Conditions of the Contract, shall always be available at the site during the actual execution of the work. The recovery of Rs. 1,00,000/- (One lac) per month shall be effected from the Contractor in the event of not fulfilling this provision. |
| | **6.1.44** | **Specialized Agencies** |
| | **i)** | The composite tender comprises of two main components: viz. civil work and E&M works. The list of specialized works is as below: |
| | a. | Structural glazing with Hermetically Sealed toughened double glass |
| | b. | Aluminum Glazing Systems |
| | c. | Factory Made Metal Doors – Fire Rated & Non Fire Rated |
| | d. | Modular False ceiling System of Mineral fiber, Metal etc. |
| | e. | Modular Toilet Cubicle System |
| | f. | Glass Reinforced Concrete work |
| | g. | Manual Three Winged Revolving Doors |
| | h. | M.S. Structural Steel Works covered with insulated Metal Sheet Roofing |
| | i. | Electrical Sub-station, DG Sets, GIS Switchgears, Panels, External Power Distribution External Lighting |
| | j. | Internal Electrical Installation- Distribution including light fittings and UPS System |
| | k. | Low Voltage Systems -Data, MATV, Telephone, Fire Alarm, PA, Conduiting and wiring for Access Control and CCTV System |
| | l. | Passenger and goods Elevators for vertical circulation. |
| | m. | HVAC High Side Works - Water Cooled Chillers, Chilled water Pumps, Cooling Towers etc. |

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| | n. | HVAC Low Side works Chilled water piping, AHUs and Ducting. |
| | o. | Building Management System |
| | p. | High Side PH Works - STP, WTP, ETP and Water Pumping Station, External Pipe lines for domestic, irrigation, Flushing, Sewer and storm water etc. |
| | q. | Low Side PH - water supply, drainage, rain water including sanitary fixtures and fittings and Solar water heating system. |
| | r. | High Side Fire Fighting System - Pumping Station, Yard Hydrants, External Pipelines for Hydrants, Sprinklers , Fire Curtain etc. |
| | s. | Low Side Firefighting System - Sprinklers and Risers including Gas based fire suppression system in sensitive areas. |
| | **ii)** | The main contractor shall submit the credential of specialized agency well in advance as per the direction of Engineer-in-charge. After verification of the same written approval will be conveyed to main contractor in this regard. The quantum of credentials will be broadly in line with guidelines issued by Engineer-in-Charge. The main contractor shall not change the specialized agency. However, if the change is warranted, he may do so, with permission of Engineer-in-charge. However before making any such change he has to enter into similar agreement as with previous agency & submit the same to Engineer - in – Charge for approval. This shall however be without any change in the accepted rates of the contract agreement and without any cost implications to the SAU. |
| | **iii)** | It shall be the responsibility of main contractor to sort out any dispute / litigation with the Specialized Agencies without any time & cost overrun to the SAU. The main contractor shall be solely responsible for settling any dispute / litigation arising out of his agreement with the Specialized Agencies. The contractor shall ensure that the work does not suffer on account of litigation/ dispute between him and the specialized agencies / sub- contractor(s). No claim of hindrance in the work shall be entertained from the Contractor on this account. No extension of time shall be granted and no claim what so ever, of any kind, shall be entertained from the Contractor on account of delay attributable to the selection/rejection of the Specialized Agencies or any dispute amongst them. |
| | **6.1.45** | **RATES** |
| | **i)** | The rates quoted by the Contractor are deemed to be inclusive of site clearance, setting out work, profile, setting lay out on ground, establishment of reference bench mark(s), installing various signage, taking spot levels, survey with total station, construction of all safety and protection devices, compulsory use of helmet and safety shoes, and other appropriate safety gadgets by workers, imparting continuous training for all the workers, barriers, preparatory works, construction of clean, hygienic and well ventilated workers housings in sufficient numbers as per drawing supplied by Engineer in charge, working during monsoon or odd season, working beyond normal hours, working at all depths, height, lead, lift, levels and location**, implementation of green building norms to achieve desired GRIHA Rating** etc. and any other unforeseen but essential incidental works required to complete this work. Nothing extra shall be payable on this account and no extension of time for completion of work shall be granted on these accounts. |
| | **ii)** | **TAXES:** The South Asian University is an Inter-Governmental Organization established by the SAARC (South Asian Association for Regional Co-operation) Nations and has been extended the Privileges and Immunities under Section '3' of the United Nations (Privileges and Immunities) Act, 1947 by the Government of India. The University is exempted from paying and collecting all Direct and Indirect Taxes in India.<br>In terms of Article 4(1) of the Agreement among SAARC Nations for establishment of South Asian University, "the (South Asian) University and its campuses and centres shall be exempted, in the state where they are located, from paying and from collecting all direct and indirect forms of taxes and duties for the establishment and operations of the University". In terms of Section-3 of the South Asian University Act 2008 (Act No. 8 of 2009) passed by the Parliament of the Republic of India, notwithstanding anything contrary contained in any other law, the provisions of the above referred Agreement among SAARC Nations for establishment of South Asian University shall have the force of law in India.<br>Accordingly, to give effect to tax exemption status of the South Asian University for construction of its campus at Maidan Garhi, New Delhi, the bid price may be inclusive of |

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| | | Delhi Value Added Tax (DVAT)/ Delhi Works Contract Tax (DWCT), but exclusive of Service Tax; Central Sales Tax; Central Excise; and Customs, as per details given below. |
| | **a)** | **Delhi Value Added Tax (DVAT)**<br>The VAT/ WCT may be charged by the contractor in the running bills. The SAU will claim reimbursement of the same from the Government of National Capital Territory of Delhi in terms of Section '4' read with Serial No. 26 of Part 'B' to the Sixth Schedule of the Delhi Value Added Tax Act, 2004. The Contractor shall adhere to the following conditions: |
| | **1.** | It is mandatory to mention the name of SAU and SAU's TIN on all tax invoices raised by Contractors registered under DVAT |
| | **2.** | The online VAT claim filed by SAU is being validated against online VAT returns of respective contractors by DVAT Department. In case of mismatch/ rejection of SAU's VAT claim due to non-compliance/ default on the part of contractors/due to non-filing of VAT return/ non deposit of VAT by the Contractors, SAU reserves its right to deduct the VAT amount not refunded by DVAT Department from the respective Contractor's subsequent running bills or to take any other appropriate action as it may deem fit. |
| | **3.** | The dealers registered in composition scheme are not liable to charge VAT and shall not be paid the VAT amount, if any, charged in the running bills. |
| | **4.** | Tax Invoice should show VAT Separately in the running bills. |
| | **5.** | The VAT applicable should be as per DVAT rates notified. |
| | **6.** | Retail Invoices are not considered i.e. Tax Invoices are only to be considered form the Contractors for payment of VAT charged in the running bills raised by the Contractors. |
| | **7.** | The DVAT is to be added and mode of billing may be VAT billing or WCT billing. |
| | **b)** | **Central Sales Tax (CST)**<br>The Contractors raising bill other than Delhi State i.e Contractors registered under VAT in State(s) other than Delhi should charge 'NIL' CST against form 'J' in terms of Section 6(4) of the Central Sales Tax Act, 1956 and the Rule 12(11A) of the Central Sales Tax (Registration and Turnover) Rules, 1957. The form 'J' shall be issued to the Contractor at the time of passing of running bills by the SAU. |
| | **c)** | **Service Tax**<br>Being an International Organization declared under Section '3' of United Nations (Privileges and Immunities) Act, 1947 by the Government of India, the Service Tax on the Contract payments will not be charged by the Contractor as the University is in the negative list vide Government of India, Ministry of Finance (Department of Revenue)'s Service Tax Notification No. 25/2012 dated 20th June 2012. The appropriate Exemption Certificate will be issued by the SAU to this effect. Service tax is exempted for this project and is not to be considered in bid price.<br>Swachh Bharat Cess and Krishi Kalyan Cess are also exempted vide Notification Nos. 22/2015- Service Tax dated 6-11-2015 and 28/2016- Service tax dated 26-05-2016 respectively. |
| | **d)** | **Customs Duty and Excise Duty Exemption**<br>The Exemptions notification No. 84/97 dated 11.11.1997 for Customs Duties and Notification No. 108/95CE dated 28.8.1995 for Central Excise Duties are applicable regarding exemption to an International organization. SAU being an International organization (Due to notification under section 3 of UN (Privilege and Immunities) Act, 1947 is eligible to provide Certificate of Exemption with due approval from the line Ministry i.e. Ministry of External Affairs, Government of India. The contractor shall inform the University at least one month in advance before issuing letter of intent to the manufacture(s)/ suppliers of the goods.<br>However, if the SAU is unable to provide Excise and Customs exemption certificate(s) as above for one reason or the other, in that eventuality, the Contractor shall be reimbursed the Customs and Excise duties paid by them on the material purchased and usable against the item(s) in the bill of quantity to the extent of utilised in the construction up to the date of preferring the running bill. Custom and excise duties are exempted for this project. The contractor shall inform University at least one month in advance before issuing letter of intent to the manufacturer(s)/ suppliers of goods. |

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| | **e)** | **Labour Cess**<br>Labour Cess @ 1% shall be deducted from the gross bill of contractor from every RA Bill. |
| | **f)** | **Change in Taxes/ New Taxes**<br>1. Any new tax/ duties/ levy after submission of bid shall be reimbursed by South Asian University only if the new Taxes/ duties/ levies are not exempted to the SAU.<br>2. Any Change of the rate of taxes by the government in the existing taxes will be reimbursed only if the exemption rate lowered or exemption fully withdrawn by the Government.<br>3. Any variation upward or downward or introduction of any new tax(s)/ levies due to change in statute after bid submission shall be reimbursed or recovered by owner on actual bases only if the new taxes / duties/ levies are not exempted to the SAU.<br>4. Further, any existing taxes / duties exemption already granted to SAU by Central/State Govt. for this project mentioned in tender document, withdraw/ amend during currency of contract, the same shall be adjusted / reimbursed by the owner on actual basis. This is correct only to the extent of withdrawal/ amendment of existing exemption status by the government. |
| | **iii)** | No foreign exchange shall be made available by the SAU for importing (purchase) of equipment, plants, machinery, materials of any kind or any other items required to be carried out during execution of the work. No delay and no claim of any kind shall be entertained from the Contractor, on account of variation in the foreign exchange rate. |
| | **iv)** | Ancillary and incidental facilities required for execution of work like labour camp, stores, fabrication yard, offices for Contractor, watch and ward, temporary ramp required to be made for working at the basement level, temporary structure for plants and machineries, water storage tanks, installation and consumption charges of temporary electricity, telephone, water etc. required for execution of the work, liaison and pursuing for obtaining various No Objection Certificates, completion certificates from local bodies etc., protection works, testing facilities / laboratory at site of work, facilities for all field tests and for taking samples etc. during execution or any other activity which is necessary (for execution of work and as directed by Engineer-in-Charge), shall be deemed to be included in rates quoted by the Contractor, for various items in the schedule of quantities. Nothing extra shall be payable on these accounts. Before start of the work, the Contractor shall submit to the Engineer-in-Charge for approval, a site / construction yard layout in the area earmarked by SAU, specifying areas for construction, site office, positioning of machinery, material yard, cement and other storage, steel fabrication yard, site laboratory, water tank, etc. |
| | **v)** | For completing the work in time, the Contractor might be required to work in two or more shifts (including night shifts). No claim whatsoever shall be entertained on this account, notwithstanding the fact that the Contractor may have to pay extra amounts for any reason, to the labourers and other staff engaged directly or indirectly on the work according to the provisions of the labour and other statutory bodies regulations and the agreement entered upon by the Contractor with them. |
| | **vi)** | All material shall only be brought at site as per program finalized with the Engineer-in-Charge. Any pre-delivery of the material not required for immediate consumption shall not be accepted and thus not paid for. |
| | **6.1.46** | **SAFETY PRACTICES** |
| | **i)** | WARNING/ CAUTION BOARDS: All temporary warning / caution boards / glow signage display such as "Construction Work in Progress", "Keep Away", “No Parking”, Diversions & protective Barricades etc. shall be provided and displayed during day time by the Contractor, wherever required and as directed by the Engineer-in-Charge. These glow signage and red lights shall be suitably illuminated during night also. The Contractor shall be solely responsible for damage and accident caused, if any, due to negligence on his part. Also he shall ensure that no hindrance, as far as possible, is caused to general traffic during execution of the work. This signage shall be dismantled & taken away by the Contractor after the completion of work, only after approval of the Engineer – in – Charge. Nothing extra shall be payable on this account. |
| | **ii)** | **SIGN BOARDS**: The Contractor shall provide and erect a display board of size and shape as required and paint over it, in a legible and workman like manner, the details about the salient features of the project, as required by the Engineer-in-Charge. |

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| | | The Contractor shall fabricate and put up a sign board in an approved location and to an approved design indicating name of the project, Client/Owner, Engineer-in-charges , SAU, Architectural, Structural & M E P Consultants, PMC etc. besides providing space for names of other Contractors, Sub-Contractors and specialized agencies within 15 days from issue of award letter. Nothing extra shall be payable on this account. In case of non-compliance/delay in compliance in this, a penalty @ Rs. 500/- per day will be imposed which will be recovered from the immediate next R/A Bill of the Contractor. |
| | **iii)** | Necessary protective and safety equipment (PPE) shall be provided to the Site Engineer, Supervisory staff, labour and technical staff of the contractor and visitors by the Contractor at his own cost and to be used at site. |
| | **iv)** | No inflammable materials including P.O.L shall be allowed to be stored in huge quantity at site. Only limited quantity of P.O.L may be allowed to be stored at site subject to the compliance of all rules / instructions issued by the relevant authorities and as per the direction of Engineer -in- Charge in this regard. Also all precautions and safety measures shall be taken by the Contractor for safe handling of the P.O.L products stored at site. All consequences on account of unsafe handling of P.O.L shall be borne by the Contractor. |
| | **6.1.47** | **QUALITY ASSURANCE** |
| | **i)** | The proposed building is a prestigious project and quality of work is of paramount importance. Contractor shall have to engage well-experienced skilled labour and deploy modern T&P and other equipment to execute the work. Many items like exposed finish form work, specialized flooring work, Polysulphide sealant and backer rod fixing in expansion joints, factory made door- window shutters, proper slope maintaining in toilet units, sanitary- water supply installation, textured finishing, grit plastering with aluminum channel insertions, water proofing treatment e t c . will specially require engagement of skilled workers having experience particularly in execution of such items. |
| | **ii)** | The contractor shall ensure quality construction in a planned and time bound manner.<br>Any sub-standard material / work beyond set out tolerance limit shall be summarily rejected by the Engineer-in-charge & contractor shall be bound to replace / remove such sub-standard / defective work immediately. If any material, even though approved by Engineer-In-Charge is found defective or not conforming to specifications shall be replaced / removed by the contractor at his own risk & cost. |
| | **iii)** | In addition to the supervision of work by the Project Management Consultants (P MC) Appoint by SAU, the technical representatives from SAU and the Consultants deployed by the SAU shall also be carrying out regular and periodic inspection of the ongoing activities in the work and deficiencies, shortcomings, inferior workmanship pointed out by them shall be communicated by PMC/SAU engineers to the contractor. Upon receipt of instructions from Engineer in Charge these are also to be made good by necessary improvement, rectification, replacement upto his complete satisfaction. Special attention shall be paid towards line and level of internal and external plastering, exposed smooth surface of RCC members by providing fresh shuttering plates, rubberized linings to all the shuttering joints, accurate joinery work in wooden doors and windows, thinnest joints in stone/ tiling / cladding work, non-hollowness in floor and dado tiles work, protection of scratches over flooring by impounding layer of plaster of Paris, water tight pipe linings, absence of hollow vertical joints in brick/ block masonry, proper compaction of filled up earth etc. to achieve an Institution of International standards and up keeping of quality assurance shall be of paramount importance, as such. |
| | **iv)** | The Contractor shall submit, within 20 days after the date of award of work, a detailed and complete method statement for the execution, testing and Quality Assurance, of such items of works, as directed by the Engineer-in-Charge or his representative. All the materials to be used in the work, to give the finished work complete in all respects, shall comply with the requirements of the specifications and shall pass all the tests required as per specifications as applicable or such specifications / standards as directed by the Engineer-in- Charge. However, keeping the Quality Assurance in mind, the Contractor shall submit, on request from the Engineer-in- Charge, his own Quality Assurance procedures for basic materials and such items, to be followed during |

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| | | the execution of the work, for approval of the Engineer-in-Charge. |
| | **v)** | All materials and fittings brought by the contractor to the site for use shall conform to the samples approved by the Engineer-in-charge which shall be preserved till the completion of the work. If a particular brand of material is specified in the item of work in Schedule of Quantity, the same shall be used after getting the same approved from Engineer-In-Charge. Wherever brand / quality of material is not specified in the item of work, the contractor shall submit the samples as per suggested list of brand names given in the tender document / particular specifications for approval of Engineer-In- Charge. For all other items, materials and fittings of ISI Marked shall be used with the approval of Engineer-In-Charge. Wherever ISI Marked material / fittings are not available, the contractor shall submit samples of materials / fittings manufactured by firms of repute conforming to relevant specifications or IS codes and use the same only after getting the approval of Engineer-In-Charge. |
| | **vi)** | The Contractor shall procure and provide all the materials from the manufacturers / suppliers as per the list attached with the tender documents, as per the item description and particular specifications for the work. The equivalent brand for any item shall be permitted to be used in the work, only when the specified make is not available. This is, however, subject to documentary evidence produced by the contactor for non-availability of the brand specified and also subject to independent verification by the Engineer-in-Charge. In exceptional cases, where such approval is required, the decision of Engineer-in-Charge as regards equivalent make of the material shall be final and binding on the Contractor. No claim, whatsoever, of any kind shall be entertained from the Contractor on this account. Nothing extra shall be payable on this account. Also, the material shall be procured only after written approval of the Engineer-in-Charge. |
| | **vii)** | All materials shall be got checked by the Engineer-in-Charge or his authorized supervisory staff on receipt of the same at site before use. |
| | **viii)** | The tests, as necessary, shall be conducted in the laboratory approved by the Engineer–in- Charge. The samples shall be taken for carrying out all or any of the tests stipulated in the particular specifications and as directed by the Engineer-in-Charge or his authorized representative. |
| | **ix)** | All the registers of tests carried out at Construction Site or in outside laboratories and all material at site (MAS) registers including cement register shall be maintained by the contractor which shall be issued to the contractor by Engineer-in-charge. All the entries in the registers will be made by the designated Engineering Staff of the contractor and same should be regularly reviewed by Engineer-in-Charge or his authorized representative. Contractor shall be responsible for safe custody of all the registers. |
| | **x)** | The Contractor shall at his own risk and cost make all arrangements and shall provide all such facilities including material and labour, the Engineer-in-Charge may require for collecting, preparing, forwarding the required number of samples for testing as per the frequency of test stipulated in the contract specifications or as considered necessary by the Engineer-in-Charge, at such time and to such places, as directed by the Engineer-in- Charge. Nothing extra shall be payable for the above. |
| | **xi)** | The Contractor or his authorized representative shall associate in collection, preparation, forwarding and testing of such samples. In case he or his authorized representative is not present or does not associate him, the result of such tests and consequences thereon shall be binding on the Contractor .The Contractor or his authorized representative shall remain in contact with the Engineer-in–Charge or his authorized representative associated for all such operations. No claim of payment or claim of any other kind, whatsoever, shall be entertained from the Contractor. |

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| | **xii)** | All the testing charges for the samples sent to outside approved laboratories shall be borne by the contractor/ SAU in the manner indicated below: |
| | **a)** | By the contractor, if the results show that the material does not conform to relevant specifications and BIS codes or any other relevant code for which confirmatory test is carried out. |
| | **b)** | By the SAU, if the results show that the material confirms to relevant specifications and BIS codes or any other relevant code for which confirmatory test is carried out |
| | **xiii)** | All the hidden items such as water supply lines, drainage pipes, conduits, sewers etc. are to be properly tested as per the design conditions before covering and their measurements in computerized measurement book duly test checked shall be deposited with Engineer in charge or his authorized representative, prior to hiding these items. |
| | **xiv)** | Water tanks, taps, sanitary, water supply and drainage pipes, fittings and accessories should confirm to bylaws and municipal body / corporation where CPWD Specifications are not available. The contractor should engage licensed plumbers for the work and get the materials (fixtures/fittings) tested by the Municipal Body/Corporation authorities wherever required at his own cost. |
| | **xv)** | The contractor shall give performance test of the entire installation(s) as per the standing specifications before the work is finally accepted and nothing extra whatsoever shall be payable to the contractor for the test. |
| | **xvi)** | The contractor shall have to execute guarantee bonds in respect of water proofing works as per Performa enclosed. |
| | **xvii)** | The Contractor shall arrange electricity at his own cost for testing of the various electrical installations as directed by Engineer-in-Charge and for the consumption by the contractor for executing the work. Also all the water required for testing various electrical installations, fire pumps, wet riser, firefighting, HVAC equipment, fire sprinklers etc. and also testing water supply, sanitary and drainage lines, water proofing of underground sump, overhead tanks, water proofing treatment etc. shall be arranged by the contractor at his own cost. Nothing extra shall be payable on this account. |
| | **6.1.48** | **SUBMISSION AND DOCUMENTATION** |
| | **i)** | The Contractor shall display all permissions, licenses, registration certificates, bar charts, other statements etc. under various labour laws and other regulations applicable to the works, at his site office. He should also keep at site at least one set of BIS Codes and other relevant codes at site and produce the same if asked for by Engineer- In-Charge. In case of non compliancez, these codes will be purchased from the Market and actual cost of purchase will be recovered from the next RA Bill of the Contractor. |
| | **ii)** | The Contractor shall coordinate and facilitate consultant for preparing four (04) sets of "As Built Drawings" along with literatures, manuals, warranty certificates etc. of various installed fittings, fixtures and equipment for the completed projects. This shall be the prerequisite for payment of final bill. |
| | **iii)** | The Contractor shall make available four (04) sets of all drawings of internal and external services i.e. Water Supply, Sanitary line and Drainage lines. This shall be the prerequisite for payment of final bill. These drawings shall have the following information: |
| | **iv)** | Run off for all piping and their diameters including soil, waste pipes and vertical stacks. |
| | **v)** | Ground and invert level of all drainage pipes together with locations of all manholes and connections, up to outfall. |
| | **vi)** | Run off for all water supply lines with diameters location of control valves, access panels etc. |
| | **vii)** | The contractor shall make available four (04) sets of computerized Standard Measurement Books (SMBs) having measurement of all the permanent standing in a building. |
| | **viii)** | The Performance Guarantee shall not be released to the contractor until the aforesaid drawings are submitted to the Engineer-in-Charge |
| | **ix)** | The contractor will submit computerized measurement sheet for the work carried out by him for making payment as per Clause – 6A of the CPWD General Conditions of Contract 2014 with correction slips upto 09.11.2015. For casting of RCC members and |

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| | | other hidden items the corrected and duly test checked measurement sheets of reinforcement or that of other hidden items shall be deposited with Engineer in charge or his authorized representative, before casting of RCC or other hidden items. The delay in submission of corrected and duly checked measurement sheet may, therefore, delay casting of RCC or execution of hidden item for which no hindrance shall be recorded. |
| | **x)** | To avoid delay, contractor should submit all samples well in advance so as to give timely orders for procurement. |
| | **6.1.49** | **PROGRAM CHART:**<br>The Contractor shall prepare an integrated program chart within fifteen days of issue of Letter of Award including civil as well as E & M activities for the execution of work, showing clearly all activities from the start of work to completion, with details of manpower, equipment and machinery required for the fulfillment of the program within the stipulated period and submit the same for approval of the Engineer-In-Charge within fifteen days of the award of the work. These shall be submitted by the contractor through electronic media besides forwarding hard copies of the same. The integrated program chart so submitted should not have any discrepancy with the physical milestones attached in the contract agreement. The program chart should include the following: - |
| | **i)** | Descriptive note explaining sequence of various activities. |
| | **ii)** | Construction Program prepared on PRIMAVERA Software, which will indicate resources in financial terms, manpower and specialized equipment for every important stage. The contractor shall make available latest hardware as well as software at site for planning and monitoring purpose. The contractor may also be asked to submit the above on PERT for which nothing extra shall be paid. |
| | **iii)** | Program for procurement of materials by the contractor. |
| | **iv)** | Program for arranging and deployment of manpower both skilled and unskilled so as to achieve targeted progress. |
| | **v)** | Program of procurement of machinery/equipment having adequate capacity, commensurate with the quantum of work to be done within the stipulated period, by the contractor. |
| | **vi)** | Program for achieving fortnightly micro milestones and periodic milestones. |
| | **vii)** | In case of non-compliance/delay in compliance in this, a penalty @ Rs.5000/- per day will be imposed which will be recovered from the immediate next R/A Bill of the Contractor. |
| | **viii)** | If at any time, it appears to the Engineer-In-Charge that the actual progress of work does not conform to the approved program referred above, the contractor shall produce a revised program showing the modifications to the approved program by additional inputs to ensure completion of the work within the stipulated time. |
| | **ix)** | The submission for approval by the Engineer-In-Charge of such program or the furnishing of such particulars shall not relieve the contractor of any of his duties or responsibilities under the contract. This is without prejudice to the right of Engineer-In-Charge to take action against the contractor as per terms and conditions of the agreement. |
| | **x)** | Apart from the above integrated program chart, the contractor shall be required to submit fortnightly progress report of the work in a computerized form on 1st and 16th of every month. The progress report shall contain the following, apart from whatever else may be required as specified above: |
| | **a)** | Construction schedule of the various components of the work through a bar chart for the next two fortnights (or as may be specified), showing the micro-milestone/milestones, targeted tasks (including material and labour requirement) and up to date progress. Atleast 10 digital colour photographs showing all the parts of construction site (d e s i g n a t e d spots) along with at least 5 minutes video of executions of different items in soft copy has to be submitted in every fortnightly progress report. |
| | **b)** | Progress chart of the various components of the work that are planned and achieved, for the fortnight as well as cumulative up to the fortnight under reckoning, with reason for deviations, if any in a tabular format. |
| | **c)** | Plant and machinery statement, indicating those deployed in the work. |
| | **d)** | Man-power statement indicating: |

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| | • | Individually the names of all the staff deployed on the work, along with their designations. |
| | • | No. of skilled workers (trade wise) and total no. of unskilled workers deployed on the work and their location of deployment i.e. blocks. |
| | **e)** | Financial statement, indicating the broad details of all the running account payment received up to date, such as gross value of work done, advances taken, recoveries effected, amount withheld, net payments details of cheque payment received, extra/substituted/deviation items if any, etc. |
| | **xi)** | In case of non compliance / delay in compliance in submission of fortnightly, a penalty @ Rs.10000/- ( Rupees Ten Thousand Only ) per fortnightly report will be imposed which will be recovered from the immediate next R/A Bill of the Contractor. |
| | **6.1.50** | **TEMPORARY WATER/ ELECTRICITY/ TELEPHONE CONNECTION** |
| | **i)** | Arrangement of temporary telephone connection, water and electricity required by Contractor, shall be made by him at his own cost and also necessary permissions shall be obtained by him directly from concerned authorities, under intimation to the SAU. Also, all initial cost and running charges, and security deposit, if any, in this regard shall be borne by him. The Contractor shall abide by all the rules/ bye laws applicable in this regard and he shall be solely responsible for any penalty on account of violation of any of the rules/byelaws in this regard. Nothing extra shall be payable on this account. The contractor is strictly prohibited to use ground water by digging bore well from the site premises. He may bring water from outside through tankers from authorized sources. |
| | **ii)** | The Contractor shall be responsible for maintenance and watch and ward of the complete installation and water / electricity meter and shall also be responsible for any pilferage, theft, damage, penalty etc. in this regard. The Contractor shall indemnify the SAU against any claim arising out of pilferage, theft, damage, penalty etc. whatsoever on this account. Security deposit for the work shall be released only after No Dues Certificates are obtained from the local Authorities from whom temporary electric/ water / telephone connection have been obtained by the Contractor. Nothing extra shall be payable on this account. |
| | **iii)** | The SAU shall in no way be responsible for either any delay in getting electric and/or water and/or telephone connections for carrying out the work or not getting connections at all. No claim of delay or any other kind, whatsoever, on this account shall be entertained from the Contractor. Also contingency arrangement of stand-by water & electric supply shall be made by the Contractor for commencement and smooth progress of the work so that work does not suffer on account of power failure or disconnection or not getting connection at all. No claim of any kind whatsoever shall be entertained on this account from the Contractor. Nothing extra shall be payable on this account. |
| | **6.1.51** | **CLEANLINESS OF SITE** |
| | **i)** | The Contractor shall not stack building material/malba/muck on the land or road of the local development authority or on the land owned by the others, as the case may be. So the muck, rubbish etc. shall be removed periodically as directed by the Engineer-in- Charge, from the site of work to the approved dumping grounds as per the local byelaws and regulations of the concerned authorities and all necessary permissions in this regard from the local bodies shall be obtained by the Contractor. Nothing extra shall be payable on this account. In case, the Contractor is found stacking the building material/malba as stated above, the Contractor shall be liable to pay the stacking charges/penalty as may be levied by the local body or any other authority and also to face penal action as per the rules, regulations and bye-laws of such body or authority. The Engineer –in-Charge shall be at liberty to recover, such sums due but not paid to the concerned authorities on the above counts, from any sums due to the Contractor including amount of the Security Deposit and performance guarantee in respect of this contract agreement. |
| | **ii)** | The contractor shall take instructions from the Engineer-In-Charge regarding collection and stacking of materials at any place. No excavated earth or building rubbish shall be stacked on areas where other buildings, roads, services and compound walls are to be constructed. |
| | **iii)** | The site of work shall be always kept clean due to constraints of space and to avoid |

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| | | any nuisance to the users of buildings in the adjacent plots. The Contractor shall take all care to prevent any water- logging at site. The waste water, slush etc. shall not be allowed to be collected at site. It may be directly pumped into the creek with prior approval of the concerned authorities. For discharge into public drainage system, necessary permission shall be obtained from relevant authorities after paying the necessary charges, if any, directly to the authorities. The work shall be carried out in such a way that the area is kept clean and tidy. All the fees/charges in this regard shall be borne by the Contractor. Nothing extra shall be payable on this account. |
| | **6.1.52** | **INSPECTION OF WORK** |
| | **i)** | In addition to the provisions of relevant clauses of the contract, the work shall also be open to inspection by Senior Officers of SAU & the representative of the Consultants The contractor shall at times during the usual working hours and at all times at which reasonable notices of the intention of the Engineer-in-charge or other officers as stated above to visit the works shall have been given to the contractor, either himself be present to receive the orders and instructions or have a responsible representative duly accredited in writing, to be present for that purpose. |
| | **ii)** | Inspection of the work by Consultant appointed by the SAU. |
| | **a)** | The Project Management Consultant (PMC) appointed by SAU, shall be inspecting the works including workshops and fabrication factory to ensure that the works are in general being executed according to the design, drawings and specifications laid down in the contract. His observations shall be communicated by SAU engineering staff and compliance is to be reported to SAU. |
| | **b)** | The consultant (PMC) appointed by SAU shall certify on completion of particular building that it has been constructed according to the approved drawings design and specifications. |
| | **iii)** | Senior Officers of SAU, Dignitaries from Central Ministry / SAU shall also be inspecting the on-going work at site at any time with or without prior intimation.<br>The contractor shall, therefore, keep updated the following requirements and detailing |
| | **a)** | Display Board showing detail of work, weekly progress achieved with respect to targets, reason of shortfall, status of manpower, wages being paid for different categories of workers. |
| | **b)** | Entrance and area surrounding to be kept cleaned. |
| | **c)** | Display layout plan key plan, Building drawings including plans, elevations and sections. |
| | **d)** | Upto date displays of Bar chart, CPM and PERT etc. |
| | **e)** | Keep details of quantities executed, balance quantities, deviations, possible Extra item, substituted Item etc. |
| | **f)** | Keep plastic / cloth mounted one sets of building drawings. |
| | **g)** | Set of PPE ( Helmets, Jackets and safety shoes as per standard colour code) for exclusive use for officers/dignitaries visiting at site. |
| | **6.1.53** | **FINAL TESTING OF THE INSTALLATION**<br>The Contractor shall demonstrate trouble free functioning of all the Civil and E & M installations and services. All arrangements required for testing and commissioning of E&M installations and services shall be made by contractor at his own cost. Power Supply for final testing and commissioning shall be made available by SAU. The Engineer-in-Charge or his authorized representatives shall carry out final inspection of the various Civil and E & M services and installations. Any defect(s) noticed during demonstration shall be rectified by the Contractor at his own cost to the entire satisfaction of the Engineer-in-Charge. Nothing extra shall be payable on this account. |
| | **6.1.54** | **SUBMISSION OF AS BUILT DRAWINGS AND OBTAINING OCCUPATION CERTIFICATE**<br>The contractor shall coordinate and facilitate consultant for preparing as built drawings and obtaining occupation certificate / completion certificate from local bodies including getting the required site visits conducted by such authorities with a view to obtain the same. |
| | **6.1.55** | **DEFECT LIABILITY PERIOD (REFUND OF SECURITY DEPOSIT)**<br>The clause 17 of the General Conditions of Contract for CPWD works shall be applicable except that 12 months shall be read as 24 months. |

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| | **6.1.56** | **DEALING WITH INCONSISTENT RATES** |
| | **i)** | The Contractors shall quote same rates for the identical items which may inadvertently appear in more than one place. If different rates are quoted by the tenderers for such identical items, the same shall be rationalized by considering the lowest quoted rate for such items, for evaluation and acceptance of tender |
| | **ii)** | Wherever any reference to any Indian Standards occurs in the documents relating to this contract, the same shall be inclusive of all amendments issued thereto or revisions thereof, if any, up to the date of receipt of tenders. |
| | **iii)** | Unless otherwise specified in the schedule of quantities, the rates for all items of work shall be considered, as inclusive of pumping out or bailing out water, if required throughout the construction period for which no extra payment shall be made. This shall also include water encountered from any source such as rains, floods, sub soil water table being high and/or due to any other cause whatsoever |
| | **iv)** | All stone aggregate and stone ballast shall be of hard stone variety to be obtained from approved quarries. |
| | **v)** | **Coarse sand should be obtained from approved sources**. The same shall be clean and sharp angular grit type. The coarse sand shall be screened before using, if required. If the sand brought to site is dirty, it must be washed in clean water to bring the sand to the required specifications. Nothing extra shall be payable on this account. |
| | **vi)** | The rates for all items of work, shall unless clearly specified otherwise, include cost of all operations and all inputs of labour, material, T & P, scaffolding, wastages, watch and ward, all incidental charges, all taxes, cess, VAT, duties, levies etc. required for execution of the work except which are exempted as specified in the tender documents. |
| | **6.1.57** | **PRODUCT DELIVERY, STORAGE AND HANDLING OF CHEMICALS** |
| | **i)** | The contractor shall construct storage space for Chemicals materials to ensure that the storage conditions are as recommended by the manufactures. |
| | **ii)** | All the materials shall be procured and delivered in sealed containers with labels legible and intact. |
| | **iii)** | All the chemicals {polymers, epoxy, water proofing compound, plasticizer, Polysulphide, SBR based elastomeric, all exterior and interior paints, polish etc.) shall be procured in convenient packs say 20 litres /Kgs.} capacity packing only or as approved by the Engineer-in-Charge, and not in bigger capacity containers, say 200 litre (Kgs.) drums unless otherwise specifically permitted by the Engineer-in-Charge. One sample from each lot of the chemical procured by the contractor shall be tested in a laboratory as approved by the Engineer-in-charge. |
| | **iv)** | All material required for the execution of the work shall be got approved, the sample shall be deposited with the SAU or their authorized representative. The materials shall be kept in joint custody of the contractor and SAU or their authorized representative. The watch and ward of such material shall, however, remain to be the responsibility of the contractor and no claim, whatsoever, on this account shall be entertained. Different containers of each chemical shall be serially numbered on packing and also consumed in that order. Day-to- Day account of receipt, issue and balance shall be maintained by the agency in the prescribed format and this shall also be checked by SAU or their authorized representative and proper account shall be maintained at site of work in the prescribed form as per the standard practice. |
| | **v)** | All the chemicals shall be procured by the contractor directly from the manufacturer. In exceptional circumstances, the contractor may be allowed to procure the materials from the authorized dealers of the manufacturers, if specifically permitted by the Engineer-in-Charge. |
| | **vi)** | The original copies of challan/cash memos towards the quantity of various chemicals procured shall be made available by the contractor at the request from the Engineer-in-Charge and a copy of the same shall be kept in record. |
| | **vii)** | The Name of manufacturers, manufacturer's product identification, manufacturer's mixing instructions, warning for handling and toxicity and date of manufacturing and shelf life shall be clearly and legibly mentioned on the labels of the each container. |
| | **viii)** | The contractor shall submit for the chemicals procured, manufacturer's and / or authorized dealer's certificate regarding supplying and verifying conformance to the material specifications, as specified. |

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| | **ix)** | All filled containers shall be handled in safe manner and in a way to avoid breaking container seals. |
| | **x)** | Empty containers of the chemicals should not be removed from site till the completion of work and shall be removed only with the written approval of the Engineer-in-Charge. |
| | **xi)** | All arrangements for measuring, dosing and mixing of material / chemicals at site have to be made by the contractor. |
| | **xii)** | Contractor shall suitably advise his site Engineer and all the workers as regards safe handling of chemicals. Necessary protective and safety equipment in form of hand gloves, goggles etc. shall be provided by the contractor and be also used at site. |
| | **xiii)** | All incidental charges of any kind including cartage, storage and wastage and safe custody of material etc. shall be borne by the contractor and no claim, whatsoever, shall be entertained on this account. |
| | **xiv)** | The chemicals shall be tested in an independent laboratory as approved by the Engineer-in-charge at the frequency as specified. If required, more samples may have to be tested as per the directions of the Engineer-in-Charge. Nothing extra shall be payable for more quantity on this account. However testing charges shall be borne by the SAU for the samples satisfying the requirements specified in the tender. |
| | **6.1.58** | **DE-WATERING** |
| | **i)** | De-watering required, if any, shall be done conforming to BIS Code IS: 9759 (guide lines for de-watering during construction) and / or as per the specifications approved by the Engineer-in-Charge. Design of an appropriate and suitable dewatering system shall be the Contractor's responsibility. Such scheme shall be modified / augmented as the work proceeds based on fresh information discovered during the progress of work, at no extra cost. At all times during the construction work, efficient drainage of the site shall be carried out by the Contractor and especially during the laying of plain cement concrete, taking levels etc. The Contractor shall also ensure that there is no danger to the nearby properties and installations on account of such lowering of water table. If needed, suitable precautionary measures shall be taken by the Contractor. Also the scheme of dewatering adopted shall have adequate built in arrangement to serve as stand-bye to attend to repair of pumps etc. and disruption of power / fuel supply. Nothing extra shall be payable on this account. |
| | **ii)** | In trenches where surface water is likely to get into cut / trench during monsoons, a ring bund of puddle clay or by any other means shall be formed outside, to the required height, and maintained by the Contractor. Also, suitable steps shall be taken by the Contractor to prevent back flow of pumped water into the trench. Nothing extra shall be payable on this account. |
| | **6.1.59** | **INSURANCE POLICIES**<br>Before commencing the execution of work, the Contractor shall, without in any way limiting his obligations and liabilities, insure at his own cost and expense against any damage or loss or injury, which may be caused to any person or property, at site of work. The Contractor shall obtain and submit to the Engineer-in-Charge proper **Contractor All Risk Insurance Policy for an amount 1.25 times the contract amount for this work, with Engineer-in-Charge as the first beneficiary**. The insurance shall be obtained in joint names of Engineer-in-Charge and the Contractor (who shall be second beneficiary). Also, he shall indemnify the SAU from any liability during the execution of the work. Further, **he shall obtain and submit to the Engineer-in- Charge, a third party insurance policy for maximum Rs.10 lakh for each accident, with the Engineer-in-Charge as the first beneficiary**. The insurance shall be obtained in joint names of Engineer-in-Charge and the Contractor (who shall be second beneficiary). The Contractor shall, from time to time, provide documentary evidence as regards payment of premium for all the Insurance Policies for keeping them valid till the completion of the work. The Contractor shall ensure that Insurance Policies are also taken for the workers of his Sub-Contractors / specialized agencies also. Without prejudice to any of its obligations and responsibilities specified above, the Contractor shall within 10 days from the date of letter of acceptance of the tender and thereafter at the end of each quarter submit a report to the SAU giving details of the Insurance Policies along with Certificate of these insurance policies being valid, along with documentary evidences as required by the Engineer-in-Charge. No work shall be |

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| | | commenced by the Contractor unless he obtains the Insurance Policies as mentioned above. Also, no payment shall be made to the Contractor on expiry of insurance policies unless renewed by the Contractor. Nothing extra shall be payable on this account. No claim of hindrance (or any other claim) shall be entertained from the contractor on these accounts. |
| | **6.1.60** | **TRAINING OF THE PERSONNEL**<br>The contractor shall arrange at no extra cost to SAU to train sufficient persons from the SAU (for civil and E&M works, on how to operate and carryout preventive maintenance of the systems (both civil and E&M). The contractor shall arrange on job training from well qualified and experience personnel for at least seven days or more as desired by SAU. |
| | **6.1.61** | **UTILISATION OF MOBILISATION ADVANCE : Mobilization advance will not be given for any material for which secured advance is payable.** T&P advance will not be given for tools & plants equipment, owned by the contractor as intimated in the eligibility documents. Installments of Mobilization advance except the first installment shall be released after receiving the utilization certificate supported by bank statement showing the disbursement of mobilization advance by the contractor. Contractor while applying for mobilization advance shall inform the intended use of mobilization advance and submit the utilization certificate of the same. Any deviation from intended use shall not be accepted without the prior approval of Engineer-in-charge. |

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| **6.2** | **SPECIAL CONDITIONS FOR GREEN BUILDING** | |
| | The buildings are registered for obtaining GRIHA L D Rating from GRIHA Secretariat under MNRE scheme to obtain 5 star rating. The contractor is required to execute the work in a befitting manner to obtain the targeted GRIHA rating. | |
| | **6.2.1** | **Special Conditions for GRIHA rating:-** |
| | **i)** | The contractor shall work in close coordination with PMC and/or the consultant appointed by SAU and prepare scheme for the approval of Engineer -in-charge for obtaining GRIHA rating in the criteria relevant to the execution of work as per advice of Green Building Consultant of main Consultant. |
| | **ii)** | The contractor shall plan and execute the work in a manner to preserve and protect the landscape during construction and shall arrange the materials/equipment and follow the procedure as per criterion 2 of the GRIHA rating as applicable. |
| | **iii)** | All the mandatory criteria of GRIHA and additional conditions for Green Building practices are to be necessarily followed for entire buildings in this work. |
| | **iv)** | The contractor shall comply with NBC norms on construction safety, health and sanitation as per criterion 8. |
| | **v)** | The construction activity shall be done in a befitting manner and the contractor shall adopt measures to prevent air pollution at site in compliance with criterion 9 of GRIHA rating as applicable. |
| | **vi)** | The contractor shall comply with all the instructions and schemes for execution of green building. |
| | **vii)** | Nothing shall be paid extra for fulfillment of all the above mentioned conditions except for the items existing in the schedule of quantities. For such items work done shall be paid on the basis of the agreement rates. |
| | **6.2.2** | **Pre-construction Stage**<br>Construction Vehicles, Equipment and Machinery |
| | **i)** | All vehicles, equipment and machinery to be procured for construction shall conform to the relevant Bureau of India Standard (BIS) norms. |
| | **ii)** | Emission from the vehicles must conform to environmental norms. |
| | **iii)** | Dust produced from the vehicular movement and other site activities is to be mitigated by sprinkling of water. |
| | **iv)** | Noise limits for construction equipment shall not exceed 75 dB(A), measured at one meter from the edge of the equipment in free area, as specified in the Environment Protection Act,1986, schedule VI part E, as amended on 9th May,1993. The maximum noise levels near the construction site should be limited to 65 dB (A) Leq (5 min) in project area. |
| | **6.2.3** | **Construction Stage**<br>Construction Wastes Disposal |
| | **i)** | The pre-identified dump locations identified by the contractor will be a part of solid waste management plan to be prepared by the Contractor in consultation with Engineer -in-charge. |
| | **ii)** | Contractor shall get approved the location of disposal site prior to commencement of the excavation on any section of the project location. |
| | **iii)** | Contractor shall ensure that any spoils of material will not be disposed off in any municipality solid waste collection bins. |
| | **6.2.4** | **Procurement of Construction Materials** |
| | **i)** | All vehicles delivering construction materials to the site shall be covered to avoid spillage of materials and maintain cleanliness of the roads. |
| | **ii)** | Tyres of Wheels of all vehicles used by of the contractor, or any of his sub contractor or materials suppliers shall be cleaned and washed clear of all dust/mud before leaving the project premises. This shall be done by routing the vehicles through tyre washing tracks. |
| | **iii)** | Contractor shall arrange for regular water sprinkling at least twice a day (i.e. morning and evening) for dust suppression of the construction sites and unpaved roads used by his construction vehicles. |

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| | **6.2.5** | **Water Pollution** |
| | **i)** | The Contractor shall take all precautionary measures to prevent the wastewater during construction to accumulate anywhere. |
| | **ii)** | The wastewater arising from the project is to be disposed off in the manner that is acceptable to the Engineer -in-charge. |
| | **6.2.6** | **Air and Noise Pollution**<br>Contractor shall use dust screens and sprinkle water around the construction site to arrest spreading of dust in the air and surrounding areas. |
| | **i)** | Contractor shall ensure that all vehicles, equipment and machinery used for construction are regularly maintained and confirm that emission levels comply with environmental emission standards/norms. |
| | **ii)** | For controlling the noise from Vehicles, Plants and Equipment, the Contractor shall confirm the following: |
| | **iii)** | All vehicles and equipment used in construction will be fitted with exhaust silencers. |
| | **iv)** | Servicing of all construction vehicles and machinery will be done regularly and during routine servicing operations, the effectiveness of exhaust silencers will be checked and if found defective will be replaced. |
| | **v)** | Noise emission from compactors (rollers) front loaders, concrete mixers, cranes (movable), vibrators and saws should be less than 75 dB(A). |
| | **vi)** | As per the standards/guidelines for control of Noise Pollution from Stationary Diesel Generator (DG) sets, noise emission i n dB(A) from DG Set (15-500 KVA) should be less than 94+10 log 10 (KVA). The standards also suggest construction of acoustic enclosure around the DG Set and provision of proper exhaust muffler with insertion loss of minimum 25 dB(A) as mandatory. |
| | **6.2.7** | **Personal Safety Measures for Labour**<br>Contractor will provide the following items for safety of workers employed by contractor and associate agencies: |
| | **i)** | Protective footwear and gloves to all workers employed for the work on mixing, cement, lime mortars, concrete etc. and openings in water pipeline/sewer line. |
| | **ii)** | Welder's protective eye-shields to workers who are engaged in welding works |
| | **iii)** | Safety helmet and Safety harness/ belt. Provide adequate sanitation/safety facilities for construction workers to ensure the health and safety of the workers during construction, with effective provisions for the basic facilities such as sanitation, drinking water and safety equipment or machinery. |
| | **iv)** | All the workers should be wearing helmet and shoes all the time on site. |
| | **v)** | Masks and gloves should be worn whenever and wherever required. |
| | **vi)** | Adequate drinking water facility should be provided at site, adequate number of decentralized latrines and urinals to be provided for construction workers. |
| | **vii)** | Full time workers residing on site should be provided with clean and adequate temporary hutment. |
| | **viii)** | First aid facility should also be provided. |
| | **ix)** | Overhead lifting of heavy materials should be avoided. Barrow wheel and hand-lift boxes should be used to transport materials onsite. |
| | **x)** | Tobacco and cigarette smoking should be prohibited onsite. |
| | **xi)** | All dangerous parts of machinery are well guarded and all precautions for working on machinery are taken. |
| | **xii)** | Maintain hoists and lifts, lifting machines, chains, ropes and other lifting tackles in good condition. Provide safety net of adequate strength to arrest falling material down below. |
| | **xiii)** | Use of durable and reusable formwork systems to replace timber formwork and ensure that formwork where used is properly maintained. |
| | **xiv)** | Ensure that walking surfaces or boards at height are of sound construction and are provided with safety rails and belts. Provide protective equipment such as helmets. |
| | **xv)** | Provide measure to prevent fire. Fire extinguisher and buckets of sand to be provided in fire-prone area and elsewhere. |
| | **xvi)** | Provide sufficient and suitable light for working during night. |
| | **xvii)** | Ensure that measures to protect workers from materials of construction, |

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| | | transportation, storage and other dangers and health hazards are taken. |
| | **xviii)** | Ensure that the construction firm/division/company have sound safety policies |
| | **xix)** | Comply with the safety procedure, norms and guidelines (as applicable) as outlined in NBC 2005 (BIS 2005c). |
| | **xx)** | Adopt additional best practices and prescribed norms as in NBC 2005 (BIS2005). |
| | **6.2.8** | Identify roads on-site that would be used for vehicular traffic. Update vehicular roads (if these are unpaved) by increasing the surface strength by improving particle size, shape and mineral type that make up the surface base. Add surface gravel to reduce source of dust emission. Limit amount of fine particles (smaller than 0.075mm) to 10 -20%. Limit vehicular speed on site 10km/h. Nothing extra will be payable for this. |
| | **6.2.9** | All material storages should be adequately covered and contained so that they are not exposed to situations where winds on site could lead to dust/particulate emissions. |
| | **6.2.10** | Spills of dirt or dusty materials shall be cleaned up promptly so the spilled material does not become a source of fugitive dust and also to prevent of seepage of pollutant laden water into the ground aquifers. When cleaning up the spill, ensure that the clean - up process does not generate additional dust. Similarly, spilled concrete slurries or liquid wastes should be contained/cleaned up immediately before they can infiltrate into the soil/ground or runoff in nearby areas. |
| | **6.2.11** | Ensure that water spraying is carried out by wetting the surface by spraying water on: |
| | **i)** | Any dusty material. |
| | **ii)** | Areas where demolition work is carried out. |
| | **iii)** | Any unpaved main-haul road and. |
| | **iv)** | Areas where excavation or earth moving activities are to be carried out. |
| | **6.2.12** | The contractor shall ensure the following: |
| | **i)** | Cover and enclose the site by providing dust screen, sheeting or netting to scaffold along the perimeter of a building. |
| | **ii)** | Covering stockpiles of dusty material with impervious sheeting. |
| | **iii)** | Covering dusty load on vehicles by impervious sheeting before they leave the site. |
| | **iv)** | Transferring, handling/storing dry loose materials like bulk cement and dry pulverized fly ash inside a totally enclosed system. |
| | **v)** | Spills of dirt or dusty materials shall be cleaned up promptly so that the spilled material does not become a source of fugitive dust and also to prevent seepage of pollutant laden water into the ground aquifers. When cleaning up the spill, ensure that the clean-up process does not generate additional dust. Similarly, spilled concrete slurries or liquid wastes should be contained / cleaned up immediately before they can infiltrate into the soil/ground or runoff in nearby areas. |
| | **vi)** | Clear vegetation only from areas where work will start right away. |
| | **vii)** | Vegetate/mulch areas where vehicles do not ply. |
| | **viii)** | Apply gravel / landscaping rock to the areas where mulching/paving is impractical. |
| | **6.2.13** | Adopt measures to prevent air pollution in the vicinity of the site due to construction activities. There is no standard reference for this. The best practices should be followed (as adopted from international best practice documents and codes). |
| | **6.2.14** | Provide sheet covering/barricading of site of not less than 3m height along the site boundary, next to a road or other public area. Nothing extra will be paid for this. |
| | **6.2.15** | The contractor shall provide experienced personnel with suitable training to ensure that these methods are implemented. Prior to the commencement of any work, the method of working, plant equipment and air pollution control system to be used on - site should be made available for the inspection and approval of the Engineer -in-Charge to ensure that these are suitable for the project. |

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| | **6.2.16** | Employ measures to segregate the waste on-site into inert, chemical or hazardous wastes. Recycle the unused chemical/hazardous wastes such as oil, paint, batteries and asbestos. The inert waste is to be disposed off to Municipal Corporation/local bodies dump yard and landfill sites. |
| | **6.2.17** | To preserve the existing landscape and protect it from degradation during the process of construction. Select proper timing for construction activity to minimize the disturbance such as soil pollution due to spilling of the construction material and its mixing with rainwater. The construction management plan including soil erosion control management plan shall be prepared accordingly for each month. The application of erosion control measures includes construction of gravel pits and tyre washing bays of approved size and specification for all vehicular site entry/exits, protection of slopes greater than 10%. Sedimentation Collection System and run-off diversion systems shall be in place before the commencement of construction activity. Preserve and protect the existing vegetation by not-disturbing or damaging to specified site areas during construction. |
| | **6.2.18** | The Contractor should follow the construction plan as proposed by the Engineer-in-charge / landscape consultant to minimize the site disturbance such as soil pollution due to spilling. Use staging and spill prevention and control plan to restrict the spilling of the contaminating material on site. |
| | **6.2.19** | Spill prevention and control plans should clearly state measures to stop the source of the spill. Measures to contain the spill and measures to dispose the contaminated material and hazardous wastes. It should also state the designation of personnel trained to prevent and control spills. Hazardous wastes include pesticides, paints, cleaners and petroleum products. |
| | **6.2.20** | A soil Erosion and Sedimentation Control Plan (ESCP) should be prepared prior to construction and should be applied effectively. |
| | **6.2.21** | The contractor shall prepare and submit 'Spill prevention and control plans' before the start of construction, clearly stating measures to stop the source of the spill, to contain the spill, to dispose the contaminated material and hazardous wastes, and stating designation of personnel trained to prevent and control spills. Hazardous wastes include pesticides, paints, cleaners, and petroleum products. |
| | **6.2.22** | The contractor shall ensure that no construction leaches (Ex: cement slurry) is allowed to percolate into the ground. Adequate precautions are to be taken to safeguard against this including reduction of wasteful curing processes, collection, basic filtering and reuse. The contractor shall follow requisite measures for collecting drainage water run-off from construction areas and material storage sites and diverting water flow away from such polluted areas. Temporary drainage channels, perimeter dike/swale, etc. shall be constructed to carry the pollutant -laden water directly to the treatment device or facility (municipal sewer line). |
| | **6.2.23** | All lighting installed by the contractor around the site and at the labour quarters during construction shall be CFL bulbs of the appropriate illumination levels. This condition is a must, unless specifically prescribed otherwise. |
| | **6.2.24** | All paints, adhesives and sealants should comply with the VOC limits prescribed by GRIHA. |
| | **6.2.25** | All the building materials and systems used on site must be as per the specifications and approved makes by the Engineer-In-Charge. |
| | **6.2.26** | All required certificates explaining the properties of the building material/system needs to be obtained from the manufacturer/vendor as required by the green building rating authority. The final certificates would be produced after the approval of green building consultant with necessary due diligence. The purchase orders of all the materials made with the manufacturers / authorized vendors should be maintained and shall be provided for the process with due diligence upon request. |

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| | **6.2.27** | Water saving measures as suggested by the consultants need to be followed on site. |
| | **6.2.28** | The contractor / subcontractor shall prepare and submit a Site Management Plan (SMP) within 10 days of start, for approval by the Engineer -in-charge. This SMP shall indicate the locations of godown, stockpiles, barricading, waste storage, offices, vehicular movement routes etc. In short this SMP would comprehensively represent how the site activities shall be managed conforming to GRIHA guidelines. Contractor will be penalized @ Rs. 500 per day of delay on non-submission of SMP beyond due date to be recovered from next RA bill |
| | **6.2.29** | Any other site management measures suggested by the Engineer-in-charge / green building consultant shall be followed on site. |
| | **6.2.30** | The contractor shall submit to the Engineer -in-Charge after construction of the buildings, a detailed as built quantification of the following within 10 days of recording of completion. Contractor will be penalized @ Rs. 500 per day of delay on non-submission of SMP beyond due date to be recovered from the Final bill: |
| | **i)** | Total materials used |
| | **ii)** | Total waste generated, |
| | **iii)** | Total waste reused, |
| | **iv)** | Total water used |
| | **v)** | Total electricity consumed, and |
| | **vi)** | Total diesel consumed. |
| | **6.2.31** | Evidence for the implementation of the all the above required measures shall be provided to the green building consultant in the form of photographs and templates as required which is required for the submission to the green building rating authority (GRIHA). |
| | **6.2.32** | Nothing extra shall be payable for above provisions unless otherwise specified in Schedule of Quantity. |

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| **6.3 CONDITIONS TO BE ADHERED TO AS PER ENVIRONMENTAL CLEARANCE OBTAINED FROM DPCC FOR SAU PROJECT** | | |
| | **6.3.1** | Provision shall be made for the housing of labour within the site with all necessary infrastructure and facilities such as fuel for cooking, mobile toilets, mobile STP, safe drinking water, medical health care along with first aid room, crèche etc. The housing may be in the form of temporary structures to be removed after completion of the project |
| | **6.3.2** | Health and safety norms of CPWD should be followed during construction |
| | **6.3.3** | Top soil (if usable good earth) excavated during construction activities should be stored within the site for use in horticulture/landscape development |
| | **6.3.4** | Disposal of muck during construction phase should not create any adverse effect on the neighboring communities and be disposed of only in approved sites with the approval of competent authority taking the necessary precautions for general safety and health aspects of people. |
| | **6.3.5** | Proper measures should be adopted to control dust emissions during construction phase by providing adequate numbers of water sprinklers |
| | **6.3.6** | Soil and water samples of the site should be tested by the Project Proponent from any laboratory recognized by MOEF/DPCC to ascertain that there is no threat to ground water quality by leaching of contaminants, on quarterly basis for inclusion in the six monthly reports |
| | **6.3.7** | Construction spoils, including bituminous material and other hazardous materials, must not be allowed to contaminate watercourses and the dump sites for such material must be secured so that they should not leach into the ground water. Bulk of the demolition waste should be recycled and minimum possible demolition waste should be dumped at designated dumping site |
| | **6.3.8** | Any hazardous waste generated during construction phase should be disposed of as per applicable rules and norms with necessary authorization from Delhi Pollution Control Committee. |
| | **6.3.9** | The diesel generator sets to be used during construction phase should be placed in an acoustically treated enclosures and operated on low sulphur diesel and should conform to the Environment Protection Rules prescribed for air and noise emission standards. |
| | **6.3.10** | The diesel required for operating DG sets shall be stored in underground tanks and if required, clearance from Chief Controller of Explosives shall be taken. |
| | **6.3.11** | Vehicles hired for bringing construction material to the site should be in good condition, have pollution check certificate, and conform to applicable air & noise emission standards. These vehicles should be operated only during non-peak hours. The material loaded or unloaded should be covered (especially sand, excavated soil, etc.) before transportation to avoid fugitive emissions etc. |
| | **6.3.12** | Ambient noise levels should conform to prescribed residential standards both during day and night hours. Adequate measures should be made to reduce ambient air and noise level during construction and operation phase. So as to conform to the norms stipulated by CPCB/DPCC. Ambient air and noise monitoring should be done by an accredited lab and data should be submitted along with compliance report in every six month. |
| | **6.3.13** | Natural drainage should be preserved as far as possible. |

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| | **6.3.14** | Fly ash should be used as building material in the construction as per the provisions of Fly Ash Notification dated September 14th, 1999 and as amended upto date |
| | **6.3.15** | Ready Mix Concrete must be used in building construction to minimize the use of water and also by use of pre-mixed concrete, curing agents and other best practices preferred. |
| | **6.3.16** | Fixtures for toilet flushing and drinking water facility should be of low flow either by use of aerators or pressure reducing devices or sensor based control mechanism. |
| | **6.3.17** | Energy Conservation Building Code to be strictly adopted in all aspects of construction Requirements of GRIHA rating, if proposed, should be followed |
| | **6.3.18** | Regular supervision of the above and other measures for monitoring should be in place all through the construction phase, so as to avoid disturbance to neighbors. |
| | **6.3.19** | The demolition waste should be sent to C& D waste site of the MCD for recycling. |
| | **6.3.20** | Officials from Ministry of Environment & Forests, Regional Office, Chandigarh and Delhi Pollution Control Committee, who would be monitoring the implementation of environmental safeguards, should be given full co-operation to inspect the facilities and documents/data on site during their site inspection. Six-monthly monitoring reports shall be prepared and submitted to Ministry of Environment & Forests, Regional Office Chandigarh & also to DPCC, Delhi.<br>The Contractor will submit the desired data to the Engineer-in-charge as and when required, and nothing extra shall be paid on this account. |

# 7.0 CIVIL WORKS

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| **7.1 ADDITIONAL CONDITIONS AND PARTICULAR SPECIFICATIONS FOR STRUCTURAL STEEL WORKS** | | |
| | **7.1.1** | This specification covers the fabrication and transportation to site and erection on prepared foundations / base and structural steel work consisting of beams, columns, purlins, vertical trusses, bracings, shear connections etc. |
| | **7.1.2** | Fabrication, erection and approval of steel structures shall be in compliance with: |
| | **i)** | General Specifications mentioned in CPWD specifications and IS: 800 – 2007. For the guidance on general fabrication and erection of structural steel work, Section 17 of IS:800 (2007) must be followed. As far as safety is concerned guidance could be obtained from Indian safety code for structural steelwork IS:7205(1974). Before the commencement of the erection, all the erection equipment tools, shackles, ropes etc. should be tested for their load carrying capacity. Such tests if needed may be repeated at intermediate stages also. |
| | **ii)** | Schematic Drawings and supplementary drawings shall be supplied to the contractors during execution of the work as and when required. The contractor shall prepare the detailed shop drawings for approval of the Engineer-in-charge. |
| | **7.1.3** | Providing shop primer coat for steel structures. Grouting of holding-down bolt pockets and below base plates where required. |
| | **7.1.4** | In case of conflict between the Clauses mentioned here and the Indian Standards, those expressed in this specification shall govern. |
| | **7.1.5** | **Scope**<br>The fabrication and erection of the steel work consists of accomplishing of all jobs ere-in enumerated including providing all labour, tools and plant all materials and consumables such as welding electrodes, bolts and nuts, oxygen and acetylene gases, oils for cleaning etc. of approved quality as per relevant IS. The work shall be executed according to the drawings, specifications, relevant codes etc. in an expeditious and workman like manner, as detailed in the specifications and the relevant Indian Standard Codes and Standard Practice and to the complete satisfaction of the Engineer-in-charge . |
| | **7.1.6** | **Fabrication Drawings** |
| | **i)** | The contractor shall prepare all fabrication and erection drawings on the basis of design drawings supplied to him and submit the same in triplicate to the Engineer-in-charge for review, Engineer-in-charge shall review and comment, if any, on the same. Such review, if any, by the Engineer-in-charge, does not relieve the contractor of any of his required guarantees and responsibilities. The contractor shall however be responsible to fabricate the structural strictly conforming to specifications and reviewed drawings. |
| | **ii)** | Fabrication drawings shall include but not limited to the following: |
| | **iii)** | - Member sizes and details<br>- Types and dimensions of welds and bolts<br>- Shapes and sizes of edge preparation for welding<br>- Details of shop and field joints included in assemblies. |
| | **iv)** | Bill of material |
| | **v)** | - Quality of structural steels, welding electrodes, bolts, nuts and washers etc. to be used.<br>- Erection assemblies, identifying all transportable parts and sub-assemblies, associated with special erection instructions, if required.<br>- Calculations where asked for approval. |
| | **vi)** | Connections, splices etc. other details not specifically detailed in design drawings shall be suitably given on fabrication drawings considering normal detailing practices and developing full member strengths. Where asked for calculations for the merit shall also be submitted for approval. |
| | **vii)** | Any alternate design or change in section is allowed when approved in writing by the Engineer-in-charge. |
| | **viii)** | However, if any variation in the scheme is found necessary later, the contractor will be supplied with revised drawings. The contractor shall incorporate these changes in his drawings at no extra cost and resubmit for review. |

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| | **ix)** | Engineer-in-charge review shall not absolve the contractor of his responsibility for the correctness of dimensions, adequacy of details and connections. One copy will be returned reviewed with or without comments to the contractor for necessary action. In the former case further three copies of amended drawings shall be submitted by the contractor for final review. |
| | **x)** | The contractor shall supply three prints each of the final reviewed drawings to the Engineer-in-charge within a week since final review, at no extra cost for reference and records |
| | **xi)** | The Engineer-in-charge will verify the correct interpretation of their requirements. |
| | **xii)** | If any modification is made in the design drawing during the course of execution of the job, revised design drawings will be issued to the contractor. Further changes arising out of these shall be incorporated by the contractor in the fabrication drawings already prepared at no extra cost and the revised fabrication drawings shall be duly got reviewed as per the above Clauses. |
| | **7.1.7** | **Materials** |
| | **A.** | **Rolled Sections** |
| | **i)** | The following grades of steel shall be used for steel structures: |
| | **ii)** | Structural steel will generally be of standard quality conforming to IS: 226/IS:2062. Whenever welded construction is specified plates of more than 20 mm thickness will generally conform to IS: 2062:2011 (Grade-B). |
| | **iii)** | Welding Material |
| | **iv)** | Welding electrodes shall conform to IS: 814:2004 and metal arch welding as IS:816:1969 . |
| | **v)** | Approval of welding procedures shall be as per IS: 823:1964. |
| | **vi)** | Electrode for metal arc welding shall be E-6013 for structural steel having thickness up to 15 mm and E-7018 above 15 mm |
| | **B.** | **Bolts, Nuts & Washers**<br>Bolts and nuts shall be as per IS: 1367:2002 and tested as per IS: 1608:2005. It shall have a minimum tensile strength of 44 Kg/mm2 and minimum elongation of 23% on a gauge length of 5.65 (A- Original cross sectional area of the gauge length). Washers shall be as per IS: 2016. |
| | **C.** | All materials shall conform to their respective specifications. The use of equivalent or higher grade or alternate materials will be considered only in very special cases subject to the approval of the Engineer-in-charge in writing. |
| | **D.** | **Receipt & Storing of Materials** |
| | **i)** | Steel materials supplied by the contractor must be marked for identification and each lot should be accompanied by manufacturer's quality certificate, conforming chemical analysis and mechanical characteristics. |
| | **ii)** | All steel parts furnished by supplier shall be checked, sorted out, straightened, and arranged by grades and qualities in stores. |
| | **iii)** | Structural with surface defects such as pitting, cracks, laminations etc. shall be rejected if the defects exceed the allowable tolerances specified in relevant standards or as directed by the chief Engineer-in-charge |
| | **iv)** | Welding wire and electrodes shall be stored separately by qualities and lots inside a dry and enclosed room, in compliance with IS: 816 - 1969 and as per instructions given by the Engineer-in-charge. Electrodes shall be perfectly dry and drawn from an electrode even, if required. |
| | **E.** | Checking of quality bolts of any kind as well as storage of same shall be made conforming to relevant standards. |
| | **i)** | Each lot of electrodes, bolts, nuts, etc. shall be accompanied by manufacturer's test certificate. |
| | **ii)** | The contractor may use alternative materials as compared to design specification only with the written approval of the chief Engineer-in-charge. |
| | **7.1.8** | **Material Tests** |
| | **i)** | The contractor shall be required to produce manufacturer's quality certificates for the materials supplied by the contractor. Notwithstanding the manufacturer's certificates, the Engineer-in-charge may ask for testing of materials in approved test houses. The test results shall satisfy the requirements of the relevant Indian Standards. |

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| | **ii)** | Whenever quality certificates are missing or incomplete or when material quality differs from standard specifications the contractor shall conduct all appropriate tests as directed by the Engineer-in-charge at no extra cost. |
| | **iii)** | Materials for which test certificates are not available or for which test results do not tally with relevant standard specifications, shall not be used. |
| | **7.1.9** | **Fabrication** |
| | **i)** | The Contractor will submit the credential with full particulars about work completed by fabricator to be deployed for this work for approval of Engineer-in-charge. After written approval is communicated in respect of fabricator, then only the jobs should be a signed to him. Fabrication shall be in accordance with IS: 800 Section V in addition to the following: |
| | **ii)** | Fabrication shall be done as per approved fabrication drawings adhering strictly to work points and work lines on the same. The connections shall be welded or bolted as per design drawings. Work shall also include fabricating built up sections. |
| | **iii)** | Any defective material used shall be replaced by the contractor at his own expense, care being taken to prevent any damage to the structure during removal. |
| | **iv)** | All the fabricated and delivered items shall be suitably packed to be protected from any damage during transportation and handling. Any damage caused at any time shall be made good by the Contractor at his own cost. |
| | **v)** | Any faulty fabrication pointed out at any stage of work shall be made good by the contractor at his own cost |
| | **A.** | **Preparation of Materials** |
| | **vi)** | Prior to release for fabrication, all rolled sections warped beyond allowable limit shall be pressed or rolled straight and freed from twists, taking care that an uniform pressure is applied. |
| | **i)** | Minor warping, corrugations etc. in rolled sections shall be rectified by cold working. |
| | **ii)** | The sections shall be straightened by hot working where the Engineer-in-charge so direct and shall cooled slowly after straightening. |
| | **iii)** | Warped members like plates and flats may be used as such only if wave like deformation does not exceed L/1000 but limited to 10 mm (L- Length). |
| | **iv)** | Surface of members that are to be jointed by lap or fillet welding or bolting shall be even so that there is no gap between overlapping surfaces. |
| | **B.** | **Marking**<br>Marking of members shall be made on horizontal pads, of an appropriate racks or supports in order to ensure horizontal and straight placement of such members. Marking accuracy shall be atleast + 1 mm. |
| | **C.** | **Cutting** |
| | **i)** | Members shall be cut mechanically (by saw or shear or by oxyacetylene flame). |
| | **ii)** | All sharp, rough, or broken edges, and all edges of joints which are subjected to tensile or oscillating stresses, shall be ground. |
| | **iii)** | No electric metal arc cutting shall be allowed |
| | **iv)** | All edges cut by oxyacetylene process shall be cleaned of impurities prior to assembly. Cutting tolerances shall be as follows: |
| | a) | For members connected at both ends + 1 mm. |
| | b) | Elsewhere + 3 mm. |
| | **v)** | The edge preparation for welding of members more than 12 mm thick shall be done by flame cutting and grinding. Cut faces shall not have cracks or be rough |
| | **vi)** | Edge preparation shall be as per IS : 823 - 1964. |
| | **D.** | **Drilling** |
| | **i)** | Bolts holes shall be drilled. |
| | **ii)** | Drilling shall be made to the diameter specified in drawings. |
| | **iii)** | No enlarging of holes filling, by mandrolling or oxyacetylene flame shall be allowed. Allowed variations for holes (out-of-roundness, eccentricity, plumb-line deviation) shall be as per IS:800. |

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| | | - Maximum deviation for spacing of two holes on the same axis shall be + 1 mm.<br>- Two perpendicular diameters of any oval hole shall not differ by more than 1 mm. |
| | **E.** | Drilling faults in holes may be rectified by reaming the holes to the next upper diameter, provided that spacing of new hole centres and distance of hole centres to the edges of members are not less than allowed and that the increase of hole diameter does not impair the structural strength. Hole reaming shall be allowed if the number of faulty holes does not exceed 15% of the total number of holes for one joint. |
| | **7.1.10** | **WELDING** |
| | **A.** | **Preparation of Members for Welding** |
| | **i)** | All welding in mild steel work shall be done with electrodes and / or by methods recommended by the suppliers of the metals being welded in accordance with corresponding Indian Standards. Type, *size* and spacing of welds, shall be as specified. All welding consumables shall be in accordance with the I.S. standards. |
| | **ii)** | Welds behind finished mild steel surfaces shall be so done as to eliminate distortion and / or discoloration on the finished side. |
| | **iii)** | Weld spatter and welding oxides on finished surfaces shall be removed by descaling and / or grinding. Plug, puddle or spot welding shall not be permitted. If weld beads are visible on exposed finished surfaces, the surfaces shall be ground and polished to match and blend with finish on adjacent parent metal. |
| | **iv)** | Structural welds shall be made by certified welders and shall conform to I.S. code. |
| | **v)** | The welds shall be tested by the Contractor to ensure quality and integrity of the structural welds. However, welding tests shall be carried out as below: and the contractor shall maintain records for Visual testing – 100 % of the welds for size and quality. Fillet weld testing- 30 % of the welds for MPI or Dye penetration test Dirt grease, lubricant, or other organic material shall be removed by vapor degreasing or suitable solvent.<br>Testing: DPT visual test, radiographic, ultrasound test as per relevant specification /code shall be performed. 25% butt welded joints shall be tested radiographically by the contractor. These tests shall be done by the contractor at his own cost. |
| | **vi)** | Joints rejected because of welding defects may be repaired only by re welding. |
| | **vii)** | Defective welds shall be removed by chipping or machining. Flame cutting shall not be allowed. |
| | **B.** | Assembly of structural members shall be made with proper jigs and fixtures to ensure correct positioning of members (angles, axes nodes etc.). |
| | **C.** | Sharp edges, rust of cut edges, notches, irregularities and fissures due to faulty cutting shall be chipped or ground or filled over the length of the affected area, deep enough to remove faults completely. |
| | **D.** | Edge preparation for welding shall be carefully and accurately made so as to facilitate a good joint. |
| | **i)** | Generally no special edge preparation shall be required for members under 8 mm thick. |
| | **ii)** | Edge preparation (bevelling) denotes cutting of the same so as to result in V, X K or U seam shapes as per IS: 823. |
| | **iii)** | The members to be assembled shall be clean and dry on the welding edges. Under no circumstances shall wet, greasy, rust or dirt covered parts be assembled. Joints shall be kept free from any foreign matter likely to get in to the gaps between members to be welded. |
| | **iv)** | Before assembly the edges to be welded as well as adjacent areas extending for atleast 20 mm shall be cleaned (until metallic polish is achieved). |
| | **v)** | When assembling members, proper care shall be taken of welding shrinkage and distortions, as the drawing dimensions cover finished dimensions of the structure. |
| | **vi)** | The elements shall be got checked and approved by the Engineer-in-charge or their authorised representative before assembly. |
| | **vii)** | The permissible tolerances for assembly of members preparatory to welding shall be as per IS: 823-1964. |
| | **viii)** | After the assemble has been checked, temporary tack welding in position shall be done by electric welding, keeping in view finished dimensions of the structure. |

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| | **7.1.11** | **Welding procedures** |
| | **i)** | Welding shall be carried out only by fully trained and experienced welders as tested and approved by the Engineer-in-charge. Any test carried out either by the Engineer-in- charge or their representative or the inspectors shall constitute a right by them for such tests and the cost involved thereon shall be borne by the contractor himself. |
| | **ii)** | Qualification tests for welders as well as tests for approval of electrodes will be carried out as per IS:817. The nature of test for performance qualification of welders shall be commensurate with the quality of welding required on this job as judged by the Engineer-in-charge. |
| | **iii)** | The steel structures shall be automatically, semi-automatically or manually welded as per direction of Engineer-in-charge |
| | **iv)** | Welding shall begin only after the checks mentioned in Clause herein have been carried out. |
| | **v)** | The welder shall mark with his identification mark on each element welded by him. |
| | **vi)** | When welding is carried out in open air, steps shall be taken to protect the face of welding against wind or rain. The electrodes, wire and parts being welded shall be dry. Before beginning the welding operation, each joint shall be checked to ensure that the parts to be welded are clean and root gaps provided as per IS: 823. |
| | **vii)** | For continuing the welding of seems discontinued due to some reason, the end of the discontinued seem shall be melted in order to obtain a good continuity. Before resuming the welding operation, the groove as well as the adjacent parts shall be well cleaned for a length of approx. 50 mm. |
| | **viii)** | For single butt welds (in V, 1/2 V or U) and double butt welds (in K, double U etc.) the rewelding of the root is mandatory but only the metal deposit on the root has been cleaned by back gouging or chipping. |
| | **ix)** | The welding seams shall be left to cool slowly. The contractor shall not be allowed to cool the welds quickly by any other method. |
| | **x)** | For multi-layer welding, before welding the following layer, the formerly welded layer shall be cleaned metal bright by light chipping and wire brushing. Backing strips shall not be allowed |
| | **xi)** | The order and method of welding shall be so that;<br>- No unacceptable deformation appears in the welded parts.<br>- Due margin is provided to compensate for contraction due to welding in order to avoid any high permanent stresses. |
| | **xii)** | The defects in welds must be rectified according to IS: 823 and as per instruction of Engineer-in-charge. |
| | **xiii)** | Weld Inspection |
| | **A.** | The weld seams shall satisfy the following :<br>- shall correspond to design shapes and dimensions.<br>- shall not have any defects such as cracks, incomplete penetration and fusion, under- cuts, rough surfaces, burns, blow holes and porosity etc. beyond permissible limits |
| | **B.** | During the welding operation and approval of finished elements, inspections and tests shall be made as shown in annexure-B. The mechanical characteristics of the welded joints shall be as in IS: 823. |
| | **xiv)** | Preparation of Members for Bolting<br>The members shall be assembled for bolting with proper jigs and fixtures to sustain the assemblies without deformation and bending. Before assembly, all sharp edges, shavings, rust dirt, etc. shall be removed. Before assembly, the contacting surfaces of the members shall be cleaned and given a coat of primer as per IS: 2074.The members which are bolt assembled shall be set according to drawings and temporarily fastened with erection bolts (minimum 4 pieces) to check the coaxiality of the holes. The members shall be finally bolted after the deviations have been corrected, after which there shall not be gaps. Before assembly, the members shall be checked and got approved by the Engineer-in-charge. The difference in thickness of the sections that are butt assembled shall not be more than 3% or maximum 0.8 mm whichever is less. If the difference is larger, it shall be corrected by grinding or filling. Reaming of holes to final diameter or |

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| | | cleaning of these shall be done only after the parts have been check assembled. As each hole is finished to final dimensions (reamed if necessary) it shall be set and bolted up. Erection bolts shall not be removed before other bolts are set. |
| | **xv)** | **Bolting up** |
| | **A.** | Final bolting of the members shall be done after the defects have been rectified and approval of joints obtained. The bolts shall be tightened starting from the centre of joint towards the edge. |
| | **B.** | Planning of Ends |
| | **C.** | Planning of ends of members like column ends shall be done by grinding when so specified in the design. Planning of butt welded members shall be done after these have been assembled, the spare edges shall be removed with grinding machines or files. The following tolerances shall be permitted on member that have been planed.;<br>- On the length of the member having both ends planed, maximum + 2 mm with respect to design.<br>- Level differences of planed surfaces, maximum 0.3 mm.<br>- Deviation between planed surface and member's axis maximum 1/1500. |
| | **xvi)** | **Holes for Field Joints** |
| | **A** | Holes for field joints shall be drilled in the shop to final diameters and tested in the shop, with trial assemblies. When three-dimensional assembly is not possible in the shop, the holes for field joints may be drilled in shop and reamed on site after erection, on approval by the Engineer-in-charge . For bolted steel structures, trial assembly in shop is mandatory. The tolerance for spacing of holes shall be + 1 mm. |
| | **xvii)** | **Tolerances** |
| | **A** | All tolerances regarding dimensions, geometrical shapes and sections of steel structures, shall be as per Annexure B, if not specified in the drawing. |
| | **xviii)** | **Marking for Identification** |
| | **A.** | All elements and members prior to dispatch for erection shall be shop marked. The members shall be visibly marked with a weather proof light coloured paint. The size and thickness of the numbers shall be chosen as to facilitate the identification of members. For the small members that are delivered in bundles or crates, the required marking shall be done on small metal tags securely tied to the bundle, while the crates shall be marked directly. Each bundle or crate shall be packed with members for one and the same assembly; in the same bundle or crate, general utility members such as bolts, quests etc. may be packed. All bill of materials showing weight, quality and dimension of contents shall be placed in the crates. |
| | **B.** | The members shall be marked with a durable paint, in a visible location, preferably at one end of the member so that these may be easily checked during storage and erection. All members shall be marked in the shop before inspection and acceptance. |
| | **C.** | When the member is being painted, the marking area shall not be painted but bordered with white paint. The marking and job symbol shall be registered in all shop delivery documents (transportation, for erection etc.) |
| | **xix)** | **Shop Test Pre-assembly** |
| | **A** | For steel structures that have the same type of welding the shop test pre-assembly shall be performed on one out of every 10 members minimum. For bolted steel structures, shop test pre-assembly is mandatory for all elements as well as for the entire structure in conformity with previous Clause. |
| | **7.1.12** | **Shop Inspection and Approval** |
| | **i)** | General :<br>The Engineer-in-charge or their representative shall have free access at all responsible times to the contractors fabrication shop and shall be afforded all reasonable facilities for satisfying himself that the fabrication is being undertaken in accordance with drawings and specifications. Technical approval of the steel structure in the shop by the Engineer-in-charge is mandatory. The contractor shall not limit the number and kinds of tests, final as well as intermediate once, or extra tests required by the Engineer-in-charge. The contractor shall furnish necessary tools, gauges, instruments etc. and technical non-technical personnel for shop tests by the Engineer- in-charge, free of cost |
| | **ii)** | Shop Acceptance : |

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| | **A.** | The Engineer-in-charge shall inspect and approve at the following stages : The following approvals may given in shop:<br>- Intermediate approvals of work that cannot be inspected later.<br>- Partial approvals<br>- Final approvals |
| | **B.** | Intermediate approval of work shall be given when a part of the work is preformed later:<br>- Cannot be inspected later<br>- Inspection would be difficult to perform and results would not be satisfactory. |
| | **C.** | Partial approval in the shop is given on members and assemblies of steel structures before the primer coat is applied and includes :<br>- Approval of materials<br>- Approval of field joints<br>- Approval of parts with planed surfaces<br>- Test erection<br>- Approval of members<br>- Approval of markings<br>- Inspections and approvals of special features, like Rollers, loading platform mechanism etc. |
| | **D.** | During the partial approval, intermediate approvals as well as all former approvals, shall be taken in to consideration.<br>- Final approval in the Shop |
| | **E.** | The final approval refers to all elements and assemblies of the steel structures, with shop primer coat, ready for delivery from shop to be loaded for transportation, or stored. The final approval comprises of:<br>- Partial approvals<br>- Approval of shop primer coat<br>- Approval of mode of loading and transport<br>- Approval of storage (for materials stored). |
| | **7.1.13** | **Painting and Delivery** |
| | **i)** | Preparation of parts for shop painting: Painting shall consist of providing at least one coat of red oxide zinc chromate primer to steel members before dispatch from shop. Primer coat shall not be applied unless : |
| | **A.** | Surface have been wire brushed, cleaned of dust, oil, rust or sand blasted as per the requirement and direction of Engineer-in-charge etc. |
| | **B.** | Erection gaps between members, spots that cannot be painted or where moisture or other aggressive agents may penetrate, have been filled with an approved type of oil and putty. |
| | **C.** | The surface to be painted are completely dry. |
| | **D.** | The parts where water of aggressive agents may collect (during transportation, storage, erection and operation) are filled with putty and provided with holes for drainage of water |
| | **E.** | Members and parts have been inspected and accepted |
| | **F.** | Welds have been accepted. |
| | **G.** | The following are not to be painted or protected by any other product :<br>- Surface which are in the vicinity of joints to be welded at site.<br>- Surfaces bearing markings<br>- Other surfaces indicated in the design. |
| | **ii)** | The following shall be given a coat of hot oil or any approved resistant lubricant only. |
| | **iii)** | Planed surfaces |
| | **iv)** | Holes for links |
| | **v)** | The surfaces that are to be embedded or in contact with the concrete shall be given a coat of cement wash. The surfaces which are in contact with the ground, gravel or brick work and subject to moisture, shall be given bituminous coat. The other surfaces shall be given a primer coating.<br>Special attention shall be given to locations not easily accessible, where water can collect and which after assembly and erection cannot be inspected, painted and maintained. Holes shall be provided for water drainage and in accessible box type sections shall be hermetically sealed by welds. |

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| | | If specified elsewhere, in the schedule of quantities, the contractor shall paint further coats of red-oxide after erection and placing in position of the steel structures |
| | **7.1.14** | **Packing, transportation, delivery** |
| | | After final shop acceptance and marking, the item shall be packed and loaded for transportation. Packing must be adequate to protect item against warping during loading and unloading. Proper lifting devices shall be used for loading, in order to protect items against warping. Slender projecting parts shall be braced with additional steel bars, before loading, for protection against warping during transportation. Loading and transportation shall be done in compliance with transportation rules. If certain parts cannot be transported in the lengths stipulated in the design, the position and type of additional splice joints shall be approved by the Engineer-in-charge. Items must be carefully loaded on platforms of transportation means to prevent warping, bending or falling during transportation. The small parts such as fish-plates, quests etc. shall be securely tied with wire to their respective parts. Bolts, nuts and washers shall be packed and transported in crates. The parts shall be delivered in the order stipulated by the Engineer-in-charge and shall be accompanied by document showing: |
| | **i)** | Quality and quantity of structure or members |
| | **ii)** | Position of member in the structure |
| | **iii)** | Particulars of structure |
| | **iv)** | Identification number job symbol. |
| | **7.1.15** | **Field Erection** |
| | **i)** | The erection work shall be permitted only after the foundation or other structure over which the steel work will be erected is approved and is ready for erection. |
| | **ii)** | The contractor shall satisfy himself about the levels, alignment etc. for the foundations well in advance, before starting the erection. Minor chipping etc. shall be carried out by the contractor on his expense. |
| | **iii)** | Any faulty erection done by the contractor shall be made good at his own cost. |
| | **iv)** | Approval by the Engineer-in-charge or their representatives at any stage of work does not relieve the contractor of any of his required guarantees of the contract. |
| | **v)** | Storage and preparation of parts prior to erection<br>The storage place for steel parts shall be prepared in advance and got approved by the Engineer-in-charge before the steel structures start arriving from the hop. A platform shall be provided by the Contractor near the erection site for preliminary erection work. The contractor shall make the following verifications upon receipt of material at site<br>- For quality certificates regarding materials and workmanship according to these general specifications and drawings.<br>Whether parts received are complete without defects due to transportation, loading and unloading and defects, if any, are well within the admissible limit. For the above work sufficient space must be allotted in the storage area which will be arranged by the contractor without any extra cost to the SAU. Steps shall be taken to prevent warping of items during unloading. The parts shall be unloaded, stored and stored so as to be easily identified. The parts shall be stored according to construction symbol and markings so that these may be taken out in order or erection. The parts shall be at least 150 mm clear from ground on wooden or steel blocks for protection against direct contact with ground and to permit drainage of water. If rectification of members like straightening etc. are required, these shall be done in a special place allotted which shall be adequately equipped. The parts shall be clean when delivered for erection. |
| | **vi)** | Erection & Tolerances<br>Erection in general shall be carried out as required and approved by the Engineer-in-charge. Positioning and leveling of the structure, alignment and plumbing of the stanchion and fixing every member of the structure shall be in accordance with the relevant drawings and to the complete satisfaction of the Engineer-in-charge.<br>The following checks and inspection shall be carried out before during and after erection.<br>- damage during transportation<br>- accuracy of alignment of structures<br>- erection according to drawings and specifications<br>- progress and workmanship. |
| | **vii)** | In case there be any deviations regarding positions of foundations or anchor bolts, which |

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| | | would lead to erection deviations, the Engineer-in-charge shall be informed immediately. Minor rectifications in foundations, orientation of Bolts holes etc. shall be carried out as part of the work, at no extra cost. The various parts of the steel structure shall be so erected so to ensure stability against inherent weight, wind and erection stresses. The structure shall be anchored and final erection joints completed after plan and elevation positions of the structural members have been verified with corresponding drawings and approved by the Engineer-in-charge. The bolted joints shall be tightened so that the entire surface of the bolt heads and nuts shall rest on the member. For parts with sloping surfaces tapered washers shall be used. |
| | **A.** | **Final acceptance and handing over the structure**<br>• At acceptance, the contractor shall submit the following documents:<br>• Shop and erection drawings – four sets soft copy and hard copies 4 copies of each of the following:<br>• Shop acceptance documents quality certificate for structural, plates, etc. (electrodes, welding wire, bolts, nuts, washers etc.)<br>• List of certified welders who worked on erection of structures.<br>• Acceptance and intermediate control procedure of erection operations. Approval by the Engineer-in-charge at any stage of work does not relieve the contractor of any of his required guarantees of the contract. |
| | **B.** | **Method of Payments**<br>• Payment for steel work shall be made on basis of admissible weight of the structure accepted, the weight being determined as described below:<br>• The rate for supply, fabrication and erection, shall include cost of all handling and transportation to site of work where supply and fabrication only are involved, trimming, straightening, edge preparation, preparation and getting reviewed of fabrication drawings, and providing one or more coat of Red-oxide zinc chromate primer as specified in the schedule of quantity.<br>• Measurements: The measurement of weight shall be same as given under para 7.2.11 of particular specifications for reinforcement item.<br>• The standard weight of steel sections shall conform to IS 808 with tolerance in size as per IS 1852.Tolerance in weight is given in table 10.3, Steel sections shall be acceptable within tolerance limits. Payment for steel sections shall be made as per actual weight within tolerances. Sections having weight on higher side than permissible tolerance may be acceptable but payment shall be made on the basis of standard weight only. Steel sections having weight variations lower than permissible variation shall not be acceptable. If sections are different from IS section, then manufacturers handbook shall be adopted. No allowance in weights shall be made for rolling tolerance.<br>• Sections built out of plates, structural shall be paid on the actual weight incorporated except for gussets which will be paid on the weight of the smallest rectangle enclosing the shape. No deductions shall be made for skew cuts in rolled steel sections.<br>• Welds, bolts, nuts, washers, etc. shall not be measured. Rate for structural steel work shall be deemed to include the same.<br>• No other payment either for temporary works connected with this contract or for any other item such as welds, shims, pacing plates etc. shall be made. Such item shall be deemed to have been allowed for in the rate quoted for steel work.<br>• The mode of measurement shall be as specified in the relevant CPWD specifications. |
| | **C.** | **Grouting of Pockets**<br>• Grouting of pockets and under base plates will be done only after the steel work has been leveled and plumbed and the bases of stanchions are supported by steel shims. The space below the base plate and pockets shall be thoroughly cleaned.<br>• The material used for grouting shall be one grade higher than the base concrete preferably with GP2 (Conbextra). It shall be poured under suitable head and tamped until the space has been completely filled. The rate of standard steel shall be inclusive of such grouts. |
| | **D.** | **Tolerances allowed in the erection of building with / without cranes**<br>The maximum tolerances for line and level of the steel work shall be + 3.00 mm on any part of the structure. The structure shall not be out of plumb more than 3.5 mm on each |

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| | | 10 Meter section of height and not more than 7.0 mm per 30 Meter section in plan. These tolerances shall apply to all parts of the structure unless the drawings issued for erection purposes state otherwise. |
| | **7.1.16** | Contractor to submit shop drawing for all structural steel work for approval. The work at site should commence only after getting the shop approved. |
| | **7.1.17** | Contractor to get erection scheme approved before commencement of erection of trusses. |

## 7.2 ADDITIONAL CONDITIONS AND PARTICULAR SPECIFICATIONS FOR REINFORCEMENT STEEL

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| **7.2.1** | The contractor shall procure TMT bars of Fe 500D grade from primary producers as per approved make list conforming to BIS specifications. |
| **7.2.2** | The specifications of TMT bars procured from primary producers shall meet the provisions of IS 1786 : 2008 pertaining to Fe 500D grade of steel as specified in the tender. charge in respect of all supplies of steel brought by him to the site of work. |
| **7.2.3** | The contractor shall have to obtain and furnish factory test certificates to the Engineer - in- charge |
| **7.2.4** | Samples shall also be taken and got tested by the Engineer -in-Charge as per the provisions in this regard in relevant BIS codes. In case the test results indicate that the ; |
| **7.2.5** | Steel arranged by the contractor does not conform to the specifications as defined, the same shall stand rejected, and it shall be removed from the site of work by the contractor at his cost within a week time of written orders from the Engineer-in-Charge to do so. Else the SAU shall remove it and recover double the cost of removal from the contractor |
| **7.2.6** | The steel reinforcement bars shall be brought to the site in bulk supply of 20 tonnes or more, or as decided by the Engineer -in-charge. |
| **7.2.7** | The steel reinforcement bars shall be stored by the contractor at site of work in such a way as to prevent their distortion and corrosion, and nothing extra shall be paid on this account. Bars of different sizes and lengths shall be stored separately to facilitate easy counting and checking. |
| **7.2.8** | For physical and chemical tests, specimens of sufficient length shall be cut from each size of the bar at random and at frequency not less than that specified below: |

| Size of Bar | For Consignment below 100 tonnes | For consignments above 100 tonnes |
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| Under 10 mm dia bars | One sample (Three specimen) for each 25 tonnes or part thereof | One sample for each 40 tonnes or part thereof |
| 10 mm to 16 mm dia bars | One sample (Three specimen) for each 35 tonnes or part thereof | One sample for each 45 tonnes or part thereof |
| Over 16 mm dia bars | One sample (Three specimen) for each 45 tonnes or part thereof | One sample for each 50 tonnes or part thereof |

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| **7.2.9** | The contractor shall supply free of charge the steel required for testing including its transportation to testing laboratories. The cost of tests shall be borne by the contractor/ SAU in the manner indicated below: |
| **i)** | By the contractor if the results show that steel does not conform to relevant BIS Codes. |
| **ii)** | By the SAU if the results show that steel confirms to relevant BIS Codes. |
| **7.2.10** | The actual issue and consumption of steel on work shall be regulated and proper accounts maintained as provided in the contract. The theoretical consumption of steel shall be worked out as per procedure prescribed in clause 42 of the contract and shall be governed by the conditions laid therein. In case, the consumption is less than theoretical consumption including permissible variations, recovery at the rate so prescribed shall be made. In case of excess consumption no adjustment shall be made. |
| **i)** | The steel brought to site and the steel remaining unused shall not be removed from site without the written permission of the Engineer-in-charge. |
| **7.2.11** | For the purpose of payment, of steel reinforcement / structural steel sections/ plates / bolts and nuts the measurement shall be as under:- |
| **i)** | Unit weight for reinforcement bars: The actual weight per meter of the reinforcement of various diameters shall be measured for three random samples collected (for each diameter of steel reinforcement) from each lot of particular diameter of steel reinforcement brought to the site for use in the work. For this, each sample (one sample consisting of three specimens) for each diameter of steel reinforcement shall be cut to require lengths and weighed and average weight calculated and recorded. The average weight for each type of steel section and steel reinforcement of each diameter shall be taken as the actual weight per metre for that steel section and that |

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| | | diameter of steel reinforcement. |
| | **ii)** | In case actual unit weight is less than standard unit weights mentioned in CPWD specifications 2009 Volume 1, but within variation, in such cases payment shall be made on the basis of actual unit weight. However, if actual unit weight is more than standard unit weights mentioned in CPWD specifications 2009 Volume 1, then payment shall be made on the basis of standard unit weight in such cases. In such case nothing extra shall be paid for difference in actual weight and standard weight. |
| | **7.2.12** | Contractor to submit Bar Bending Schedule (BBS) for reinforcement steel work for approval of the Engineer-in-charge. The RCC work should commence only after getting the BBS approved and signing of pour card by the representative of Engineer-in-charge. |
| | **7.2.13** | The work shall be carried out as per the CPWD specifications. |

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| **7.3 ADDITIONAL CONDITIONS AND PARTICULAR SPECIFICATIONS FOR CEMENT** | | |
| | **7.3.1** | The contractor shall procure Portland Pozzolana Cement (PPC) [conforming to IS:1489 (Part-I)], with a flyash content of 28% or more as required in the work, from reputed manufacturers of grey cement having a production capacity of one million tonnes or more per annum, as approved by CPWD for this sub region and holding license to use ISI certification mark for their product whose name shall be got approved from Engineer-in- charge. Supply of cement shall be taken in 50 Kg. bags bearing manufacturer's name and ISI marking. |
| | **7.3.2** | Every delivery of cement shall be accompanied by producer's certificate confirming that the supplied cement conforms to relevant specifications. These certificates should be endorsed to Engineer-in-charge for his record. |
| | **7.3.3** | For each grade, cement bags shall be stored in two separate godowns, one for tested cement and the other for fresh cement (under testing) constructed by the contractor at his own cost as per sketch given in General Conditions of Contract for CPWD 2014 with weather proof roofs and walls. The actual size of godown shall be as per site requirements and as per the direction of the Engineer in charge and nothing extra shall be paid for the same. The decision of the Engineer-in-charge regarding the capacity required/needed will be final. However, the capacity of each godown shall not be less than 250 tonnes or as decided by Engineer-In-Charge. |
| | **7.3.4** | Each godown shall be provided with a single door with two locks. The keys of one lock shall remain with Engineer-in-charge or his authorized person and that of other lock with the authorized agent of the contractor at the site of work so that the cement is issued from godown according to the daily requirement with the knowledge of both the parties. The account of daily receipt and issue of cement shall be maintained in a register in the prescribed Performa and signed daily by the contractor or his authorized agent in token of its correctness. The contractor shall be responsible for the watch & ward and the safety of the cement godown. The contractor shall facilitate the inspection of the cement godown by the Engineer-in-charge any time. |
| | **7.3.5** | The contractor shall supply free of charge the cement required for testing including its transportation cost to testing laboratories. Samples of cement arranged by the contractor shall be taken by the Engineer-in-charge and got tested in accordance with provisions of relevant BIS codes. The cement shall be used on the work only after satisfactory test results have been received. In case the test results indicate that the cement arranged by the contractor does not conform to the relevant BIS codes, the same shall stand rejected, and it shall be removed from the site by the contractor at his own cost within a week's time of written order from the Engineer- in-charge to do so |
| | **7.3.6** | The cost of tests shall be borne by the contractor/SAU in the manner indicated below |
| | **i)** | By the contractor, if the results show that the cement does not conform to relevant BIS codes. |
| | **ii)** | By the SAU, if the results show that the cement conforms to relevant BIS codes. |
| | **7.3.7** | PPC (Portland Pozzolana Cement) shall be used in RCC structures in accordance with the circular issued by the Directorate General of Works vide No.CDO/SE(RR)/Fly Ash (Main)/102 dt.09.04.2009. The use of PPC shall be regulated as per the following conditions stipulated in the circular dt.09.04.2009:- |
| | **i)** | IS:456-2000 Code of Practice for Plain and Reinforced Concrete (as amended upto date) shall be followed in regard to Concrete Mix Proportion and its production as under: |
| | **A.** | The concrete mix design shall be done as "Design Mix Concrete" as prescribed in clause-9 of IS 456 mentioned above. |
| | **B.** | Concrete shall be manufactured in accordance with clause 10 of above mentioned IS:456 covering quality assurance measures both technical and organizational, which shall also necessarily require a qualified Concrete Technologist to be available during manufacture of concrete for certification of quality of concrete |

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| | **ii)** | Minimum M25 or as specified grade of concrete shall be used in all structural elements of RCC, both in load bearing and framed structure. |
| | **iii)** | The mechanical properties such as modulus of elasticity, tensile strength, creep and shrinkage of concrete using fly ash blended cements (PPCs) are not likely to be significantly different and their values are to be taken same as those used for concrete made with OPC. |
| | **iv)** | To control higher rate of carbonation in early ages of concrete in PPC based concrete, water/binder ratio shall be kept as low as possible, which shall be closely monitored during concrete manufacture. If necessitated due to low water/binder ratio, required workability shall be achieved by use of chloride free chemical admixtures conforming to IS:9103. The compatibility of chemical admixtures and super plasticizers with each set PPC received from different sources shall be ensured by trials. |
| | **v)** | In environment subjected to aggressive chloride or sulphate attack in particular, PPC based concrete is recommended. In case, where structural concrete is exposed to excessive magnesium sulphate, fly ash content shall be limited to 18% by weight. Special type of cement with low C3A content may also be alternatively used. Durability criteria like minimum binder content and maximum water/binder ratio also need to be given due consideration is such environment. |
| | **vi)** | Wet curing period shall be enhanced to a minimum of 10 days or its equivalent. In hot & arid regions, the minimum curing period shall be 14 days or its equivalent. |
| | **vii)** | Subject to General Guidelines detailed out as above, PPC manufactured conforming to IS:1489 (Part-I) shall be treated at par with OPC for manufacture of Design Mix Concrete for structural use in RCC. |
| | **viii)** | Till the time, BIS makes it mandatory to print the %age of fly ash on each bag of cement, the certificate from the PPC manufacturer indicating the same shall be supplied by the contractor. |
| | **ix)** | While using PPC for structural concrete work, no further admixing of fly ash shall be permitted. |
| | **7.3.8** | The actual issue and consumption of cement on work shall be regulated and proper accounts maintained as provided in clause 10 of the contract. The theoretical consumption of cement shall be worked out as per procedure prescribed in clause 42 of the contract and shall be governed by conditions therein. No payment for excess consumption of cement will be allowed. However for consumption lesser than permissible theoretical variation, a recovery shall be made in accordance with conditions of contract of schedule A to F without prejudice to action for acceptance of work/item of reduced rate or rejection, as the case may be. |
| | **7.3.9** | For non-schedule items, the decision of the Engineer-in-charge or successor thereof regarding theoretical quantity of cement which should have been actually used shall be final and binding on the contractor |
| | **7.3.10** | Cement brought to site and cement remaining unused after completion of work shall not be removed from site without written permission of the Engineer-in-charge. |
| | **7.3.11** | Damaged /settled/expired cement shall be removed from site immediately by the contractor on receipt of notice in writing from the Engineer-in-charge. If he does not do so within three days of receipt of such notice, the Engineer-in-charge shall get it removed at the cost of the contractor. |

## 7.4 ADDITIONAL CONDITIONS AND PARTICULAR SPECIFICATIONS FOR R.C.C. WORK (DESIGN MIX CONCRETE )

**7.4.1 GENERAL:-**

The RCC work shall be done with RMC Design Mix Concrete, unless otherwise specified in the nomenclature of items, wherever letter M has been indicated, the same shall imply for the Design Mix Concrete. The Ready Mix Concrete shall be as per IS : 4926 and as per CPWD Specification and guide lines. For the nominal mix in RCC, CPWD specification shall be followed. The Design Mix Concrete will be designed based on the principles given in IS : 456, 10262 and SP 23. The contractor shall carry out design mixes for each class of concrete indicating that the concrete ingredients and proportions will result in concrete mix meeting requirements specified. The cement shall be actually weighed as presumption of each bag having 50 kg shall not be allowed. In case of use of admixture, the mix shall be designed with these ingredients as well. The specification mentioned herein below shall be followed for Design Mix Concrete.

**INGREDIENTS**

**i)** Coarse Aggregate :- As per CPWD Specifications

**ii)** Fine Aggregate :- As per CPWD Specifications.

**iii)** Water :- As per requirements laid down in IS 456-2000 and CPWD specifications.

**iv)** Cement: Cement arranged by the contractor will be PPC (in bags) conforming to IS : 1489 : Part-I.

**7.4.2** Admixture:- Admixtures shall not be used without approval of Engineer-in-Charge. Wherever required, admixtures of approved quality shall be mixed with concrete to achieve the desired workability within specified water cement ratio. The admixture shall conform to IS : 9103. The chloride content in the admixture shall satisfy the requirement of BS : 5075. The total amount of chlorides in the admixture mixed concrete shall also satisfy the requirements of IS : 456-2000

**7.4.3** The contractor shall not be paid anything extra for admixture required for achieving desired workability without any change in specified water cement ratio for RCC / CC work.

**7.4.4** The characteristic compressive strength of various grades of concrete shall be as given below :-

| Sl. No | Grade Designation | Specified Characteristic Compressive strength of15cm cubes at 28 days in N/mm$^2$ | Standard Deviation in N/mm$^2$ | Minimum cement content * (Kg per Cum) | Maximum water cement ratio |
|---|---|---|---|---|---|
| (i) | M-10 | 10 | 3.5 | 220 | 0.5 |
| (ii) | M-15 | 15 | | 240 | |
| (iii) | M-20 | 20 | 4.0 | 300 | 0.45 |
| (iv) | M-25 | 25 | | 330 | |
| (v) | M-30 | 30 | | 340 | |
| (vi) | M-35 | 35 | 5.0 | 350 | |
| (vii) | M-40 | 40 | | 360 | 0.40 |
| (viii) | M-45 | 45 | | 380 | 0.35 |
| (ix) | M-50 | 50 | | 400 | |
| (x) | M-60 | 60 | 6.0 | 420 | |

**7.4.5** The recommended values of slump for various members to confirm IS 456

**7.4.6** The Concrete mix will be designed for minimum workability as specified in para 7 of IS–456- 2000

**7.4.7** Workability of concrete (unless otherwise specified elsewhere or as decided by engineer in charge.

| ***Placing Conditions*** | Degree of Workability | Slump (mm) |
|---|---|---|
| (1) | (2) | (3) |
| Lightly reinforced sections in slabs, beams, walls, columns | Low | 25-75 |
| Heavily reinforced section in slabs, beams, walls, columns. | Medium | 50-100 |

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| | | Pumped concrete | Medium | 75-100 |

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| | **7.4.8** | (a) In the designation of concrete mix letter M refers to the mix and the number to the specified characteristic compressive strength of 15 cm – Cube at 28 days expressed in N/mm2.<br>**(b) For all grades of concrete manufactured/produced, minimum cement content in the Reinforcement concrete shall be 330 kg per cubic meter of concrete. Also, irrespective of the grade of concrete the maximum content of cement shall not be more than 500kg per cubic meter of concrete. These limitations shall apply for all types of cements of all strengths.**<br>(c) **OPC shall be used for concrete above grade M50 only, rest of the concrete shall be produced with PPC confirming to IS:1489 (part-I) only. Supplementary cementitious materials; micro silica, silica fumes, aluco fines, GGBS can be used in OPC (for higher grade mentioned above) only with prior permission of Engineer in Charge for Concrete Design Mix. Nothing extra will be paid for using these admixtures, the bidders are requested to quote accordingly. Fly ash shall not be allowed to mix in the concrete/cement.** |
| | **7.4.9** | The concrete mix design with or without admixture will be carried out by the contractor through IIT Delhi or NCBM Ballabhgarh and as per direction of Engineer-In-Charge. |
| | **7.4.10** | The various ingredients for mix design/laboratory tests shall be sent to the lab / test houses through the Engineer-In-Charge of the project and got it tested in approved laboratories as may be decided by the Engineer-in-charge immediately after award of work and the samples of such aggregate sent shall be preserved at site by the contractor/SAU. The admixture if used by contractor shall be at his own cost without any extra payment.<br>* Note : The Cement content means PPC Cement including fly ash added during production of PPC at the cement plant/factory. |
| | **7.4.11** | |
| | **7.4.12** | The contractor shall submit the mix design report from any of above approved laboratories like IIT Delhi, NCBM, Ballabhgarh for approval of Engineer in charge within 30 days from the date of issue of letter of acceptance of the bid. No concreting shall be done until the mix design is approved. |
| | **7.4.13** | In case of change of source or characteristic properties of the ingredients used in the concrete mix during the work, a revised laboratory mix design report conducted in laboratories approved by Engineer-In-Charge shall be submitted by the contractor as per the direction of the Engineer in charge. |
| | **7.4.14** | **APPROVAL OF DESIGN MIX** |
| | **i)** | The mix design for a specified grade of concrete shall be done for a target mean compressive strength Tck = Fck + 1.65s<br>Where Fck = Characteristic Compressive Strength at 28 days<br>s = Standard deviation which depends on degree of quality control. |
| | **ii)** | The degree of quality control for this work is “good” for which the standard deviation (s) obtained for different grades of concrete shall be as per IS relevant IS Standards/ Codes. |
| | **iii)** | Out of the six specimen of each set, three shall be tested at seven days and remaining three at 28 days. The preliminary tests at seven days are intended only to indicate the strength to be attained at 28 days. |
| | **7.4.15** | **NO EXTRA CHARGES FOR DESIGN MIX** |
| | **i)** | All cost of mix designing and testing connected therewith including charges payable to the laboratory shall be borne by the contractor. |
| | **ii)** | **Based on the design criterion mentioned above, the agency will get the design mix prepared from the approved laboratory. The Rate of concrete shall be inclusive of all constituents including extra cement over the minimum, admixture, micro silica and other additives wherever required. Nothing extra shall be paid on this** |

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| | | **account.** |
| | **7.4.16** | **DESIGN MIX CONCRETE FROM FULLY AUTOMATIC COMPUTERISED CONCRETE BATCHING AND MIXING PLANT** |
| | **i)** | Proportioning Concrete<br>In proportioning cement concrete, the quantity of both cement and aggregates shall be determined by weight. The cement shall be weighed separately from the aggregates. Water shall either be measured by volume in calibrated tanks or weighed. All measuring equipment shall be maintained in a clean and serviceable condition. The amount of mixing water shall be adjusted to compensate for moisture content in both coarse and fine aggregates. The moisture content of aggregates shall be determined in accordance with IS : 2386 (Part III). Suitable adjustments shall also be made in the weights of aggregates to allow for the variation in weight of aggregates due to variation in moisture content. |
| | **ii)** | Production of Concrete ; The contractor shall install fully automatic concrete batch mix plant at site of work, RMC from other plants shall not be allowed unless in emergent situation with prior approval of Engineer in charge.<br>The concrete shall be RMC produced in a central batching and mixing plant with computerized printing for contents and admixture dosage. The batching plant shall be fully automatic. Automatic batcher shall be charged by devices which when actuated by a single starter switch will automatically start the weighing operation of each material and stop automatically, when the designated weight of each material has been reached. The batching plant shall have automatic arrangement for dispensing the admixture and shall also be capable of discharging water in more than one stage. A print out from the batching plant for every lot shall be submitted. A batching plant essentially shall consist of the following components :Separate storage bins for different sizes of aggregates, silo for cement; and water storage tank.<br>• Batching equipment<br>• Mixers<br>• Control panels<br>• Mechanical material feeding and elevating arrangements |
| | **iii)** | The compartments of storage bins for aggregates shall be approximately of equal size. The cement compartment shall be centrally located in the batching plant. It shall be watertight and provided with necessary air vent, aeration fittings for proper flow of cement & emergency cement cut off gate. The aggregate and sand shall be charged by power operated centrally revolving chute. The entire plant from mixer floor upward shall be enclosed and insulated. The batch bins shall be constructed so as to be self-cleansing during drawdown. The batch bins shall in general conform to the requirements of IS :4925. |
| | **iv)** | The batching equipment shall be capable of determining and controlling the prescribed amounts of various constituent materials for concrete accurately i.e. water, cement, sand, individual size of coarse aggregates etc. The accuracy of the measuring devices shall fall within the following limits.<br>Measurement of Cement — ±2% of the quantity of cement in each batch<br>Measurement of Water — ±3% of the quantity of water in each batch<br>Measurement of Aggregate — ±3% of the quantity of aggregate in each batch<br>Measurement of Admixture — ±3% of the quantity of admixture in each batch |
| | **7.4.17** | **Mixing Concrete**<br>The mixer in the batching plant shall be so arranged that mixing action in the mixers can be observed from the operator's station. The mixer shall be equipped with a mechanically or electrically operated timing, signaling and metering device which will indicate and assure completion of the required mixing period. The mixer shall have all other components as specified in IS : 4925 |
| | **7.4.18** | **Transportation, Placing and Compaction of Concrete** |
| | **i)** | Mixed concrete from the batching plant shall be transported to the point of placement by transit mixers or through concrete pumps or steel closed bottom buckets capable of carrying 6 cum concrete. In case the concrete is proposed to be transported by transit |

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| | | mixer, the mixer speed shall neither be less than 4 rev/ min. of the drum nor greater than a speed resulting in a peripheral velocity of the drum as 70 m / minute at its largest diameter. The agitating speed of the agitator shall neither be less than 2 rev / min. nor more than 6 rev / min. of the drum. The number of revolutions of the mixing drum or blades at mixing speed shall be between 70 to 100 revolutions for a uniform mix, after all ingredients, have been charged into the drum. Unless tempering water is added, all rotation after 100 revolutions shall be at agitating speed of 2 to 6 rev / min. and the number of such rotations shall not exceed 250. The general construction of transit mixer and other requirements shall conform to IS : 5892. |
| | **ii)** | In case concrete is to be transported by pumping, the conduit shall be primed by pumping a batch of mortar / thick cement slurry through the line to lubricate it. Once the pumping is started, it shall not be interrupted (if at all possible) as concrete standing idle in the line is liable to cause a plug. The operator shall ensure that some concrete is always there in the pump-receiving hopper during operation. The lines shall always be maintained clean and shall be free of dents. |
| | **iii)** | Materials for pumped concrete shall be batched consistently and uniformly. Maximum size of aggregate shall not exceed one-third of the internal diameter of the pipe. Grading of aggregate shall be continuous and shall have sufficient ultra fine materials (materials finer than 0.25mm). Proportion of fine aggregates passing through 0.25mm shall be between15 & 30% and that passing through 0.125 mm sieve shall not be less than 5% of the total volume of aggregate. When pumping long distances and through hot weather, set- retarding admixtures may be used. Admixtures to improve workability can be added. Suitability of concrete through pumping shall be verified by trial mixes and by performing pumping tests. |
| | **7.4.19** | **PREPARATION OF MIXES AS PER APPROVED DESIGN MIX AND CONDUCTING CONFIRMATORY TEST AT FIELD LAB.** |
| | **i)** | The contractor shall make the cubes of trial mixes as per approved Mix design at site laboratory for all grades in presence of Engineer-in-charge using sample of approved materials proposed to be used in the work prior to commencement of concreting and get them tested in his presence to his entire satisfaction for 7 days and 28 days. Test cubes shall be taken from trial mixes as follows.<br>For each mix, a set of six cubes shall be made from each of the three consecutive batches. Three cubes from each set of six shall be tested at age of 7 days and remaining three cubes at age of 28 days. The cubes shall be made, cured, transported and tested strictly in accordance with the specifications. The average strength of nine cubes at age of 28 days shall exceed the specified target mean strength for which design mix has been approved. The evaluation of test results will be done as per IS : 456-2000. |
| | **7.4.20** | **WORK STRENGTH TEST** |
| | **i)** | **TEST SPECIMEN**<br>Work strength test shall be conducted in accordance with IS: 516 on random sampling. Each test shall be conducted on six specimen, three of which shall be tested at 7 days and remaining three at 28 days. Additional samples shall be prepared, if required, as per direction of Engineer in charge for testing samples cured by accelerated method as described in IS : 9103 |
| | **ii)** | **TEST RESULTS OF SAMPLE**<br>The test results of the sample shall be the average of the strength of three specimen. The individual variation shall not be more than + - 15 percent of the average. If variation is more, the test results of the sample are invalid. 90% of the total tests shall be done at the laboratory established at site by the contractor and remaining 10% in the laboratory of Government Engineering colleges, or in any other approved laboratory as directed by the Engineer-in- charge |
| | **A.** | **STANDARD FOR ACCEPTANCE** |
| | **i)** | Standard of acceptance shall be same as specified in clause 16 of IS 456-2000. |
| | **ii)** | In order to keep the floor finish as per direction of Engineer-in-charge and as per Architectural drawings and to provide required thickness of the flooring as per specification, the level of top surface of RCC shall be accordingly adjusted at the time |

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| | | of its centering, shuttering and casting for which nothing extra shall be paid to the contractor. |
| | **B.** | **Ultrasonic Pulse Velocity Method of Test for RCC** |
| | **i)** | The underlying principle of assessing the quality of concrete is that comparatively higher velocities are obtained when the quality of concrete in terms of density, homogeneity and uniformity is good. The consistency of the concrete as regards its general quality gets established. In case of poorer quality, lower velocities are obtained. If there are cracks, voids or flaws inside the concrete which come in the way of transmission of pulse, lower velocities are obtained. |
| | **ii)** | The quality of concrete in terms of uniformity, incidence or absence of internal flaws, cracks and segregation etc. indicative of the level of workmanship employed, can thus be assessed using the guidance given in table below which have been evolved for characterizing the quality concrete in structure in term of the ultrasonic pulse velocity.<br>**Velocity criterion for Concrete Quality Grading:**<br>**Sl. No. / Pulse velocity by Cross Probing (km/sec) / Concrete Quality Grading**<br>1 / Above 4.5 / Excellent<br>2 / 4.5 to 3.5 / Good<br>3 / 3.5 to 3.0 / Medium<br>4 / Below 3.0 / Doubtful<br>**Note : In Case of "doubtful" quality, it may be necessary to carry further tests.** |
| | **iii)** | Pulse velocity method of test of concrete is to be conducted for SAU works as a routine test. The acceptance criteria as per the above table will be applicable which is as per IS 13311 (part-1): 1992. From the above, "Good" and "Excellent" grading are acceptable and below these grading the concrete will not be acceptable |
| | **iv)** | 5% of the total number of RCC members in each category i.e. beam, column, slab and footing may be tested by UPV test method for establishing quality of concrete. It is suggested that test be conducted on RCC beam near joint with column, on RCC column near joint with beam, on RCC footings and rafts. On RCC rafts, a suitable grid can be worked out for determining number of tests. In addition, doubtful areas such as honeycombed locations, where continuous seepage is observed, construction joints and visible loose pockets will also be tested. |
| | **v)** | The test results are to be examined in view of the above acceptance criteria "Good" and "Excellent" and wherever concrete is found with less than required quality as per acceptance criteria, repairs to concrete will be made. Honeycombed areas and loose pockets will be repaired by grouting using Portland Cement Mortar/Polymer Modifies Cement Mortar /Epoxy Mortar ,etc. after chipping loose concrete in appropriate manner. In areas where concrete is found below acceptance criteria and defects are not apparently visible on surface ,injecting approved grout in appropriate proportion using epoxy grout /acrylic Polymer modified cements slurry made with shrinkage compensating cement / plain cement slurry etc. will be resorted to for repairs. (refer relevant chapters from CPWD Hand Book on Repairs and Rehabilitation of RCC Buildings). Repair to concrete will be done till satisfactory results are obtained as per the acceptance criteria by retesting of the repaired area. If satisfactory results are not obtained, dismantling and relaying of concrete will be done. |
| | **C.** | **MEASUREMENT**<br>As per CPWD specifications. |
| | **7.4.21** | **TOLERANCES**<br>As per CPWD specifications. |
| | **7.4.22** | **RATE** : |
| | **i)** | The rate includes the cost of materials and labour involved in all the operations described above except for the cost of centering, shuttering and reinforcement, which will be paid separately. |
| | **ii)** | In case of actual average compressive, strength being less than specified strength which shall be governed by para ' Standard of Acceptance" as above, the rate payable shall be worked out accordingly on prorata basis. |
| | **iii)** | In case of rejection of concrete on account of unacceptable compressive strength, governed by para 'Standard of Acceptance' as above, the work for which samples have |

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| | | failed shall be redone at the cost of contractors. However, the Engineer-in-charge may order for additional tests (like cutting cores, ultrasonic pulse velocity test, load test on structure or part of structure etc.) to be carried out at the cost of contractor to ascertain if the portion of structure wherein concrete represented by the sample has been used, can be retained on the basis of results of individual or combination of these tests. The contractor shall take remedial measures necessary to retain the structure as approved by the Engineer in charge without any extra cost. However, for payment, the basis of rate payable to contractor shall be governed by the 28 days cube test results and reduced rates shall be regulated in accordance with para 5.4.13 of Revised CPWD specification 2009, Vol.-I. |
| | **iv)** | As per general engineering practice, level of floors in toilet / bath, balconies, shall be kept 12 to 20mm or as required, lower than general floors. Shuttering should be adjusted accordingly. The landing level of mumty / Staircase cabin shall be Kept one riser level higher than adjoining slab level so as to accommodate water proofing treatment over terrace slab. In case of kitchen slab the portion of floor trap below kitchen platform be kept at lower level as per drawings. Nothing extra is payable on this account. |
| | **v)** | For the execution of centering and shuttering, the contractor shall use propriety "Reebole" chemical mould release agent of FOSROC or equivalent as shuttering oil as approved by Engineer-in-charge and nothing extra shall be paid on this account. |
| | **7.4.23** | **COVER/SPACER BLOCK**<br>The contractor shall provide approved type of support for maintaining the bars in position and ensuring required spacing and correct cover of concrete to reinforcement as called for in the drawings. Chairs and spacer bars shall be used in order to ensure accurate positioning of reinforcement. Spacer blocks shall be cast well in advance with approved proprietary pre- packed free flowing mortars (Conbextra as manufactured by M/S Fosroc Chemicals India Ltd. or equivalent as approved by the Engineer-in-charge at his discretion) of high early strength and same colour as surrounding concrete. Pre-cast cement mortar/concrete blocks/blocks of polymer shall not be used as spacer blocks unless specially approved by the Engineer-in- charge, rate of RCC items is inclusive of cost of such cover blocks. |

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| **7.5 ADDITIONAL CONDITIONS AND PARTICULAR SPECIFICATIONS FOR FLOORING , WALL LINING / VENEER WORKS** | | |
| | **7.5.1** | The Flooring work, wall lining work and stone cladding work, in general, including testing etc. shall be carried out as per CPWD specifications. |
| | **7.5.2** | **Granite Works** |
| | | The granite stonework shall, in general, be carried out as per the CPWD Specifications. The specifications for dressing, laying, curing, finishing, measurements, rate etc. for the granite stone flooring shall be same as that of works for the Marble flooring, skirting and risers of steps under Flooring Sub Head of the CPWD Specifications. The wall lining / veneer work with granite stone shall be as per the CPWD Specifications for Marble work Sub Head.<br>Granite stone tiles and slabs shall be pre polished (mirror polished), eggshell polished, flame finished or given any other surface treatment as specified in BOQ/ architectural drawings and as directed by the Engineer-in-Charge.<br>Machine polishing and cutting to required size shall be done with water (as lubricant) only. Sawing shall also be done preferably with water as lubricant but as a special case, the Engineer-in-Charge may permit, at his discretion, oil or kerosene as lubricant subject to all kerosene or oil in the body and surface of tiles / slabs being thoroughly dried in ovens. Tiles / slabs with stains or patches due to the use of oil or otherwise, either before or after installation, shall be rejected and shall be replaced by the Contractor at his own cost. Nothing extra shall be payable on this account.<br>Granite stone slabs shall be individually packed in cardboard paper. These shall be handled carefully to prevent any damage. The stone slab procured shall be free of any surface defect or any edge damage. The damaged stones shall not be allowed to be used in the work. So the Contractor shall procure additional quantities to cover such contingencies. However nothing extra shall be payable on this account. The stone slabs shall not be waxed or touched up with dyes / colours.<br>The granite stone slabs to be procured for the work shall match the samples approved by Engineer –in-charge. Before starting the work, the Contractor shall procure and submit the samples of granite stone slab (matching the approved samples) for the approval of the Engineer-in- Charge. The samples shall be submitted along with the following details: |
| | **i)** | Three representative samples for each type of granite stone specified. |
| | **ii)** | Details of physical characteristics such as dimensional tolerances (within the specified limits), water absorption, compressive strength, Mohs Hardness, Specific gravity with reference to IS or International standards. |
| | **iii)** | Source of supply to be approved by Engineer –in-charge and confirmation of availability in full quantity and uniformity of colour, tone and textures to be assured by the contractor. |
| | **iv)** | Company profile of Suppliers. |
| | **v)** | The decision of the Engineer-in-Charge as regards the approval of the samples for the various types of the granite stones shall be final and binding on the Contractor. No claim of any kind whatsoever shall be entertained from the Contractor on this account. The Contractor shall then procure and get the mock up prepared at site of work for approval of quality of workmanship and the granite stone as specified. The mock up shall be prepared,. on one of the floors at the location as decided by the Engineer-in-charge. The size of the stones shall be as per the architectural drawings. If the quality of the workmanship and the material is as per the required standards, the mock up shall be allowed as part of the work and measured for payment and shall not be dismantled. Otherwise, it shall be dismantled by the contractor as directed by the Engineer-in-Charge and taken away from the site of the work at his own cost. Nothing extra shall be payable on this account. |

| S.No. | Tolerance | |
|---|---|---|
| a) | Length | ± 1mm |
| b) | Width | ± 1mm |
| c) | Thickness | - 1mm |
| d) | Angularity at corners | ± 0.25% |

The entire supply for each type of granite stone slab shall be procured from one location (in one quarry), and supplied preferably, in one lot to keep variations to the minimum. The Contractor shall also segregate and sort the slabs according to colour, shade, texture and size of grains etc. to keep variation(s) in stones used at any one floor to the minimum. Any slab with variation in the colour, shade, texture and size of grains etc., not acceptable to the Engineer-in-Charge, shall not be used in the work and shall be removed and replaced by the Contractor. Nothing extra shall be payable on these accounts. Also, no claim of any kind shall be entertained from the Contractor on this account.

The stone work may be required to be carried out in patterns, design and / or in combination with granite stones of different colour and shade with or without borders and in combination of different stone slabs / ceramic tiles for which nothing extra shall be payable. The stones shall be provided in sizes and shapes as per the approved architectural drawings and wastages and incidental costs, if any, shall be deemed to be covered in the cost of the relevant items. Nothing extra shall be payable on this account. For the purpose of payment, only the actual area of each type of granite stone provided and fixed shall be measured separately under the relevant items.
The stone (slab and tiles) not meeting the above tolerance limits shall be rejected and not permitted to be used in the work. Nothing extra shall be payable on this account.

Stones slabs shall have uniform thicknesses within the tolerance limits and linear items like treads, sills and jambs, coping, risers, urinal partitions, kitchen / wash basin platforms, vanity counters, facias and other similar locations etc. shall have edge polished calibrated thickness i.e. exposed edges shall have edge polished uniform thickness throughout the length of the work. Nothing extra shall be payable on this account.

The flooring work shall be carried out as per the architectural drawings in design and pattern (geometric, abstract etc.) and in linear and / or curvilinear portions and in combination with stones of different colour and shade and ceramic tiles etc. For the flooring portions curved in plan, the stone slabs (at the edge) shall be cut to the required profile and shape as per the architectural drawings. Nothing extra shall be payable on this account and any consequent wastages and incidental charges on such accounts shall be deemed to be included in the cost of such items. For the purpose of payment, the actual area of each type granite stone as laid shall be measured separately under the relevant items.

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| **7.6 ADDITIONAL CONDITIONS AND PARTICULAR SPECIFICATIONS FOR CIVIL FINISHES WORK** | | |
| | **7.6.1** | **FINISHING** |
| | **7.6.2** | **General** |
| | **i)** | The work shall be done in accordance with CPWD Specifications -2009 Vol. I to Vol. II with upto date correction slips and the manufacturer's specifications where CPWD specifications are not available. |
| | **ii)** | The quantity of paint required as per the theoretical consumption including wastages, if any, shall be procured from the approved manufacturer or his authorized dealers and deposited with the representative of the Engineer-in-Charge at site. |
| | **iii)** | The paint shall be obtained in minimum packing of 20 litre. |
| | **iv)** | The paint shall be kept in the joint custody of the SAU or it's representative and the Contractor and day- to- day account of receipt and issue shall be maintained. However, the safe custody and watch and ward shall remain to be the responsibility of the Contractor. Nothing extra shall be payable on this account. |
| | **v)** | The name of the manufacturer, manufacturer's product identification, manufacturer's mixing instructions, warnings and instructions for handling and application, toxicity and date of manufacturing and shelf life shall be clearly and legibly mentioned on the labels of each container. These details shall be kept in record. The material shall be consumed in the order of material brought to site, first come first consume basis. The Contractor shall obtain and submit to the SAU the manufacturer's certificate for compliance of the various characteristics of the materials as per the manufacturer's specifications and also copy of the manufacturer's test report for the record. |
| | **vi)** | Empty containers of the paints shall not be removed from site till the completion of the work unless otherwise permitted and shall be removed only with the permission of the Engineer-in- Charge or his authorized representative at site of work.<br>All arrangements for measuring, dosing etc. at site shall be made by the Contractor. Nothing extra shall be payable on this account. |
| | **vii)** | The Contractor shall apply samples of each kind of paint for the approval of shade and colour as per the directions of the Engineer-in-Charge before procuring the paint in mass. |
| | **viii)** | All incidental charges of cartage, storage, wastage, safe custody, scaffolding, cost of samples and mock ups etc. shall be borne by the Contractor and no claim, whatsoever, shall be entertained on this account. |
| | **ix)** | For the item of Epoxy paint, it is clarified that the surface for painting shall be prepared by shot blasting. The metal surface shall be cleaned off any rust using sand/ emery paper and also by mechanical brush / power tool cleaning using grinder as required as per the manufacturer's specifications etc. The sand blasting as such is not required to be carried out on the surface. However the epoxy primer shall be applied immediately after the surface preparation. |
| | **7.6.3** | **QUALITY ASSURANCE**<br>For Quality Assurance the Contractor shall ensure that color and texture of finish coats, shall match the approved sample. Also, |
| | **i)** | Color of priming coat shall be lighter than body coat. |
| | **ii)** | Color of body coat shall be lighter than finish coat. |
| | **iii)** | Color prime and body coats as required so as not to show through the finish coat and to mask surface imperfections<br>Before starting application of each type of paint, the Contractor shall apply the paint to a specimen area, not to exceed 10 square meter and get finish and texture approved and shall use it as a sample for the remainder of the work. |

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| **7.7** | **ADDITIONAL CONDITIONS AND PARTICULAR SPECIFICATIONS FOR WATER PROOFING WORKS** | |
| | **7.7.1** | The work shall be got executed as per CPWD Specifications and as per the manufacturer's specification through specialized agency as approved by the Engineer-in-Charge. The contractor shall furnish the following particulars immediately after the issue of letter of acceptance by the SAU. |
| | **i)** | The name of the specialized firm. |
| | **ii)** | The trade names of the product, which would be used. |
| | **iii)** | List of works where the treatment has been used. |
| | **iv)** | Quantity of chlorides and sulphides used in the product. |
| | **7.7.2** | **GUARANTEE FOR WATER PROOFING TREATMENT** |
| | **i)** | The contractor shall be fully responsible for and shall guarantee proper performance of the entire waterproofing system for a period of 10 (Ten) years from the final completion of works. In addition, specific 10 years written guarantee (to be furnished in a non-judicial stamp paper of value not less than Rs.100/-) in approved proforma shall be submitted for the performance of the system, before final payment and shall not in any way limit any other rights to the **Engineer-in-charge,** may have under the contract .Guarantee for water proofing shall comprises of all the items described in the BOQ. |
| | **ii)** | All water-proofing work shall be carried out through approved specialist agency as per method of working approved by the Engineer-in-charge. However the Contractors shall be solely responsible for waterproofing treatment until the expiry of the above guarantee period.<br>Ten years guarantee in prescribed proforma attached shall be given by the contractor for the water proofing treatment. In addition 10% (ten percent) of the cost of these items of water proofing under this sub head shall be retained as guarantee to watch the performance of the work executed. However, half of this amount (withheld) would be released after five years from the date of completion of the work, if the performance of the waterproofing works is satisfactory. The remaining withheld amount shall be released after completion of ten years from the date of completion of work, if the performance of the waterproofing work is satisfactory. If any defect is noticed during the guarantee period, it should be rectified by the contractor within seven days of issuing of notice by the Engineer-in-Charge and, if not attended to, the same shall be got done through other agency at the risk and cost of the contractor and recovery shall be effected from the amount retained towards guarantee. In any case, the contractor and the specialist agency, during the guarantee period, shall inspect and examine the treatment once in every year and make good any defect observed and confirm the same in writing. The security deposit can be released in full, if bank guarantee of equivalent amount, valid for the duration of guarantee period, is produced and deposited with the SAU. |
| | **7.7.3** | **GENERAL :**<br>All materials shall be in accordance with the requirements of this Specification and the relevant Indian and International standards mentioned herein. |
| | **i)** | All materials shall be approved in accordance with the Quality Assurance procedures in this Specification and installed in accordance with the Manufacturer's requirements by specially trained and experienced operators. |
| | **ii)** | The waterproofing system provided shall be installed without damage and protected against construction operations. It shall be designed to be fully effective over the design life of the structure. |
| | **iii)** | The waterproofing system and its joints shall be designed to resist the maximum water head of water to be imposed on the structure. |
| | **iv)** | Waterproofing material shall be specially formulated to allow application in the hot climatic conditions encountered in India and it should not be adversely affected by temporary heat gain whilst exposed during construction. |
| | **v)** | Materials shall be compatible with other materials against which they abut. Particular consideration shall be given to compatibility of interfaces and junctions with adjacent buildings, or those likely to be built in the foreseeable future on adjoining sites. |

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| | **vi)** | Under installation and normal service conditions a factor of safety of at least two shall be provided against failure of any kind, including but not limited to the following:<br>▪ Damage during installation and follow-on construction;<br>▪ Pressures from solids, liquids or gases;<br>▪ Soil-induced and other forms of chemical and biological attack;<br>▪ Abrasion and other effects of traffic or flow of materials over joints;<br>▪ UV light degradation, thermal effects and other natural phenomena;<br>▪ Damage caused by cracking of the sub-strata up to 0.5mm crack width;<br>▪ Fire |
| | **vii)** | Materials shall be properly formulated for their intended use and shall be specified within their movement and fatigue capability, taking account of construction tolerances. |
| | **viii)** | Materials shall be physically and chemically stable at handover and not liable to subsequent release of toxic agents. |
| | **ix)** | Materials that are in contact with potable water and other groundwater sources shall be in accordance with BS 6920-1: 2000. |
| | **x)** | Materials that will be exposed to food products, or used in a food handling or storage area, shall be fully cured at handover. On curing, they shall be inert, non-toxic, odourless, non-tainting, mould resistant and waterproof. |
| | **xi)** | All site-mixed materials shall have adequate pot-life to allow proper installation by the operators, taking into account the size of container and the conditions under which the operators are working. |
| | **xii)** | Materials that will be in any way exposed when the work is completed shall be resistant to attack by vermin, rodents and insects |
| | **xiii)** | Materials that will normally be open to view once the works are completed shall be fixed to present a neat appearance. Solvents shall not bleed and stain adjacent work, with their colour approved by the Engineer. |
| | **7.7.4** | **EXTERNAL WATER STOPS:** |
| | **i)** | An external water-bar shall to be provided together with an internal re-injectable hose for injection of repair resin at all construction joints. These shall be compatible with waterproof membrane barrier to allow fully watertight jointing between the water stop and the membrane. Furthermore, they shall not clash or reduce the performance of the internal injection hose system. |
| | **ii)** | External water stops shall be profiled to provide a keyed interface with the concrete structure to prevent water tracking between the water-bar and the structural element. They shall allow cyclic building movements over the full design life without lose of integrity, deterioration, fracture or failure of any kind. |
| | **iii)** | External water stops shall have integral nailing flanges outside the area of waterproofing and grout tight fins centrally placed to prevent grout loss during construction. No tie wire for hanging from reinforcement shall be left within the concrete cover zone |
| | **iv)** | All water stops shall be extruded from high quality polyvinylchloride (PVC) compound. The Contractor shall submit appropriate systems for approval from the BASF, Grace Servicised, Fosroc or SIKA range of systems, or similar approved, for installation in line with Manufacturer instructions. |
| | **v)** | Water stops at kickers shall be a minimum 240mm wide. |
| | **vi)** | Water stops at expansion joints shall be 240mm wide and allow for expansion and contraction of the concrete. |
| | **vii)** | All junctions and transitions of water stops shall be made with preformed factory moulded pieces. No forming of these junctions and transitions shall be permitted on site. Only butt jointing of identical pieces shall be carried out on site using the manufacturers recommended equipment and procedures. |
| | **viii)** | The Contractor shall provide details of all proposed construction joint locations prior to pouring concrete. The Contractor shall inform the Engineer without delay if the need for any additional joints arises. |
| | **7.7.5** | **HYDRO-EXPANSIVE WATER STOPS :** |
| | **i)** | Hydro-expansive water stops shall be conformable, swellable polymer / butyl rubber strips that expand when in contact with water. They shall not deteriorate under repeated wet/dry cycles. |
| | **ii)** | Hydro-expansive water-stops shall be fully encapsulated by poured concrete and shall |

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| | | form a seal to resist the applied water pressures. |
| | **iii)** | The Contractor shall submit appropriate systems, for approval by the Engineer, from the Grace Serviced Servistrip or Fosroc Supercast range of systems, or similar approved, for installation in line with the Manufacturer's instructions. |
| | **7.7.6** | **PENETRATIONS:**<br>Penetrations through the waterproof barrier by services and ductwork shall be sealed with a compatible waterproof system as recommended by the waterproofing Manufacturer. As a rule, they shall incorporate a hydro-expansive water-stop to prevent tracking of water into the structure if the sealed waterproof system fails. |
| | **7.7.7** | **SPECIFICATION FOR TERRACE INSULATION & WATERPROOFING USING SPRAY APPLICATION** |
| | **i)** | **SCOPE**<br>This specification covers the insulation and waterproofing system for terrace having roof slab/ terrace garden using Spray Applied puff insulation and Polyurethane waterproofing system. |
| | **ii)** | **GENERAL** |
| | | • **Quality assurance:** All products in the system shall meet the key performance properties listed in Section A against each and shall be sourced from a manufacturer with a certified QA system such as, ISO 9001 or an established and proven QA system that has ensured consistent products.<br>• **Approved sources:** All products in the roof waterproofing and insulation system shall be sourced from a single manufacturer, from amongst the list of approved products and sources for each.<br>• **Installation:** All the products/systems specified in this document shall be installed by a Single Specialist Applicator (waterproofing cum insulation) approved by the manufacturer strictly in accordance to the written application guide by the manufacturer.<br>• **Multiple sources and compatibility:** Should the Specialist Applicator or the Contractor want products from different sources, they shall submit proof of compatibility between the products of different sources.<br>• **Alternate equivalents:** Should the Specialist Applicator or Contractor prefer to use alternative equivalent product(s) to the approved list, it can only be after obtaining a written approval by the Engineer-in-charge for use of the preferred alternative; such approvals can only be issued by the Engineer-in-charge after establishing conformity to the specified key performance properties.<br>• **Substrate preparation**: Before starting to install the specified waterproofing system, the substrate shall jointly be inspected by the Contractor and the Specialist Applicator for soundness; any defects shall first be repaired utilising products and systems compatible with the specified waterproofing system.<br>• A coat of cementitious grout of Tapecrete or equivalent shall be applied on top of slab before applying the insulation layer as per the manufacturer specifications. |
| | **iii)** | **THE INSULATION SYSTEM**<br>The specified insulation system is meant for Thermal insulation of the roof would be done using spray polyurethane rigid foam insulation. The thermal insulation built-up would be done in a highly technical manner using the latest technologies, products and innovations. Thermal insulation built-up which would consist of **40mm - 60 mm** average thick layer of spray applied polyurethane insulation to achieve the U – values specified below:-<br>Roof Value for all the buildings in design is 0.079 Btu/h $ft^2$.°F / R-12.53.<br>Contractor giving Guarantee should confirm the meeting the desired U –Value with the thickness of PUF insulation and get approval for the same from the Engineer-in-charge. |

**iv)** **THE WATERPROOFING SYSTEM**

The specified waterproofing system is meant for the water tightness of terrace slab covering the horizontal & the vertical surface and different parts; each generic product specified shall meet the key performance properties.

**v)** **Waterproofing system for Terrace slab with built-up over it:**

Providing and installing spray applied Polyurethane Waterproof system of **2mm** average thickness**.** The system to be installed over puff insulation directly after application of moisture insensitive primer and broadcasted with sand to create mechanical anchor for waterproofing to follow.

The waterproofing shall be spray applied covering every possible surface and area of the deck to be made watertight after the surface preparation is complete as per the system layer built-up. It shall cover all types of substrates.

**vi)** **SECTION A**

**Key performance properties of the specified products**

**Insulation Material**

| Sr No | Parameter | Test Method | Results |
|---|---|---|---|
| 1 | Grade of Product | | Polyurethane |
| 2 | Core density | DIN EN ISO 845 | 40 Kg/m3 |
| 3 | Therm l conductivity (λ , | DIN 52612 | < 0.024 W/(m.K) |
| 4 | Comp. Strength | DIN 53423 | > 175 kPa |
| 5 | Flexural Strength | DIN 53423 | > 250 KPa |
| 6 | Water absorption | DIN 52428 | <2.5% |
| 7 | Closed cells | ISO 4590 | 90% |
| 8 | Fire Retardance | DIN 4102-1 | Class B2 |

**vii)** **Waterproofing Material**

The Terrace slab shall be made waterproof using Polyurethane Spray applied waterproof system. The waterproofing system specified shall be spray applied fast curing, heat resistant , seamless waterproofing membrane and all other essential components from single manufacturer to ensure the waterproofing integrity of the structure. The waterproofing membrane has high elasticity, excellent tensile strength, high tear strength and exceptional abrasion resistance. Waterproofing shall have 100% solid content and free from solvents and polyurea, bituminous material.

**Two Component spray applied polyurethane system** consist of the following components:

| | | |
|---|---|---|
| 1) | Primer | Moisture Insensitive Primers for Concrete (Or Primer as per the Substrate. As specified by the manufacturer) |
| 2) | Sand Board Casting | Graded Quartz Sand |
| 3) | Waterproofing membrane | Spray applied advance Polyurethane Waterproof Membrane |
| 4) | UV Top Coat | UV Stable Top Coats of Required colour to be used for exposed surface only . Colours as per RAL Shades as specified |
| 5) | Total thickness of system | Average 2 mm |

The system shall be installed by a specialist waterproofing applicator recognized by manufacturer.

**viii) Key performance properties of PU Membrane**

| Property | Test Method | Results |
|---|---|---|
| Solids Content | DIN 53213 | 100% |
| Mixing ratio | A:B | 100:70 (By volume)<br>100:72 (By weight) |
| Density at 23oC | Component A<br>Component B | 1.06 g/cm3<br>1.10 g/cm3 |
| Tensile Strength | DIN 53504 | 8 – 10 MPa |
| Elongation at break | DIN 53504 | 400% |
| Tear Strength | DIN 53515 | 18 N/mm2 |
| Dynamic Crack Bridging (1000 cycles, heat ageing at 700C | ZTV-SIB 90 | 28days,no change |
| Shore A Hardness | | 75-80 |
| Permeability to CO2 | EN 1504-2:2004 | Sd>50 |
| Permeability to water vapour | EN 1504-2:2004 | Class II |
| Water tightness | DIN 1048 | 10 bar (100m) back pressure |
| Resistance to Water Pressure | MOAT No. 27 | No Leaks |
| Root Penetration Resistance | DIN 4062 | Passed |
| Skid Resistance | HAPAS, UK | Passed |
| Chemical Resistance | ASTM D 1308:02 | No averse effect |
| Adhesion<br>(Steel)<br>(Concrete) | Conica Research Laboratory | > 10 N/mm2<br>3.3N/mm2 (concrete failure) |

**A.** **Treatment of Exposed surfaces:** UV Top coat to be applied in all areas where waterproofing is exposed.

**B.** **Screed Laid to Slope:** Providing and laying slope built-up cum protection layer of cement screed of M-20, reinforced with Polypropylene fibers as per the manufacturer's specifications and working out a smooth finish. The screed shall have a minimum thickness of 50mm if above waterproofing and 20mm if below insulation using bonding agent (as per architect detailing) and shall be laid in slope of 1:100. The screed shall be cured by ponding for a minimum of 7 days. The groove of 6mm x 12mm shall be cut in concrete to make a panel of size 2 meter x 2 meter.

**C.** **Application of Sealant:** Within 24 hours Grove cutting @ 2x2 Sq.m panels of size 6mmX12mm using polysulphide sealant/polyurethane sealant

**7.7.8** **Testing**

Visual Checking – There should not be any pin holes. If pin holes observed applicator to repair the same at their own cost.

Water ponding test shall be conducted for 7 days after PU spray application.

**7.7.9** **Mock-up**

Before the installation by the Applicator, minimum of 4 sq. m. a roof location will be identified for installation of Mock-up of entire roof buildup. The mockup sample will be approved by the Engineer-in- charge before proceeding for the application of the system on the entire area.

**7.7.10** **Measurement**

Flat Surface Area of the roof shall be measured for payment

**7.7.11** **Rates**

The rates shall include the cost of labour, material, wastage complete in all respects.

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| **7.8 TECHNICAL SPECIFICATIONS FOR PRECAST CONCRETE** | | |
| | **7.8.1** | Local/Regional Materials: The materials and products that are extracted, harvested or recovered within 800 km of the project site |
| | **7.8.2** | **PRECAST NOMINAL MIX CONCRETE** |
| | **i)** | **General**<br>All precast concrete shall be cast by suitable mechanical means, over vibrating tables or by using form vibrators. The concrete mix shall conform in all respect to "Various Concretes" described in the appropriate paragraph under this section.<br>Exposed precast surfaces shall be finished as called for on the drawing or as directed by the Engineer-in-charge. All surfaces coming in contact with in situ concrete shall be wire brushed and hosed down until the aggregate is free from cement slurry. Castellation shall be provided wherever called for. Leaving grouting holes, grooves, inserts, projections reinforcements, lifting hooks etc. Shall conform to the erection procedure. All edges and delicate projection likely to be damaged during erection shall be protected by means of wooden cover fillets, until placed in position.<br>**Shop Drawing – submittal & approval.**<br>Shop drawings shall be prepared by the Contractor for submission and prior approval obtained from the Owner's Representative before commencing the work. The submittal shall include precast unit identification plan, formwork/mould design, mix design calculations, erection methodology, all details of inserts, openings, lifting hooks, edge protection, etc.<br>In addition to above, Contractor shall test for fire rating and furnish the certificate thereof for concrete blocks. |
| | **ii)** | **Precast Blocks, Lintels, Bollards, Tree Guards, Kerb Stone, Lamp Post, etc.**<br>All precast members shall be exactly of the size and pattern shown on the drawings and shall be made face up in the following manner. All units shall be integrally cast and steel formwork shall be used for making units.<br>Provide in the formwork as shown in the drawings. Stiff plastic concrete 1: 1.5 : 3 or as specified / instructed shall be used with coarse aggregate 1/2" (12 mm) and down gauge.<br>The precast units shall not be removed from the forms for three days. Precast work shall be cured under cover and shall be kept under water for fifteen days before placing in position.<br>Samples of each part shall be approved by the Engineer-in-charge before proceeding with the work.<br>Unit may require wetting before bedding. The concrete base shall be wetted and coated with slurry and minimum of mixing water shall be used in the bedding mortar which shall be Portland cement and sand 1:3. |
| | **7.8.3** | **PRECAST DESIGN MIX CONCRETE**<br>The section shall apply to precast controlled concrete work. |
| | **i)** | For all precast controlled concrete work a specially equipped site factory, complete with casting yard, pre-tensioning beds of individual moulds for pre-tensioned pre-stressed work concrete mixing and vibrating plants, cement store, concrete laboratory erection equipment, etc. are to be provided. The Contractor is deemed to have included in his rates all the above provisions needed for a workman like construction in precast controlled concrete. |
| | **ii)** | All precast design mix concrete shall be weigh batched. |
| | **iii)** | **Placing and compacting of concrete: -** All precautions in handling and placing of high strength concrete mixes apply. The concrete placed shall be compacted thoroughly by using pin, vibrators, shutter vibrators or other suitable means. No construction joints shall be allowed in precast design mix concrete work. Unshuttered top surface shall be finished smooth with trowel. |
| | **iv)** | During the period of initial setting special precautions shall be taken to keep precast members sufficiently moist to protect them against vibrations and any adverse loading. |

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| | **7.8.4** | **Form work and tolerances** |
| | **i)** | All form work for precast design mix concrete work shall be in use proprietary system formwork adequately stiffened and braced to give uniform concrete finish. |
| | **ii)** | Only exterior form bracing is to be used for lateral tying of formwork. To ensure uniformity of appearance in the cast members, or units, care should be taken that the contact surfaces or forms or forms liners are of uniform quality and texture, and joints in formwork are symmetrically located. Shuttering oil to be used shall be colourless, non-staining, and emulsifiable in water. |
| | **iii)** | **Tolerance** - Forms for precast members shall be true to size and dimensions shown on plans and should be constructed and protected from warping so that the finished product will be within the limits given below: - |

| | **Member** | Tolerance | Maximum limit |
|---|---|---|---|
| A | Overall dimensions of members | + 1 mm per | ± 12 mm |
| B | Cross sectional largest dimensions sections less than 150 mm | | ± 3 mm |
| C | Cross sectional dimensions sections less than 450 mm | | ± 5 mm |
| D | Sections 450 mm to 900 mm | | ± 6 mm |
| E | Sections over 900 mm | | ± 10 mm |
| F | Deviation from straight line in long sections | | not more than mm per metre |
| G | Deviation from specified counter | | ± 0.5 mm per metre of span |
| H | Differential between adjacent units in erected position | | 6 mm |

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| | **iv)** | **Storage, Handling & Hoisting of precast members**<br>Precast members are to be stored and handled in such a manner so as not to overstress the member beyond the design limits. Storage and handling procedures must be approved by the Engineer-in-charge before commencement of work.<br>The precast members are to be stored very carefully in the immediate vicinity of the casting yard or in the moulds themselves, for a minimum period of 21 days. During the initial period of the storage these are to be properly protected against radiation, heat of the Sun, drying air etc. by covering them with straw mats Hessian etc. which are to be kept continuously wet. For this purpose, the yard shall be provided with a mechanical water sprinkling system.<br>Precast concrete battens shall be cast in horizontal position on ground and/ or vibratory table and shall be lifted off the casting moulds or beds by means of stiffening frames, which shall support the batten at specified point. Precast members must attain a minimum strength before the same are lifted off from their moulds. These values of strength are given in section for prestressed concrete and shall apply also to precast RCC trusses.<br>The battens shall be temporarily propped after hoisting till permanent in situ screed is laid over it, so that the lateral stability and excessive deflections are controlled. Precast members are not to be transferred from the casting to the stockyard before they are 21 days old. Lifting shall be done only at points provided for this purpose. Under no circumstances shall the precast members be reversed while handling, or lifted at mid span. |

## 7.9 TECHNICAL SPECIFICATIONS FOR POLYURATHENE PROTECTED FLOORING SYSTEM

**7.9.1 Scope :**

This specification covers the protection flooring system for car parking in basement.

**7.9.2 General :**

- **Quality assurance:** All products in the system shall meet the key performance properties and shall be sourced from a manufacturer with a certified QA system such as, ISO 9001 or an established and proven QA system that has ensured consistent products.
- **Approved sources:** All products in the specified system shall be sourced from a single manufacturer, from amongst the list of approved makes.
- **Installation:** All the products/systems specified in this document shall be installed by a Specialist Applicator approved by the manufacturer strictly in accordance to the written application guide by the manufacturer.
- **Multiple sources and compatibility:** Should the Specialist Applicator or the Contractor want products from different sources, they shall submit proof of compatibility between the products of different sources.
- **Substrate preparation:** Before starting to install the specified flooring system, the substrate shall jointly be inspected by the Contractor and the Specialist Applicator for soundness; any defects shall first be repaired utilising products and systems compatible with the specified system.

**7.9.3 The car parking protection flooring system**

Polyurethane car parking system shall be a UV stable polyurethane based multi-layered car park decking system for exposed and intermediate traffic decks where crack bridging and abrasion properties are required. The Liquid applied multi layered traffic deck coating system based on advanced polymeric materials. It consists of a primer, wearing coat, polyurethane intermediate coat and a polyurethane top coat. The seamless coating has an attractive, skid resistant, UV and weather resistant finish which is easy to clean and maintain. It is resistant to petrol, diesel oil, battery acid, de-icing salts and alkaline cleaners Final Product shall consist of Following :-

**a)** **Primer** : Shall be a high grade; low viscosity two-component epoxy resin primer and substrate sealer also used as a sealer or scratch coat with, and without, the addition of quartz sand. Product shall have following properties:-

| **Cured at 7 days @20°C** | |
|---|---|
| Pot Life (25°C): | 20 mins |
| Density: | 1.09 |
| Bonding strength | Greater than cohesive strength of typical good quality concrete substrate |
| Application time | approx. 20 mins. at approx. 25°C |
| Application temperature | 10°C to 40°C substrate temp |
| Recoatable after | approx. 6 hours at 30°C |
| | approx. 12 hours at 20°C |

**b)** **Sand Broadcasting**: A graded, high purity quartz aggregate with a particle size in the range 0.3-0.9mm. Used as a multi action: mechanical key, wear enhancer and to provide skid resistance, it's use is the means by which thickness is attained with economy for the various wearing conditions such as: in traffic lanes, ramps and turning areas.

**Consumption**: 0.6 kgs per sqmt above primer and
1.5kgs above waterproofing cum crack bridging coat.

**c)** **Polyurethane Crack bridging coating** shall be a two component solvent free polyurethane membrane suitable for use in trafficked coating systems that require crack bridging capability. Product shall have following properties:-
**Coverage**: 0.7kg per sqmt
Product shall have following properties:-

| | |
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| Pot Life at 25°C: | 45 min. |
| Tensile strength: ASTM C 957 | 6 $N/mm^2$ |
| Elongation (ASTM D957): | 100% |

**d)** **Final Polyurethane coat Light grey** : Over polyurethane crack bridging coat sand broadcasting shall be done @ 1.5kg per sqmt to create mechanical key for intermediate coat. Followed by a two component solvent-free polyurethane coating designed for application as an intermediate coat cum final coat.

**Coverage**: Application of Final coat shall be done @ .35kg per sqmt in all areas and @.8kg per sqmt in ramps and turning areas

Product shall have following properties:-

| | |
|---|---|
| Density: | 1.5 $g/cm^3$ |
| Solids content: | Solvent Free |
| Pot Life at 23°C: | 45 min. |
| Open to foot traffic at 25°C / 50% rh: | 1 day |
| Open to vehicular traffic at 25°C / 50% rh: | 3 days |
| Tensile strength: | >10 $N/mm^2$ |
| Elongation (ASTM D638): | > 50% |
| Tear strength: | > 40 $N/mm^2$ |
| Taber Abrasion ASTM C 957: | <50mg |

**e)** **Colored top coat**: (For line markings, color variation or contrast top coat is done). Is a surface applied pigmented top coat. Top coat shall be a two-component elastomeric pigmented polyurethane coating designed for application as a top coat on traffic deck systems. It has very good chemical, abrasion and UV resistance properties.
**Coverage:** 0.4kg per Sqmt

Product shall have following properties:-

| | |
|---|---|
| Density: | 1.2 $g/cm^3$ |
| Solids content: | Solvent Free |
| Pot Life at 20°C: | 30 min. |
| Open to foot traffic | 1 day |
| Open to vehicular traffic | 3 days |
| Tensile strength: (DIN 53504) 14 days | 18 $N/mm^2$ |
| Tear resistance:(DIN 53515) 14 days | 45 $N/mm^2$ |

**7.9.4** **Mock-up :**
Before proceeding for mass installation of Car Park protection flooring system, the contractor should fix typical mock-up of at least 25 Sq. M. to demonstrate aesthetic effects and set quality standards for materials and execution. The contractor should proceed for mass application only after approval of Mockups by Engineer-in-Charge

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| | **7.9.5** | **Measurement :**<br>The surface area of Car park protection flooring system shall be measured for payment. |
| | **7.9.6** | **Rates :**<br>The rates shall include the cost of labour, material, wastage complete in all respects. |

## 7.10 TECHNICIAL SPECIFICATIONS FOR EXTERNAL SILANE SILOXAINE PROTECTION COATING FOR NATURAL STONES

**7.10.1 SCOPE**

This Specification covers Water repellent External coating for Natural Stones.

**7.10.2 GENERAL**

i) **Quality assurance:** All products in the system shall meet the key performance properties listed against each and shall be sourced from a manufacturer with a certified QA system such as, ISO 9001 or an established and proven QA system that has ensured consistent products.

ii) **Approved sources:** All products in the specified system shall be sourced from a single manufacturer, from amongst the list of approved products and sources

iii) **Installation:** All the products/systems specified in this document shall be installed by a Specialist Applicator approved by the manufacturer strictly in accordance to the written application guide by the manufacturer.

iv) **Multiple sources and compatibility:** Should the Specialist Applicator or the Contractor want products from different sources, they shall submit proof of compatibility between the products of different sources for Approval from Engineer-in-Charge

v) **Alternate equivalents:** Should the Specialist Applicator or the Contractor prefer to use alternative equivalent product(s) to the approved list, it can only be after obtaining a written approval by the Engineer-in-Charge; such approvals can only issue by the Engineer-in-Charge after establishing conformity to the specified key performance properties.

vi) **Substrate preparation:** Before starting to install the specified floor topping system the substrate shall jointly be inspected by the Contractor and the Specialist Applicator for soundness; any defects shall first be repaired utilising products and systems compatible with the specified floor topping system.

vii) **External Coating**

Coating shall be deep penetrative water repellent based on Silane Siloxine chemistry can be used direct from the container, no mixing is required, but stir before use. Key performance properties of the specified products are as follows:-

| Property | Test Method | Results |
|---|---|---|
| Aspect | | Clear free flowing liquid |
| Mixed Density | | 0.79+- 0.02 Kg/lit |
| Viscosity | | 10 CPS @ 25 Degree C |
| Minimum Application | | 5 Degree C |
| Over Coating Time | | 120 mins @ 25 Degree C |

**7.10.3 Testing**

As directed by Engineer-in-Charge.

**7.10.4 Mock-up**

Before the installation by the Applicator, a small patch of Silane Siloxaine Protection Coating shall be installed to approximately 2 Sqm on the cladded stone surface and practically tested for resistances to various exposures the wall is likely to be exposed. The mockup sample will be approved by the Engineer-in- charge before proceeding for the application of the system on the entire area.

**7.10.5 Measurement**

Surface Area of the cladded Stone shall be measured for payment

**7.10.6 Rates**

The rates shall include the cost of labour, scaffolding, material, wastage complete in all respects.

## 7.11 TECHNICAL SPECIFICATIONS FOR HOLLOW METAL FIRE DOORS AS PER BS/IS STANDARD

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| | **7.11.1** | **SCOPE**<br>This specification covers the design, supply of materials, Manufacture and installation of factory made Hollow metal fire doors of approved make an ISO 9001-2000 Certified Company and the manufacturer has to be approved manufacturer of supply and fixing of CE/UL certified hollow metal steel fire doors at all levels with all accessories and including supply and installation of hardware. |
| | **7.11.2** | **CODES AND STANDARDS**<br>All standards, specifications, acts, and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions.<br>List of certain important Indian Standards, Acts and Codes applicable to this work is given below. However, the applicable standards and codes shall be as per but not limited to the list given below:<br>**IS: 277 Galvanised** steel sheet (plain and corrugated) of GPL Grade with Z 120 Coating.<br>**IS: 3614 Metallic and non-metallic** fire check doors – Resistance test and Part – 2 performance criteria. |
| | **7.11.3** | **GENERAL**<br>The Contractor shall furnish all materials, labour, operations, equipment, tools & plant, scaffolding and incidentals necessary and required for the completion of all metal work in connection with steel doors, as called for in the drawings, specifications and bill of quantities which cover the major requirements only. Anything called for in the tender documents shall be considered as applicable to the items of work concerned. The supply and installation of additional fastenings, accessory features and other items not specifically mentioned, but which are necessary to make a complete functioning installation shall form a part of this contract.<br>**The Contractor shall submit the details of manufacturers from the list of approved makes from which he intends to procure the doors. The contractor shall procure the doors only after the approval of the manufacturer from the Engineer-in-charge**.<br>All metal work shall be free from defects, impairing strength, durability and appearance and shall be of the best quality for purposes specified made with structural proprieties to withstand safety strains, stresses to which they shall normally be subjected to.<br>All fittings shall be of high quality and as specified and as per approval.<br>The Contractor shall strictly follow, at all stages of work, the stipulations contained in the Indian Standard Safety Code or its Equivalent British Standard and the provisions of the safety code and the provision of the safety rules as specified in the General Conditions of the Contract for ensuring safety of men and materials.<br>Any approval, instructions, permission, checking, review, etc., whatsoever by the PMC/ Engineer-in- Charge, shall not relieve the Contractor of his responsibility and obligation regarding adequacy, correctness, completeness, safety, strength, quality, workmanship, etc. |
| | **7.11.4** | **HOLLOW METAL FIRE DOOR WITH HONEY COMB CORE**<br>Fire door shall be 2 hour fire rated and door quality shall be as approved by TAC/CBRI and tested conforming to IS : 3614 Code or its Equivalent British Standard BS 476 Part 20 and 22.<br>Unless otherwise specified, maximum size of door in this type:<br>Single shutter door : 1200 mm x 2200mm<br>Double shutter door : 2000 mm x 2400 mm<br><br>For doors above 2200 mm height (Single Doors) and 2400 mm height (Double Door) the options shall be:<br>A man operation door of size above 2049 mm height shall be provided with a removable panel / fixed panel on top.<br>The construction of above panel shall be designed similar to that of a shutter in case of flush panel to match the exteriors. |
| | **7.11.5** | **FRAME -**<br>**Material** - Frame to be manufactured from 1.60 mm (16 gauges) galvanised steel sheets complying with latest IS 277 Code of GPL Grade with Z 120 Coating or its Equivalent British Standard. |

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| | | **Profile** - Door frame profile to be single rebated of dimensions 125 mm X 60 mm (+ / - 0.3mm) with bending radius of 1.4 mm with Grooved profile. Door frame profile to be for Two hour fire rated door.<br>**Manufacture** - Frame to be manufactured from 1.60 mm thick galvanized steel sheet to the specified profiles and dimensions. Frames manufactured at factory shall be knock down form with mitered assembly at site.<br>**Door frame preparations** – Frames to be provided with a 3 mm thick Soffit bracket plates on all jambs with provision for anchor bolt fixing to wall openings. All frames to have reinforcement pads for fixing of door closer, at appropriate location as per manufacturer's details.<br>Frames to have factory finish-pre-punched cut outs to receive specific hardware and ironmongery.<br>Frames to be provided with hinge plates 3 mm thick pre-drilled to receive hinges for screw mounted fixing. All cut outs including hinge plates, strike plates to have mortar guard covers from inside to prevent cement, dust ingress into cut outs at the time of grouting.<br>Frames to have rubber shutter silencer on strike jambs for single shutter frames and on the head jambs for double shutter frames.<br>**Finish-** All doors and frames shall be finished with polyurethane aliphatic grade paint of approved colour. The door leaf and frame shall have passed minimum 250 hours of salt spray test. |
| | **7.11.6** | **FIRE DOOR SHUTTER**<br>**Material -** Fire door shutter to be manufactured from 1.2 mm (18 gauge) galvanized sheets conforming to latest IS: 277 Code of GPL Grade with Z 120 coating or its Equivalent British Standard.<br>**Manufacture** - Shutters to be press formed to 46 mm thick double skin hollow door with lock seam joints at stile edges. Shutters to have no visible screws or fasteners on either face. Internal reinforcement to be provided at top bottom and stile edges for desired fire rating.<br>**Door Shutter Cores** – Shutters to be provided with honeycomb kraft paper core to be bonded to the inner faces of the shutter.<br>**Door shutter preparations** – Shutters to be factory prepared with pre-punched cut-outs and reinforcements to receive ironmongery as per final finish hardware schedule. The shutter should have an interlocking arrangement at this stile edges for flat surface on either side.<br>Shutters to have pre-drilled hinge plates with hinge guard covers. Shutters with locks to have concealed lock box with lock fixing brackets with pre-tapped holes.<br>For shutter with door closer reinforcement pads to be provided at appropriate location as per manufacturer's design. All ironmongery preparation to have adequate reinforcement for flush fixing at site. |
| | **7.11.7** | **Vision panel for Fire rated door** -Vision panel to be provided with Clear Toughened Glass of the thickness **11mm/12 mm** for upto two hours fire rating. Glass to be fixed with clip on frames for square and rectangular vision panels and with spin turned rings for circular vision panels and Glazing Tape with one side adhesive. Vision Panels to be fixed with clip-on frames for square and rectangular Vision Panels with no visible screws. Unless otherwise specified standard sizes are 200 mm x 300 mm and 360 mm diameter.<br>**Finish** - All doors and frames shall be finished with polyurethane aliphatic grade paint of approved colour. The door leaf and frame shall have passed minimum 250 hours of salt spray test.<br>For Fully Glazed door minimum top & side rail should be 100mm & bottom rail should be 200mm.door shutter should be minimum 46mm thick. |
| | **7.11.8** | **HARDWARE for Fire Rated Metal Doors**<br>Hardware for Fire Rated doors shall be as per hardware schedule mentioned in Bill of Quantities |
| | **7.11.9** | **PACKING Frame**<br>Individual frames members to be protected with Co-extruded PE film, with low tack adhesive. PE film to be minimum 56 micron thick, abrasion resistant with 6 months UV |

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| | | resistance Capability. (Manufacturers Test Report to be submitted) and placed in individual card board boxes. Individual boxes to be sealed. Frames to be assembled at site with aid of roofing bolts.<br>**Shutters**<br>Shutters to be protected with Co-extruded PE film, with low tack adhesive. PE film to be minimum 56 micron thick, abrasion resistant with 6 months UV resistance Capability. (Manufacturers Test Report to be submitted) and packed in card board and strapped. All frames and shutters duly marked as per door schedule for easy identification at site.<br>**Storage**<br>All knocked down frames shall be stacked flat and shutters vertically on wooden runners and suitably covered as per the instructions of manufacturer to prevent rust and damage. |
| | **7.11.10** | **INSTALLATION Door frame fixing**<br>The door frames should be assembled adjacent to the place of installation as the frames are not designed for transporting in an assembled condition. After assembly it is to be ensured that all threaded preparations are covered from the back of the frame using self adhesive strip to prevent penetration of mortar back-fill into screw threads. The head member of assembled frame shall be positioned against jambs ensuring correct alignment and secured using M8 x 20 long plated bolts or as per approved shop drawing together with nuts spring and flat washers.<br><br>The assembled frame shall be kept in position within the opening by means of bracing. In order to correctly position the frame against finished floor level or equalise on adjustable floor anchors where specified, shim shall be used under jambs. The frame shall be checked for squareness, alignment, twist etc. with carpenters bevel and plumb.<br>A tie rod shall be fixed to the frame during installation to ensure the correct dimensions between the frame rebated and the same may be removed after installation. After fixing the frame shall be filled with cement mortar slurry 1:3 or Plaster of Paris or Gypsum powder slurry as approved. Gap between frame and wall to be closed by cement pointing using cement mortar 1:3.Where a 2nd fix application is required a shim detail is suggested to take up gap between frame and existing opening |
| | **7.11.11** | **TESTING**<br>**Test Report of the Prototype**: The door frames and shutters shall be fabricated from approved manufacturers with materials and specifications identical to those for the prototype test report in accordance with IS:3614 (Part-2) for prescribed fire rating either by CBRI Roorkee, or ARAI, Pune, and as Per BS 476 part-22 for stability and integrity certified by CERTIFIRE, Warrington.<br>One random sample out of **100 doors** shall be selected from the site and shall be tested in the approved laboratory. The cost of sample shall be borne by the contractor however the testing charges shall be borne by the employer in the manner as specified in CPWD specifications.<br>**Submittals**<br>Shop drawings of the doors, in accordance to the prototype profiles used to obtain fire test certificate by approved national or international test house shall be prepared and submitted for approval by the Engineer-In-Charge. The shop drawings shall include details of construction, anchoring, connections, fastenings etc. Any suitable modification in fittings, fixtures as required for project specific installations shall have to be incorporated in door profile and approval obtained prior to the installation of the door.<br>**Measurement**<br>Measurement outer frame to outer frame shall be taken for payment of door. Hardware for the doors shall be measured separately in individual numbers.<br><br>**Fixing Sequence**<br>Brace, position, level etc.<br>Mark all positions of fixings on wall.<br>Remove frame and drill wall to appropriate specified size. Fit rod anchor shells metal expansion bolts into the wall. Fit jamb spacer bracket into back of frame profile. |

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| | | Reposition frame back into opening and realign.<br>Lightly screw CSK HD machine screws into shells, shim behind frame.<br>Slowly tighten screws continually checking plumb, square etc. Finally ensure frames are not deformed as tightened.<br>After fixing the frame shall be filled with cement mortar slurry 1:3 or Plaster of Paris or Gypsum powder slurry as approved. Gap between frame and wall to be closed by cement pointing using cement mortar 1:3.<br>Back full the frame through holes provided and inserts nylon plugs.<br>**Door shutter fixing**<br>Fix all the hardware to the door shutter like hinges, flush bolts, bolts, mortise locks, door closer, door stoppers, handles etc. with the appropriate screws and bolts supplied.<br>The shutter is to be then fixed to the frame which is already installed. Align the shutter to match the hardware to the cutouts in the frame. Tighten the hinge screws.<br>Application of Fire / Smoke UL 10 C / UL 1784 (2001) classified seal (for smoke check if specifically required) |
| | **7.11.12** | **Mock-up**<br>Before proceeding for mass production of all units, the contractor should fix typical mockup units of each type to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution. The contractor should proceed for mass production only after approval of Mockups by Engineer-in-Charge or his authorized representative. |
| | **7.11.13** | **Rates**<br>**The rates shall include the cost of labour, material, wastage complete in all respects.** |

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| **7.12** | **TECHNICAL SPECIFICATIONS FOR HOLLOW METAL GENERAL PURPOSE DOORS AS PER BS/IS STANDARD** | |
| | **7.12.1** | **SCOPE**<br>This specification covers the design, supply of materials, Manufacture and installation of factory made Hollow metal doors of approved make an ISO 9001-2000 Certified Company and the manufacturer has to be approved from the third party certified company from CE/UL for hollow metal steel doors at all levels with all accessories and including supply and installation of hardware. |
| | **7.12.2** | **CODES AND STANDARDS**<br>All standards, specifications, acts, and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions.<br>List of certain important Indian Standards, Acts and Codes applicable to this work is given below. However, the applicable standards and codes shall be as per but not limited to the list given below:<br>IS : 277 Galvanized (Graintech/Plain) steel sheet of GPL Grade with Z 120 Coating. |
| | **7.12.3** | **GENERAL**<br>The Contractor shall furnish all materials, labour, operations, equipment, tools & plant, scaffolding and incidentals necessary and required for the completion of all metal work in connection with steel doors, as called for in the drawings, specifications and bill of quantities which cover the major requirements only. Anything called for in the tender documents shall be considered as applicable to the items of work concerned. The supply and installation of additional fastenings, accessory features and other items not specifically mentioned, but which are necessary to make a complete functioning installation shall form a part of this contract.<br>**The Contractor shall submit the details of manufacturers from the list of approved makes from which he intends to procure the doors. The contractor shall procure the doors only after the approval of the manufacturer from the Engineer-in-charge**<br>All metal work shall be free from defects, impairing strength, durability and appearance and shall be of the best quality for purposes specified made with structural proprieties to withstand safety strains, stresses to which they shall normally be subjected to.<br>All fittings shall be of high quality and as specified and as per approval.<br>The Contractor shall strictly follow, at all stages of work, the stipulations contained in the Indian Standard Safety Code or its Equivalent British Standard and the provisions of the safety code and the provision of the safety rules as specified in the General Conditions of the Contract for ensuring safety of men and materials.<br>Any approval, instructions, permission, checking, review, etc., whatsoever by the Engineer-in-charge, shall not relieve the Contractor of his responsibility and obligation regarding adequacy, correctness, completeness, safety, strength, quality, workmanship, etc**.** |
| | **7.12.4** | **HOLLOW METAL GENERAL PURPOSE STEEL DOOR WITH HONEY COMB CORE**<br>Unless otherwise specified, maximum size of door in this type:<br>Single shutter door: 1200 mm x 3000 mm<br>Double shutter door: 2300 mm x 3000mm |
| | **7.12.5** | **FRAME**<br>**Material** – Frame to be manufactured from 1.20 mm (18 gauges) galvanized steel sheets complying with latest IS 277 Code of GPL Grade with Z 120 Coatings or its Equivalent British Standard.<br>**Profile -** Door frame profile to be single rebated of dimensions 125 mm X 60 mm (+ / - 0.3) with bending radius of 1.4 mm with Grooved profile.<br>**Manufacture -** Frame to be manufactured from 1.20 mm thick galvanized steel sheet to the specified profiles and dimensions. Frames manufactured at factory shall be mitered & knock down form with butt joints assembly at site.<br>**Door frame preparations** – Frames to be provided with a 3 mm thick soffit back plates on all jambs with provision for anchor bolt fixing to wall openings. All frames to have reinforcement pads for fixing of door closer, at appropriate location as per manufacturer's details.<br>Frames to have factory finish-pre-punched cut outs to receive specific hardware and ironmongery.<br>Frames to be provided with hinge plates 3 mm thick pre-drilled to receive hinges |

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| | | for screw mounted fixing. All cut outs including hinge plates, strike plates to have mortar guard covers from inside to prevent cement, dust ingress into cut outs at the time of grouting.<br>Frames to have rubber shutter silencer on strike jambs for single shutter frames and on the head jambs for double shutter frames.<br>**Finish**<br>All doors and frames shall be finished with polyurethane aliphatic grade paint of approved colour. The door leaf and frame shall have passed minimum 250 hours of salt spray test. |
| | **7.12.6** | **DOOR SHUTTER**<br>**Material**<br>General purpose door shutter to be manufactured from **1.0 mm (20 gauge)** galvanized sheets conforming to latest IS : 277 Code of GPL Grade with Z 120 Coating or its Equivalent British Standard.<br>**Manufacture**<br>Shutters to be press formed to 46 mm thick double skin hollow door with lock seam joints at stile edges. Shutters to have no visible screws or fasteners on either face.<br>**Door shutter core**<br>Shutters to be provided with honeycomb paper cored to be bonded to the inner faces of the shutter.<br>**Door shutter preparations**<br>Shutters to be factory prepared with pre-punched cutouts and reinforcements to receive ironmongery as per final finish hardware schedule. The shutter should have an interlocking arrangement at this stile edges for flat surface on either side.<br>Shutters to have pre-drilled hinge plates with hinge guard covers. Shutters with locks to have concealed lock box with lock fixing brackets with pre-tapped holes.<br>All ironmongery preparation to have adequate reinforcement for flush fixing at site. For shutter with door closer reinforcement pads to be provided at appropriate location as per manufacturer's design.<br>**Vision panel**<br>Vision panel to be provided with clear toughened glass of the thickness 5mm. Glass to be fixed with clip on frames for square and rectangular vision panels and with spin turned rings for circular vision panels and Glazing Tape with one side adhesive. Vision Panels to be fixed with clip-on frames for square and rectangular Vision Panels with no visible screws. Unless otherwise specified standard sizes are 200 mm x 300 mm, 300 x 750 mm, 450 x 750 mm and 360 mm diameter.<br>**Finish**<br>All doors and frames shall be finished with polyurethane aliphatic grade paint of approved colour. The door leaf and frame shall have passed minimum 250 hours of salt spray test. |
| | **7.12.7** | **HARDWARE for General Purpose Metal Doors**<br>Hardware for doors shall be as per hardware schedule mentioned in Bill of Quantities |
| | **7.12.8** | **PACKING**<br>**Frame**<br>Individual frames members to be protected with Co-extruded PE film, with low tack adhesive. PE film to be minimum 56 micron thick, abrasion resistant with 6 months UV resistance Capability. (Manufacturers Test Report to be submitted) and placed in individual card board boxes. Individual boxes to be sealed. Frames to be assembled at site with aid of roofing bolts.<br>**Shutters**<br>Shutters to be protected with Co-extruded PE film, with low tack adhesive. PE film to be minimum 56 micron thick, abrasion resistant with 6 months UV resistance Capability. (Manufacturers Test Report to be submitted) and packed in card board and strapped. All frames and shutters duly marked as per door schedule for easy identification at site.<br>**STORAGE**<br>All knocked down frames shall be stacked flat and shutters vertically on wooden runners and suitably covered as per the instructions of manufacturer to prevent rust and damage. |
| | **7.12.9** | **INSTALLATION**<br>**Door frame fixing**<br>The door frames should be assembled adjacent to the place of installation as the frames |

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| | | are not designed for transporting in an assembled condition. After assembly it is to be ensured that all threaded preparations are covered from the back of the frame using self-adhesive strip to prevent penetration of mortar back-fill into screw threads. The head member of assembled frame shall be positioned against jambs ensuring correct alignment and secured using M8 x 20 long plated bolts together with nuts spring and flat washers.<br>The assembled frame shall be kept in position within the opening by means of bracing. In order to correctly position the frame against finished floor level or equalize on adjustable floor anchors where specified, shim shall be used under jambs. The frame shall be checked for squareness, alignment, twist etc. with carpenters bevel and plumb. After fixing the frame shall be filled with cement mortar slurry 1:3 or Plaster of Paris or Gypsum powder slurry as approved. Gap between frame and wall to be closed by cement pointing using cement mortar 1:3.<br>A tie rod shall be fixed to the frame during installation to ensure the correct dimensions between the frame rebated and the same may be removed after installation.<br>Where a 2nd fix application is required a shim detail is suggested to take up gap between frame and existing opening. |
| | **7.12.10** | **TESTING**<br>**Test Report**: The contractor has to provide material test report from Manufacturer for each batch of doors supplied on site.<br>**Submittals**<br>Shop drawings of the doors, in accordance to the prototype profiles used shall be prepared and submitted for approval by the Engineer-In-Charge. The shop drawings shall include details of construction, anchoring, connections, fastenings etc. Any suitable modification in fittings, fixtures as required for project specific installations shall have to be incorporated in door profile and approval obtained prior to the installation of the door. |
| | **7.12.11** | **Measurement**<br>Measurement outer frame to outer frame shall be taken for payment of door. Hardware for the doors shall be measured separately in individual numbers.<br>**Fixing Sequence**<br>Brace, position, level etc.<br>Mark all positions of fixings on wall.<br>Remove frame and drill wall to appropriate specified size. Fit rod anchor shells metal expansion bolts into the wall. Fit jamb spacer bracket into back of frame profile.<br>Reposition frame back into opening and realign.<br>Lightly screw CSK HD machine screws into shells, shim behind frame.<br>Slowly tighten screws continually checking plumb, square etc. Finally ensure frames are not deformed as tightened.<br>After fixing the frame shall be filled with cement mortar slurry 1:3 or Plaster of Paris or Gypsum powder slurry as approved. Gap between frame and wall to be closed by cement pointing using cement mortar 1:3.<br>Back full the frame through holes provided and insert nylon plugs.<br>**Door shutter fixing**<br>Fix all the hardware to the door shutter like hinges, flush bolts, bolts, mortise locks, door closer, door stoppers, handles etc. with the appropriate screws and bolts supplied.<br>The shutter is to be then fixed to the frame which is already installed. Align the shutter to match the hardware to the cutouts in the frame. Tighten the hinge screws. |
| | **7.12.12** | **Mock-up**<br>Before proceeding for mass production of all units, the contractor should fix typical mockup units of each type to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution. The contractor should proceed for mass production only after approval of Mockups by Engineer-in-Charge. |
| | **7.12.13** | **Rates**<br>The rates shall include the cost of labour, material, wastage complete in all respects. |

## 7.13 TECHNICAL SPECIFICATIONS FOR PIGMENTED GLASS REINFORCED CONCRETE JAALI

**7.13.1 SCOPE**

Providing and Fixing of (Glass Fiber Reinforced Jali) GRC Jalli 50 mm thick of required size, pattern, design, and colour of approved make to be fixed on/between RCC / Block work Column or structural steel work with Dry Fixing method.

**7.13.2 GRC General Specifications**

| Property | Units | Hand or Machine | Vibration |
|---|---|---|---|
| Glass fiber(Weight%) | | 5 | 3 |
| Bending | | | |
| Ultimate Strength (MOR) | MPa | 20-30 | 10-14 |
| Elastic Limit (LOR) | MPa | 7-11 | 5-6 |
| Tensile | | | |
| Ultimate Strength (UTS) | MPa | 8-11 | 4-7 |
| Elastic Limit (LOR) | MPa | 7-11 | 5-8 |
| Shear | | | |
| Inter laminar Strength | MPa | 3-5 | N.A |
| In-plane Strength | MPa | 8-11 | 4-7 |
| Compressive Strength | MPa | 50-80 | 40-60 |
| Impact Strength | Kj/m² | 10-25 | 10-15 |
| Elastic Modulus | Gpa | 10-20 | 10-20 |
| Strain to Failure | % | 0.6-1.2 | 0.1-0.2 |
| Dry Density | T/m³ | 1.9-2.1 | 1.8-2.0 |

**7.13.3 Material**

The jali shall be made from 53 grade White Portland Cement , Quartz, Fine Silica Sand, Alkali Resistant Glass Fiber , Super Plasticizers and UV Resistant Synthetic inorganic pigments . The material casting should take place in Synthetic Rubber / FRP mould manufactured by RECKLI or approved equivalent.

**7.13.4 Workmanship**

The work shall include erection of all fasteners, flashing and capping for all edges, caps corners etc. The fixing detail as mentioned in Bill of Quantities and as per manufacturer's specification.

The work will include cost of all labour, equipment's, materials, submission of shop drawing, cost of M.S Framework if required, consumables, fasteners, washers, etc.

Fixing of (Glass Fiber Reinforced Jali) GRC Jali to be fixed on/between RCC / Block work Column or structural steel work with Dry Fixing method with appropriate steel frame work , using fasteners, and necessary hardware etc. in Building Façade. The jali shall be securely fixed with stainless steel bolts and anchor fasteners (304 grade) of required size at specified locations. The fixing shall be done by the specialized approved agency as directed by Engineer-in-Charge.

**7.13.5 Testing**

As directed by Engineer-in-Charge.

**7.13.6 Measurements**

The surface area of Jali shall be measured for payment

**7.13.7 Rates**

The rates shall include the cost of labour, scaffolding, material, wastage complete in all respects.

## 7.14 TECHNICAL SPECIFICATIONS FOR COMPACT LAMINATE TOILET CUBICLES

**7.14.1 SCOPE**

Supply & Installation of MODULAR Toilet cubicles partition systems

**7.14.2 Applicable Codes :**

IS : 2046 For Compact Laminate

**7.14.3 Materials**

Modular Toilet Cubicles Made of 12 mm thick solid grade compact high pressure laminate as per IS:2046 and BS-476 class 1 fire retardant in Suede finish, manufactured under high specific pressure > 5 MPa and temperature >120$^{o}$C with bunch of kraft papers impregnated with thermosetting phenolic resin and decorative papers made of Alpha cellulose fiber impregnated with thermosetting melamine resin which provide superior scratch, abrasion, heat, chemical, impact, graffiti & moisture resistance along with anti-bacterial properties. Panels have a black core that when machined, presents a distinctive black edge. Panel is anchored to the wall with SS 304 grade U & F Channel. The top fitting should consist of SS square top rail which will get fixed with pilasters. All screws will be of SS 304 Grade in stainless steel.

All pilasters are supported with Adjustable Palm Design Pedestal Footing made from Stainless steel grade 316 giving a clearance height of 150 mm from the floor. The base will be anchored to the floor.

Compact laminate should be Green guard and IGBC certified.

The following stainless steel (SS 304) accessories to be used :

Door Knob; coat hook with rubber stopper; self closing (gravity) hinges; privacy Thumb turn with occupancy indicator, top rail and Adjustable Palm Design Pedestal Footing SS 316 Grade.

Design no. as specified by Arch. / Engineer-in-charge in suede finish. Size of panels to be as per drawing.

The mockup shall be approved by the Engineer-in-Charge before starting the installation of toilet cubicles. Vendor shall submit the certificate of warranty for a term of 5 years on moisture related damages (partitions), 1 years for toilet cubicles workmanship and accessories.

**7.14.4 Workmanship**

All the materials being supplied will be in ready to install form. Vendor will depute its own team to install the toilet cubicles as per fullest satisfaction of Engineer-in-Charge.

**7.14.5 Civil Works**

Vendor shall be fully responsible for the conduct and installations at site.

Floor & sections wise distribution of material shall be responsibility of vendor, though, the

Engineer-in-Charge will ensure safety of material during storage and course of installation. After installation of toilet cubicles vendor will take approval from Engineer-in-Charge.

Vendor shall provide experienced / authorized installer. The following fittings shall be provided in each toilet cubical.

| | | |
|---|---|---|
| 1 | Gravity hinge | 3 Nos. |
| 2 | Coat hook cum Door stopper | 1 No. |
| 3 | Door knob | 1 No. |
| 4 | Thumb Turn vacant / engaged position showing device | 1 No. |

**7.14.6 Testing:**

Required numbers of tests shall be performed on Decorative Thermosetting Synthetic Resin Bonded Compact Laminated Sheets as per provision of IS: 2046. Hardware and fittings shall be of grade 304 stainless steel shall also be tested based on relevant IS codes as decided by the Engineer-in-Charge. Testing charges shall be paid by the department.

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| | **7.14.7** | **Measurement:**<br>Surface area of one side only including door shall be measured and paid. |
| | **7.14.8** | **Rates**<br>The rates shall include the cost of labour, material, wastage complete in all respects. |

## 7.15 TECHNICAL SPECIFICATIONS FOR ALUMINIUM GLAZING AND DOOR AND WINDOWS WORKS

**7.15.1 SCOPE OF WORKS:**

- The scope of work includes complete Design, Engineering, Fabrication, Supply, installation & performance for the all External glazing works products.
- Proposed system drawing details for following façade elements along with the engineering calculations in line with the tender drawings and specification requirement.
- Proper site survey report prior to grid module finalization and shop drawing preparation.
- Shop drawings, Engineering calculations, Structural analysis for all products and components to the satisfaction of the approving authority.
- Installation methodology. Detailed project schedule.
- All material approval plans & Design submission plan.
- All Aluminum trims & flashing covers to inside and outside of the building to seal the façade and the building structure.
- All stainless steel anchor bolts, fasteners and structural washers.
- Aluminum alloy brackets with serrations and serrated washers in chromate finish or MS Hot dip Galvanized brackets
- Glazing materials, Silicon gaskets, EPDM gaskets, setting blocks, backer rod, sealants, spacer tapes, and related other materials.
- All metal separators in nylon and GI shims.
- All material testing and processing test reports. As built drawings.

**The Contractor shall submit the details of manufacturers from the list of approved makes from which he intends to procure the aluminium glazing systems. The contractor shall procure the aluminium glazing systems only after the approval of the manufacturer from the Engineer-in-charge.**

**7.15.2 STANDARDS: ALUMINUM CODES:**

- IS 8147 : Code of Practice for Use of Aluminum Alloys in structures
- BS EN 12020 : Part 2 – Tolerance on dimensions & form Aluminum & Aluminum alloys – Extruded Precision profiles in Alloys EN AW 6060 & EN AW 6063
- BS EN 12373-1 : Specification for Anodized Aluminum
- BS 1474 : Specification for Wrought Aluminum & Aluminum Alloys for general Engineering Purposes: Bars, Extruded Round Tubes & sections
- BS 3019 : Specification for TIG welding of Aluminum, Magnesium and their alloys
- BS 3571 : Specification for MIG welding of Aluminum & Aluminum Alloys
- BS 8118 : Structural use of aluminum. Code of practice for design.
- BS 1470 : Specification for wrought Aluminum and Aluminum alloys for general engineering purposes: plate, sheet and strip
- BS EN 485 : Aluminum and Aluminum alloys. Sheet, strip and plate. Mechanical properties
- BS EN 515 : Aluminum and Aluminum alloys. Wrought products. Temper designations
- BS EN 573 : Aluminum and Aluminum alloys. Chemical composition and form of wrought products. Chemical composition and form of product
- AS/NZS 1664 : Aluminum Structure code

**7.15.3 MATERIALS:**

**ALUMINUM:**

- Provide Accepted aluminum extrusions and/or sheet of alloy and grades suitable for the structural requirements, applied finishes and project conditions not less than the strength and durability properties of the alloy and temper designated in the relevant Standards. Submit details including proposed alloy types with supporting justification data for review and Acceptance.
- All aluminum materials shall be of consistent high quality regardless of source.
- Manufacturers shall be accepted established manufacturers with a reputation for producing high quality materials with a minimum of 5 years documented continuous track record. Submit details for review and Acceptance.
- Mill finish on non-visible surfaces will not be acceptable.

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| | | • Each batch shall be suitably identified and cross referenced with the certificate.<br>• **Warranty:**<br>• The contractor shall furnish 10 years warranty for complete system including powder coating. |
| | **7.15.4** | **ALUMINUM EXTRUSION**<br>• Aluminum extrusion shall be of Alloy 6061 / 6063 T5/T6 confirming to BS 1470 / BS 1471 / BS 1473 / BS 1474<br>• Minimum wall thickness for the structural members shall be 2.5mm & for non-structural member shall be 1.5mm thick.<br>• The extrusion tolerances shall confirm to BS EN 12020 In case of Aluminum structural support brackets the Alloy shall be 6005 grade & T5 temper.<br>• Extruded profiles shall be free from die lines, pressure marks, scratches or graphite lines.<br>• The Extrusions Shall have the webs, walls & flanges of sufficient thickness and eliminated permanent distortion of elements in the finished works<br>• Extruder shall subject to quality review by consultants<br>• All matching sections should be extruded with single extruder to avoid profiles mis match<br>• Solid Aluminum sheet shall be of Alloy 5005 H14 Series.<br>• Solid Metal Panels shall be designed, fabricated & installed in such a manner that the panel should be flat when viewed from any time & any angle.<br>• Distortions, waviness, ripples shall not permitted in any solid metal panels. |
| | **7.15.5** | **FINISH TO ALUMINUM PROFILES**<br>No part of Aluminum to be left in mill finish. Different types of coatings / finishes applicable to Aluminum are as follows:<br>POWDER COATING (High Durability or Super Durable Powder Coating) Internal Visible Profiles<br>**GENERAL**<br>• High Durability / Super durable powder coating shall be factory applied by electrostatic spray.<br>• The finish to confirm as per AAMA 2604<br>• Coating thickness for single coat shall be 50 to 60 micron<br>• Aluminum, surfaces shall be pretreated in accordance with ASTM B449 under chromates Class 1 to provide maximum corrosion protection.<br>• Use a single supplier & applicator throughout production to ensure consistency.<br>• The coatings are to be free of flow lines, streaks, blisters, pin holes, tears, damage & other surface defects.<br>• Powders shall be of thermosetting and super durable type. It must be Lead, Cadmium and TGIC (triglycidyl is ocyanurate) free, to ensure strict environmental compliance. The powder manufacturer shall provide written confirmation on this item<br>**COLOUR AND FINISH**<br>• The colour and gloss range samples shall be submitted to the Engineer-in-charge for Acceptance. The two (2) samples in each set shall represent both the degree of specular gloss, and the lightest and darkest shades of that colour that will be acceptable. For colour of coatings, refer to Finishes Schedule.<br>• Aluminum surfaces shall be pre-cleaned in accordance with the procedures recommended by the paint manufacturer. Aluminum surfaces shall be pre-treated in accordance with ASTM B 449 Class1.<br>• All coatings, when cured, shall be visibly free of frowziness, streaks, sags, blisters or other surface imperfections or defects.<br>• The Contractor shall provide a compatible air-dried coating for field touch-up as recommended by the coating manufacturer and based on, at the minimum, the standards set out in AAMA 2605 for external surfaces and AAMA 2604 for internal surfaces, to match the factory-applied finished work.<br>• Touch-up sample should be provided to the **Engineer-in-charge,** for Acceptance, prior to the commencement of painting. |

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| | **7.15.6** | **QUALITY RECORDS & TESTING**<br>• Submit manufacturer's production and test records prior to shipping materials to site.<br>• Material Test certificates to accompany each batch of delivered material on site. |
| | **7.15.7** | **DESIGN / PERFORMANCE CRITERIA**<br>• The service life of the building envelope shall be not less than 50 years.<br>• Design Wind Load shall be 150 Kg / m2 (For full height) in line with the IS 875, **Part III**. The system shall pass at 1.5 times the design pressure without any failure of components.<br>• Design wind load for glazing full height from ground floor shall be 150 Kg / m2<br>• System shall be transfer their own self weight & other associated dead loads to the main building structure<br>• Deflection limits of monolithic glass under Wind Load: L / 60 or 20mm Max (L = Shorter span).<br>• Deflection limits of Insulated glass unit under Wind Load: L / 90 or 20mm Max (L = Shorter span) |
| | **7.15.8** | **MATERIALS & FINISHES:**<br>**EPDM GASKET**<br>• All unexposed / exposed weather gaskets shall be of EPDM micro wave cured gaskets confirming BS 4255<br>• Shore A Hardness shall be 75 +/-5 for Solid Profiles & 60 +/-5 for Hollow Profiles confirming to ASTM D2240<br>• All gaskets shall be black in color unless specifically asked for<br>• All gaskets must be resistant to oxidation, Ozone & UV degradation.<br>• Inaccessible gaskets should remain effective during the life time of the building to ensure the water tightness<br>• Where indicated on the Drawings or required, provide dense profiles including flashings, wiper seals and the like, complying with ASTM C864, as follows:<br>  o Shore A durometer hardness: 75 +/- 5 for solid profiles and 60 +/- 5 for hollow profiles when tested in accordance with ASTM D2240.<br>  o Compression set 100% (168 hrs): Not greater than 40% when tested in accordance with ASTM D395. |
| | **7.15.9** | **SCREWS & FASTNERS**<br>• All Bolts & Nuts for visible / non-visible area shall be Stainless steel A2 grade (304 Grade) confirming to BS 6105.<br>• Screws and fasteners threading shall confirm to DIN standard or equivalent.<br>• Tightening Torque shall be as per Manufacturer recommendation by Torque Wrench only. |
| | **7.15.10** | **INSTALLATION**<br>• Install materials in accordance with the manufacturer's printed instructions, unless otherwise specified and documented.<br>• Clean all substrates to be sealed using the solvent recommended in the sealant manufacturer's laboratory adhesion report.<br>• Suitable solvents include isopropanol, MEK and xylene, but recommended solvent will depend on substrates being cleaned.<br>• Use masking tape or other precautions required to prevent contact of sealant or primer with adjoining surfaces which could be permanently stained or damaged by cleaning methods required to remove sealant smears.<br>• Remove tape immediately after tooling without disturbing sealant.<br>• Prime all substrates recommended by the sealant manufacturer, based upon adhesion testing.<br>• Primer should be applied before installation of spacer or backer rods.<br>• Install spacer tape for structural joints, as shown on approved drawings.<br>• Install backer rod for weather seal joints as recommended by the sealant manufacturer, to prevent 3-sided adhesion, which can impair the performance of the sealant.<br>• Do not puncture the surface of polyethylene backer rods.<br>• Apply sealants in continuous beads filling joint from the bottom without openings, |

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| | | voids or air pockets so as to provide a watertight and airtight seal for the entire joint length.<br>• Apply sealants in the depth shown or apply in accordance with the manufacturer's recommendations.<br>• Apply elastomeric sealants, in field joints to a depth equal to half of the joint width, but not less than 6mm and not more than 12mm.<br>• Immediately after sealant application and prior to skinning, tool sealants to form smooth, uniform beads and to ensure contact and adhesion of sealant to sides of joint.<br>• Remove excess sealant from surfaces adjacent to joint.<br>• Do not use tooling agents.<br>• Only trained glaziers to be used. |
| | **7.15.11** | **BRACKETS, FIXINGS & ANCHORS**<br>**GENERAL :**<br>• Design and provide all connections, brackets and fixings by Accepted methods so that all loads can be transferred from the building envelope system to the base structure in accordance with the design criteria and in a manner that prevents excessive joint displacement, slippage or distortion.<br>• All components are to be designed for the maximum tolerance of the system, and due consideration shall be given to additional forces from prying action and bolt group effects.<br>• There shall be no direct fixing or close contact between any part of the building envelope system and the base structure or internal linings, except through Accepted bracket connections.<br>• Brackets and related components shall be scheduled and described in detail on shop drawings.<br>• Show details of all related components and connections to areas by others.<br>**Brackets**<br>• All fixing brackets shall be Mild Steel with Hot Dip Galvanized or Aluminum Alloy of 6005 T5 or Stainless Steel (SS 316 Grade)<br>• Brackets shall be resist all loads, movements & dimensional changes that may occur in the building due to thermal changes, deflections, settlement & creep<br>• Use locknuts to prevent loosening due to movements / Vibrations<br>• Brackets shall accommodate the three dimensional building tolerance with serrations / serration washers<br>• Fixings shall be corrosion resistant, and non-staining to adjacent work.<br>• Fixings shall be concealed unless otherwise accepted in the drgs.<br>**Base Building Substrates**<br>• Provide contingency design and installation procedures for all typical substrate conditions and deficiencies including:<br>o Reinforcement clash.<br>o Excessive out-of-tolerance concrete.<br>o Clash with concrete joints, and other structural details.<br>o Mislocated, missed and incorrect embedment.<br>• Check all base structure reinforcement locations. Coordinate with the Engineer-in-charge and refer to structural drawings to establish bracket fixing locations. Verify relationship between brackets and concrete reinforcement on shop drawings.<br><br>**Anchors**<br>• Provide anchors and other methods of attachment of the building envelope system to the base structure which:<br>• Are compatible with the bracket assembly and together provide three-way adjustment to accommodate fabrication and construction tolerances.<br>• Fix the building envelope system in its correct position providing for building and building envelope movements.<br>• Are structurally adequate to carry the design loads for the worst possible bracket |

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| | | positioning.<br>• Comply with all local Authorities requirements. |
| | **7.15.12** | **GLASS FOR GLAZING**<br>**Vision Panel: IGU: Hermetically sealed unit of 24 mm Clear DGU.**<br>• Outer lite:6 mm thk clear HS glass with edge arised<br>• Air Gap (Spacer):12 mm thick natural anodized Aluminum one piece bent spacer profile.<br>• Inner lite: 6 mm thk clear HS glass with edge arised.<br>• Desiccant: Silica molecular sieve.<br>• Primary Seal: Butyl seal (PIB = Poly Iso Butyl)<br>• Secondary seal: Insulating Glass sealant - Two part sealant<br>**Vision Panel : SGU**<br>• 6mm thk. Clear toughened with edge arised.<br>The Contractor to provide material test certificate for all glass being supplied on site and inform the Engineer-in-charge of the standard being followed by the glass manufacturer |
| | **7.15.13** | **SUBMITTALS:** |
| | **A.** | **SHOP DRAWINGS & METHOD STATEMENT:**<br>The contractor shall submit shop drawings for approval of Engineer-in charge before start of work. Drawings shall show all major systems components. Submit samples of typical extrusions, sample units, glass, EPDM gaskets etc. for approval from Engineer-in-charge.<br><br>Comprehensive, detailed and dimensioned shop drawings to indicate all set-out and construction details, adjacent work by others and for all proprietary products where required details are not indicated in the manufacturer's product data. Separate packages of shop drawings should be submitted without limitation for the following:<br>• Typical Door & Windows Units<br>• Curtain Wall<br>• Louvers<br>The approval of shop drawings is for member sizes, surface treatment and the soundness of structural connections. Acceptance will not be given for any setting out or fabrication related issues. Furthermore, Acceptance and Endorsement in no way alleviates the Contractor from responsibility for errors or omissions.<br>Time required for examination of shop drawings will be 15 working days for each submission, including re-submissions. The Contractor shall incorporate required changes due to inaccurate data or incomplete definition so that delivery and installation schedules are not affected. The Contractor's revision response time is not justification for delivery or installation delay of the contract works. Any re-submission shall include requested corrections and shall be responded to previous comments in point-by-point format.<br><br>Manufacture should not commence until Acceptance and Endorsement has been obtained to use the relevant shop drawings. Packages of Shop Drawings shall, without limitation, include and indicate:<br>• A drawing index sheet indicating all drawing numbers and full description of content. The drawings shall be clear and all texts must be written in English.<br>• General notes indicating: (1.) relevant codes and standards, (2.) project load conditions, acoustic requirements, and other performance criteria, (3.) material and structural properties and specifications for all metals, glass, silicone, etc., (4.) material properties and specifications for all other materials, insulation, etc., (5.) schedules of all hardware, (6.) schedules of fasteners, bolts, fixings, and anchors.<br>• Overall elevations and plans for all components.<br>• Set-out of all work, including reference points, edge conditions and joint pattern, indicated on plans, elevations and sections as applicable.<br>• Framing, anchorage and fixings supported from base-structure, and embedment in the base structure, if required.<br>• Movement joints. |

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| | | • Methods of assembly at all junctions, including sealing and fixing, indicated by three- dimensional and exploded views if requested<br>• Glazing details, including but not limited to the following:<br>o Glazing materials including sealants, gaskets, tapes, setting and spacer blocks.<br>o Rebate depth and edge restraint.<br>o Clearances and tolerances.<br>o Methods of in-service glass replacement.<br>o Hardware, fittings and accessories.<br>• Method of draining the assembly, including details showing:<br>o Pressure equalized drained joints.<br>o Location, number and size of weep-holes/slots.<br>o Mechanical baffles to drainage outlets which are not pressure equalized.<br>• Panel details, including all joints and junctions, and support systems and panel stiffening.<br>• Submit details for review and Acceptance.<br>• Indicate the location of each individual panel on shop drawings. Submit as-built elevations progressively indicating the location of each individual panel. |
| | **B.** | **SUBMITTALS AT COMPLETION OF WORK**<br>The contractor has to submit operation and maintenance manuals & as built drawings on completion of works.<br>• **Operation and Maintenance Manuals**<br>The O&M Manual shall include, without limitation, recommendations for operating, and routine cleaning and maintenance, and all information required to ensure the full service capability of the work, including source of replacement components, and methods of replacement of damaged components. The method of cleaning and timetable shall be specified together with cleaning agents which can and cannot be used.<br>• The Operation and Maintenance Manual is to include the following documents:<br>o Comprehensive list of all materials suppliers and agents.<br>o Sealant and Gasket Information – All brands.<br>o Finishes information – coating system type colour, supplier.<br>o Defective works log to be kept up to date for the duration of the warranty period outlining each defect type location and corrective action to rectify each defect.<br>o All Warranties from suppliers and Contracting Parties.<br>o As-built drawings (AutoCAD Files and A3 hard copy).<br>• **As-Built Record Documents**<br>Prepare as-built drawings, photographs and other records progressively as the work proceeds. Submit progress reports on monthly intervals and provide complete as-built documentation at Completion of contract works. As-built drawings shall be submitted to the Engineer-in-charge for necessary onward submission to the relevant Regulatory Authorities for endorsement. These drawings should have been updated to reflect all construction-related modifications to the original drawings. This set of drawings shall be indexed and bound.<br>Submission of design engineering and Shop Drawings to the satisfaction of consultant and taking final approval from the Engineer-in-charge shall be façade contractor's responsibility. Hardware accessories details also included in the shop drawings. |
| | **7.15.14** | **STRUCTURAL CALCULATIONS**<br>• Submit for review structural computations, of all the critical elements that constitute the door and window units including mock up. Comply with given design criteria and loads following the given standards. Include analysis for design wind pressure, dead loads, thermal stresses and seismic loads for all elements in the load path. Show section computations for framing members.<br>• The Contractor / specialized agency shall submit the design duly vetted by Structural/ Facade Consultants approved by the Engineer-in-charge along with the shop drawing before the start of aluminium glazing works. |

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| | **7.15.15** | **TESTING**<br>Randomly selected sample of material shall be got tested by the Engineer-in-charge in approved laboratory. The charges for the test shall be borne by SAU as mentioned in CPWD specifications. |
| | **7.15.16** | **Mock-up**<br>Before proceeding for mass production of all units, the contractor should fix typical mock-up units of each type to verify selections made under sample selections and to demonstrate aesthetic effects and set quality standards for materials and execution. The contractor should proceed for mass production only after approval of Mockups by Engineer-in-Charge. |
| | **7.15.17** | **Measurement**<br>**The surface area of Fixed Window will be measured for payment. Surface area of Openable window/door shutter only will be measured and paid extra over item of fixed window. Surface area of louvered portion will be measured and paid extra over item of fixed window. For Sliding Window the surface area of sliding portion will be deducted from fixed window item and paid separately under item of Sliding Window**. |
| | **7.15.18** | **Rates**<br>The rates shall include the cost of labour, scaffolding, material, wastage , hardware and accessories complete in all respects. |

## 7.16 TECHNICAL SPECIFICATIONS FOR STRUCTURAL GLAZING

### 7.16.1 INTRODUCTION

This specification covers the general requirements of external façade work (Hard finishing and Aluminium glazing work) including engineering design involving structural stability of system as a whole, supply, fabrication, installation, testing, ensuring water tightness and maintenance etc.

Products used in this work shall be produced by manufacturers regularly engaged in manufacturing of similar items for at least last ten years and with a history of successful production proof acceptable to the **Engineer-in-charge**.

Work under this section shall be performed by Specialized agency, who is regularly engaged in the engineering, fabrication, finishing and installation of glazing system including glazing and sealing of glass comparable to the volume of work in this project. The contractor shall submit full details and credentials of specialized agency for verification and to demonstrate to the satisfaction of the Engineer-in-charge that he has successfully performed comparable projects over the last three years ending 31-10-2015 as per the departments guidelines only after written approval of engineer in charge, the contractor will engage such specialized agency for this work.

Subcontracting any part of this work is specifically prohibited, except for that which may be approved by the Engineer-in-charge in writing prior to the award of the Contract.

### 7.16.2 SCOPE OF WORK

- The scope of work includes all labour, material, equipment and services as required for the complete design, engineering, testing, fabrication, assembly, delivery, anchorage, installation and water tightness of the glazing system. Anchorage includes all primary and secondary anchor assemblies and supportive structural framing as required for securing the glazing to the building structure.
- **The scope of work also includes complete design, engineering, testing, fabrication, assembly, delivery, anchorage and installation of a suitable gondola/jib system for cleaning of the vertical glass and stone façade wherever required and approved by the Engineer-in-Charge. However, Payment shall be made under BOQ item.**
- The contract documents define only the design intent and general performance requirements. The contractor is fully responsible for design, structural calculations, shop drawings, procurement of materials, fabrication, installation, warranties, certifications and related documentation. The entire work shall be carried out strictly in accordance with the true intent and meaning of the specification and drawings taken together regardless of whether the same may or may not be shown particularly on the drawings or described in the specification provided that the same can be reasonably inferred from there.
- Only suggestive sizes and details are proposed by the Engineer-in-charge that have a visual impact on façade. Contractor's fabrication / shop drawing will seek these suggestions and design the final construction details.
- The glazing shall be designed, fabricated at works, supplied, delivered and installed in accordance with the shop drawings and samples of materials approved by the Engineer-in- charge and shall be constructed to meet the performance requirements and standards.
- In general, the system should be designed to suit the aesthetics and performance requirements, taking into consideration the necessary factors to suit fabrication and the site conditions for erection.
- Calculation of all wind loads applicable before designing the system
- The contractor shall strictly follow, at all stages of work, the stipulations contained in the Indian standard safety code and the provisions of the safety rules for ensuring safety of men and material. The successful bidder shall submit a safety plan for approval of the **Engineer-in-charge**. On approval of the same, the same shall be followed during the currency of the contract.
- The contractor must comply with all applicable local-building regulations and all the safety guidelines particularly specified for glazing work as per relevant I.S codes
- Shop and field materials and workmanship shall be subject to inspection of the

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| | | Engineer- in-charge and his authorized representative at all time. Such inspections do not relieve the contractor from obligations to provide materials conforming to all requirements of the contract documents and industry standards for material quality.<br>• All approvals, instructions, permission, checking, review etc. whatsoever by the Engineer- in-charge shall not relieve the contractor of his responsibility and obligation regarding adequacy, correctness, completeness, safety, strength, quality, workmanship etc. of the structural glazing system.<br>• Testing will be done as per nomenclature of the item of typical **DGU Panel** of approved size in factory and in field through an approved testing agency. The testing charges for laboratory test will be paid by the SAU on successful test report as per actual. |
| | **7.16.3** | **LOCATION**<br>The works shall be carried out for the **South Asian University, Village Maidan Garhi, New Delhi – 110068** |
| | **7.16.4** | **SYSTEM DESCRIPTION**<br>The contractor shall devise a suitable framing system for vertical glazing application keeping in view the performance characteristics and aesthetics requirements.<br>The vertical structural glazing system shall be semi unitized and shall be designed to suit sealed insulated glass units (hereafter referred to as "DGU"). Aesthetically the design of the vertical glazing system shall provide a filtering envelope to the building and provide a uniform appearance. The glazing system shall have flush glazed exterior joints both horizontal and vertical. The structural glazing system shall be designed to receive fixed glazing as well as structurally glazed openable vents with protection of the glass edges. The contractor shall take adequate measures to ensure the thermal performance of the glazing system under the increased solar radiation prevalent in the region. No onsite sealant application will be permitted except for weather sealant in case of semi unitized system. The system shall comprise of factory prefabricated glazed vision and spandrel panels. The system should preferably permit re-glazing of vision panels from inside the building. Smaller dimension of mullion should not be more than 75mm. The contractor should choose a appropriate system also keeping in view the various requirements arising during future maintenance during the life span of the glazing system.<br>The structural glazing system shall be designed to allow for three-dimensional adjustments due to dead load, live load, wind load, seismic load and thermal movement. The framing system must be designed to provide adequate support for the DGU units to prevent transfer of loads to the glazing below and to provide uniform support to both sides of the DGU unit. Intermediate mullions should be of same size as that of outer mullions.<br>The structural aspects of the structural glazing system must be carefully integrated with the glazing rabbet and drainage details to ensure proper performance. The structural glazing system shall be designed on the rain screen principle with provision for pressure equalization.<br>The structural silicon sealant to be used in this structural glazing system shall be of such quality / designed to transfer wind, seismic, live and dead loads from the glass to the framed structure of the structural glazing.<br>The design shall incorporate floor-to-floor noise isolators, fire and smoke stops between the floor slabs and sill flashing etc. as per the NBC of India and also of the best international practices. |
| | **7.16.5** | **PERFORMANCE REQUIREMENTS** |
| | **i)** | **System design**<br>The vertical glazing system and its components shall be designed to withstand dead loads and live loads caused by positive and negative wind loads acting normal to the plane of the glazing system. Design wind loads shall be 2.0 KPa. The contractor to submit the design calculation and weight of aluminium per meter<br>The vertical glazing system shall also be designed to withstand seismic forces as calculated in accordance with I.S: 1893 (latest revision) under seismic zone IV.<br>Apart from the above, the glass and the glazing system should also be designed to withstand a concentrated load of 100kg applied at any location so as to produce the |

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| | | maximum stresses in the glazing components. This load is envisaged to be encountered during cleaning of the glass facade.. |
| | ii) | **Deflection**<br>The deflection of any structural member in the plane normal to the glass surface when subjected to the specified loads shall not exceed L/175 of its clear span and shall be fully recoverable on withdrawal of the specified loads. Deflection of any framing member shall not exceed 19mm within any glass panel.<br>Parallel to glazing plane, deflection of a framing member when carrying full design load shall not exceed an amount reducing the glazing unit bite below 75% of the design dimension. It shall also not reduce the edge clearance to less than 3mm nor shall it damage or impair the function of any joint seals. |
| | iii) | **System assembly** |
| | | The system assembly should accommodate the following without damage to the system, components or deterioration of seals.<br>• Movement within the system<br>• Movement between system and perimeter framing components.<br>• Dynamic loading and release of loads<br>• Deflection of structural support framing<br>• Tolerance of supporting components<br>• Shortening of building concrete structural columns<br>• Creep of concrete structural members<br>• Inter story drift<br>• A mid span slab edge deflection of 25mm<br>• Accommodate building construction tolerance of ±30mm. These tolerances are not cumulative. |
| | iv) | **Water Tightness**<br>Water penetration shall be defined as the appearance of uncontrolled water on inside face of any part of the structural glazing. No water leakage will be permitted when tested in accordance with ASTM E331. The test shall be carried out for duration of 15 minutes with a test pressure difference of 20 % of design pressure with a minimum differential of 137 N / mm2 and a maximum of 575 N / mm2. The minimum uniform water flow rate of 3.4L/m2/min. |
| | v) | **METHOD STATEMENT FOR HOSE TESTING (ON SHORE) AT SITE:-**<br>STANDARD :-<br>AAMA 501.2 – 94 Field Check of Metal Storefronts, Curtain Walls, and Sloped Glazing Systems for Water Leakage<br>(i) TEST AREA :-<br>Area (s) to be tested will be selected by the Engineer-in-charge accordance with the standard. The total area will be not more than that can be tested in one day.<br>Testing shall be done at least one area of 10 square meter, in accordance with the test standard, or more, depending on the time, and availability of suitable access to the exterior. In case of failure the prescribed procedure for a reasonable time but not more than that can be completed on the same day shall be followed. The test will be supervised via two-way radio from the inside.<br>(ii) EQUIPMENT: -<br>Testing equipment generally consists of the following and any other equipment as required for carrying out the test :-<br>a) The 'Monarch' nozzle with pressure gauge and valve as prescribed by AAMA and recommended by CWCT.<br>b) Two-way headset radio for communication between engineers and the people in the cradle.<br>c) Other Requirements<br>i) (Optional) washing of the area as recommended in Paragraph 7.4 of the CWCT Standard.<br>ii) Visual checking of test area for snags, visible defects etc.<br>iii) A cradle or scaffolding on the exterior at the locations (s) of the test specimen (s) with an operator, a person to stabilise the cradle, a person to hold and point the nozzle, technical person to communicate between the people on |

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| | | the exterior and test engineer.<br>iv) Clean water in a minimum ¾" supply hose with approximately 4 bar pressure. Note that the pressure given for the test is with the water flowing, much higher actual pressure is necessary. Water pressure drops 1 bar for every 10m rise in height.<br>v) Drying of test area and application and removal of tape if necessary to locate leaks.<br>vi) The test shall be conducted by the contractor at his own cost and nothing extra shall be paid. |
| | **vi)** | **TEST CRITERIA:-**<br>Water will be sprayed at a pressure of 30 –35 psi (2.07-2.41 Bar) in accordance with the test standard. The flow rate will not be monitored.<br>The nozzle will be held 30 cm. from the wall spraying 1.5m lengths back and forth along each joint, successively, for five minutes each, working from the bottom up. Joints are interfaces between materials, and where these are less than 120mm apart are to be considered one joint. |
| | **vii)** | **TEST PROCEDURE**<br>a) The initial area shall be the width of the cradle. The lowest horizontal joint will be wetted first, covering each 1.5m length in five minutes.<br>b) Next the cradle will be positioned so that the first 1.5m above the bottom horizontal joint can be reached and each vertical will be sprayed in turn over a period of 5 minutes.<br>c) The cradle will then be raised to test the next 1.5m and then the next horizontal and so on. |
| | **viii)** | **LEAKAGE**<br>If there is any leakage the test will be stopped and the procedure described in the Standard will be followed up to the time allowed.<br>A compliance report suggesting any modification / corrective steps to be taken if any leakage was observed. |
| | **ix)** | **SYSTEM INTERNAL DRAINAGE**<br>Drain water entering joints, condensation occurring in glazing channels, or route moisture occurring within the system to the exterior by a weep drainage network. |
| | **x)** | **EXPANSION/CONTRACTION**<br>The system shall provide for expansion and contraction within system components caused by a cyclical temperature range of 80℃ over a 12hour period without causing any detrimental effect to the system components. |
| | **xi)** | **TEST FOR STRUCTURAL PERFORMANCE**<br>When tested in accordance with ASTM E330, the glazing system shall conform to the performance requirements |
| | **xii)** | **PRODUCTS** |
| | **a)** | **Glass**<br>Glass used should be from the list of approved makes & the Contractor to provide material test certificate for all glass being supplied on site and inform the Engineer-in-charge of the standard being followed by the glass manufacturer. |
| | **b)** | **Other materials**<br>The aluminium extrusions shall be 6063 alloy T6 temper conforming to ASTM B221 or equivalent. They shall be clean, straight, with sharply defined edges and free from distortion and defects impairing appearance, strength and durability. It shall be of suitable wall thickness and profile for strength with respect to tension, shear and bending stresses, capable of local and lateral stability.<br>Fixing bolts, screws and nuts, where in contact with aluminium, will be of stainless steel 304 grade.<br>Glazing tape for structural glazing shall be Norton or approved equivalent.<br>All dissimilar metal surfaces shall be isolated to prevent anti galvanic action. Materials used for this purpose shall be non absorptive. Metal surfaces shall be separated in such a manner that metal does not move on metal.<br>Aluminium surface in contact with mortar, concrete fireproofing, plaster, masonry and absorptive materials shall be coated with anti-galvanic moisture-barrier material and |

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| | | nothing extra will be paid for this. |
| | c) | **Accessories**<br>Extruded gaskets, weather stripping, extruded seals and spacers which do not come into contact with structural silicone sealant shall be of ethylene propylene diene monomer (EPDM). Where in parallel contact with structural silicone sealant, all gaskets, setting blocks and spacers other than foam glazing tapes shall be of heat-cured silicone rubber, chemically compatible with the silicone sealant and suitable for the specific purpose intended. All extruded gaskets, weather stripping and spacers other than foam glazing tapes shall have continuous mechanical engagement to framing members; **any adhesive attachment is not acceptable.** Unless otherwise approved, gaskets, weather stripping, extruded seals and spacers shall have a hardness of 40±5 durometer Shore A. |
| | d) | **Flashing**<br>To prevent leakage, flashing shall be formed from aluminum sheet of minimum 2.0mm thickness with joints tapped and sealed 150mm minimum.<br>Flashing shall be provided on all sides of glazing where external glazing terminates and wherever else required to provide a completely watertight installation. Wherever visible, it shall have the matching finish of Aluminum. |
| | e) | **Thermal insulation**<br>Thermal insulation shall be provided in all spandrel areas without fail. Insulation shall be provided using fasteners of the type and spacing recommended by the insulation manufacturer.<br>The thermal insulation in spandrel panel shall be 50mm thick chemically inert semi-rigid black faced fiberglass wool batts with a density of 48 Kg/Cum. conforming to IS: 8183 / BS: 3958. Insulation within every spandrel panel shall consist of a single panel of mineral wool or fiberglass without butt joints.<br>The Contractor shall replace any damaged or wetted insulation material when so instructed by the **Engineer-in-charge**. |
| | f) | **Fire Stop**<br>At each floor edge the required fire protection is to be maintained between elements of structure by using fire stop insulation to give a minimum of 2 hours fire protection between floors including in front of columns or blank walls. The fire stop material is to be installed to completely seal up the void between the face of the structure and the glazing and shall fully comply with local Codes and Regulations. The fire stop material must be flexible to allow movement between the structure and the external glazing.<br>The fire stop material shall be located and held in position in such a way so as to ensure integrity of the fire protection as well as preventing accidental damage or loss of materials. The Contractor is required to provide full details of all fire stop material including fire test certificates and confirmation of local Fire Service Bureau approved material status. Shop drawings shall also be submitted for approval showing the full details of fire stops. |
| | g) | **Finishes**<br>All exposed framing members shall be free of scratches and other blemishes. All aluminum surfaces shall be powder coated in approved colour. The powder coating shall conform to relevant ASTM Codes. The powder coating shall be tested in an approved laboratory. Prior to powder coating, all aluminium shall be rendered uniform in appearance free from disfiguring scratches, stains or other blemishes and etched in caustic soda solution. Requisite tests shall also be carried out at the site as required by the **Engineer-in-charge** and the contractor shall arrange all assistance and equipment required for the purpose. |
| | xiii) | **PROGRAMME OF WORK**<br>The contractor shall submit a detailed program of work along with time schedule indicating the various items of work pertaining to the structural glazing work as below:<br>• Design and approval<br>• Shop drawings<br>• Submission of samples<br>• Mock-up |

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| | | • Test reports<br>• Material co-ordination, ordering and delivery<br>• Fabrication<br>• Installation<br>• Inspection and remedial measures. |
| | **xiv)** | **DESIGN CALCULATIONS** |
| | **i)** | The contractor shall be responsible' for the design of the structural glazing system including all its various components like glass, sealant, framing system, gaskets, fixing and anchorages proposed by respective specialists. The contractor shall submit structural design calculations prepared in accordance with relevant Indian/International codes and standards as applicable. The design shall be carried out under the direct supervision of a professional engineer experienced in design of this type of work and licensed at the place where the project is located. Structural design shall include, but not limited to, computations for the justification of external glazing sections and connections including fasteners, welds and anchorage assemblies. |
| | **ii)** | The contractor shall submit for Engineer-in-charge's approval all structural calculations with reference to structural properties and physical characteristics and dimensional limitations of the framing members of the glazing system. The contractor shall also submit design calculations for all connections, die dimensions of all extrusions and complete data of all alloys proposed to be used for the project. Approval of structural calculations shall not relieve the contractor from any of the responsibilities and requirements specified therein. |
| | **iii)** | The contractor shall submit the glass manufacturer's wind pressure analysis, seismic load analysis and thermal analysis showing that the specified maximum deflections and probabilities of breakage are not exceeded. |
| | **xv)** | **SHOP DRAWINGS**<br>The contractor shall submit shop drawings showing clearly the relationship of the structural glazing facade to the building structure, mechanical and electrical systems, floor slabs and any<br>other related works. They shall show the arrangement of components, instructions and explanatory details for the sequence of fabrication, assembly, erection and installation of all materials including the glass and de-glazing procedures. They shall include the following:<br>• Plan, elevation and details required to fully describe the structural glazing system.<br>• System dimensions framed opening requirements and tolerances for squareness, corner offset and bows.<br>• Dimensional position of glass edge/face relative to the aluminium framing, full size junction details between mullion and transom and end details.<br>• Isometric drawings of flashing, joints between transom and mullions, end details etc.<br>• Expansion and contraction joint location and details<br>• Weep and condensation drainage network<br>• Full size details including isometric drawing of sealing, flashing and jointing Methods<br>• Materials, type, size, location, spacing of all screws, bolts, weld, anchoring devices and all accessories. |
| | **xvi)** | **SAMPLES**<br>The contractor shall submit all samples at his own cost. Samples shall be submitted for approval well in advance of the date, on which the particular work involving the use of materials for which samples are submitted, is scheduled to begin.<br>The work shall be carried out in accordance with the approved samples. The following shall be submitted:<br>• 2 samples of 600mm x 600mm in size illustrating pre-coated aluminium mullion and transom junction detail complete with glass skin and glazing materials illustrating edge and corner.<br>• 4 nos. 12" x 12" samples of each type of glass.<br>• 4 nos. 6" long samples of principal extrusions.<br>• 4 nos. manufacturer's samples of each type of aluminium finish.<br>• 4 nos. manufacturer's samples of each type of sealant |

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| | | • 2 nos. manufacturer's samples of all accessories and hardware envisaged to be used for the structural glazing system. |
| | **xvii)** | **SOURCES**<br>The contractor shall submit the name of the suppliers for the following items of work along with the shop drawings and samples.<br>• All components of the structural glazing system<br>• Aluminium extrusions<br>• Anodizing paint from manufacturer I authorized applicator<br>• Sealant<br>• Glass<br>• Hardware<br>• Gaskets<br>• Fasteners<br>• Anchorages |
| | **xviii)** | **SUBMITTALS**<br>The contractor shall submit 4(four) copies of the following documents pertaining to the engineering of the structural glazing using structural glazing system to the engineer for approval, review etc.<br>• Shop drawings<br>• Structural design calculations for aluminium framing, glass thickness and sealant byte sizes.<br>• Calculations for deflection.<br>• Test reports as per the performance requirements.<br>• As-built drawings<br>• Maintenance manual upon completion of the project. |
| | **xix)** | **PROTECTION**<br>The contractor shall be responsible for all materials against damage from mechanical abuse and foreign matter during installation. A layer of protective tape with a minimum life of 90 days shall be applied on all aluminium members before they are brought to site. The protective layer shall be removed at handover stage.<br>On virtual completion and receiving instruction from the Engineer, the Contractor shall remove all protective coverings, manufacturer's seals, labels etc. The contractor shall thoroughly clear the internal and external glazing area and members with cleaning solution recommended by the respective manufacturers.<br>The Contractor shall ensure that the highest possible standards of material protection are maintained both in the fabrication and installation of the external glazing system. |
| | **xx)** | **CLEANING**<br>The Contractor shall ensure that all actions are taken during installation to eliminate the effects of corrosive substances on the finishes of the external glazing.<br>The Contractor shall clean both internal and external surfaces to remove corrosive substances, dust or cement / mortar dropping during the installation as may be directed and instructed by Engineer-in-charge.<br>The internal surfaces of glass and aluminum frame are to be cleaned with compatible cleaning agents prior to the installation of the internal protective sheeting.<br>Prior to snagging inspections the Contractor shall remove the internal protection sheets and carry out a thorough cleaning of all glass, aluminum and spandrel panels as per the direction of Engineer-in-charge.<br>The protective sheeting shall then be removed permanently provided that no other wet works or services work are required in the immediate vicinity of the external glazing.<br>Prior to the handing over of each floor to the Engineer-in-charge, the Contractor shall carry out a final cleaning of the external glazing. |
| | **xxi)** | **REMOVAL OF IMPROPER WORK AND MATERIALS**<br>Any materials/or works which, in the opinion of the Engineer-in-charge, are not in accordance with the specification, shop drawings and instructions shall be removed from the site immediately |
| | **7.16.6** | **PERFORMANCE GUARANTEE** |
| | | The contractor shall be solely responsible for the design including shop drawings |

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| | | and performance of the installed structure glazing system, The installations shall be guaranteed by the contractor during the guarantee period for materials used, workmanship, water tightness (wherever specified), structural design, performance requirements and other requirements as given in the specifications. The contractor shall submit in the enclosed format a written guarantee for the same for a period of 10 years from the date of completion of the work. In addition, the contractor shall obtain and submit to the Engineer-in-Charge a similar back-to-back guarantee for same duration from the specialist agency / structure glazing fabricator engaged by them. |
| | **7.16.7** | **MAINTENANCE MANUAL**<br>On completion of the works, The contractor shall prepare a detailed maintenance manual for the structural glazing system. The manual should cover the following:<br>• Complete and detailed explanation of operating principles of the structural glazing system<br>• Description of all the various components of the glazing system,<br>• Recommended Inspection schedule and periodic inspection procedure,<br>• Complete parts list,<br>• Instructions for proper cleaning procedures and routine maintenance of the facade including frequency,<br>• Cleaning products and their source<br>• Method statement for re-glazing and replacement of component parts with appropriate drawings;<br>Four copies of the maintenance manual must be handed over to the SAU within four weeks from actual completion of work. |
| | **7.16.8** | **Mock-up**<br>Before proceeding for mass production of all structural glazing, the contractor should fix typical mock-up units of each type to verify selections made under sample selections and to demonstrate aesthetic effects and set quality standards for materials and execution. The contractor should proceed for mass production only after approval of Mockups by Engineer-in-Charge. |
| | **7.16.9** | **Measurement**<br>The surface area of structural glazing will be measured for payment. |
| | **7.16.10** | **Rates**<br>The rates shall include the cost of labour, scaffolding, material, wastage , hardware and accessories complete in all respects. |

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| **7.17 TECHNICAL SPECIFICATIONS FOR MOTORIZED ROLLING SHUTTERS** | | |
| | **7.17.1** | **SCOPE**<br>This specification covers the design, supply of materials, fabrication, delivery and erection of Rolling shutters /Grills with motor drive and manual operation including all accessories as hereinafter specified. |
| | **7.17.2** | **COMPONENTS & INSTALLATION** |
| | **i)** | Slats for rolling shutters shall be made from tested bright cold rolled, annealed M.S. strips, not less than 0.9 mm thick for shutters within between interlocking, The profile, will be such as to prevent excessive deflection under specified wind load. |
| | **ii)** | Rolling grills shall be constructed out of 8 mm dia, rods at with vertical links spaced not more than 200 mm centers. Alternatively, rolling grills shall be made from perforated slats of approved design reinforced with 6mm dia rods. |
| | **iii)** | End locks shall be heavy type M.C.I./C.I. and shall be provided at each end of alternate slats unless specified otherwise in the Schedule. |
| | **iv)** | Bottom bars shall be finished with two angles not less than 5mm thk. for external shutters. When shown on drawings, a flexible weather strip shall be applied to make tight contact with the floor. |
| | **v)** | Guides shall be such depth as to retain the shutter under a wind pressure of 100 Kg / Sq.M or as specified in Schedule. |
| | **vi)** | Shafts shall be of Mid steel of sufficient size to carry the torsional load with a maximum deflection of 1/360th of span. Grease packed ball bearings or brushings shall be provided for smooth trouble free operation. |
| | **vii)** | Hoods shall be formed of not less than 20 gauge steel, suitable reinforced to prevent sag. |
| | **viii)** | Locks shall be slide rolling nasp, or cylinder lock operable one or both sides. Provision securing hand chain with pad-lock., provision for removable handle for hand cranks etc., shall be made as described in Schedule or as described by the Engineer-in-charge. |
| | **ix)** | Power unit shall be suitable for 3 phase , 50 cycle, 400 volt A.C. Power supply and shall be either floor or wall mounted unit. The motor shall be of sufficient capacity to move the shutter in either direction at a speed of 0.3 mts / second. In addition to the gear motor each standard power unit shall include a magnetic brake, a reversing starter with a built in overload protection, a geared limit switch and one push button station located inside the building unless otherwise stated in drawing. It is desirable that the bottom bar of motor operated doors shall be provided with a sensitive edge, electrically connected to stop the travel of the door on meeting an obstruction |
| | **x)** | Operating chains shall be of tested quality, heavily galvanized and with all ends rounded to assure smooth operation and hand protection. |
| | **xi)** | Reduction gears shall be high strength gray cast iron, machine molded from machine out patterns. |
| | **7.17.3** | **POWER OPERATED SHUTTERS/GRILLS**<br>These shall be operable from a push button station conveniently located beside the door or as shown on drawings. One emergency hand chain / crank operation shall also be provided for use in case of failure of the electric system. Where called for in Schedule, externally mounted shutters shall be operated by control mechanism located inside the building. |
| | **7.17.4** | **SHOP COAT**<br>Shutters shall be painted with one coat of red lead or zinc chromate primer |
| | **7.17.5** | **ERECTION**<br>Door shall be installed by the manufacturer or his authorized representative and all work shall be as per manufacturer's instructions. Any drilling or cutting to shutters and all abrasion to shop coat shall be cleaned up. All electrical work shall be in strict accordance with the latest Indian Electricity Rules. |

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| | **7.17.6** | **ACCEPTANCE CRITERIA** |
| | **7.17.7** | **SHOP INSPECTION**<br>After completing the manufacture of the different components of the rolling shutter, an arrangement for shop inspection by the Engineer-in-charge shall be made to check the conformity with approved shop drawings. |
| | **7.17.8** | **SITE INSPECTION**<br>After installing the shutters, the Contractor shall test the performance of the shutter in the presence of the Engineer-in-charge. The Doors shall be smoothly openable under all ambient conditions. All control and locking devices shall give fault-free performance. |
| | **7.17.9** | **GUARANTEE**<br>The Contractor shall give two year guarantee for the successful operation of the shutters. This shall be supported by a separate and unilateral guarantee from the manufacturer of the shutters. |
| | **7.17.10** | **MEASUREMENT**<br>Measurements of finish wall opening to receive rolling shutter shall be taken as surface area of the shutter. |
| | **7.17.11** | **MOCK-UP**<br>Before proceeding for mass production of all units, the contractor should fix typical mockup units of each type to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution. The contractor should proceed for mass production only after approval of Mockups by Engineer-in-Charge. |
| | **7.17.12** | **RATES**<br>The rates shall include the cost of labour, scaffolding, material, wastage, hardware and accessories complete in all respects. |

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| **7.18 TECHNICAL SPECIFICATIONS FOR ZINC TITANIUM STANDING SEAM ROOFING SYSTEM** | | |
| | **7.18.1** | **General Specifications:**<br>Providing and fixing of 25/430 zinc titanium double lock standing seam roofing system (thickness: 0.7mm) with crest height of 25 mm thick consisting of fixing clips made of stainless steel to connect the zinc panel to the Hat section. Comprising of the following layers.<br>The zinc roof cladding system shall consist of the following elements to form a rigid, non-ventilated and watertight support base for installation of the pre weathered quartz zinc roofing sheets.<br>The roof system shall comprise of the following described from top to bottom: |
| | **i)** | **Top Layer** – 25/430 mm Profiled sheet manufactured from zinc titanium standing seam roof system manufactured from zinc titanium alloy as specified in EN 988 standard with minimum material thickness of 0.7 mm in pre weathered QUARTZ Aspect .The seam height shall be 25 mm & maximum length shall be as per manufacturers recommendations. The material properties shall be as follows :Ultimate tensile strength: minimum 150 N/mm2,0.2% Proof Stress: min 100 N/mm2,Modulus of elasticity: 90,000 N/mm2. Including Accessories, stainless steel fixing & sliding clips and fasteners. Sheets are to be laid to meet the requirements of the building geometry and fixed using SS clips to the substructure. Clip to be fixed on 1 mm GI Sheet & 0.47 mm low rib decking sheet with Galvanized screws only. All installation is to be carried out by approved trained roofing installer. The installation team shall be fully trained and approved by the manufacturer. The roof sheeting manufacturer/supplier must have a registered office in India The roof sheeting manufacturer shall have ISO 9001 / 14001 quality certifications for their manufacturing units. |
| | **ii)** | Anti abrasive breathable membrane laid at the underside of zinc panels. |
| | **iii)** | 0.47mm TCT Hi-Tensile steel sheets profile with nominal 3.5 mm deep ribs at pitch of nominal 48 mm centre to centre distance 550 MPa Yield Strength. |
| | **iv)** | GI Top Hat Z Section 1.2 mm thick |
| | **v)** | Insulation layer- Insulation – Rockwool / Stone wool Insulation of 100 mm thickness x minimum 64 kg/m3 density. Thermal Transmittance (U-value) to be 0.5 W/m2.K including all losses and calculation to be submitted in accordance with BS EN ISO 6946 and shall take account of the thermal bridging effects of any fixing elements Fire classification with test procedures to BS 476: Parts 6 & 7. with low chloride content, chemically inert, non- sulphurous, rot proof, vermin proof, impervious to hot water and steam, non- injurious to health and non- corrosive to steel,. The insulation with density of 64kg/m3 – 100 mm as per ASTM E84/EN 13501-1/UL 723. |
| | **vi)** | Bottom Sheet - Trapezoidal profiled high tensile (550 mpa yield stress) colour coated, zinc aluminum alloy coated steel sheet having crest height of 28-30mm at a pitch distance of 195mm – 250 mm . The sheet thickness shall be 0.47-0.58mm TCT (total coated thickness) comprising of base metal thickness of 0.47mm over which zinc aluminum alloy coating mass of 150 gms / m2 on both sides .Colour coating to be done as per finish approved by the Engineer-in-charge. |
| | **7.18.2** | Physical characteristics of pre-weathered Zinc roofing sheets:<br>• Density: 7.2kg/dm3<br>• Thermal expansion coefficient: 0.022 mm/m x ºC<br>• Melting point: 420 ºC<br>• Re-crystallization point: 300 ºC<br>• Heat conductivity: 110 W/ (m.K)<br>• Electrical conductivity: 17Ms/m<br>The zinc roofing sheets shall have a protective coating at the underside of the sheet. Characteristics of the protective coating PLUS (=Protective coating Laid Under Side).<br>The zinc roof sheets shall have a proprietary protection on its underside consisting of a 60 micron thick composite acryl ate-urethane protective coating. The protective coating eliminates any risks related to possible corrosion due to contact with incompatible materials and where the underside of the roof sheets is not ventilated. |
| | **7.18.3** | **Compatibility between materials**<br>Acceptable contact materials include: |

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| | | • Lead<br>• Aluminium<br>• Galvanized Steel<br>• Stainless Steel<br>• Timber such as pine, spruce, poplar and Scots pine |
| | **7.18.4** | **Unacceptable contact materials include:**<br>• Copper<br>• Steel (Non-galvanized)<br>• Plywood or chipboard<br>• Bituminous felt<br>• Concrete or reinforced concrete<br>• Timber such as larch, Douglas fir, chestnut, oak, red cedar and white cedar. |
| | **7.18.5** | **Transportation and storage**<br>The zinc sheets shall be transported and stored in dry conditions and in a constant temperature.<br>Item includes supplying, installation and fixing of profiled zinc sheeting including cost of system accessories insulation, vapour barrier, liner sheet, gutters, flashing, capping, trims, fasteners, gaskets, brackets, screws, rivets, sealants, inner closure fillers, fixtures, all machineries and all taxes, i.e., sales tax, VAT, excise duty, customs duty, etc., complete. The above work is to be carried out by a specialized agency approved by the Engineer-in-Charge. |
| | **7.18.6** | **Special Specifications** |
| | | Installation of 25 /430 Double Lock Standing Seam roofing System with minimum thickness of 0.7 mm . The zinc roof sheets shall have a protection on its underside consisting of a 60 micron thick composite acryl ate-urethane protective coating with inner sheet comprising of Trapezoidal /Galvanised steel liner sheet, 0.47mm thick, 980-1000 mm total cover width.<br>The substrate is hot dipped galvanized steel coil. Treatment is a corrosion resistant chromate conversion coating.<br>Outer sheet comprise of profiled sheeting manufactured from Zinc alloy ZnTiCu as specified in EN 988, minimum thickness of 0.7 mm and The zinc roof sheets shall have a protection on its underside consisting of a 60 micron thick composite acryl ate-urethane protective coating<br>**Standing seam panels**<br>The zinc roofing sheets shall be installed with a double locked standing seam. The height of the standing seam shall be a minimum of 25mm in order to ensure perfect water tightness. The transversal junctions will depend on the slope. The minimum slope shall be ≥ 3º (or 5%).<br>**Fixing clips for standing seam panels**<br>The roof cladding system shall meet loading requirements in conformity with minimum pull-out strength of 50daN for each of the fixing clips (fixed and sliding), provided that the entire support transmits the cumulated load of all fixing clips to the structure. For this purpose, the support shall rest on at least 3 bearing elements.<br>The fixing of the roof sheets shall be done with fixed and sliding clips. These clips have a dual function of ensuring the mechanical resistance of the entire cladding and roofing area; and allowing free expansion of the cladding and roofing material.<br>Fixed clips shall be stainless steel with a thickness of not less than 0.5mm. The clips shall be pre-punched with counter-sunk holes for attachment and designed to withstand negative load requirements<br>The Sliding clips shall be stainless steel with a thickness of not less than 0.6mm for fixed base and not less than 0.4mm thick for the sliding part. The sliding clip base shall incorporate a 70mm long slot to allow permits movement. The clips shall be pre-punched with counter-sunk holes for attachment and designed to withstand negative load requirements.<br>The fixing to the support shall be done with stainless steel clips, with minimum pull-out strength of 50daN for each of the fixing clips (fixed and sliding).<br>Particular care shall be given to the calculations of the number of fixing clips per zinc |

panel with respect to weather and site conditions, and exposure of wind indifferent parts of the cladding and roofing area.
Particular care shall also be given to allow the bottom end of the zinc panels to dilate freely.
Whenever necessary, the soldering works should be in accordance to the manufacturer's recommendations (either chemically with stripping products or mechanically).
Fastener for standing seam panels
Oval head, self drilling screws, 316 series stainless steel. All fasteners are designed to seat in pre-punched holes of the clips to eliminate potential contact and abrasion between fastener head and panel.
Fasteners shall be selected to resist all negative design load requirements. Minimum pullout strength: 50 daN.
**Transversal junctions for standing seam panels**
When the length of the roof slope exceeds the maximum recommended length, it is necessary to join the sheets using transverse junctions to suit the pitch of the roof. These include:
Step (or drip): for pitches of 3° (5%) or more
The step height will be a minimum of 8 cm for standing seam.
**Double welt: for pitches of 11° (20%) or more**
The double welt can be used for pitches of 11° and above. The minimum length of the overlap is 200 mm with a securing clip at the top. The dimensions can vary due to the projected expansion and/or contraction based on the conditions at the time of installation.
Depending on climatic conditions such as wind and rain, the overlap should be increased. The fixed clip should be soldered onto the zinc sheet, not fastened to it.
**Single welt: for pitches > 25° (47%) or more**
The single welt or single lock cross-welt with an overlap of 50mm can be adopted for pitches greater than 25° (42%) in the standing seam technique.
**Welding**
Welding for Zinc: ASTM B 32, contains 60 percent lead and 40 percent tin with low antimony, as recommended by manufacturer
**THERMAL PERFORMANCE**
The Standing Seam 25/430 zinc roofing system will be designed, and installed to withstand the expansion and contraction forces resulting from an atmospheric temperature range 5 to 45 degrees Celsius. The complete roofing system will meet the required thermal performance U value of 0.5 W/m2K using 100m (100 +50 mm) of Insulation.
The Complete Roof built shall provide a STC of 45+- 3 dB for acoustical performance of the system.
**DETAILS AT FLASHING, CAPPING AND FASCIA**
Flashing and Capping to the roof will be manufactured from the same quality grade and finish of material as the roofing elements.
**EAVES & GUTTER FLASHING**:
The Flashings for eaves / gutters to be profiled as per the Details Provided by Manufacturers.
The flashing needs to be installed along with GI stiffener of 1 mm thick wherever recommended by the manufactures.
**FASTENERS**
Fasteners such as screws and other fastening devices shall be suitable for the conditions of each application and shall be of austenitic stainless steel to prevent galvanic action with the components fastened. Where fasteners are not manufactured in stainless steel, then fasteners of metal compatible with adjoining materials and having a permanent corrosion resistance finish will be used.
**GUTTERS :**
Factory fabricated gutters of semicircular shape and 333 mm radius to be provided in zinc titanium alloy of same finish as the roof. The eave gutter shall be fixed on the Eave Structure using concealed clamps made of galvanized steel.
The gutters shall have proper accessories like inward corner, outer corner, down

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| | | spouts, down take Pipes, 90 degree bend as mentioned in the BOQ .<br>**Flashing/Trims :**<br>Joints in flashings and trims shall be installed to fully accommodate thermal movement. Flashing joints generally shall comply with the Cladding Manufacturer's recommendations.<br>**Sealing Laps:**<br>a. The Sheet Manufacturer shall recommend sealant type(s) for the purpose. The position of sealing laps shall be in straight unbroken lines immediately below fixing positions and parallel to the edges of sheets. They shall be placed into corrugation and not allowed to stretch or sag in position.<br>b. Ensure continuity and effectiveness of seal especially at corners of sheets. Do not over compress.<br>c. Same as Item 1.1 above but for Gutters all complete and in straight lengths.<br>**MEASUREMENTS:**<br>The area for roof sheeting shall be calculated by measuring actual length X breadth of roof sheeting o site up to two decimal places. . Flashings for eaves, gables, ridges shall be charged extra on linear meter basis.<br>Gutters if provided to be charged on linear meter basis. Accessories to be charged on no of pieces . For Skylight shall be extra from roof measurement on girth / spread out basis..<br>No deduction in measurement shall be made for opening up to 2 sqm and nothing extra shall be allowed for forming such openings. In case of tapered panels / diagonal cutting standard width of the coil shall be taken in to account for arriving at measurement.<br>**RATE:**<br>The rate shall include the cost of all the materials, machinery and man power involved in all the operations described above. Any other item required for completion of roofing system shall also be treated as included in the item and nothing extra will be paid for such extra work.<br>**Protection of material**<br>The zinc Façade sheets shall come with a proprietary protective film on the topside to protect it against damage and defect during transportation and storage.<br>The protective film should be removed promptly after installation since the film is not UV resistant and residues of the adhesives may remain on the metal.<br>The protective film shall be removed no later than six weeks from the date of installation. |

| 7.19 TECHNICAL SPECIFICATIONS FOR FALSE CEILINGS | | |
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| | 7.19.1 | **GENERAL**<br>Work shall in general be carried out as per the CPWD specification. Modular and acoustical false ceiling shall be provided and installed in areas as specified in drawings. A Combination of fixed board ceiling and openable tiles is used in the interiors for visual effect as long as the majority of the ceiling is openable.<br>Modular acoustical tile ceilings with high reflectivity of light and recessed grid is to be provided meeting with the international standards.<br>False ceiling shall be coordinated with the services to achieve maximum height from the finished floor level in the office areas with cove lighting.<br>The false ceiling material shall be of Gypsum board, metal, acoustic modular tiles or mineral fibre ceiling tiles. The technical assistance and guidance is to be taken from the respective approved manufacturers and work shall be done strictly according to the manufacturers specifications and manuals. Material from original source shall only be used.<br>A sample of each finish shall be got approved before proceeding for bulk production. GI framing shall be erected as per recommendation of the manufacturer specification and approval of Engineer-in-Charge. No sagging, unleveled stretch of work or chipped tiles shall be accepted. Contractor shall take full responsibility for its firmness with the structure.<br><br>The false ceiling comprises of Gypsum board, Acoustical Ceiling Tiles Mineral Fiber Tile, Metallic Tiles and Metal Baffle Ceiling. A sample of each finish shall be got approved before proceeding for bulk production. GI framing shall be erected as per recommendation of the manufacturer specification and approval of the Engineer-in-charge. The main contractor shall engage specialized agency and submit its credentials to Engineer-in-charge for approval. The criteria for setting the terms and conditions shall be broadly in line with CPWD criteria for similar works. The work shall be taken up only when specialized agency is approved in writing by Engineer-in-charge. False ceiling work shall be carried out in accordance with the actual site conditions at different split-levels. Any sagging, unleveled stretch of work shall be redone /replaced and made good, at no extra charge, to the satisfaction of Engineer-in-charge. No compensation shall be paid on account of provision /coverage of openings for lighting fixtures, air-conditioning ducts and the likes as detailed in drawings and /or directed. |
| | 7.19.2 | **CODES & STANDARDS**<br>All standards, specifications, act and codes of practices referred to herein shall be the latest editions including all applicable official amendments and revisions. |
| | 7.19.3 | **MINERAL FIBRE TILES FALSE CEILING** |
| | i) | The mineral fiber tiles/rockwool shall be procured from an approved manufacturer as per the list of Approved makes. |
| | ii) | The tiles and the suspension system shall be as specified in the item nomenclature. The Contractor shall prepare the shop drawings for the False Ceiling based on actual measurements at site and based on the architectural drawings, clearly indicating the typical panel as well as edge panel on all sides with details to adjust the minor variations in orthogonally. Also, junction details with different types of false ceiling materials shall be prepared and submitted for the approval of the Engineer-in-Charge before execution. |
| | iii) | The installation shall be got done through a Reputed Interior Contractor who shall be engaged by the Contractor. The details of earlier works executed by the Interior Contractor shall be submitted to the Engineer-in-Charge in advance. If required, those works shall be inspected to assess the Quality of workmanship. The false ceiling shall be perfectly level after installation. The Contractor shall then prepare the mock-up at site for approval of material and quality of workmanship by the Engineer-in-Charge. Only after the approval of Mock-up, the Contractor shall start the mass work. |
| | iv) | The mineral fiber tiles shall be of size 600x600mm or 1200x600mmas required as per the architectural drawings and as per the site requirements and shall be of the |

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| | | texture and physical & other characteristics as specified in BOQ. The tiles shall have sound absorption, sound attenuation, humidity resistance, impact resistance and fire resistance as specified as per the manufacturer's specifications. The thickness of the tiles shall not be less than 15mm.The tiles shall have light reflectance, thermal conductivity, Relative Humidity and sound absorption (Noise Reduction Co-efficient) with sound attenuation as per the item description. The weight shall not be less than 3.5 kg per sqm without grid. The contractor shall obtain and submit to the SAU the manufacturer's certificate for compliance of the mineral fiber tiles & the suspension system as per the manufacturer's specifications and also copy of the manufacturer's test report for the record. |
| | **v)** | The tiles shall be made of non -combustible bio-soluble wool and shall have finely granulated surface texture with virtually invisible micro-perforations as specified & as required for its performance. It shall meet the various performance parameters like aesthetics, acoustics (sound absorption), hygiene, humidity resistance, impact resistance, fire resistance, durability etc. |
| | **vi)** | The tiles shall have precisely machined edges including edge treatment required for the installation depending on the type of suspension system grid and manufacture as approved by the Engineer-in-Charge and as per the architectural drawings. The openings of required size for light fittings, fire detection devices, sprinklers, AC diffusers etc. shall be suitably made in the tiles by cutting in an approved and workmanlike manner. For the purpose of measurement, no deduction shall be made in the area of false ceiling on this account. Also, nothing extra shall be payable on this account. The end tiles shall be cut to the required size in a workmanlike manner as per the site requirement. Nothing extra shall be payable on account of any wastage in the material and /or account of providing grid at closer spacing than 600mm c/c. |
| | **a)** | These tiles shall be fixed on to coordinated suspension ceiling system with supporting grids system that fully integrates with the ceiling tiles. It shall be ensured that the suspension system shall be suitable to take all the incidental and dead loads and other authorized loads efficiently and shall not sag .The permissible sag shall be as per the British Standards BS 8290 - 1991. The Contractor shall provide a guarantee for 10 years against sag on account of defective material and / or workmanship. |
| | **b)** | The contractor shall ensure that the grid system is designed and installed to carry all incidental loads and no other unauthorized load shall be transferred to this system. The luminaries, air grills / diffusers, signages etc. shall be as far as possible independently supported to avoid any over loading of the ceiling system which may result in excessive deflection or twisting of grids. Any strengthening of grid system by providing additional hangers, fasteners, runners, cross tees etc. or providing additional bracing may be carried out as required for any specific locations or for specific purpose for which nothing extra shall be payable. Perimeter trims / edge profiles of required size and shape, powder/coil coated to required colour and shade, shall be installed at the suspension grid perimeter to completely enclose the ceiling and shall be properly secured to the walls at not more than 450 mm centre to centre using stainless steel screws and PVC sleeves. It shall be neatly jointed at all external and internal angles and over lap sections in a workman like manner with mitred joints. |
| | **c)** | The ceiling should be set out such that the perimeter boards or tiles are in excess of half a module so that the edge panels on both the sides are of equal sizes as far as possible. The tiles shall be cut to required size and shape with rebates as specified using hand tools or mechanically operated tools in a workman like manner but with all precautions as per the manufacturer's specifications regarding generation of dust and ventilation. |
| | **d)** | The entire installation shall have minimum half an hour fire rating and integrity as specified as per BS 476 |
| | **e)** | The contractor shall ensure that the material is procured and delivered at installation site without any damage. Adequate care shall be taken before installation as well as afterwards till handing over the building for occupation. It shall be protected from rains, excessive humidity, chemical fumes, vibrations, dust etc. The contractor shall ensure careful handling and storage and prevent any rough |

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| | | handling, rolling of cartons or dropping cartons to prevent any edge damage or breakage. Any tile with edge damaged or crack etc. shall not be allowed to be used in the work and shall be replaced by the contractor at his own cost. Similarly, adequate care shall be taken by the contractor while placing or removing and handling the tiles so as not to cause any damage. Also, the contractor shall direct his interior contractors to take adequate precautions to prevent the tiles from any dirt, fingerprints, any other marks / splashes etc. The ceiling shall not be wet cleaned. Abrasive cleaners shall not be used to clean the marks. |
| | **f)** | The rate for the item of false ceiling includes cost of all inputs of labour, materials, wastage if any, T&P, scaffolding, staging or any other temporary enabling structure / services etc. and all other incidental charges including making necessary cut outs for A.C diffusers, Light fittings, grills, Fire detection, alarm, sprinklers devices and fittings etc. No deduction in the area shall be made for openings nor anything extra shall be payable for making the openings. Also nothing extra shall be payable on account of any wastage in materials. Also nothing extra shall be payable on account of any strengthening of the supporting suspension system for the false ceiling, around the openings in the false ceiling by using additional hangers, fasteners, runners, cross tees, etc.. However, for the purpose of payment only the actual area of the false ceiling shall be measured in sq.m.<br>The Tile & Grid system used together of all sizes should carry a 15 year warranty |
| | **7.19.4** | **ACOUSTICAL CEILING TILE of Sand Texture Mineral Fiber Tile - 600mmx600mm with 15mm Exposed T-Grid System (NRC 0.55)** |
| | **i)** | **SCOPE**<br>This specification covers the supply and installation of Pin Hole Texture Mineral Fiber RH 99 of approved make, tested for fire resistance and sound absorption from a reputed Third Party certified testing company. |
| | **ii)** | **GENERAL**<br>The Contractor shall furnish all materials, labour, operations, equipment's ,tools & scaffolding and incidents necessary and required for the completion of all metal working connection with Pin Hole Mineral Fiber Tile, as called in the drawings, specifications and bill of quantities which is applicable to the items of work concerned. The supply and installation of additional fastenings, accessory features and other items not specifically mentioned but which are necessary to make a complete functioning installation shall form a part of this contract. All work shall be free from defects, impairing strength, durability and appearance and shall be of the best quality for purposes specified made with structural properties to withstand safety strains, stresses to which they shall be subjected to. All fittings shall be of high quality and as specified and as per approval.<br>The contractor shall strictly follow, at all stages of work, the stipulation contained in the Indian Standard Safety Code or its Equivalent and the provision of the safety code and the provision of the safety code and the provision of the safety rules as specified in the General Conditions of the for ensuring safety of men and material.<br>Providing & Fixing of Pin Hole Texture Mineral Fiber Acoustical Suspended Ceiling System with 15mm Exposed T- GRID. The tiles should have Humidity Resistance (RH) of 99%, NRC 0.55, Light Reflectance ≥87%, Thermal Conductivity k = 0.052 - 0.057 w/m K, Colour White, Fire Performance UK Class 0 / Class 1 (BS 476 pt - 6 &7) in module size of 600 x 600 x 16mm , suitable for Green Building application, with Recycled content of 30%. The tile shall be laid on 15 mm wide T – section with 38mm Web Height, flanges colour white having rotary stitching on all T sections i.e. the Main Runner, 1200 mm & 600 mm Cross Tees with a web height of 38mm and a load carrying capacity of 14 Kgs/M2 & pull out strength of 100kgs.. The T Sections have a Galvanizing of 90 grams per M2 and need to be installed with suspension system The Tile & Grid system used together should carry a 30 year warranty. |
| | **iii)** | **INSTALLATION**<br>To comprise main runner spaced at 1200mm centres securely fixed to the structural soffit using suspension system (specifications below) at 1200mm maximum centre. The First/Last of suspension system at the end of each main runner should not be greater than 450mm from the adjacent wall. Flush fitting 1200mm long cross tees to be interlocked between main runners at 600mm centre to form 1200 x 600 mm |

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| | | module. Cut cross tees longer than 600mm require independent support. 600 x 600mm module to be formed by fitting 600mm long flush fitting cross tees centrally between the 1200 mm cross tees. Perimeter trim to be of size wall angles of size 3000x19x19mm, secured to walls at 450 mm maximum centres. Installation to be carried out by Trained Installation team & Installation should be carried out as per recommended procedure. |
| | **iv)** | **SUSPENSION SYSTEM**<br>Accessories manufactured and supplied by manufacturer consisting of M6 Anchor Fasteners with Vertical Hangers made of Galvanised steel of size 26 x 26 x 25 x 1.2mm with a Galvanised Thickness of 80gsm, A pre Straightened Hanger wire of dia – 2.5 mm of 1.8 m length., thickness of 80gsm and a tensile strength of 344-413 MPa, along with Adjustable hook clips of 0.8mm thick, galvanised spring steel for 2.68 mm with a minimum pull strength of 110 kg. The adjustable clip also consists of a 3.5 mm aquiline wire to be used with the main runner. |
| | **7.19.5** | **Tech zone Suspended ceiling system with Mineral Fiber Acoustic Ceiling 600x1200x 20mm thick with 15mm exposed T-grid system. (NRC 0.7)** |
| | **i)** | **SCOPE**<br>This specification covers the supply and installation of Sand Texture Mineral Fiber 20mm Thick RH 99 Tile of approved make, tested for fire resistance and sound absorption from a reputed Third Party certified testing company. |
| | **ii)** | **GENERAL**<br>The Contractor shall furnish all materials, labour, operations, equipment's ,tools & scaffolding and incidents necessary and required for the completion of all metal working connection with Sand Texture Mineral Fiber Tile, as called in the drawings, specifications and bill of quantities which is applicable to the items of work concerned. The supply and installation of additional fastenings, accessory features and other items not specifically mentioned but which are necessary to make a complete functioning installation shall form a part of this contract.<br>All works shall be free from defects, impairing strength, durability and appearance and shall be of the best quality for purposes specified made with structural properties to withstand safety strains, stresses to which they shall be subjected to.<br>All fittings shall be of high quality and as specified and as per approval.<br>The contractor shall strictly follow, at all stages of work, the stipulation contained in the Indian Standard Safety Code or its Equivalent and the provision of the safety code and the provision of the safety code and the provision of the safety rules as specified in the General Conditions of the for ensuring safety of men and material. |
| | **iii)** | The Techzone ceiling system has a ceiling module of 1200x1350 and the on centre spacing between two adjacent technical zones is 1350 mm. The Techzone orientation is such that the main runners run parallel to the technical zone and hence making this layout compatible with continuous lighting fixtures or Air diffusers. Mineral Fiber field panel is of size 600x1200x20mm mm. The 150mm wide technical zone formed is where the technical elements like lighting fixtures & air diffusers would be installed. Where there are no technical elements the technical zone would be covered by using Mineral Fiber Technical Panels of size 1200mm x150mm in conjunction with a special 150mm long cross tee. The Mineral Fiber panels should have Humidity Resistance (RH) of 99, NRC 0.7, Light Reflectance ≥85%, Thermal Conductivity k = 0.052 - 0.057 w/m K, Colour White, Fire Performance UK Class 0 / Class 1 (BS 476 pt - 6 &7), suitable for Green Building application, with Recycled content of 63%. The panels shall be laid on 38mm Web height with 24 mm wide T - section flanges colour white having rotary stitching on all T sections i.e. the Main Runner & 1200 mm Cross Tees with a web height of 38mm. The T Sections have a Galvanizing of 90 grams per M2 with pull out strength of minimum 100 Kgs and need to be installed with suspension system. |
| | **iv)** | **INSTALLATION**<br>Technical zones to be formed by using 2 main runners which run parallel to each other at a distance of 150mm and thus forming a Technical zone of 150mm. The on centre spacing between two adjacent technical zones to be 1350mm. Thus we get a module of1200x1350mm where 1350 is the on centre spacing between the adjacent technical |

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| | | zones.<br>To lay the field panel of size 600x1200mm, flush fitting 1200mm long cross tees to be interlocked between main runners at 600mm centre.<br>The technical zone where there are no technical elements can be covered using the technical panels of size 1200mm x 150mm. These technical panels to be laid in the technical zone using a special 150mm long cross tee interlocked at every 1200mm in the technical zone. |
| | **v)** | Perimeter trim to be wall angles of size 3000x19x19mm, secured to walls at 450 mm maximum centres. Installation to be carried out by Manufacturers Trained Installation team & Installation should be carried out as per recommended procedure. |
| | **7.19.6** | **ACOUSTICAL CEILING TILE OF SIZE 600x1200 - Providing and fixing of Techzone Suspended ceiling system with sand textured mineral fiber tiles 16mm thick with 15mm exposed grid system (NRC 0.5)** |
| | **i)** | **SCOPE**<br>This specification covers the design, supply of material. Manufacture and installation of DUNE RH 99 of approved for fire rating and sound absorption from NVLAP & EXOVA a third party certified company respectively. |
| | **ii)** | **GENERAL**<br>The Contractor shall furnish all materials, labour, operations, equipment's ,tools & scaffolding and incidents necessary and required for the completion of all metal working connection with Sand Texture Mineral Fiber Tile, as called in the drawings, specifications and bill of quantities which is applicable to the items of work concerned. The supply and installation of additional fastenings, accessory features and other items not specifically mentioned but which are necessary to make a complete functioning installation shall form a part of this contract. All work shall be free from defects, impairing strength, durability and appearance and shall be of the best quality for purposes specified made with structural properties to withstand safety strains, stresses to which they shall be subjected to. All fittings shall be of high quality and as specified and as per approval. The contractor shall strictly follow, at all stages of work, the stipulation contained in the Indian Standard Safety Code or its Equivalent and the provision of the safety code and the provision of the safety code and the provision of the safety rules as specified in the General Conditions of the for ensuring safety of men and material. |
| | **iii)** | The Techzone ceiling system has a ceiling module of 1200x1350 and the on centre spacing between two adjacent technical zones is 1350 mm. The Techzone orientation is such that the main runners run parallel to the technical zone and hence making this layout compatible with continuous lighting fixtures or Air diffusers. Field panel is of size 600x1200x16mm. The 150mm wide technical zone formed is where the technical elements like lighting fixtures & air diffusers would be installed. Where there are no technical elements the technical zone would be covered by using mineral fiber tile Technical Panels of size 1200mm x150mm in conjunction with a special 150mm long cross tee. The ceiling panels should have Humidity Resistance (RH) of 99, NRC 0.5, Light Reflectance ≥85%, Thermal Conductivity k = 0.052 - 0.057 w/m K, Colour White, Fire Performance UK Class 0 / Class 1 (BS 476 pt - 6 &7), suitable for Green Building application, with Recycled content of 32%. The panels shall be laid on 15 mm wide T - section flanges with 38mm web height, colour white having rotary stitching on all T sections i.e. the Main Runner & 1200 mm Cross Tees with a web height of 38mm. The T Sections have a Galvanizing of 90 grams per M2 with pull out strength of minimum 100 Kgs and need to be installed with suspension system. |

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| | **iv)** | **INSTALLATION**<br>Technical zones to be formed by using 2 main runners which run parallel to each other at a distance of 150mm and thus forming a Technical zone of 150mm. The on centre spacing between two adjacent technical zones to be 1350mm. Thus we get a module of 1200x1350mm where 1350 is the on centre spacing between the adjacent technical zones. To lay the field panel of size 600x1200mm, flush fitting 1200mm long cross tees to be interlocked between main runners at 600mm centre. The technical zone where there are no technical elements can be covered using the |

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| | | technical panels of size 1200mm x 150mm. These technical panels to be laid in the technical zone using a special 150mm long cross tee interlocked at every 1200mm in the technical zone. Perimeter trim to be wall angles of size 3000x19x19mm, secured to walls at 450 mm maximum centres. Installation to be carried out by Trained Installation team & Installation should be carried out as per Manufacturer's recommended procedure. |
| | **v)** | **SUSPENSION SYSTEM**<br>Accessories consisting of M6 Anchor Fasteners with Vertical Hangers made of Galvanised steel of size 26 x 26 x 25 x 1.2mm with a Galvanised Thickness of 80gsm, A pre Straightened Hanger wire of dia – 2.5 mm of 1.8 m length., thickness of 80gsm and a tensile strength of 344-413 MPa, along with Adjustable hook clips of 0.8mm thick, galvanised spring steel for 2.5 mm with a minimum pull strength of 110 kg. The adjustable clip also consists of a 3.5 mm aquiline wire to be used with the main runner. |
| | **7.19.7** | **600 X 600mm GI METAL Clip In with GI Swing Down in Standard Perforated** |
| | **i)** | **SCOPE**<br>This specification covers the design, supply of material. Manufacture and installation of approved for fire rating and sound absorption from Warrington Specification and ARAI a third party respectively certified company. |
| | **ii)** | **GENERAL**<br>The Contractor shall furnish all materials, labour, operations, equipment's ,tools & scaffolding and incidents necessary and required for the completion of all metal working connection with GI Clip-in Metal Plain, as called in the drawings, specifications and bill of quantities which cover the applicable to the items of work concerned. The supply and installation of additional fastenings, accessory features and other items not specifically mentioned but which are necessary to make a complete functioning installation shall form a part of this contract.<br>All metal work shall be free from defects, impairing strength, durability and appearance and shall be of the best quality for purposes specified made with structural properties to withstand safety strains, stresses to which they shall be subjected to.<br>All fittings shall be of high quality and as specified and as per approval.<br>The contractor shall strictly follow, at all stages of work, the stipulation contained in the Indian Standard Safety Code or its Equivalent and the provision of the safety code and the provision of the safety code and the provision of the safety rules as specified in the General Conditions of the for ensuring safety of men and material. |
| | **iii)** | **Providing & Fixing** true horizontal level suspended ceiling comprising of GI Clip-in with double pip self-leveling feature and special tabs to allow removal of tile to enable plenum access with standard perforated ( 2.5mm diameter – 16% open area) visual consisting of 600X600 mm clip in tiles of galvanized steel in 0.5 mm thickness with bevel edge in Global white color precoated with primer coat at the rear side with Light Reflectance > 60% and suitable for Green Building application, with Recycled content of 25%. Tiles would have Soundtex fleece hot pressed at the back of the perforated panel to achieve an NRC of upto 0.7 and fire performance of Class A2-s1.d0 as per EN13501. |
| | **iv)** | **<u>INSTALLATION:</u>**<br>To comprise 3000mm long 'C' channels spaced at 1200mm centers securely fixed to the structural soffit by support clamp & approved hangers. The last hanger at the end of each C channel should not be greater than 600mm from the adjacent wall. Use a C-channel connector for splicing two pieces of C-channels. 4000mm Main carriers (spring tee bars) shall be spaced at 600mm centers in a direction perpendicular to the C-channels and shall be secured at every intersection with C channel using a hanger. Use connector to splice two pieces of main carriers. Tiles should be clipped in between two carriers (spring tee bars) from below. This is a downward installation. Installation to be carried out by Trained Installation team & Installation should be carried out as per manufacturer's recommended procedure. |
| | **7.19.8** | **ACOUSTICAL CEILING TILE OF SIZE 600x1200 - Providing and fixing of Techzone Suspended ceiling system with Soft Fiber Glasswool ceiling tiles** |

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| | | **20mm thick with 15mm exposed grid system. (NRC 0.9)** |
| | **i)** | **SCOPE**<br>This specification covers the design & supply of material. Manufacture and installation of Soft Fiber 20mm thick RH 95 of approved make tested for fire resistance and sound absorption from reputed third party certified company. |
| | **ii)** | **GENERAL**<br>The Contractor shall furnish all materials, labour, operations, equipment's ,tools & scaffolding and incidents necessary and required for the completion of all metal working connection with Metal Clips, as called in the drawings, specifications and bill of quantities which cover the applicable to the items of work concerned. The supply and installation of additional fastenings, accessory features and other items not specifically mentioned but which are necessary to make a complete functioning installation shall form a part of this contract.<br>All metal work shall be free from defects, impairing strength, durability and appearance and shall be of the best quality for purposes specified made with structural properties to withstand safety strains, stresses to which they shall be subjected to.<br>All fittings shall be of high quality and as specified and as per approval.<br>The contractor shall strictly follow, at all stages of work, the stipulation contained in the Indian Standard Safety Code or its Equivalent and the provision of the safety code and the provision of the safety code and the provision of the safety rules as specified in the General Conditions of the for ensuring safety of men and material. |
| | **iii)** | The Techzone ceiling system has a ceiling module of 1200x1350 and the on centre spacing between two adjacent technical zones is 1350 mm. The Techzone orientation is such that the main runners run parallel to the technical zone and hence making this layout compatible with continuous lighting fixtures or Air diffusers. Soft Fiber ceiling tile field panel is of size 600x1200x20mm. The 150mm wide technical zone formed is where the technical elements like lighting fixtures & air diffusers would be installed. Where there are no technical elements the technical zone would be covered by using Soft Fiber tile Technical Panels of size 1200mm x150mm in conjunction with a special 150mm long cross tee. The panels should have Humidity Resistance (RH) of 95, NRC 0.9, Light Reflectance ≥85%, Thermal Conductivity k = 0.052 - 0.057 w/m K, Colour White, Fire Performance UK Class 0 / Class 1 (BS 476 pt - 6 &7), suitable for Green Building application, with Recycled content of 66%.<br>The panels shall be laid on 15 mm wide T - section with 38mm web height flanges colour white having rotary stitching on all T sections i.e. the Main Runner & 1200 mm Cross Tees with a web height of 38mm. The T Sections have a Galvanizing of 90 grams per M2 with pull out strength of minimum 100 Kgs and need to be installed with suspension system. |
| | **iv)** | **INSTALLATION**:<br>Technical zones to be formed by using 2 main runners which run parallel to each other at a distance of 150mm and thus forming a Technical zone of 150mm. The on centre spacing between two adjacent technical zones to be 1350mm. Thus we get a module of 1200x1350mm where 1350 is the on centre spacing between the adjacent technical zones.<br>To lay the field panel of size 600x1200mm, flush fitting 1200mm long cross tees to be interlocked between main runners at 600mm centre.<br>The technical zone where there are no technical elements can be covered using the technical panels of size 1200mm x 150mm. These technical panels to be laid in the technical zone using a special 150mm long cross tee interlocked at every 1200mm in the technical zone.<br>Perimeter trim to be wall angles of size 3000x19x19mm, secured to walls at 450 mm maximum centres. Installation to be carried out by Trained Installation team & Installation should be carried out as per Manufacturer's recommended procedure. |
| | **v)** | **SUSPENSION SYSTEM**<br>Accessories consisting of M6 Anchor Fasteners with Vertical Hangers made of Galvanised steel of size 26 x 26 x 25 x 1.2mm with a Galvanised Thickness of 80gsm, A pre Straightened Hanger GI wire of dia – 2.5 mm of 1.8 m length., |

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| | | thickness of 80gsm and a tensile strength of 344-413 MPa, along with Adjustable hook clips of 0.8mm thick, galvanised spring steel for 2.68 mm with a minimum pull strength of 110 kg. The adjustable clip also consists of a 3.5 mm aquiline wire to be used with the main runner Perimeter trim to be Armstrong wall angles of size 3000x19x19mm, secured to walls at 450 mm maximum centres. Installation to be carried out by Armstrong Trained Installation team & Installation should be carried out as per Armstrong recommended procedure |
| | **7.19.9** | **METALWORKS BAFFLE CEILING SYSTEM with 100mm X 25mm on centre spacing of 200mm in WOOD GRAIN FINISH** |
| | **i)** | **SCOPE**<br>This specification covers the supply and installation of metal baffle ceiling in wood grain finish of size 100 x 25 x 3000/3600mm on center to center spacing of 200mm. |
| | **ii)** | **GENERAL**<br>The Contractor shall furnish all materials, labour, operations, equipment's , tools & scaffolding and incidents necessary and required for the completion of all metal working . All works shall be free from defects, impairing strength, durability and appearance and shall be of the best quality for purposes specified made with structural properties to withstand safety strains, stresses to which they shall be subjected to. All fittings shall be of high quality and as specified and as per approval. The contractor shall strictly follow, at all stages of work, the stipulation contained in the Indian Standard Safety Code or its Equivalent and the provision of the safety code and the provision of the safety code and the provision of the safety rules as specified in the General Conditions of the for ensuring safety of men and material. |
| | **iii)** | Providing & fixing **Vertical Linear Baffle Ceiling** made out of Aluminum Extrusion in Aluminum alloy grade 6063. The baffle blade shall be in size of **100x 25 x 3000/3600mm on centre spacing of 200mm in Wood grain finish.** The baffle blade shall be suspended using Slotted U-profile at on-center spacing in multiples of 25mm. Longer lengths of Baffle to be connected by Baffle Joiner and the ends to be fixed with End caps. |
| | **iv)** | **INSTALLATION**<br>Installation of U-Grid:<br>The U profile to be suspended at every 1200mm on-centre using 6mm threaded rod from the structural soffit using U-profile hanger. U-profile splice to be used to join more than one U profiles of length 3.75M. 1st U-Grid Channel must be not more than 400mm from the perimeter.<br>Installation of Baffles:<br>Locate the slot for Baffle Hangers in slot of Baffle section at 1200mm centres. Hangers are inserted into the slot, then rotated 90° and fixed into position by tightening the grub screw. Baffle to be lifted into position and hangers engage over lip of U-Grid Channel. Each Hanger to be secured into position by inserting the Locking Clip. Baffles blades to be connected at ends with Baffle Joiner, which are inserted into the top and bottom slots of the Baffle closed profile for alignment only. The bottom Joiner to be located first and fastened on one side only. The top Joiner to be fitted then and secured with grub screws on one side. Then the two Baffle sections shall be joined and the top Joiner is screw fastened on the 2nd Baffle profile.<br>End Caps to be located by pushing the End Cap tongues into Baffle slots. Installation to be carried out by Trained Installation team & Installation should be carried out as per Manufacturer's recommended procedure. |
| | **v)** | **Mock-up**<br>Before proceeding for mass installation of false ceilings, the contractor should fix typical mock-up units of each type to verify selections made under sample selections and to demonstrate aesthetic effects and set quality standards for materials and execution. The contractor should proceed for mass production only after approval of Mockups by Engineer-in-Charge. |
| | **vi)** | **Measurement**<br>The surface area of false ceilings shall be measured to the nearest Cm. All works shall be measured net & fixed & area calculated to the nearest two places of |

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| | | decimal. No deduction / extra payment shall be made on account of cutting holes for light fittings, HVAC grills & other services fittings etc. |
| | **vii)** | Rates<br>The rates shall include the cost of labour, material, wastage, hardware and accessories complete in all respects. |

| 7.20 TECHNICAL SPECIFICATIONS FOR DOUBLE SKIN DRYWALL PARTITIONS | | |
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| | **7.20.1** | **SCOPE**<br>This specification covers the design, supply of material, manufacture and installation of drywall partitions (minimum 120mm) of approved make for required fire resistance and sound absorption from ARAI; a third party certified company. |
| | **7.20.2** | **CODES & STANDARDS**<br>All standards, specifications, act and codes of practices referred to herein shall be the latest editions including all applicable official amendments and revisions. |
| | **7.20.3** | **GENERAL**<br>The Contractor shall furnish all materials, labour, operations, equipment's ,tools & scaffolding and incidents necessary and required for the completion of works, as called in the drawings, specifications and bill of quantities which cover the applicable to the items of work concerned. The supply and installation of additional fastenings, accessory features and other items not specifically mentioned but which are necessary to make a complete functioning installation shall form a part of this contract.<br>All work shall be free from defects, impairing strength, durability and appearance and shall be of the best quality for purposes specified made with structural properties to withstand safety strains, stresses to which they shall be subjected to.<br>All fittings shall be of high quality and as specified and as per approval.<br>The contractor shall strictly follow, at all stages of work, the stipulation contained in the Indian Standard Safety Code or its Equivalent and the provision of the safety code and the provision of the safety code and the provision of the safety rules as specified in the General Conditions of the for ensuring safety of men and material. |
| | **7.20.4** | **DRYWALL PARTITION**<br>120mm thick stud partition which includes two layers of 12.5mm thick Gypboard Plain (conforming to IS 2095 Part 1 : 2011 ) screw fixed with Drywall Screws of 25mm & 35mm respectively at 600mm at centre and 300mm at periphery of board to either side of 70mm C stud (0.5mm thick having one flange of 34mm and another flange of 36mm made of GI Steel) placed at 610mm centre to centre in 72mm floor and ceiling channel (0.5mm thick have equal flanges of 32mm made of GI steel), which is anchored to the floor & True ceiling using HILTI HLC 8X40/HILTI X-GN20MX anchor fasteners at 600mm c/c in zigzag manner. Stud and floor channel are crimped together with crimping tool. The boards are to be fixed vertically to the framework with joints staggered to avoid leakage through joints. A noggin channel of 70mm width (0.5mm thick having two flanges of 40mm each) has to be provided at the horizontal joints of the outer layer boards screw fixed to the studs using Metal to Metal flat head screws. 25x25x0.5mm angle bead should be used at all L-Junctions of partition. 50mm glasswool slab of density 20kg/m³ shall be placed in metal framework. Glasswool holding clip should be used to hold Glasswool slab in its position. Finally square and tapered edges of the boards are to be jointed and finished so as to have a flush look which includes filling and finishing with Pro-Fill Jointing compound, Joint Paper tape or fiber tape (as per recommended practices of manufacturer). The junction of the partition with masonry & all penetration through the partition has to treated with fire and acoustic sealant. All other detailing and specifications to be followed as per approved shop drawing. The drywall shall be 1 hour fire rated (60 mins). |
| | **a)** | **INSTALLATION PROCEDURE**<br>Draw the reference line from the column. Mark the drywall layout as per floor plan & dimension. Check the accuracy of right angle using laser. Fix the floor channel on the floor with fasteners (600mm c/c, 8mm x 45mm). The position of fasteners on 50mm floor channel should be at centre & zigzag pattern for 72mm & above floor channel. At starting point of floor channel, put two fasteners. Transfer this line on the soffit with the help of Laser or Plumb. Similarly fix the ceiling channel on soffit with fasteners @ 600mm c/c. match the slots of all studs from one side. Cut all the studs 10mm shorter than actual height from one end only. Fix the end studs on the structure with fasteners at 600mm c/c. do boxing of studs wherever required, place the stud into the floor & ceiling channel at 610mm/410mm/305mm c/c, as per specification. Ensure that studs are placed in one direction. Complete the junction details as per the layout. Check the vertical alignment of stud with the spirit level. Put the supports for planned loadings. Put additional noggin |

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| | | channel for mounting the switch box wherever required. Pass the services through the cut outs of studs. Ensure proper baffling for the fire to restrict. Do one side boarding. Put the 25mm drywall screws at 600mm for the first layer of board & 35mm screws at 300mm for second layer boarding. Place the glass wool inside the cavity of studs & lock with glass wool holding clips. Put the other side of the board. Screw it properly. Put fire & acoustic sealant at the periphery of drywall. Finish all the joints of boards with JC & paper tape. Apply topcoat finally. Use cavity toggles for unplanned loads wherever required. |
| | **7.20.5** | **<u>IMPACT RESISTANT DRYWALL PARTITION</u>**<br>Minimum 120mm thick stud partition which includes outer layers of tapered edge minimum 12.5mm thick impact resistance board (conforming to EN 520:2004, Type D,F,I & R) & inner layer of tapered edge 12.5mm thick Gypboard Plain (conforming to IS:2095 – 2011-Part-I) is screw fixed with Drywall Screws of 25mm & 35mm at minimum spacing of 300mm at Centre and 150mm at periphery of wall to either side of 70mm C stud (0.5mm thick having one flange of 34mm and another flange of 36mm made of GI Steel) placed at 610mm Centre to Centre in 72mm floor and ceiling channel (0.5mm thick have equal flanges of 32mm made of GI steel), which is anchored to the floor & true ceiling using Rawl plug Ø8x45mm/Hilti X-GN20MX anchor fasteners at 600mm c/c in centre line. Stud and floor channel are crimped together with crimping tool. A noggin channel of 70mm width (0.5mm thick having two flanges of 40mm each) has to be provided at the horizontal joints of the outer layer boards screw fixed to the studs using Metal to Metal flat head screws. 50mm Glass wool slab of density 20kg/m³ shall be placed in metal framework. Glasswool holding clip should be used to hold Glasswool slab in its position. The boards are to be fixed vertically to the framework with joints staggered to avoid leakage through joints. 25x25x0.5mm angle bead should be used at all L-Junctions of partition. Finally square and tapered edges of the boards are to be jointed and finished so as to have a flush look which includes filling and finishing with Pro-Fill Jointing compound, Joint Paper tape or fiber tape (as per recommended practices of manufacturer). The junction of the partition with masonry & all penetration through the partition has to be treated with fire and acoustic sealant. All other detailing and specifications to be followed as per approved shop drawing. The drywall shall be 1 hour fire rated (60 mins) |
| | **a)** | **INSTALLATION PROCEDURE**<br>Draw the reference linefrom the column. Mark the drywall layout as per floor plan & dimension. Check the accuracy of right angle using laser. Fix the floor channel on the floor with fasteners (600mm c/c, 8mm x 45mm). the position of fasteners on 50mm floor channel should be at centre & zigzag pattern for 72mm & above floor channel. At starting point of floor channel, put two fasteners. Transfer this line on the soffit with the help of Laser or Plumb. Similarly fix the ceiling channel on soffit with fasteners @ 600mm c/c. match the slots of all studs from one side. Cut all the studs 10mm shorter than actual height from one end only. Fix the end studs on the structure with fasteners at 600mm c/c. do boxing of studs wherever required, place the stud into the floor & ceiling channel at 610mm/410mm/305mm c/c, as per specification. Ensure that studs are placed in one direction. Complete the junction details as per the layout. Check the vertical alignment of stud with the spirit level. Put the supports for planned loadings. Put additional noggin channel for mounting the switch box wherever required. Pass the services through the cut outs of studs. Ensure proper baffling for the fire to restrict. Do one side boarding. Put the 25mm drywall screws at 600mm for the first layer of board & 35mm screws at 300mm for second layer boading. Place the glass wool inside the cavity of studs & lock with glass wool holding clips. Put the other side of the board. Screw it properly. Put fire & acoustic sealant at the periphery of drywall. Finish all the joints of boards with JC & paper tape. Apply top coat finally. Use cavity toggles for unplanned loads wherever required. |
| | **b)** | **Mock-up**<br>Before proceeding for mass installation of dry walls, the contractor should fix typical mock-up units of each type to verify selections made under sample selections and to demonstrate aesthetic effects and set quality standards for materials and execution. The contractor should proceed for mass production only after approval of Mockups by Engineer-in-Charge. |
| | **c)** | **Measurement**<br>The surface area of dry walls from one side shall be measured to the nearest Cm. All |

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| | | works shall be measured net & fixed & area calculated to the nearest two places of decimal. No deduction / extra payment shall be made on account of cutting holes for electrical boxes, HVAC grills & other services fittings etc. |
| | **d)** | **RATE**<br>The rates shall include cost of labour, material, wastage, hardware and accessories in all operations described in Bill of Quantities. |

## 7.21 TECHNICAL SPECIFICATIONS FOR THREE WINGED MANUAL REVOLVING DOOR

**7.21.1 Scope :**

Supply, Installation, Handover of Manual revolving door with three wings (leaves) of approved make, rigid turnstile with standard frame profile system, drum walls made of glass, Upper Ceiling made of Melamine White coated laminated board (Top and Bottom), Lower Ceiling made of Melamine White coated laminated board (Top and Bottom), Dust Protected, with LED Lights in the Lower Ceiling, with Manual Locking of door leaves and horizontal push bar, Ø 32 mm, stainless steel fixed on the door Leaves, Manufactured in an ISO 9001 approved facility

**7.21.2 Door Dimensions:**

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| Inside diameter | 2600 mm |
| Outside diameter | 2696 mm (Outer Dia : Inner Dia + 96mm) |
| Clear passage height | 2100 mm (Min ht: 2100mm, Max recommended ht: 2500mm) |
| Canopy Height | 100 mm (Min Canopy ht: 100mm) |
| Total Height | 2200 mm (Clear Passage Height + Canopy Height) |

**7.21.3 Constructional description**

**i) Side walls:**
- Curved side walls, 46 mm thick, posts 70 x 46 mm, sockets 100 mm high top and bottom, prepared for 24 mm wide sidewall-to-structure connection panel in door axis.
- Glazing of 8.76 mm Laminated Safety Glass LSG, type GH, neutral

**ii) Ceiling:**
- All-aluminium support structure, welded. Upper and lower ceiling sections of Melamine White board / Metal Sheets. Canopy of U-profile aluminum sections, curved.

**iii) Turnstile:**
- Revolving door frame turnstile of special profile frames, 57 mm deep, fair face width 80 mm with replaceable horse-hair brushes. Locking by top shoot bolt designed for Europrofile cylinder.
- Glazing of 6 mm TSG tempered safety glass, neutral
- Rigid turnstile wings

**iv) Canopy construction**:
- Height =100 mm height with Silver Anodized Finish

**v) Colour of Revolving Door assembly**:
- Silver Anodized Finish, E6/CO

**vi) Number of wings**: (√) 3-wing

**vii) Side walls**:
- 8.76 mm laminated safety glass (LSG), cast resin sealed (GH), set within curved aluminum profile, height 100 mm

**viii) Ceiling:**
- Standard – Melamine White ceiling, splash-proof, white RAL 9010

**ix) Integrated ceiling downlight**s:
- With integrated ceiling downlights (halogen 10 W, including transformer, 80 W),
- Reflector design: Silver Colour

**x) Floor covering:**
- Floor covering as per drawing/ bill of quantities.

**xi) Pull handles:**
- Horizontal push bar, Ø 32 mm, Stainless Steel– Horizontal Handles

**xii) Mechanical locking of wings**:
- Bolt locks on Door Leaf prepared for Europrofile cylinder

**7.21.4 Installation**
- Installation to be carried out strictly as per Manufacturer's Assembly manual.

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| | **7.21.5** | **Product Life Cycle**<br>Product should be Designed for a Product Life Cycle 1 Million Operations. Manufactured in accordance with German code of practice ZH 1/494, latest edition, governing power-operated windows, doors and gates, German UVV (accident prevention) regulations, and VDE (Association of German Engineers) regulations; type approved by the TÜV (German Technical Inspectorate), Complaint with DIN 18650 standards for Pedestrian Safety. Power supply data: T 230 V AC, 50 Hz. |
| | **7.21.6** | **Measurement**<br>This item will be measured in numbers inclusive of supply & fixing of all components, hardware, accessories, glass, LED Light as described in the bill of quantities. |
| | **7.21.7** | **Rates**<br>The rates shall include the cost of labour, material, wastage , hardware and accessories complete in all respects. |

**7.22 GUARANTEE TO BE EXECUTED BY CONTRACTOR FOR REMOVAL OF DEFECTS AFTER COMPLETION OF WORK** in respect of water proofing works, fire doors works, aluminium work and Stone Cladding

This agreement made this day of_____two thousand Sixteen and between _____(Name of the contractor, hereinafter call Guarantor of the one part) and the SAU (hereinafter called the OWNER of the other part).

Whereas this agreement is supplementary to a contract (hereinafter called the Contract) dated_ and made between the GUARANTOR of the one part and the OWNER of the other part where by the Contractor inter alia, undertook to render the buildings and structures in the said contract recited completely water and leak proof.

And whereas the Guarantor agreed to give a guarantee to the effect that the said structures will remain water / leak proof for ten years from the date of completion of work.

Now the Guarantor hereby guarantees that water proofing treatment given by him will render the structures completely leak proof and the minimum life of such water proofing treatment shall be ten years to be reckoned from the date completion of work.

Provided that the Guarantor will not be responsible for leakage caused by earthquakes or structural defects or misuse of roof or alterations and for such purpose

a) Misuse of roof shall mean by operation, which will damage roofing treatment, like chopping of firewood and things of the same nature, which might cause damage to the roof.
b) Alteration shall mean construction of an additional storey or a part of roof or construction adjoining to existing roof, where by roofing treatment is removed in parts.
c) The decision of the Engineer-in-Charge with regard to cause of leakage shall be final.

During this period of guarantee, the Guarantor shall make good all defects and in case of any defects being found, render the building water proof at his own cost, to the satisfaction of the Engineer-in-Charge and shall commence the work for such rectification within seven days from the date of issue of the notice from the Engineer-in-Charge calling upon him to rectify the defects, failing which the work shall be got done by SAU through some other contractor at the GUARANTOR'S cost and risk. The decision of the Engineer-in-Charge as to the cost, payable by the Guarantor shall be final and binding.

That is the Guarantor fails to execute the necessary rectification or commits breach there under then the Guarantor will indemnify the Principal and his successors against all loss, damage, cost expense or otherwise which may be incurred by him by reasons of any default on the part of GUARANTOR in performance and observance of this supplementary agreement. As to the amount of loss and / or damage and / or cost incurred by the owner, the decision of the Engineer-in-Charge will be final and binding on the parties.

In witness where of these presents has been executed by the Obligator_____and by _____and for and on behalf of the SAU on the day month and year first above written.
Signed, sealed and delivered by (OBLIGOR) in the presence of:

1.
2.
Signed for and on behalf of SOUTH ASIAN UNIVERSITY _
in the presence of:
1.

2.

## 7.23 GUARANTEE TO BE EXECUTED BY CONTRACTOR FOR STRUCTURE GLAZING AND OTHER RELATED WORKS after completion of work

This agreement made this day of two thousand and between (Name of contractor, hereinafter call Guarantor of the one part) and the SAU (hereinafter called the Government of the other part).

WHEREAS THIS agreement is supplementary to a contract (hereinafter called the Contract) dated made between the GUARANTOR of the one part and the GOVERNMENT of the other part for construction of SAU Campus at Village Maidan Garhi, New Delhi, whereby the Contractor, inter alia, undertook to carry out structural analysis and design , preparation of shop drawings , getting the structural design and shop drawings vetted from the Principals of the structure glazing system, setting out, fabrication, supply, assemble, install, align and fix to the building structure the structure glazing units and execute other related works , all as specified and set out in the contract and as per the correct international / national standards.

AND WHEREAS THE GUARANTOR agreed to give a guarantee (for all works as stated above) for the following:

1. System

   1.1 Structural design has been carried out for design loads, as specified, thermal stresses, building movements and the consequent deflections without compromising the performance characteristics.

   1.2 That deflections in the framing members shall be within permissible limits as specified.

   1.3 Structural stability, safety, integrity and required performances of the work for all design loads and building movements as specified.

2. Material

   2.1 Glass (Single, Laminated or DGUs) – Substrate, coatings, lamination of laminated glass, insulation of DGUs. Replacement of broken glass panes (breakage not attributable to vandalism or accident), defective insulated glazed units (evident due to condensation or dirt between the lites, failure of seal and damage to internal glass panes, staining, damage to the soft coating etc.) during the guarantee period.

   2.2 Sealants – Material used, performance of sealant used, usage as per the requirement of structural design and functional requirement, compatibility with different substrate and sealants, bite size, quality assurance during sealing of DGUs and fixing glass to glass and glass to the aluminium frame, etc.

   2.3 EPDM / Silicone gasket – for ozone resistance and other properties as specified etc.

   2.4 Aluminium - material quality, tempering requirement, suitability of aluminium grade and anodizing etc.

   2.5 Anchor fasteners – suitability and strength requirements as per manufacturers' specifications etc.

   2.6 Aluminium composite panel cladding - Material quality and PVDF coating / lumiflon-based fluoropolymer resin coating for colour retention, chalking resistance, humidity resistance, hardness and gloss retention etc. as specified.

3. Performance

3.1 Water tightness, wherever specified in the Contract.

3.2 workmanship

3.3 Integrity of system during movements within and relative to the building structure.

3.4 Indemnify the SAU against all claims of whatsoever nature due to defective designing by the contractor, material & workmanship etc. and /or non-performance of the work during the guarantee period.

NOW THE GUARANTOR hereby guarantees that the work executed by him shall perform to the specified standards of quality and workmanship during the guarantee period of ten years to be reckoned from the date of completion of work.

During this period of guarantee, the guarantor shall make good all defects and if any defect is noticed during the guarantee period, it shall be rectified by the contractor within seven days of issue of notice to the contractor, at least temporarily, to the satisfaction of the Engineer-in-Charge, till the permanent rectification of the defects / replacement of defective materials is carried out by the contractor, in maximum four months period, retaining same aesthetic and other functional parameters of the original work. If not attended to, the same shall be got done by the SAU through other agency at the risk and cost of the contractor which shall be final and binding on the contractor.

That is the Guarantor fails to execute the necessary rectification or commits breach there under, then the Guarantor will indemnify the Principal and his successors against all loss, damage, cost expense or otherwise which may be incurred by him by reasons of any default on the part of GUARANTOR in performance and observance of this supplementary agreement. As to the amount of loss and / or damage and / or cost incurred by the Government, the decision of the Engineer-in-Charge will be final and binding on the parties.

IN WITNESS WHERE OF these presents has been executed by the OBLIGOR and by and for and on behalf of the SAU on the day month and year first above written.
SIGNED, SEALED AND DELIVERED by OBLIGOR in the presence of: 1.

2.

SIGNED FOR AND ON BEHALF OF SOUTH ASIAN UNIVERSITY BY in the presence of:

1.

2.

# 7.24 LIST OF APPROVED MAKES- CIVIL WORKS

| | **NOTE :** |
|---|---|
| **1.** | The Contractor shall obtain prior approval from the Engineer-in-charge before placing order for any specific material or engaging any of the specialized agencies. The Contractor shall make a detailed submittal with catalogues and highlighted proposed specifications, as well as full details of the works executed by the specialized agency, as specified. |
| **2.** | Wherever applicable, the Engineer-in-charge may approve any material equivalent to that specified in the tender subject to proof being offered by the Contractor for equivalence to his satisfaction. |
| **3.** | Unless otherwise specified, the brand / make of the material as specified in the item nomenclature, in the particular specifications and in the list of approved materials attached in the tender, shall be used in the work |

In case of non-availability of the brand specified in the contract the Contractor shall be allowed to use alternate equivalent brand of the material subject to submission of documentary evidence of non - availability of the specified brand. The necessary cost adjustments on account of above change shall be made for the material.

**A. MATERIALS: (PROPOSED FOR SAU PROJECT)**

| SL.NO | MATERIALS | APPROVED MAKE |
|---|---|---|
| **1.** | CEMENT (PPC/ OPC) | ACC/ ULTRATECH/VIKRAM/ AMBUJA/ JAYPEE CEMENT/ J.K. CEMENT/ LAFARGE/ BIRLA/ L&T |
| **2.** | WHITE CEMENT | J.K. WHITE/ BIRLA WHITE |
| **3.** | REINFORCEMENT STEEL | SAIL/ TATA STEEL Ltd./ RINL/ JINDAL STEEL & POWER Ltd AND JSW STEEL Ltd. |
| **4.** | STRUCTURAL STEEL SECTIONS | SAIL/ TATA STEEL Ltd./ RINL/ JINDAL STEEL & POWER Ltd AND JSW STEEL Ltd. |
| **5.** | SUPER PLASTICIZERS | MC BAUCHEMIE/FOSROC/SIKA/BASF |
| **6.** | SPRAY APPLIED POLYURETHANE WATER | FOSROC/ BASF/SIKA |
| **7.** | AAC BLOCK | J.K LAXMI CEMENT LTD./MAGICRETE BUILDING SOLUTION/B.D SHIRKE/BILT/ BRIXO/ ULTRATECH EXTRA LIGHT |
| **8.** | GALVANISING | JENCO/ STEEL LITE/ KARAMTARA ENGINEERING PVT.LTD |
| **9.** | STAINLESS STEEL | JINDAL STEEL/ SALEM STEEL/TATA /SAIL |
| **10.** | CERAMIC TILES | KAJARIA/H & R.JOHNSON/NITCO/ SOMANY |
| **11.** | VITRIFIED TILES | H & R JOHNSON/KAJARIA/NITCO/RAK CERAMICS/RESTILE |
| **12.** | GLASS MOSAIC TILES | PALLADIO GLASS LTD./ COLORATO-PAVEIT CERAMICS/ OCCAN |
| **13.** | POLYMER MODIFIED CEMENTITIOUS GROUT | BAL ENDURA/WEBBER/MYK LATICRETE/ LATYPOXY/ARDEX |
| **14.** | HARDENDERS | IRONITE/FEROK/HARDONATE/FOSROC/BASF /SIKA |
| **15.** | FLUSH DOORS | GREEN/DURO/MERINO/CENTURY/KITPLY/ LEGEND |
| **16.** | METAL DOORS | SHAKTI HORMANN / ARDOR / NAVAIR |

| SL.NO | MATERIALS | APPROVED MAKE |
|---|---|---|
| 17. | METAL FIRE DOORS | SHAKTI HORMANN/ **PROMAT-**ARDOR / NAVAIR |
| 18. | ALUMINUM DOOR & WINDOWS & GLAZING SYSTEMS | ALUK BUILDING SYSTEM/ SCHUCO/ REYNAERS |
| 19. | COMMERCIAL BOARD | GREEN/DURO/MERINO/CENTURY/LEGEND |
| 20. | COMMERCIAL PLYWOOD | GREEN/DURO/MERINO/CENTURY/LEGEND |
| 21. | BWP PLYWOOD | GREEN/DURO/MERINO/CENTURY/LEGEND |
| 22. | NATURAL WOOD VENEERS | SONEAR/GREEN PLY/TRUWOOD/MAYUR/ ARCHID/LEGEND |
| 23. | WATER BASED MELAMINE POLISH | ASIAN PAINTS / PIDILITE INDUSTRIES/ ICI DULUX |
| 24. | ANTI STATIC HIGH PRESSURE LAMINATE | FORMICA/GREENLAM/DECOLAM MERINO |
| 25. | STAINLESS STEEL & GLASS RAILING SYSTEM | DORMA / QRAILING / SADEV |
| 26. | POLYSULPHIDE SEALANT | FOSROC/PIDILITE/SIKA |
| 27. | DASH FASTENERS | HILTI/FISCHER/BOSCH/CANNON |
| 28. | ALL TYPES OF GLASS | AIS /ST. GOBAIN/ MODIGUARD/PILKINGTON |
| 29. | FIRE-RATED GLASS (TWO HOUR FIRE RATING) TRANSPARENT CLEAR GLASS | AIS/ST. GOBAIN /PILKINGTO |
| 30. | PU ENAMEL METALLIC PAINTS ON MS STRUCTURE | SKK/OIKOS/ACRO |
| 31. | EPOXY PRIMER AND PAINTS | ICI/NEROLAC/ ASIAN PAINTS |
| 32. | DRYWALL SYSTEMS | ST. GOBAIN GYPROC/ USG BORAL/INDIA GYPSUM |
| 33. | ACCESS FLOOR SYSTEM ALONG WITH PANELS, STRINGERS, PEDESTAL | KINGSPAN (HEWETSON)/DONN OF USG LINDNER/HUILI/UNITED/UNIFLOR |
| 34. | LAMINATED FLOOR | ACTION/ TESA/ PERGO |
| 35. | ALL HARDWARE AND FITTINGS DOORS & METAL DOORS | DORMA/ HORMANN / HAFELE /GEZE |
| 36. | STUD ANCHORS CHEMICALS & MECHANICAL ANCHORS | HILTI/FISCHER/BOSCH/CANNON |
| 37. | ANCHOR FASTENERS | HILTI/FISCHER/BOSCH/CANNON |
| 38. | CLAMP SYSTEM FOR DRY STONE CLADDING | HILTI/FISCHER/BOSCH/CANNON |
| 39. | ADHESIVE FOR FLOOR VITRIFIED TILES, MARBLE STONE, GRANITE STONE ETC.I | LATICRETE/FERROUSCRETE/BAI LENDURA |

| SL.NO | MATERIALS | APPROVED MAKE |
|---|---|---|
| 40. | LACQUERED GLASS, | SAINT GOBAIN/GLWAVERBEL/MODIGUARD |
| 41. | WEATHER SILICON SEALANT | WACKER/DOW CORNING/MCCOY/ SOUDAL |
| 42. | BACKER ROD | SUPREME IND LTD./SYSTRANS POLYMERS |
| 43. | FRAME SYSTEM FOR INTERNAL PARTITION | SAINT GOBAIN GYPROC/USG BOROL/AMF |
| 44. | EPOXY MORTAR | FOSROC/SIKA/CICO/LATICRETE |
| 45. | METAL DECKING SHEET | CRIL/RAJINDER ALLOYS LIMITED/ PENNAR INDUSTRIES LIMITED |
| 46. | FIRE RETARDANT PAINTS | ASIAN PAINTS/BERGER PAINTS/SHALIMAR/ AKZO NOBEL |
| 47. | CEMENTOUS GROUT | XYPEX /FOSROC/KRYTONE |
| 48. | CRYSTALINE CEMENTIOUS WATERPROOFING | BASF/ XYPEX/CONSRUCTION CHEMICALS/ KRYTONE |
| 49. | STAINLESS STEEL DOOR HANDELS, LOCKS AND | DORMA/HAFELE/GEZE/GUARDIAN |
| 50. | FLOOR SRINGS, DOOR CLOSERS, PANIC BARS | DORMA/HAFELE/GEZE/GUARDIAN |
| 51. | METAL CEILING | HUNTER DOUGLAS / ARMSTRONG/ LINDNER/ SAINT GOBAIN GYPROC/ DURLAM |
| 52. | MINERAL FIBRE FALSE CEILING | ARMSTRONG / USG BORAL / **DECOSONIC / AMF** |
| 53. | GYPSUM CEILING | SAINT GOBAIN GYPROCK / USG BORAL / INDIA GYPSUM |
| 54. | MOISTURE RESISTANT GYPBOARD | ST. GOBAIN GYPROC/USG BORAL/INDIA GYPSUM |
| 55. | GRASS PAVERS | KK MANHOLE/ NIMCO/ TUFFTECH |
| 56. | APP WATERPROOFING MEMBRANE | STP LTD/ TEXSA/ BITUMAT CO. LTD/TIKITAR/ DERMABIT |
| 57. | GLASS REINFORCED CONCRETE JAALIS / | UNISTONE, BIRLA ULTRATECH, MAHESH PREFAB |
| 58. | WATER PROOFING COMPOUND (LIQUID) | PIDILITE/ FOSROC/ CICO |
| 59. | TOILET CUBICLES | MERINO/TRESPA/CENTURY |
| 60. | EXPANSION JOINT COVERS | CS (CONSTRUCTIONS SPECIALITIES) / MIGUA/ MCGILL |
| 61. | PU WALL COATING | BASF/ FOSROC/ SIKA |
| 62. | EPOXY TILE GROUT | BASF/ LATICRETE/ ARDEX ENDURA |
| 63. | POLYURETHANE SPRAY INSULATION | BASF/ DOW CORNING/ LLOYD |
| 64. | POLYURETHANE SPRAY AAPLIED WATER PROOFING MEMBRANE | BASF/ FOSROC/SIKA |
| 65. | SILANE SILOXAINE WATER REPELLENT COATING | BASF/ GE/ DOW |
| 66. | CRYSTALLINE WATERPROOFING | BASF/ XYPEX/ SIKA |
| 67. | POLYURETHANE FLOORING FOR CAR PARKING | BASF/ FOSROC/ SIKA |
| 68. | ZINC SHEETS | VMZINC/ HALCORE/ IEQSA |
| 69. | MANNUAL REVOLVING | DORMA/ GEZE / SAVEX/AUTOINGRESS |
| 70. | FIRE STOP SEALS | HILTI / 3M/ PROMAT |

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| **71.** | AUTOMATED STEEL ROLLING SHUTTERS | SHAKTI HORMANN/ TOSHI |
| **72.** | ENTRANCE FLOOR MATS (DUST CONTROL) | 3M / CS (CONSTRUCTION SPECIALTIES) |
| **73.** | FAÇADE CLEANING SYSTEM (BUILDING MAINTENANCE UNIT) | SIMPLE ENGINEERING SOLUTIONS / CLEAN INDIA / |
| **74.** | HAND DRYER | EURONICS / DAYSON / BOBRICK |
| **75.** | TISSUE PAPER DISPENSER | EURONICS / DAYSON / BOBRICK |
| **76.** | WASTE PAPER BIN | EURONICS / JAQUAR / TOTO / KOHLER |
| **77.** | SHOE SHINE MACHINE | EURONICS / |
| **78.** | SOAP DISPENSER | EURONICS / JAQUAR / TOTO / KOHLER |
| **79.** | ALUMINIUM COMPOSITE PANELS | RENOBOND, ALSTRONG, ALUCOBOND |
| **80.** | ALUMINIUM TUBES, SECTIONS FOR LOUVRES | HINDALCO, JINDAL, INDAL |

# 8.0 SPECIAL CONDITIONS OF CONTRACT FOR E & M WORKS

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| **8.0** | **SPECIAL CONDITIONS OF CONTRACT FOR E&M WORKS** | |
| | These special conditions of contract shall be read along with the general conditions of contract, Schedule of Quantities, Technical Specifications, Drawings and other documents relating to the work and shall have preference over laid down general conditions. In the event of conflict between them the decision of Engineer-in-Charge shall be final and binding. | |
| | **8.1** | **GENERAL :** |
| | **8.1.1** | These special conditions of contract shall be read in conjunction with the other documents forming part of the contract. In case of any variance, these conditions shall supersede any other conditions mentioned in contract document. |
| | **8.1.2** | Notwithstanding separate sections of this document, every part of each section shall be deemed to be supplementary and complementary to every other part and shall be read with and into the contract, so far as it may be practicable to do so. |
| | **8.1.3** | Contractors shall mobilize and employ sufficient resources to achieve the detailed schedule within the broad frame work of the accepted methods of working and safety. The contractor shall provide everything necessary for the proper carrying out of the work, including tools, plants and other materials. |
| | **8.1.4** | No additional payment will be made to the contractor for any multiple shifts work or other incentive methods contemplated by him in his work schedules even though the time schedule is approved by the Engineer-in-charge. |
| | **8.1.5** | The work shall be carried out as per specifications in the tender schedule/latest C.P.W.D. Specifications, along with the correction slips; in case of doubt the decision of the Engineer-in-Charge shall be final and binding on the Contractor. The work shall be executed as per the program drawn or approved by the Engineer-in-charge and it shall be so arranged as to have full coordination with any other agency employed at site. No claim for idle labour shall be entertained nor shall any claim on account of the delay in the completion of the building work to be tenable. |
| | **8.1.6** | The contractor shall permit free access and afford normal facilities and usual conveniences to other agencies or departmental workmen to carry out connected work or other work services under separate arrangements. The contractor will not be allowed any extra payment on this account. |
| | **8.1.7** | All soil, filth or other matter of any offensive nature taken out of any trench, sewer drain, cesspool or other place shall not be deposited on the surface, but shall at once be carted away by the contractor free of charge to a suitable pit or place to be provided by him. |
| | **8.1.8** | The contractor shall provide all equipment, instruments, labour and such other assistance required by the Engineer-in-Charge for measurement of the work, materials etc. |
| | **8.1.9** | If any temporary works are required, the Contractor shall take approval for the same and bear all responsibility for the same. If required, the contractor shall provide access roads to the site from the nearest main road at no extra cost and as directed by the Engineer-in-charge. |
| | **8.1.10** | In the absence of any Specifications covering any material, design of work(s) the same shall be performed / supplies / executed in accordance with Standard Engineering Practice as per the instructions / directions of the Engineer-in-Charge, which will be binding on the Contractor |
| | **8.1.11** | Cleaning of all fixtures/equipment and piping including flushing of all pipe work to remove any foreign matter shall be carried out in sections as the work progresses. |
| | **8.1.12** | Contractor shall temporarily cover & protect all fixtures, equipments & open pipe ends etc. It is the responsibility of the Contractor to protect all the installed fixtures/fittings and all equipments until the time of testing, commissioning & handing over to the employers. |
| | **8.1.13** | The Contractor shall verify the sufficiency of the size of the hume pipes (under road crossings), excavation in trenches. The Contractor shall locate all equipment which must be serviced, operated or maintained in fully accessible positions. The exact location and size of all trenches, Hume pipes, required for each crossing, shall be finalized and communicated in sufficient time, to be provided in the normal course of work. Failing this, the Contractor shall make all the necessary repairs and changes at his own expense |
| | **8.1.14** | **Drawings:**<br>The HVAC, Electrical, PH & FF and other engineering services drawings, which are issued with tenders, are diagrammatic only and indicate arrangement of various systems and the extent of work covered in the contract. These Drawings indicate the points of supply and of |

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| | | termination of services and broadly suggest the routes to be followed. Under no circumstances shall dimensions be scaled from these Drawings. The architectural/interiors drawings and details shall be examined for exact location of equipment's and cut-outs.<br>The contractor shall follow the GFC drawings in preparation of his shop drawings, and for subsequent installation work. He shall check the drawings of other trades to verify spaces in which his work will be installed.<br><br>Maximum headroom and space conditions shall be maintained at all points. Where headroom appears inadequate, the contractor shall notify the Architect/Consultant/Owner's site representative before proceeding with the installation. In case installation is carried out without notifying, the work shall be rejected and contractor shall rectify the same at his own cost.<br><br>The Drawings indicate the extent and general arrangement of power distribution, location of lighting fixtures, controlling switches, wiring system, cabling and earthing. These drawings are essentially diagrammatic. The Drawings indicate the point of termination of conduit runs and broadly suggest the routes to be followed. The work shall be installed as indicated on the Drawings. However, any change found essential to coordinate the installation of this work with other trades shall be made without any additional cost to the Owner. The data given herein and on the Drawings is as exact as could be secured, but its complete accuracy is not guaranteed. The drawings are for the guidance of the contractor, exact locations, distances and levels shall be governed by the site conditions and the Architectural & Interior layouts.<br>The location of the Plumbing & Sanitary & fire pipe lines, indicated in the drawing is only indicative. The actual route of Plumbing & Sanitary & fire pipe lines may differ from the plans according to the details of the building construction and the conditions of executions of the installations.<br><br>The contractor shall examine all architectural, structural, plumbing, HVAC and other services drawings and check the as-built works before starting the work and report to the Owner's site representative any discrepancies and obtain clarification. Any changes found essential to coordinate installation of his work with other services and trades, shall be made with prior approval of the Architect/Consultant/Owner's site representative without additional cost to the Owner |
| | **8.1.15** | **Technical Data**<br>All technical data to be filled by the bidders in Technical specs shall be accepted in metric system or after the approval from Consultant/ Engineer In charge only. Any bidder submitting the technical data in any other unit would render his bid liable for rejection. The technical data should be typed in capitals only. |
| | **8.1.16** | **Fees & Permits**<br>The Contractor shall pay any and all liasioning fees and obtain all necessary permits required for the installation, testing commissioning, and hand over and operation of all works. On completion of the work, the contractor shall obtain and deliver to the Owner, NOC's (No objection certificates), Licences, Permits, Clearance Certificates, Completion Certificate / Occupancy Certificate, from all Statutory Authorities, electricity and water supply agencies / authorities, Municipal, State / Central Govt. agencies whichever is applicable) |
| | **8.1.17** | **Bye-laws and Regulations**<br>The installation shall be in conformity with the Bye Laws, regulation and standards of the local authorities concerned in so far as these become applicable to the installation. But if these specifications and drawings call for a higher standard of materials and /or workmanship than those required by any of the above regulations and standards, than these specifications and drawings shall take precedence over the said regulation and standards. However, if the drawings and specifications require something which violates the Bye-laws and regulations, then the bye laws and regulations shall govern the requirements of this installation. |
| | **8.1.18** | The work shall be carried out to the satisfaction of the Engineer In-charge and in accordance with the Specifications, Regulations of the Statutory Authorities, Water and Electricity Agencies / Authorities, latest Indian Standards and as per the requirements of the Chief Fire Officer of the Delhi Fire Service. |

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| | **8.1.19** | SAU has planned the proposed University at Maidan Garhi as smart campus with centralized server and control room having modern ICT solution for which a specialized consultant may be appointed by SAU/Engineer-in charge in due course. |
| | **8.1.20** | The BMS (Building Management Services) for centralized HVAC plant, Fire-fighting, Plumbing system, Electrical and MEO services in individual buildings has been put in the scope of this contract. Later on it shall be integrated with main server. For that the items considered in BOQ can be changed at later stage due to compatibility issues with main server or up gradation in technology. To facilitate these, the bidder will procure the BMS items only after the written approval of the Engineer-in-charge and as per an agreed and approved procurement schedule. |
| | **8.1.21** | The procurement for BMS by the contractor will be done only after coordination and approval with specialized ICT consultant/contractor appointed by SAU, who will ensure the integration of all low voltage systems. |
| | **8.1.22** | Before procurement the final clearance will be obtained by the contractor from SAU. |
| | **8.1.23** | BMS system works shall be executed in consultation and approval from Engineer-in-Charge. |
| | **8.1.24** | SAU reserves the right to exclude the BMS items from the scope of this contract and for that the agency will not claim anything extra. |
| | **8.1.25** | The contractor shall guarantee for the installed system at an uptime of 99%. |
| | **8.2** | **SITE LOCATION AND CONDITIONS:**<br>The design conditions are based on ISHRAE weather data and statistics of the most recent data of 10 year period, published by the India Metrological Department and .epw weather data files from the DOE. |

| **Description** | **Value (units)** |
|---|---|
| Site Latitude/Longitude | 28.38°N, 77.13°E |
| Site Sea level | 216 m |
| Clearness number | 0.95 |
| Summer outdoor air DB/WB temperature | 43.3°C (109.94 °F) /23.9 (75.02 °F) |
| Winter outdoor air DB/WB temperature | 7.2°C (44.96 °F) / 5.0°C(41.0°F) |
| Monsoon outdoor air DB/WB temperature | 35°C (95.0°F)/ 28.3°C (82.94) |

Design Ambient temperature : 50 deg C

**Notes**: All equipment shall give required output under the above condition.

The contractor shall be deemed to have inspected the site and thoroughly acquainted himself with the site conditions availability of water & electricity for construction, storage space for materials, work area available for construction, disposal/stacking of surplus materials etc. and to acquaint himself with the general nature of the site and its other features likely to affect tender and construction of works. No claim/extension of the time whatsoever shall be entertained on account of prevailing site conditions.

Contractor has to make his own arrangement for water and power required during construction at his own cost. Contractor will arrange for Power back up through DG set in case power from electricity board is not available / supplied. All expenses pertaining to operating and running of DG Set will be borne by the contractor.

**8.3** **SCOPE OF WORK**

The general character and the scope of work to be carried out under this contract is illustrated in DBR, Drawings, Specifications and Schedule of Quantities. The Contractor shall carry out and complete the said work under this contract in every respect in conformity with the contract documents and with the direction of and to the satisfaction of the Engineer-in-

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|---|---|---|
| | | Charge. The contractor shall furnish all labour, materials and equipment as listed under Schedule of Quantities and specified otherwise, transportation and incidental necessary for supply, installation, testing and commissioning of the complete HVAC, Electrical, PH & FF system as described in the Specifications and as shown on the drawings. This also includes any material, equipment, appliances and incidental work not specifically mentioned herein or noted on the Drawings/Documents as being furnished or installed, but which are necessary and customary to be performed under this contract. The HVAC, Electrical, PH & FF system shall comprise of (but not limited to) the buildings of the Package - 3 of SAU Campus; Faculty of Maths & I.T. and Physical and Chemical Sciences, Faculty of Law and Humanities, Library, Administration, Institute of SAARC Studies, Faculty of Art & Design and Convention Centre, Utility Building housing and External Development. |
| | **8.3.1** | **Scope of HVAC works** shall comprise of (SITC) Supply, installation, testing & commissioning of following works (but not limited to):- |
| | **i)** | All refrigerant, Chilled/ Hot water piping works including insulation, pressure testing, protection, hanging and support works for all the above mentioned buildings & existing Package 2 buildings (already under construction). |
| | **ii)** | All ducting works including insulation, pressure testing, protection, hanging and support works for all the above mentioned buildings. |
| | **iii)** | Supply and installation of BMS compatible electri1cal panel for HVAC equipment. |
| | **iv)** | Electrical and control wiring from panel to HVAC equipment in case of chilled water AHUs. |
| | **v)** | Electrical wiring from panel to Outdoor and control cabling from outdoor to indoor units. Electrical wiring of indoor units. |
| | **vi)** | Earthing (Grounding) System. |
| | **vii)** | SITC of all High side equipment that includes, |
| | **a)** | Centrifugal Chillers |
| | **b)** | Cooling Towers |
| | **c)** | Pumps – Primary, secondary, Condenser, Tertiary |
| | **d)** | Electrically operated Hot water generators |
| | **e)** | Expansion Tanks, Air separators |
| | **f)** | Any other in plant room |
| | **viii)** | SITC of site level infra Chilled/ Hot water hydronic piping including trenching, filling and laying of pipe with Valves, chambers etc. to complete the work |
| | **ix)** | A required hydronic pipe tapping for the Life science and earth science building of the tender package 2 as per drawings. This is the responsibility of the contractor to ensure the required flow rate, temperature and pressure are met as per the design documents. The contractor is also responsible for co-coordinating with other prime contractor of the tender package building 2 i.e. LSES. |
| | **x)** | SITC of Basement Ventilation system |
| | **xi)** | Supply, installation and commissioning of AHUs, FCUs, Ventilation Fans, condensing units and any other HVAC equipment/ accessories mentioned in BOQ or necessary to successfully complete the project as per clients requirements |
| | **xii)** | Supply, installation and commissioning of VAVs and related accessories. |
| | **xiii)** | Supply, installation and commissioning of Pumps and related accessories. |
| | **xiv)** | SITC of all HRW and its interlocking with all AHUs, fans etc. |
| | **xv)** | Foundations for equipment including foundation bolts and vibration isolation spring/pads. |
| | **xvi)** | Suspenders, brackets and floor/wall supports for suspending/supporting ducts and pipes. |
| | **xvii)** | Suspenders and/or cable trays for laying the cables. |
| | **xviii)** | Excavation and refilling of trenches in soil wherever the pipes are to be laid directly in ground, including necessary base treatment and supports. Included in the scope of Lead Contractor. |

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| | **xix)** | Sealing of all floor slab/ wall openings provided by the lead contractor or contractor for pipes and cables, from fire safety point of view, after laying of the same. |
| | **xx)** | Painting of all exposed metal surfaces of equipment and components with appropriate color. |
| | **xxi)** | Making openings in the Walls/Floors/Slabs or modification in the existing openings wherever provided for carrying pipe line, ducts, cables etc. |
| | **xxii)** | Providing wooden/ metallic frames for fixing grills/diffusers. |
| | **xxiii)** | Making good all damages caused to the structure during installation and restoring the same to their original finish. |
| | **xxiv)** | All electrical associated works as per BOQ and drawings, specifications. |
| | **xxv)** | Obtaining approvals from Chief Fire Officer and all approvals from all Statutory authorities |
| | **8.3.2** | **SCOPE OF ELECTRICAL WORKS shall comprise of (SITC) Supply, installation, testing & commissioning of following works (but not limited to):-** |
| | **i)** | All conduit work including junction boxes, outlet boxes and wiring for lighting and power circuit in 3 nos. for all Package 3 buildings as mentioned above. |
| | **ii)** | Switches, plug sockets, cover plates and other wiring accessories. |
| | **iii)** | Cables (LT), Mains and Sub-Mains. |
| | **iv)** | Main/ Sub Distribution board and internal/external Lighting Distribution boards. |
| | **v)** | Cables on cable trays including installation, cable trays, Raceways, hangers, supports, cable terminations and all fixing accessories. |
| | **vi)** | Earthing (Grounding) System. |
| | **vii)** | Lighting Fixtures for 3 nos. for all Package 3 buildings as mentioned above. |
| | **viii)** | Landscape lighting. |
| | **ix)** | LV system such as Fire alarm and detection system, Public Address System, Telephone system, Data system, Conduiting & cabling for CCTV system, and Access Control system. |
| | **x)** | UPS system |
| | **xi)** | Elevators. |
| | **xii)** | Lightning protection system |
| | **xiii)** | Bus Ducts |
| | **xiv)** | Main LT panels, Main Distribution / Sub Distribution panels, Distribution panels & Capacitor Panels. |
| | **xv)** | Lighting cum lightning Masts, street light Poles, Feeder pillars etc. |
| | **xvi)** | 66/11 KV, 5/6.3 MVA Power transformers, with all accessories including marshaling box & RTCC panel 66 KV GIS Switchgears, 66KV Cables and cable interference unit work 11 KV HT switchgears & Compact substation (CSS-1, CSS-2, CSS-3 & CSS-4). |
| | **xvii)** | Isolator cum Capacitor Panels. |
| | **xviii)** | 11 KV DG sets with their exhaust chimneys through a lattice Tower, DG synchronizing panel & HSD underground Tank with oil pumps & piping. |
| | **xix)** | Obtaining approvals from Electrical Inspector and all approvals from all statutory authorities. |
| | **8.3.3** | **THE SCOPE PH & FF WORKS shall comprise of (SITC) Supply, installation, testing & commissioning of following works (but not limited to):** |
| | **i)** | **WATER TREATMENT PLANT (WTP)**<br>These special conditions are meant to elaborate the specifications, Bills of Quantities and Drawings.<br>The materials, design and workmanship shall satisfy the specifications contained herein and Codes Referred to. Where the technical specifications stipulate the requirement in addition to those contained in the Standard Codes and specifications those additional requirements shall also be satisfied. In the absence of any Standard/ Specifications covering any part of the work covered in this tender document, the instruction/directions of Engineer-in-Charge will be binding on the sub-contractor.<br>The scope of this section is to describe materials and systems for Water Filtration system, which form together with the project documents, a complete volume of work and quality description. |

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| | | Water Filtration System installation shall be of high quality, including all necessary items including like instrumentation & control accessories whether or not specified herein. Filtration System shall be completed in accordance with the regulations and standards as mentioned in the technical specifications to the satisfaction of the Engineer-in-Charge. The general provisions, special provisions and general requirements apply to the entire installation.<br><br>The work shall be carried out simultaneously with building work and shall be continued till it is completed satisfactorily along with the completion of essential portions of the building works.<br><br>The work to be carried out under the contract shall cover the supply, installation, testing and commissioning of the complete water treatment plant as described herein and detailed in schedule of quantities.<br>In general the work to be performed shall comprise of the following: |
| | **a)** | Supply, installation, testing & commissioning of MS Multigrade Filters/ ACF, Water Softener with Brine Tank. |
| | **b)** | Supply, installation, testing and commissioning of Dosing System |
| | **c)** | Supply, installation, testing and commissioning of GI (heavy class) interconnecting piping and valves for the whole plant. |
| | **d)** | **Submittals:**<br>The following submittals are to be submitted along with design / shop drawing for evaluation of Engineer-in-Charge:-<br>Treated water cost analysis in the following format:- |
| | **i)** | Chemical Consumption: Detailed analysis of chemicals used are to be submitted with costing |
| | **ii)** | Membranes / Filter Media: Costing details of membrane replacement (with expected life cycle) and media replacement. |
| | **iii)** | Power consumption: booster pump, dosing pumps etc. |
| | **iv)** | Complete list of essential spares with approximate value. |
| | **e)** | **Interlocking Details**:<br>Complete in regards to pump tripping and pressure switch / monitoring devices operation. |
| | **ii)** | **EFFLUENT/SEWERAGE TREATMENT PLANT (ETP/STP)**<br>Supply Installation, testing and commissioning of Sewerage Treatment Plant of capacities of 360 KLD -1 No. & 280 KLD- 1 No. and ETP of capacity of 3 KLD -1 No. based on Phytorid technology of NEERI, Nagpur. The scope includes Designing, construction, supply, installation, testing and commissioning of Phytorid based Effluent /Sewage Treatment Plant by a licensee of Phytorid technology having minimum of three years of experience of similar work. The rates shall include design approval by CSIR-NEERI and the RCC structural design approval by IIT Delhi. The work shall be carried out through specialized agency approved by the engineer-in-charge.<br><br>The scope includes design and construction of Collection sump tank, Pre-settling tank and Phytorid bed including plantation with all plumbing, electrical and mechanical equipment, pumps for ETP and STP including supply, installation, testing and commissioning of pipe, suction & delivery header, NRV, ball valve & butterfly valve flange, nipples, bypass pump and associated accessories complete in all respects from collection tank to phytorid bed upto the satisfaction of Engineer –in charge . The work shall also include loading, unloading, safe storage of material and equipment and painting at site. The rates shall include two years DLP and obtaining consent from the state pollution control board. However, the statutory fees shall be reimbursed by SAU on production of valid receipts.<br>**The ETP/STP scope of work also includes:** |
| | **a)** | Supply Installation, testing and commissioning of sump pumps/ Plant Room drainage sump pump/Waste water Transfer pump (From sump to municipal sewer). |
| | **b)** | Supply, installation, testing and commissioning of filter feed pumps /back wash pump/ irrigation water pumps / Soft water lifting pump, Hydro pneumatic pumps. |
| | **c)** | Supply Installation Testing and commissioning of Multi-grade Sand filter/ activated carbon filter/ softener with brine tank with Ozonator System. |

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| | **d)** | Supply, Installation, Testing and commissioning of chemical dosing pumps with dosing tanks. |
| | **e)** | Supply Installation, Testing and commissioning of Pipe, suction & Delivery Header, NRV, Ball Valve & Butterfly Valve Flange, nipples and Associated Accessories. |
| | **f)** | By pass arrangement including Bypass pump, valves and Accessories. |
| | **g)** | Approval from pollution control board. |
| | **h)** | Electrical Work including supply and installation of electrical Panel, Cable, Cable Tray, Cable Termination, Earthing strip/ wires. |
| | **i)** | Testing and commissioning of entire ETP/STP Plant. |
| | **j)** | Supply of Good for construction drawings including all civil work, structural drawings, P&I diagram, equipment layout with piping detail. |
| | **iii)** | **Without restricting to the generality of the foregoing, the plumbing / sanitary installations & fire protection shall include the following ;-** |
| | **a)** | Sanitary fixture & CP Fittings, Internal Water distribution system, External Water distribution system for new buildings and previous buildings, Connection for Municipal water line and/or water tank inlet / provision for tanker water supply, piping work for lawn hydrant |
| | **b)** | External sewerage, storm water lines including connection to STPs/Re-charge pit/Pond for new and previous buildings, external connection to municipal sewer/storm water drainage line. |
| | **c)** | Water treatment plant |
| | **d)** | Sewage treatment plant |
| | **e)** | Rain water harvesting system. |
| | **f)** | Plumbing pumps & equipment. |
| | **g)** | Fire Protection pumps & equipment. |
| | **h)** | Fire hydrants / Sprinkler & water curtain piping from Pump room 1 & 2 and connection to each building. |
| | **i)** | Hydraulic calculation of sprinkler system as part of shop drawing if required by Engineer-in-Charge. |
| | **j)** | Electrical control panels including control wiring, cables, cable trays, earthing pits & earthing. |
| | **k)** | Connections to all mechanical equipment as per requirements. |
| | **l)** | Other miscellaneous items those are associated with plumbing and fire fighting. |
| | **m)** | Balancing, testing & commissioning of entire system including test reports. |
| | **n)** | Training of staff. |
| | **o)** | Obtaining approvals from all Statutory Authorities. |
| | **iv)** | All incidental jobs connected with plumbing & fire services installation such as excavation in trenches and back filling, cutting chase in concrete and brick/block and making good, cutting/ drilling holes through walls, floors and grouting for fixing of fixtures, Structural supports & other supports as required at site shall be part of plumbing & fire works. |
| | **v)** | Painting of all concealed and exposed pipes, equipment as specified including weather proof treatment on exposed/ burried pipe work shall be part of this contract, even if it is implicitly/explicitly not specified in B.O.Q. |
| | **8.3.4** | **RATES:** |
| | **i)** | The rates quoted shall be deemed to allow for all minor extras (if any) and constructional details which are not specifically shown on drawings or given in the specifications but are essential in the opinion of the Engineer-in-charge for the execution of works to conform to good workmanship and sound engineering practice. The Engineer-in-charge reserve the right to make any minor changes during the execution without any extra payment. |
| | **ii)** | The decision of the Engineer-in-charge to clarify any item under minor changes, minor extras and constructional details shall be final, conclusive and binding on the Contractor. The Contractor may see the clause of terms mentioned in the Part A of Contract Document for details. |
| | **iii)** | The rates quoted by the Contractor shall include for supplying materials and labour necessary for completing the work in the best and most workmanship like manner to the satisfaction of the Engineer-in-charge. The rates shall be complete in all respects including cost of materials, erection, fabrication, labour, supervision, tools and plant, transport, sales |

and other taxes, royalties, duties and materials, contingencies, breakage, wastage, sundries, scaffoldings, etc. on the basis of works contract. As SAU enjoys certain tax exemptions as detailed in this tender document elsewhere, the bidder may quote accordingly.

**iv)** In case the rates of identical items under different sub-heads/parts are different, the lowest of these will be taken for the purpose of making the payments.

**v)** The rates for different items are for all heights, depths, widths and positions, unless otherwise specified against the item. No claim in respect of any leads/lifts for any item specified in the Schedule of Quantities, for which separate items for lead/lift do not exist in that schedule, will be entertained.

**vi)** The work shall be executed as per the programme drawn or approved by the Engineer-in-charge and it shall be so arranged as to have full co-ordination with any other agency employed at site. No claim for idle labour shall be entertained nor shall any claim on account of delay in the completion of the work be tenable.

**vii)** The Contractor shall permit free access and afford normal facilities and usual convenience to other agencies or departmental workmen to carry out connected work or other services under separate arrangements. The Contractor will not be allowed any extra payment on this account.

**viii)** The contractor shall provide all equipment, instruments, labour and such other assistance required by the Engineer-in-charge for measurement of the works, materials etc.

**ix)** Even though the payment shall be effected under different items in the schedule of quantities, various items in the schedule of quantities shall be deemed to cover all aspects of the work for the completion of the work as per drawings, from excavation to the finishing not withstanding any space adjustment possible omission in the description of the item and specifications thereof regarding incidental items of work, without which the whole work cannot be deemed to have been included under the scope of the different items of the schedule of quantities. The Contractor is advised to keep this in mind while quoting rates as no claim in this regard shall be entertained.

**x)** Payment against supply of equipment's items shall be regulated as given below:

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| 1 | On supply and receipt at site of the equipment along with test reports etc. | 70% of quoted price |
| 2 | After erection along with associated works (Ready for testing & commissioning) | 15% of Quoted Price |
| 3 | After Completion of Testing. Commissioning and Handing Over. | 15% of Quoted Price |

For all other items 80% payment shall be made against measurement duly certified by Engineer In charge and balance 20% after handing over of the system duly commissioned.

**8.3.5** **WORK AND WORKMANSHIP :**

To determine the acceptable standard of workmanship, the Engineer-in-charge may order the Contractor to execute certain portions of works and services under the close supervision of Engineer-in-charge. On approval, these items shall be labelled by them as guiding samples so that further works are executed to conform to these samples.

**8.3.6** **MATERIAL & EQUIPMENT**

All materials and equipment shall conform to the relevant Indian Standards and shall be of the approved make and design. Makes shall be strictly in conformity with list of approved makes given in tender document.

The Contractor shall ensure & maintain the sufficient stock at his cost at Manufacturer service center to make the delivery of items problem free during any phase of project. The Contractor shall be responsible for the safe custody of all materials and shall insure them against theft or damage in handling or storage etc. A list of items of materials and equipment, together with a sample of each shall be submitted to the Engineer In-charge within 15 days of the award of the contract. Any item which is proposed as a substitute, the contractor shall state the credit, if any, due to the Owner in the event the substitution is approved. All changes and substitutions shall be requested in writing and approvals obtained in writing

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| | | from the Engineer In-charge/architects.<br><br>Prior to delivery / arrival of any Equipment's on site, Contractor has to take approval of the Engineer In charge well in time. Contractor has to submit a material Inspection report stating the physical inspection and technical data. The report should be signed and documented as a part of project documents.<br><br>Owner through the Architect/Consultant/ Engineer In-charge reserves the right to order equipment and material from any and all alternates, and /or to order high side and /or low side equipment and materials or parts thereof from one or more tenderers. |
| | **8.3.7** | **TOOLS, TACKLES, EQUIPMENTS & SCAFFOLDING :**<br>The Contractor shall provide and install all necessary hoists, ladders, tools, tackles, all transport for labour and materials and plant necessary for the proper execution and completion of the work to the satisfaction of the Engineer In-charge. All tools, tackles & equipment necessary for works shall be provided by the contractor. The quoted rates shall take into account for providing any such equipment, which may not form part of the installation, but are necessary for the execution of the job. |
| | **8.3.8** | **COORDINATION WITH OTHER CONTRACTORS/ AGENCIES:**<br>The Contractor during the execution of the Works shall co-ordinate with other Works, and other Agencies associated with the Project and shall work in harmony with them without causing any hindrance or obstruction or impeding the progress of their work in any way.<br><br>In respect of the work of other Services and Agencies, where the commencement or progress of such work of any other Service, or Agency is dependent upon the completion of particular portions of the Contractor's Works or generally upon the Contractor maintaining progress in accordance with the approved co-ordinate construction programmed, it shall be the responsibility of the Contractor to complete such portions and maintain such progress.<br><br>Should any differences arise between the Contractor and the other Works, and Agencies, these shall immediately be brought to the attention of the Engineer – in – Charge who after reviewing the matters causing the differences will give his decision which shall be final and binding on the Contractor.<br><br>The specialized work as defined in the Contract document shall be executed by the agencies approved by Engineer-in-Charge. The main Contractor shall be solely responsible for coordination between these specialized agencies wherever required. |
| | **8.3.9** | **Contractor shall coordinate with LV System, fire alarm and fire protection system agency to get the complete information regarding interface of fire alarm / fire protection system, cable route/ piping route.**<br>Contacror shall coordinate with Building automation and Security System agency for following activities; |
| | **i)** | Stop/Manual/ Auto switches along with potential free contacts for monitoring the manual operation status, to be provided for those equipment whose start / stop is controlled by Building Automation System |
| | **ii)** | Potential free 'NO' contacts for monitoring 'Run' status of equipment wherever required. |
| | **iii)** | Installation of current transformer & Transducer along with wiring between Current Transformer & Transducer up to the terminal block shall be provided by the Plumbing & Fire Protection contractor. All transducers shall be supplied by BAS contractor. |
| | **iv)** | The low voltage BAS Cables shall be brought up to the Plumbing & Fire Protection system panel by BAS contractor and all terminations into the Plumbing & Fire Protection panels shall be made by Plumbing & Fire Protection contractor after being satisfied of the wiring system. The final responsibility for the sufficiency, adequacy and conformity to the contract requirements, of the system, lies solely with the contractor. |
| | **v)** | The Contractor during the execution of the Works shall co-ordinate with other Contractors, and other Agencies associated with the Project and shall work in harmony with them without causing any hindrance or obstruction or impeding the progress of their work in any way. |
| | **vi)** | The other Contractors and Agencies that the Contractor shall be required to co-ordinate with are: |

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| | **a)** | Civil Works Contractor of this package or contractors of ongoing and future packages |
| | **b)** | Building Automation System Contractor |
| | **c)** | Fire Fighting / Security System Agency of this package or contractors of ongoing and future packages |
| | **d)** | Suppliers of owner supplied materials (If any) |
| | **e)** | Any other agencies related to the work. |
| | **vii)** | In respect of the work of other Contractors and Agencies, where the commencement or progress of such work of any other Contractor, or Agency is dependent upon the completion of particular portions of the Contractor's Works or generally upon the Contractor maintaining progress in accordance with the approved coordinated construction programme, it shall be the responsibility of the Contractor to complete such portions and maintain such progress.<br><br>Should any differences arise between the Contractor and the other Contractors, and Agencies, these shall immediately be brought to the attention of the Engineer-in-Charge who after reviewing the matters causing the differences will give his decision which shall be final and binding on the Contractor. |
| | **8.4** | **PROJECT EXECUTION AND MANAGEMENT :**<br>The Contractor shall ensure that senior planning and erection personnel from his organization are assigned exclusively for this project. The Contractor shall appoint HVAC / Electrical / PH/FF engineers and supervisors as elaborated elsewhere in the contact, the staff shall be posted at site as specified.<br><br>The project management shall be through modern technique. The Contractor's office at site shall be fully equipped with fax, computers & plotter and shall prepare proper bar chart and completion schedules to be submitted & ensure timely completion. Erection engineer and supervisors shall be provided with mobile communication system so that they can always be reached.<br><br>For quality control & monitoring of workmanship, contractor shall assign staff as per contract requirements and would be exclusively responsible for ensuring strict quality control, adherence to specifications and ensuring top class workmanship for the HVAC / Electrical / PH/FF installation. |
| | **8.5** | **ASSOCIATED CIVIL WORKS :**<br>All civil works associated with HVAC, Electrical, PH & FF works are included in HVAC, Electrical, PH & FF Contractor's scope of work, like wall chasing by electrically operated tools, making holes etc. for installation of piping/ducting and conduits/cables and making good of these surfaces. These shall be executed in accordance with approved shop drawings of HVAC, Electrical, Ph & FF contractor. Manual drilling or chiseling shall be permitted only after prior approval of Engineer-In-Charge. Beams, girders and other principal structural members shall not be cut or drilled unless prior permission has been granted by the Engineer-in-Charge. If such drilling and cutting are made on finished surfaces, any marring of the surfaces shall be made good by repair at the HVAC / Electrical / PF & FF Contractor's expense. All chasing, core cuts and openings made by the contractor for pipe lines/fixtures shall be filled/covered over with cement concrete / cement plaster in reasonable manner, as per specifications. Before rough plastering on the pipe surfaces the concealed pipes shall be secured to the wall by using appropriate supports/clamps.<br>Excavation, Trenches including duct/ pipe supports for laying/ installation of piping/ duct, Repair of all disturbed surfaces/openings made by Electrical Contractor shall be included in the scope of work and accounted for in the relevant HVAC work item. No extra payment / claim shall be made on this account. |
| | **8.6** | **SAFETY BARRIERS AND CONSTRUCTION SAFETY :**<br>The Contractor shall at his own cost provide for the protection and safety of the persons working in the area, safety barriers around all openings in every location and at the periphery and edges of all slabs, staircases and stairwells, lift shafts, ducts etc., all to the approval and satisfaction of the Engineer-in-charge.However contractor shall take appropriate safety precautions suitable for specific locations/ situations and as instructed by the Engineer-in-charge. |

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| | | The Contractor shall, in general, be fully responsible for all matters with regard to every form of safety during construction and in connection with the execution of the Works, and the Contractor shall take all necessary precautions and provide at his cost everything necessary to ensure such safety at all times. Should any accidents occur due to the Contractor's failure to comply with such safety requirements and to take all other safety measures necessary, the Contractor shall be fully responsible for all such accidents and he shall bear and pay for all costs and damages in connection therewith and as a consequence thereof. The Contractor shall indemnify the Employer from and against all claims in this regard.<br><br>The Engineer-in-charge shall have powers to withhold amounts from payment certificates in case of Contractor's persistent non compliance with provisions of this clause. Also the Engineer-in-charge is empowered to employ another agency at Contractor's cost after one week's notice to implement this Clause in case of Contractor's noncompliance with provisions of this Clause.<br><br>The safety conditions shall not be regarded as exhaustive. These have been issued for the guidance of the Contractor and will not in any way absolve the Contractor from any such obligations or liabilities he might incur or transfer such obligations or liabilities to the Owner.<br><br>The Contractor shall remove all the waste material and rubbish from and around the work site and leave the job thoroughly cleaned up, ready for use. No combustible material is to be stored on or near any source of heat, and before leaving the work place contractors should ensure that nothing is left which could start a fire. Contractor shall indemnify Owner from any and all claims, damages or penalties and will remain liable for the losses caused to Owner as result of Contractors non-compliance of the said requirements.<br><br>All precautions necessary for not only for the safe working of the contractors workmen at site shall be taken by the contractor, but he shall also deploy all precautions to safeguard existing structures, equipment and persons of other agencies in and around the job site. |
| | **8.7** | **<u>USE OF CIVIL CONTRACTOR'S ESTABLISHED/ AVAILABLE FACILITIES AT SITE BY SPECIALIST AND SERVICES CONTRACTORS/ NOMINATED SUB-CONTRACTORS :</u>**<br>The main contractor at his discretion may allow the use of his established/available facilities at site such as storage, scaffolding, lifting and hoisting, other plant and machinery, means of access, water, power, labour camp etc. to the Service Contractor /Sub Contractor/ Specialized agency subject to prior agreement being made by the sub contractor with the civil work Contractor. |
| | **8.8** | **<u>REFERENCE POINTS :</u>**<br>Contractor shall provide permanent bench marks, flag tops and other reference points for the proper execution of works and these shall be preserved till the end of the work.<br>All such reference points shall be in relation to the levels and locations, given in the architectural and plumbing drawing. |
| | **8.9** | **<u>REFERENCE DRAWINGS :</u>**<br><br>The Contractor shall maintain one set of all drawings issued to him as reference drawings. These shall not be used on Site. All important drawings shall be mounted on boards and placed in racks indexed, no drawings shall be rolled.<br><br>All correction, deviations and changes made on the site shall be shown on these reference drawings for final incorporation in the completion drawings. All changes to be made shall be initialed by Engineer-in-Charge. |

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| | **8.10** | **SAMPLES AND CATALOGUES & LIST OF APPROVED MAKES:**<br><br>Before ordering/procurement of the material necessary for these installations, the contractor shall submit to the Engineer In charge/Consultants for approval of catalogues with their dimensional details. All equipment cut sheets along with required technical data shall be submitted for approval.<br><br>The contractor shall ensure that the dimensional details of the equipment fit into the allotted space provided in the building / allotted space.<br><br>On Instructions of Engineer-in-Charge the Contractor shall submit samples of materials proposed to be used in the works. Sample of each and every proposed material such as; Pipes and accessories, Cables, Light Fixtures, Sanitary fixtures, valves, diffusers, grills, insulation, switches, wires, control cables etc. shall be procured and displayed in site office for approval of the Engineer-in-Charge. Approved samples shall be kept in the office of the Engineer-in-Charge and returned to the Contractor at the appropriate time.<br><br>Only material of makes and specifications as mentioned in the list of approved makes given in the tender document / Contract Document shall be used unless otherwise specified and expressly approved in writing by the Engineer-in-Charge. |
| | **8.11** | **SHOP DRAWINGS:** |
| | **i)** | All shop drawings shall be prepared on AutoCAD or REVIT software based on architectural drawings, site measurements and engineering services consultant's drawings. Contractor shall submit (in four sets) all detailed shop drawings after coordinating with structural, architectural and other services drawings. All structural openings & pipe sleeves shall be identified and schedule of cutouts/openings with levels and dimensions to be incorporated in the shop drawings. Shop drawings shall be furnished within four weeks after getting instructions from Engineer in charge. |
| | **a)** | Contractor shall execute; HVAC / Electrical and PF & FF services installations as per approved shop drawings and as described in this specifications and as per the latest BIS codes. If any item(s) of work(s) which are explicitly/implicitly not specified in B.O.Q. but are necessary either as per specifications/BIS Codes or as per mandatory / local authority requirements; these shall be identified by the contractor with cost implication before execution of work, failing which no claims to this respect shall be permitted during execution of the contract. |
| | **b)** | Before starting the work at site the contractor shall examine all services drawings and report to Engineer-in-charge for discrepancies and obtain clarifications. Any work done without regard or consultation with other trades, shall be removed by the contractor without additional cost to the employer. |
| | **ii)** | He shall prepare shop drawings incorporating the details given by manufacturers for the items included in his contract and also and any other items which need to be coordinated with other contractors for interfacing. |
| | **iii)** | Before starting the work, the contractor shall submit approved shop drawings to Engineer-in-charge for his final approval for the entire installation. |
| | **iv)** | The Engineer-in-charge reserves the right to alter or modify these drawings if they are found to be insufficient or not complying with the established technical standards or if they do not offer the most satisfactory performance or accessibility for maintenance. Contractor shall supply in six (6) sets of all approved shop drawings for execution. |
| | **v)** | Shop drawings shall include the following:- |
| | **a)** | Large scale drawings showing fixing detail of fixtures, equipment and showing co-ordination with other services. |
| | **b)** | Showing any change in layout of routing of services. |
| | **c)** | Equipment layout, piping and wiring diagram. |
| | **d)** | Manufacturer's or Contractor's fabrication drawings for any materials or equipment supplied by him |
| | **e)** | Any extra detail required by Engineer-in-Charge. |
| | **vi)** | The contractor shall submit one copy of catalogues, manufacturer's drawings, equipment |

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| | | characteristics data or performance chart as required by the Engineer-in-Charge:- |
| | **a)** | Detailed shop drawings of all equipment and materials including layouts for chilled water/ condenser water / Hot water piping, refrigerant piping, valve locations (HVAC) & layouts for all conduit layouts, distribution panels, switch boards, cabinets, special pull boxes, cable trays (Electrical). and any other requirement to be fabricated or purchased by the contractor. All structural openings & pipe sleeves shall be identified and schedule of cutouts/openings with levels and dimensions to be incorporated in the shop drawings. Shop drawings shall be furnished within four weeks (for PH & FF) after getting instructions from Engineer in charge. |
| | **b)** | These shop drawings shall contain all information required to complete the Project as per specifications and as required by the Engineer-in-Charge. These Drawings shall contain details of construction, size, arrangement, operating clearances, performance characteristics and capacity of all items of equipment, also the details of all related items of work by other contractors. Each shop drawing shall contain tabulation of all measurable items of equipment/materials/ works and progressive cumulative totals from other related drawings to arrive at a variation-in-quantity statement at the completion of all shop drawings. |
| | **c)** | Each item of equipment/material proposed shall be a standard catalogue product of an established manufacturer strictly from the manufacturers list given in the tender document.<br>If the Engineer-in-Charge makes any amendments in the above drawings, the contractor shall supply four fresh sets of drawings with the amendments duly incorporated along with check print, for approval. The contractor shall submit further six sets of shop drawings to the Engineer-in-Charge for his exclusive use by other agencies. No material or equipment may be delivered or installed at the job site until the contractor has in his possession, the approved shop drawing for the particular material/equipment/installation. |
| | **d)** | Approval of shop drawings shall not be considered as a guarantee of measurements or of building dimensions. Where drawings are approved, said approval does not mean that the drawings supersede the contract requirements, nor does it in any way relieve the contractor of the responsibility or requirement to furnish material and perform work as required by the contract. |
| | **e)** | Within four (4) weeks of approval of all the relevant shop drawings, the contractor shall submit four copies of a comprehensive variation in quantity statement, and itemized price list of recommended (by manufacturers) imported and local spare parts and tools, covering all equipment and materials in this contract. Contractor shall initiate action for procurement of materials on approval of variation statement from the Engineer-in-Charge. |
| | **f)** | Maximum headroom and space conditions shall be maintained at all points. Where headroom appears inadequate, the contractor shall notify the Architect/Consultant/Owner's site representative before proceeding with the installation. In case installation is carried out without notifying, the work shall be rejected and contractor shall rectify the same at his own cost. |
| | **8.12** | **<u>"AS BUILT" DRAWINGS :</u>**<br>Upon completion of the work and before issuance of certificate of virtual completion the contractor shall submit to the Engineer-in-Charge six sets of as built drawings in progressive manner for individual systems drawn at approved scale indicating the complete HVAC, Electrical, Plumbing & Fire-fighting systems as installed at site. Drawings shall be prepared on AUTO-CAD (latest version)/Revit. Along with the six sets hard copies, the contractor shall submit soft copies of all drawings wherever referred on CD. |
| | **8.13** | **<u>MANUFACTURERS :</u>**<br>Where manufacturers have furnished specific instructions relating to the materials used in this job, covering points not specifically mentioned in these documents, these instructions shall be followed in all cases.<br><br>Where manufacturer's names and/or catalogue numbers are given, this is an indication of the quality, standards and performance required. For items not covered under the `List of Approved Makes', contractor shall offer items of first class quality, standards and performance and obtain the approval of Engineer-in-Charge before procuring them. |

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| | | Where interfacing occurs, equipment shall be mutually compatible in all respects. |
| | **8.14** | **RATING :**<br>Rating of all items shall be appropriate for the conditions on the particular site on which the item will be used. All the equipment shall be fit for continuous running/working under the most severe conditions of site. |
| | **8.15** | **INSPECTION AND TESTING :**<br>The Engineer In charge reserves the right for inspection and testing of manufacturer's works at all reasonable times during manufacture of items for this contract. No equipment shall be delivered without prior written confirmation from the Engineer In-charge. Tests on site of completed works shall demonstrate, among other things: |
| | **i)** | That the equipment installed complies with specification in all particulars and is of the correct rating for the duty and site conditions. |
| | **ii)** | That all equipment operate efficiently and quietly to meet the specified requirements. |
| | **iii)** | That all components, equipment are correctly protected and that protective devices are properly coordinated. |
| | **iv)** | That all non-current carrying metal parts are properly and safely grounded in accordance with the specifications and Codes of Practice |
| | **v)** | The contractor shall provide all necessary instruments and labour for testing, shall make adequate records of test procedures and readings, shall repeat any tests requested by the Engineer In charge and shall provide test certificates signed by a properly authorized person. Such test shall be conducted on all materials and equipment and on completed work as called for by the Engineer In charge.<br>If it is proved that the installation or part thereof is not satisfactorily carried out then the contractor shall be liable for the rectification and retesting of the same as called for by the Engineer In charge at the cost of the contractor.<br>The above general requirements as to testing shall be read in conjunction with any particular requirements specified elsewhere. All tests shall be carried out by a house approved by the Construction Manager. All routine test shall be carried out as per technical specification and relevant IS/IEC codes. |
| | **vi)** | All testing instruments, meggering, tonge tester, fluke meter, velocity meter, digital thermometer, psychrometer, measuring steel tapes tools, scaffolding and ladders etc. that may be required for taking measurements shall be arranged by contractor at his own cost. |
| | **vii)** | On the completion of the installation the Contractor shall arrange to carry out various initial tests as detailed below, in the presence of Engineer-In-Charge and to the entire satisfaction of the Engineer-in-Charge. Any defect or short-coming found during the tests shall be speedily rectified or made good by the Contractor at his own expense. |
| | **viii)** | The initial tests shall include, but, not be limited to the tests strictly mentioned in the specifications of each discipline. |
| | **ix)** | On the satisfactory completion of all Initial tests & one major seasonal test i.e. either summer or monsoon the system shall be considered Virtually Complete for the purpose of taking over by the Client**.** |
| | **x)** | The contractor shall submit test certificates for all the equipment and system installed Type tests shall be carried out as per relevant standards mentioned in technical specifications. For other items, such test certificates issued by Government recognized inspection office certifying that all equipment, materials, construction and functions are in compliance with the requirements of these specifications and accepted standards of BIS/International standards. |
| | **8.16** | **TESTING , BALANCING AND COMMISSIONING**<br>The Engineer In charge reserves the right for inspection and testing of manufacturer's works at all reasonable times during manufacture of items for this contract. No equipment shall be delivered without prior written confirmation from the Engineer In-charge.<br>Balancing, testing and commissioning of all systems and all tests as called for in the Specifications shall be carried out by the contractor through specialized sub-contractors/vendors (as required), in accordance with the Specifications and required Standards. Any costs associated with the TAB shall be borne by the contractor. Performance test shall consist of three days of 10 hour each operation of system for each season. Cost of performance witness test of major equipment such as Chillers, Cooling towers, Pumps, AHUs, Ventilation fans, Pumps, equipment, panels etc. at factory with personnel appointed by the Engineer-in-Charge. The installation shall be tested again after removal of defects and |

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| | | shall be commissioned only after approval by the Engineer In charge. |
| | **i)** | This Section includes TAB to produce design objectives for the following: |
| | **a)** | Air Systems:<br>1) Constant-volume air systems.<br>2) Variable-air-volume systems.<br>3) Multizone systems. |
| | **b)** | Hydronic Piping Systems:<br>1) Constant-flow systems.<br>2) Variable-flow systems.<br>3) Primary-secondary systems |
| | **c)** | Steam systems (if any). |
| | **d)** | HVAC equipment quantitative-performance settings. |
| | **e)** | Kitchen hood airflow balancing. |
| | **f)** | Laboratory fume hood airflow balancing. |
| | **g)** | Verifying that automatic control devices are functioning properly. |
| | **h)** | Reporting results of activities and procedures specified in this Section. |
| | **i)** | The commissioning of the complete system shall be per ASHRAE commissioning standards. A complete season testing shall be observed including winter heating and summer cooling. The performance of the systems shall meet design documents during both systems. |
| | **ii)** | Testing and commissioning of all systems and equipment like Power/ distribution transformers, DG sets, GIS switchgears, Elevators, HT/ LT panels, compact sub-stations, panels and all tests as called for in the Specifications shall be carried out by the contractor through the specialized vendors/sub-contractors (as required), in accordance with the Specifications and required Standards. The installation shall be tested again after removal of defects and shall be commissioned only after approval by the Engineer In charge. |
| | **iii)** | Testing and commissioning of all equipment of PH & FF systems and equipment including STP, WTP and ETP as called for in the Specifications shall be carried out by the contractor through the specialized vendors/sub-contractors (as required), in accordance with the Specifications and required Standards. The installation shall be tested again after removal of defects and shall be commissioned only after approval by the Engineer In charge. |
| | **8.17** | **PERFORMANCE GUARANTEE**<br>The contractor shall carry out the work in accordance with the Drawings, Specifications, Schedule of Quantities and other documents forming part of the Contract.<br>The contractor shall be fully responsible for the performance of the selected equipment (installed by him) at the specified parameters and for the efficiency of the installation to deliver the required end result. The replacement warrantee of different items is as mentioned in specification.<br>The contractor shall guarantee that the HVAC/Electrical/PH & FF systems installed shall perform to complete satisfaction of the owner.<br>Complete set of architectural drawings is available at Office of Executive Engineer (Civil), SAU and reference may be made to same for any details or information. The contractor shall also guarantee that the performance of various equipment individually, shall not be less than the quoted capacity; also actual power consumption shall not exceed the quoted rating, during testing and commissioning, handing over and guarantee period.<br>The Contractor shall hold himself fully responsible for reinstallation or replacement, free of cost to Owner the following: |
| | **i)** | Any defective work or material supplied by the Contractor |
| | **ii)** | Any material or equipment damaged or destroyed as a result of defective workmanship by the Contractor. |
| | **8.18** | **QUIET OPERATION AND VIBRATION ISOLATION ;**<br>All equipment shall operate under all conditions of load without any sound or vibration which is objectionable in the opinion of the owner's site representative. In case of rotating machinery sound or vibration noticeable outside the room in which is installed. Or annoyingly noticeable inside its own room, shall be considered objectionable. Such conditions shall be corrected by the contractor at his own expense. The contractor shall guarantee that the |

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| | | equipment installed shall maintain the specified db/NC levels. |
| | **8.19** | **UPTIME GUARANTEE**<br>The contractor shall guarantee for the installed system an uptime of 98**%. In case of shortfall in any month during the defects liability period, the Defects Liability period shall get extended by a month for every month having shortfall. In case of shortfall beyond the defects liability period, the contract for Operation and Maintenance shall get extended by a month for every month having the shortfall and no reimbursement shall be made for the extended period**.<br>The Contractor shall provide log in soft copy and bound, printed comprehensive log book containing tables for daily record of all temperatures, pressures, humidity, power consumption. starting and stopping times for various equipment, daily services rendered for the system alarms, maintenance and record of unusual observations etc. Contractor shall also submit preventive maintenance schedule. |
| | **8.20** | **INSTRUCTION / MAINTENANCE MANUAL :**<br>The Contractor shall prepare and produce instruction, operation and maintenance manuals in English for the use, operation and the maintenance of the supplied equipment, installations and all systems included in this contract and submit to the Engineer In charge/ Consultants in six (6) complete bound sets of typewritten operating instructions and maintenance manuals. These manuals shall also include basis of design, detailed technical data for each piece of equipment as installed, and recommended spares for 03 year period of maintenance of each equipment; at the time of handing over. In addition one set with editable version will be given on compact disc. The manual shall generally consist of the following: |
| | **i)** | Description of the project. |
| | **ii)** | Operating instructions. |
| | **iii)** | Maintenance instructions including procedures for preventive maintenance. |
| | **iv)** | Manufacturers catalog. |
| | **v)** | Periodic maintenance |
| | **vi)** | Spare parts list. |
| | **vii)** | Trouble shooting charts. |
| | **viii)** | Drawings. |
| | **ix)** | Log sheets |
| | **x)** | Type and routine test certificates of major items. |
| | **8.21** | **COMPLETION CERTIFICATE :**<br>On completion of all HVAC, all Electrical, all Plumbing/Sanitary & Fire Fighting installation a certificate shall be furnished by the contractor countersigned by the licensed Engineer/Electrician/Plumber/Supervisor, under whose direct supervision the installation was carried out. This certificate shall be in the prescribed form as required by the local authorities, statutory authorities. The contractor shall be responsible for getting the HVAC, Electrical, Plumbing/Sanitary & Fire Fighting installation inspected and approved by all concerned statutory authorities, for obtaining the necessary; NOC's (No objection certificates), Licences, Permits, Clearance Certificates, Completion Certificate / Occupancy Certificate, from all Statutory Authorities, utility providers; electricity and water supply etc. and shall comply with and obtain necessary environmental, GRIHA related documentation approved.. |
| | **8.22** | **GUARANTEE :**<br>At the closure of work and before issuance of final certificate of completion by Engineer-in-charge, the contractor shall furnish written guarantee indemnifying the employer against defective materials and workmanship for a period of two year after completion. The contractor shall hold himself fully responsible for reinstallation or replacement, free of cost to employer, the following : |
| | **i)** | Any defective work or material supplied by the Contractor. |
| | **ii)** | Any material or equipment damaged or destroyed as a result of defective workmanship by the contractor. |
| | **8.23** | **MAINTENANCE AND TRAINING OF PERSONNEL:** |

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| | | The contractor shall arrange to provide at no extra cost necessary personnel and material to carry out all routine and special maintenance of the plant as required regularly for a period of Twenty four (24) months from date of handing over including weekly inspection by contractor or his technical representative during guarantee period.<br>The contractor shall also train the employer's personnel to operate the plant and carry out routine checks. During the period of installation and testing, if found necessary, the employer shall train such personnel at his work at no extra cost to the employer. |
| | **i)** | **TRAINING :**<br>The contractor shall impart training to the field personnel or Engineer appointed by Owner responsible for daily operations and maintenance. Such trainings shall consist of but not be limited to following:- |
| | **a)** | Providing classroom training as well as field training. The duration of classroom training shall be minimum of **3** hours and that of field training shall be **05** hours and shall be repeated for all buildings and systems. |
| | **b)** | Training syllabus shall be submitted to the Engineer In charge for approval prior to the training. |
| | **c)** | Contractor shall provide training video recording of every such training (4 copies) in CD/DVD/Pen drive to the “Owner”. |
| | **d)** | Representatives of the respective OEM shall be present (as per requirement) for imparting training and to ensure that all necessary information is conveyed to the owner’s representatives. |
| | **8.24** | **TIME FOR COMPLETION :**<br>Time for completion for all the works shall be as per the Project Time Line Matrix from the date of issue of Letter of Intent (LOI).<br>The work shall be executed strictly as per the Time Schedule, working drawings and specification of the items included into the schedule of items. The period of work given includes the time required for mobilization and completion in all respects to the entire satisfaction of the Engineer-in-Charge. |
| | **i)** | Weekly programs of work will be drawn up by the Contractor to be approved by the Engineer-in- Charge. The Contractor shall scrupulously adhere to these schedules by deploying adequate personnel and construction tools and tackles. In all matters concerning the extent of targets set out for weekly programs and degree of achievements, the decision of Engineer-in-Charge shall be final and binding. |
| | **ii)** | The time for completion mentioned above shall be inclusive of any monsoon following within the aforesaid time for completion. Delay/ held up of work on account of monsoon/ rain will not be considered for granting of additional time to complete the work. |
| | **8.25** | **MEASUREMENTS :**<br>The Engineer-in-Charge shall, except as otherwise stated ascertain and determine by measurement the value of Work done, in accordance with the Contract and as per actual Work done. The Engineer-in-Charge shall, when he requires any part or parts of the Works to be measured, give notices to the Contractor's authorized agent or representative who shall forthwith attend or send a qualified agent to assist the Engineer-in-Charge in making such measurement and shall furnish all particulars required by either of them. Should the Contractor not attend or neglect or omit to send such representative then the measurement made by the Engineer- in-Charge shall be taken to be the correct measurement of the Work. For all measurements, figured dimensions given in the drawings shall be followed. Measurement of all hidden items shall be carried out by the Engineer-in-Charge. The Contractor or his representative who attends may at the time of measurement take such notes and measurements as he may desire.<br><br>Where Works have to be measured for any purpose whatsoever, it shall be in accordance with item specifications as per relevant Indian Standards unless otherwise specifically indicated in the Contract Specifications. All measurements will be recorded in metric units only. In case of absence of mode of measurement of any item not covered by both the methods mentioned above, the Engineer-in- Charge's decision shall be final and binding. The required number of bills, registers, bill forms, level/field books, materials/ account registers, testing registers, site order books and any other stationary item pertaining to this contract shall be printed and provided for by the contractor, at his own cost in the format prescribed and approved by the Engineer-in-Charge in writing. |

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| | **8.26** | **CONTRACTOR'S PERSONNEL AT SITE:**<br>The contractor shall employ competent fully licensed qualified, experienced full time engineers (as per deployment schedule of the Contract) to direct & supervise the work of HVAC, Electrical, Plumbing & fire installation in accordance with the drawings and specifications.<br><br>The engineers shall be available at all times at site to receive instructions from the Engineer-in-charge, in the day to day activities throughout the duration of contract. The engineer shall correlate the progress of the work in conjunction with all the relevant requirements of the Employer.<br><br>List of persons employed by Contractor for the subject work mentioning their residential address shall be submitted to SAU. In case of any revision, the same shall be informed to SAU from time-to-time.<br>The Contractor shall be directly responsible for any/all disputes arising between him and his personnel and keep SAU indemnified against all losses, damage and claims arising thereof.<br><br>Contractor's personnel shall not do any private work other than their normal duties within SAU premises,<br>The contractor shall provide photo passes to the personnel required by him, for security and safety reasons and furnish the details of the same when asked for.<br><br>Contractor shall be fully responsible for theft, burglary, fire or any mischievous deeds by his staff and any loss to SAU shall be recovered from the immediate bill of the Contractor.<br><br>Contractor shall provide all necessary tools and tackles, equipment, safety belt, wheel barrow, scaffolding, ladders, drilling m/c & safety equipment etc. required to carry out job at his cost and material used by Contractor shall be of standard make and approval of Engineer-In-Charge shall be taken for the same.<br><br>Engineer In-charge also reserves the right to ask the Contractor to remove particular person(s) from site with immediate effect if his behaviour/performance is not up to the mark and/or found indulging in unlawful activities, Contractor shall immediately comply with such instructions.<br>It will be the responsibility of contractor's engineer to ensure that their personnel behave in a proper manner. |

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| | **8.27** | **<u>Site Acceptance Test (SAT):</u>**<br>The SAT will include the following tests: -<br>• Finishing Visual check.<br>• Main component Visual check.<br>• Utility functionality and setting check.<br>• Material checklist.<br>• Finishing packing list check.<br>• Check for any damage upon receiving.<br>• Check for any missing item/ part.<br>• Complete documents/ manual check.<br><br>**Item that does not fulfill the above conditions for SAT, shall be considered a failure and needs to be replaced.**<br>At completion, devices subject to manual operation shall be operated at least five times in presence of Engineer In-charge to demonstrate satisfactory operation. |
| | **8.28** | **<u>Handing Over Procedure:</u>**<br>The contractor shall prepare a checklist of the work done by him before handing over. The checklist shall be verified in the presence of Engineer In-charge / main contractor. The work done shall be inspected, tested & commissioned in the presence of above representatives. Further, the contractor shall also furnish all the technical documents/ manuals of all equipment to Engineer In-charges.<br>Note :<br>• The installation of the equipment at site shall be up to the satisfaction level of architect/ engineer in-charge.<br>  • Contractor shall submit rate analysis for items for approval from PMC/Engineer-in-charge, if PMC/ Engineer-in-charge as asked upon. |
| | **8.29** | **<u>Compliance of various rules and regulations during execution of HVAC Works and other works in line with Green Building norms as per GRIHA.</u>**<br>All measures will need to be complied with by the Contractor in order to ensure that the correct information is obtained at required times and in correct formats. Such information shall be sent to the Engineer-in-Charge, on a fortnight basis. The Engineer-in-Charge will supervise the collated information and records to assess any discrepancy or improvement required in order to prepare the submittal to GRIHA for Green Building Certification.<br>A photographic and paper record as required will have to be provided of all above mentioned measures to the Engineer-in-Charge. |

## ADDITIONAL CONDITIONS FOR OPERATION & MAINTENANCE

1. These conditions shall be read in conjunction with relevant conditions of contract mentioned elsewhere in this document.
2. After successful completion of the construction of Package-III buildings, the main contract agreement shall be closed and the operation & maintenance works as given in the BOQ shall be executed through a supplementary agreement on the prescribed format. This shall be known as O & M Contract.
3. For the remaining period of three years of operation & maintenance beyond DLP, the contractor has to deposit Performance Guarantee of 5% of contract value of the O&M subhead valid up to two months beyond the completion for O & M Contract. After the Defects Liability Period (DLP) of 24 months is over, the Performance Guarantee & Security deposit of main contract shall be released after signing of the O & M Contract.
4. For general maintenance related activities, CPWD maintenance manual 2012 may be referred.

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| | **8.30** | **MAINTENANCE DURING DEFECT LIABILITY PERIOD:**<br>Contractor is responsible to provide a comprehensive maintenance for the system installed and commissioned by him for a minimum of **Two (2) years** and is covered under this defect liability period. The defect liability period shall start from the **Date of Handover (DOH)** of the system. Contractor shall take actions as described below but not limited to: |
| | **i)** | **Complaints:**<br>The Contractor shall receive calls for any and all problems experienced in the operation of the system under this contract, attend to these within 2 hours of receiving the complaints and shall take steps to immediately correct any deficiencies that may exist. Corrective actions to problem experienced, if takes longer time, shall be complied 100% by during next business hours. |
| | **ii)** | **Repairs:**<br>All equipment that requires repairing shall be immediately serviced and repaired. Since the period of Mechanical Maintenance runs concurrently with the defects liability period, all replacement parts and labour shall be supplied promptly free-of-charge to the Owner.<br>• Minor rectifications - 2 to 4 hours<br>• Major rectifications - 12 to 24 hours |
| | **iii)** | **Log Book:**<br>The contractor shall provide four (4) copies of bound printed comprehensive log book containing tables for daily record of all temperature pressures, humidity, power consumption, starting and stopping times for various equipment, and record of unusual observations. This log book shall contain pages for one year's records of above observations. |
| | **iv)** | **Extension of time limit**<br>Notwithstanding anything to the contrary as specified above, if the nature and extent of any Defect or deficiency justifies more time for its repair or rectification than the time specified herein, the Contractor shall be entitled to additional time in conformity with Good Industry Practice. Such additional time shall be determined by SAU and conveyed to the Contractor with reasons thereof. |
| | **v)** | **Emergency Repairs/Restoration**<br>Notwithstanding anything as mentioned above, if any defect, deficiency or deterioration in the Project Components poses a hazard to safety or risk of damage to property, the Contractor shall promptly take all reasonable measures for eliminating or minimizing such danger. |
| | **8.31** | **OPERATION AND MAINTENANCE:**<br>After completion of free of cost maintenance during the 2 years of DLP, the contractor shall provide (on chargeable basis) maintenance of HVAC, Electrical, PH & FF, STP, ETP & WTP works complete for duration of another 3 years after DLP as specified in |

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| | | Bill of Quantities.<br>The contractor shall also quote for operation of HVAC, Electrical, PH & FF system for the duration of 5 years after handing over. However, during the operation, a snag list may be issued to contractor for further modification without any cost implication during the DLP period. The payment shall be made on quarterly basis for the operation and maintenance part. |
| | **i)** | The contractor will follow all labour laws and other statutory laws of Central Govt. / State Govt. as applicable and enforced from time to time. Any violation for not following the labour laws shall be contractor's sole responsibility. |
| | **ii)** | The Contractor shall ensure that the dues of all employees engaged by him/her are paid in time and their Provident Fund and ESI dues are deposited in time. Necessary certificate towards the above compliance will be submitted by the licensee every month. Bills shall only be cleared on submission of mandatory compliances. |
| | **iii)** | The University shall not be liable for any payment to the staff of the Contractor on account of Salary and Allowances, Leave, Medical Aid, Insurance Policy, provident Fund, ESI dues etc. whatsoever, except mentioned specifically elsewhere which shall be the responsibility of the Contractor. The Contractor shall also ensure that the norms prescribed by the Human Rights Commission or Government of India, Minimum Wages Act, Provisions of Industrial Disputes Act or any such other legislation, to the extent applicable, are fully observed by the Contractor and the University authorities are kept harm-free and indemnified in this behalf. The Contractor hereby undertakes to keep the Registrar and officers of SAU harm- free and indemnified against any claim or demand of his/her workmen under any industrial law for the time being in force, or as may be amended from time to time. |
| | **iv)** | INSURANCE OF THE WORKERS: The insurance cover shall be as per labor law requirements. The contractor shall submit papers for suitable insurance cover for his men and shall also submit an undertaking indemnifying the University. |
| | **v)** | RENEWAL OF CONTRACT LABOUR LICENCE: The contractor shall renew the contract Labor License from time to time and inform the University's representative in this regard. It shall be the contractor's obligations to comply with all applicable statutory requirements including in particular, relating to Minimum Wages and the Dearness Allowance and emoluments payable to the employees. It shall be the contractor's responsibility to furnish each month; a certificate confirming the due compliance of all statutory requirements. In the event of incurring any liability by reason of any lapse and/or omission on the part of the contractor, from time to time, and at all times. The contractor shall indemnify SAU & its staff against all such liability including the cost thereof on Attorney and Client basis. |
| | **vi)** | All necessary registers required as per statutory labor laws shall be maintained by the Contractor for the staff deployed by it and the same should be available for inspection and verification by the representative of SAU and Labour Enforcement Officer, as and when asked for. |
| | **vii)** | The contractor shall be responsible for maintaining office decorum and good behavior and character of the staff engaged by him. |
| | **viii)** | SAU shall in no way be involved in any dispute of whatever kind between the contractor and the staff engaged by him. |
| | **ix)** | The personnel shall report on duty irrespective of Saturdays, Sundays, public holidays (including National holidays). Nothing extra shall be paid by SAU on this account. The agency shall have to provide reliever on Saturdays. Sundays, holidays etc. Nothing extra shall be paid on this account by SAU. |
| | **x)** | Penalty three times the rate of the prevailing minimum wage rates shall be deducted if the manpower do not report for duty or are found missing from the duty. For Supervisors & Engineer recovery shall be made at the rate of Rs 3000/- & Rs 5,000/- on per day / per shift basis respectively. |
| | **xi)** | The contractor will not be paid anything extra for transportation of material, tools and labour for working at various offices within premises of Maidangarhi Campus, New Delhi. |

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| | **xii)** | The University will provide suitable space for storing material, T&P and sitting space for manpower i.e labor and supervisor free of cost. Facility of an intercom telephone extension and an internet connection for laptop / desktop of the contractor issued to maintenance head, will also be provided free of cost. |
| | **xiii)** | Proper record of the complaints being attended shall be maintained by the agency and furnish time to time for assessment of the works being carried out. |
| | **xiv)** | All the equipment shall be operated & maintained in such a manner that they all give optimum performances. |
| | **xv)** | No escalation shall be paid over & above the BOQ rates for operation & maintenance. |
| | **xvi)** | All workmen deployed in operation and maintenance will be in neat & tidy uniform. All key men shall be provided with an active mobile phone and connection by the agency. SAU shall not pay anything extra on this account. |
| | **xvii)** | The resume of all workers i.e Engineers / Technicians / Supervisors / Helpers etc. shall be submitted to SAU and got approved from the Engineer-in-charge before deployment at site for operation & maintenance. |
| | **xviii)** | Any type of Tools / testing equipment / declogging or cleaning equipment / ladders / torch light / safety shoes / tolls required for repairs etc required for proper operation & maintenance shall be arranged by the contractor and present at all times in the SAU campus. |
| | **xix)** | No staff shall leave his duty unless relieved by his reliever. University authorities reserve the right to detain the staff for duty in the next shift if the reliever fails to turn up. Nothing extra shall be paid on this account. |
| | **xx)** | If additional hands are required to complete the job in justified time limits. The same shall be supplied by the contractor free of cost. |
| | **xxi)** | The rates of the BOQ items for operation & maintenance have been derived as per the items described in BOQ for the original work. If, in case, any major item of BOQ is not executed or deviated/substituted beyond plus/minus 10%, then the rates quoted in operation & maintenance are subject to revision on pro-rata basis. |
| | **xxii)** | The agency will deploy trained manpower under supervision of Supervisor for maintenance works. This manpower shall be in addition to manpower given in the BOQ item of operation for different subheads. |
| | **xxiii)** | The agency will also provide computer & internet literate person to maintain the front office of the service center. The main responsibility of the operator shall be to keep record of the complaints, attending the complaint, closure of complaints. The computer & internet connection shall be provided by university. |
| | **xxiv)** | The maintenance activity will include cost of material required for day-to-day maintenance including any type of consumables. |
| | **xxv)** | Day to day maintenance activity has to be attended in a time bound manner. Urgent complaints of water leakages / power outages / fire / choking in sanitary traps / no water etc. shall be attended immediately but maximum within 2 to 3 hrs. Failing which a recovery of Rs 2,000/- per compliant per day shall be levied keeping in view the type of maintenance. |
| | **xxvi)** | Minor / routine complaints shall be attended within 24 hrs. Failing which a recovery of Rs 1,000/- per day shall be levied. |
| | **xxvii)** | The agency will ensure the safety & welfare of activity of work force as are given in CPWD General Conditions of Contracts. |
| | **xxviii)** | The contractor shall be solely responsible for safety & security and general wellbeing of his men working in the premises. The university in no way be responsible for any accident or mishap on the university work site or any injury caused to any worker of the contractor during the course of his work in the university premises. |
| | **xxix)** | Any accident / electrocution caused due to negligence or during the course of normal work etc., shall be responsibility of the Contractor. The contractor shall be responsible for all and any type of compensation to the staff engaged by him. |

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| | **xxx)** | The contractor will ensure that the routine / preventive maintenance as per the schedules of OEM (Original Equipment Manufacturer) is being complied in due time period & proper record be maintained failing which suitable recovery towards the activity not being carried out shall be made. All routine / preventive maintenance as per the schedules of OEM (Original Equipment Manufacturer) shall be carried out by OEM or its authorized agents only. The decision of university in this regard shall be final & binding. |
| | **xxxi)** | Although the comprehensive maintenance of all the services are in the scope of the main contractor, following services have to be arranged through OEM / authorized vendor only:-<br>• DG set<br>• Fire Extinguishers<br>• Water pump automation system.<br>• UPS system<br>• high side of the Central Air conditioning plant<br>The ETP / STP shall be maintained by specialized agency approved by NEERI. The bidder may quote rates accordingly as nothing extra shall be paid to the agency in this regard. |
| | **xxxii)** | Lifts shall be comprehensively maintained by the respective lift manufacturer only. |
| | **xxxiii)** | The operation of CCTV & Access control system shall not be part of this contract. |
| | **xxxiv)** | For repair works other that routine maintenance, the agency will be paid as per actual work done, measured and paid for under DSR plus/minus cost index applicable at that time. For NON-DSR items, prevailing market rates shall be applicable as agreed & approved by Engineer-in-Charge. These repair works shall be carried out after taking prior approval of the Engineer-in-Charge. |
| | **xxxv)** | The maintenance of road, footpath, and drain shall also be part of this contract; the rates are included in the total O & M contract. |
| | **xxxvi)** | Cleaning & upkeep of pump house plant room, generator area, HVAC area & other similar areas shall be in the scope of O & M part are inclusive of them. Nothing extra shall be paid on this account. |
| | **xxxvii)** | Requirement of diesel (HSD oil) shall be met by SAU. Other consumables like engine oil, grease, refrigerant, gaskets etc. will be provided by the agency and nothing extra shall be paid on this account. |
| | **xxxviii)** | The contractor shall maintain a store with fast moving items of spares and consumables for whole year. The space shall be provided by SAU free of cost. The same shall be subject to inspection by SAU authorities. Proper record of the material shall also be maintained. The contractors will also provide & maintain suitable ladders, platforms, trolleys, scaffoldings, chain-pulleys, forklift etc. required for the maintenance of the system. Nothing extra shall be paid on this account. |
| | **xxxix)** | After successful completion of the construction of package-III buildings, the main agreement shall be closed and the operation & maintenance works as given in the BOQ shall be executed through a supplementary agreement on the prescribed format. |
| | **a)** | Operation contract (Electrical & HVAC):<br>• 10 hours a day, year round during working office hours for full load<br>• 14 hours a day, year round during non-work hours for part load.<br>• All stand-by equipment to be operated as per mutually agreed program.<br>• Proper entry and upkeep of relevant log books.<br>• Maintain complaints register and submit weekly report.<br>• Proper housekeeping of all areas under the contract.<br>• Prepare daily consumption report and summary of operation. |

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| | **b)** | Operation contract (Plumbing & Fire Fighting) :<br>• Manpower as per BOQ item to be deployed.<br>• Manpower required for operation and maintenance of specialized work like STP, ETP etc. to be deployed only by the respective specialized agencies.<br>• All stand-by equipment to be operated as per mutually agreed programme.<br>• Proper entry and upkeep of relevant log books.<br>• Maintain complaints register. Submit weekly report.<br>• Proper housekeeping of all service areas under the contract.<br>• Prepare daily consumption report and summary of operation.<br>• The Plumber/Operator/Supervisor shall have working mobile no. and the cost shall be borne by the Contractor. |
| | **xl)** | List of items under DLP and maintenance –All items given in the BOQ and executed by the Contractor are included under DLP and Maintenance. |
| | **a)** | All Inclusive Maintenance Contract:<br>o Scope - The AMC shall cover all the items installed by the contractor.<br>o Routine Preventive Maintenance Schedule to be submitted<br>• Schedule to cover manufacturer's recommendation and/or common engineering practice (for all plant and machinery under contract).<br>• Plant and machinery history card giving full details of equipment and frequency of checks and overhaul.<br>• Monthly status report.<br>• Entire Plumbing & fire fighting installation to be repainted in fourth year (from commissioning) before the expiry of operation and maintenance contract. |
| | **b)** | Uptime during maintenance contract<br>• 98% uptime of all systems under contract.<br>• Up time shall be assessed every month and in case of shortfall during any month the contract shall be extended by a month.<br>• There shall be no reimbursement for the extended period.<br>• Break-downs shall be attended immediately. |
| | **c)** | Shut Downs<br>• Routine shut downs shall be permitted with prior permission of SAU.<br>• Contractor shall be at liberty to carry out routine maintenance as and when required but with prior permission of the SAU. |
| | **d)** | Payment Terms<br>• Payment will be made on quarterly basis after successful and satisfactory completion of operation and maintenance of system given in the contract to the satisfaction of the Engineer-in-Charge, on pro-rata basis, on submission of valid documents**.** |
| | **xli)** | **<u>OPERATING INSTRUCTIONS :</u>**<br>The contractor shall submit a draft copy of comprehensive operating instructions and maintenance schedule for all systems and equipment included in this contract. This shall be supplementary to manufacturer's operating and maintenance manuals. Upon approval of the draft, the contractor shall submit four (4) complete bound sets of typewritten operating instructions, maintenance schedules, and log books.<br>The manual shall be carefully indexed and shall include sections on: |
| | **a)** | General description of equipment's & systems. |
| | **b)** | Handbooks operation & maintenance instructions of manufacturers. |
| | **c)** | Lubrication Schedule |
| | **d)** | Drive List |
| | **e)** | Technical Particulars of Equipment's |
| | **f)** | Startup & stopping procedure. |
| | **g)** | Procedure & setting of Controls |
| | **h)** | List of as built drawings |
| | **i)** | Complete single line diagram of the A.C work and associated Wiring diagrams |
| | **j)** | Schedule of spare parts essential & others. |
| | **k)** | Test results & certificates. |
| | **l)** | Log Book format |

# 9.0. PLUMBING / SANITARY WORKS TECHNICAL SPECIFICATIONS

## 9.1. APPLICABLE CODES AND STANDARDS

All equipment, supply, erection, testing and commissioning shall comply with the requirements of Indian Standards and code of practices. All equipment and material being supplied by the Contractor shall meet the requirements of IS., Tariff advisory committee's regulation (fire insurance), electrical inspectorate and Indian Electricity rules and other Codes/Publications as given below.

### 9.1.1. GENERAL :

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| SP : 6 (1) | Structural steel sections |
| IS : 27 | Pig lead |
| IS : 325 | Three phase induction motors |
| IS : 554 | Dimensions for pipe threads where pressure tight joints are required on the threads. |
| IS : 694 | PVC insulated cables for working voltages up to and including 1100 V. |
| IS : 779 | Specification for water meters (domestic type) |
| IS : 782 | Specification for caulking lead |
| IS : 800 | Code of Practice for general construction in steel |
| IS : 1068 | Electroplated coatings of nickel plus chromium and copper plus nickel plus chromium |
| IS : 1172 | Code of basic requirements for water supply drainage and sanitation |
| IS : 1367 (Part- 1) | Technical supply conditions for threaded steel fasteners : Part 1 introduction and general information. |
| IS : 1367 (Part- 2) | Technical supply conditions for threaded steel fasteners : Part 2 product grades and tolerances. |
| IS : 1554 (Part- 1) | PVC insulated (heavy duty) electric cables : Part 1 for working voltages up to and including 1100V. |
| IS : 1554 (Part- 2) | PVC insulated (heavy duty) electric cables : Part 2 for working voltages from 3.3 kV up to and including 11 kV. |
| IS : 1726 | Specification for cast iron manhole covers and frames |
| IS : 1742 | Code of practice for building drainage. |
| IS : 2064 | Selection, installation and maintenance of sanitary appliances - Code of practice. |
| IS : 2065 | Code of practice for water supply in buildings. |
| IS : 2104 | Specification for water meter boxes (domestic type) |
| IS : 2373 | Specification for water meters (bulk type) |

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| IS : 2379 | Colour code for identification of pipe lines |
| IS : 2527 | Code of practice for fixing rainwater gutters and down pipes for roof drainage. |
| IS : 2629 | Recommended practice for hot dip galvanizing on iron and steel |
| IS : 3114 | Code of practice for laying of cast iron pipes |
| IS : 4111 (Part 1) | Code of practice for ancillary structures in sewerage system : Part 1 manholes |
| IS : 4127 | Code of practice for laying glazed stoneware pipes. |
| IS : 4853 | Recommended practice for radiographic inspection of fusion welded butt joints in steel pipes |
| IS : 5329 | Code of practice for sanitary pipe work above ground for buildings. |
| IS : 5455 | Cast iron steps for manholes. |
| IS : 6159 | Recommended practice for design and fabrication of material prior to galvanizing |
| IS : 7558 | Code of practice for domestic hot water installations |
| IS : 8321 | Glossary of terms applicable to plumbing work |
| IS : 9668 | Code of practice for provision and maintenance of water supplies and fire fighting. |
| IS : 9842 | Preformed fibrous pipe insulation |
| IS : 9912 | Coal tar based coating materials and suitable primers for protecting iron and steel pipe lines. |
| IS : 10221 | Code of practice for coating and wrapping of underground mild steel pipelines |
| IS : 10234 | Recommendations for general pipeline welding. |
| IS : 10446 | Glossary of terms relating to water supply and sanitation. |
| IS : 11149 | Rubber Gaskets |
| IS : 11790 | Code of practice for preparation of butt-welding ends for pipes, valves, flanges and fittings. |
| IS : 12183 (Part 1) | Code of practice for plumbing in multistoreyed buildings : Part 1 Water supply |
| IS : 12251 | Code of practice for drainage of building basements |
| IS : 5572 | Code of practice for sanitary pipe work |
| IS : 6700 | Specification for design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages. |
| IS : 8301 | Code of practice for building drainage |

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| BSEN : 274 | Sanitary tapware, waste fittings for basins, bidets and baths. General technical specifications. |

**9.1.2. PIPES AND FITTINGS :**

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| IS : 458 | Specification for precast concrete pipes (with and without reinforcement) |
| IS : 651 | Salt glazed stone-ware pipes and fittings |
| IS : 1239 (Part 1) | Mild steel tubes, tubulars and other wrought steel fittings Part 1 Mild Steel tubes |
| IS : 1239 (Part 2) | Mild steel tubes, tubulars and other wrought steel fittings : Part 2 Mild steel tubulars and other wrought steel pipe fittings. |
| IS : 1536 | Centrifugally cast (spun) iron pressure pipes for water, gas and sewage |
| IS : 1537 | Vertically cast iron pressure pipes for water, gas and sewage. |
| IS : 1538 | Cast iron fittings for pressure pipes for water, gas and sewage |
| IS : 1729 | Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories. |
| IS : 1879 | Malleable cast iron pipe fittings |
| IS : 1978 | Line pipe |
| IS : 1979 | High test line pipe |
| IS : 2501 | Copper tubes for general engineering purposes |
| IS : 2643 (Part 1) | Dimensions for pipe threads for fastening purposes : Part 1 Basic profile and dimensions. |
| IS : 2643 (Part 2) | Dimensions for pipe threads for fastening purposes : Part 2 Tolerances |
| IS : 2643 (Part 3) | Dimensions for pipe threads for fastening purposes : Part 3 Limits of sizes. |
| IS : 3468 | Pipe nuts |
| IS : 3589 | Seamless or electrically welded steel pipes for water, gas and sewage (168.3 mm to 2032 mm outside diameter) |
| IS : 3989 | Centrifugally cast (spun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories. |
| IS : 4346 | Specifications for washers for use with fittings for water services. |
| IS : 4711 | Methods for sampling steel pipes, tubes and fittings |
| IS : 6392 | Steel pipe flanges |
| IS : 6418 | Cast iron and malleable cast iron flanges for general engineering purposes. |

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| IS : 7181 | Specification for horizontally cast iron double flanged pipe for water, gas and sewage. |

**9.1.3. VALVES :**

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| IS : 778 | Specification for copper alloy gate, globe and check valves for water works purposes |
| IS : 780 | Specification for sluice valves for water works purposes (50 mm to 300 mm size) |
| IS : 1703 | Specification copper alloy float valves (horizontal plunger type) for water supply fittings |
| IS : 2906 | Specification for sluice valves for water works purposes (350 mm to 1200 mm size) |
| IS : 3950 | Specification for surface boxes for sluice valves |
| IS : 5312 (Part 1) | Specification for swing check type reflux (non return) valves : Part 1 Single door pattern |
| IS : 5312 (Part 2) | Specification for swing check type reflux (non return) valves : Part 2 Multi door pattern |
| IS : 12992 (Part 1) | Safety relief valves, spring loaded : Part 1 - Design |
| IS : 13095 | Butterfly valves for general purposes. |

**9.1.4. WATER QUALITY TOLERANCE :**

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| IS : 3025 (Part 1 to 44) | Method of sampling and test (physical and chemical) for water and waste water |
| IS : 4764 | Tolerance limits for sewage effluents discharged into inland surface waters |
| IS : 10500 | Drinking water |

**9.1.5. PUMPS AND VESSELS :**

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| IS : 1520 | Specification for horizontal centrifugal pumps for clear cold fresh water |
| IS : 2002 | Steel plates for pressure vessels for intermediate and high temperature service including boilers |
| IS : 2825 | Code for unfired pressure vessels |
| IS : 4682 (Part 1) | Code of practice for lining of vessels and equipment for chemical processes Part 1 : Rubber lining |
| IS : 5600 | Specification for sewage and drainage pumps |
| IS : 8034 | Specification for submersible pump sets for clear, cold, fresh water |
| IS : 8418 | Specification for horizontal centrifugal self priming pumps |

## 9.2. MATERIALS AND WORKMANSHIP

### 9.2.1. INTRODUCTION

This part of the Specification sets out the general standards of materials to be supplied and the workmanship required to be ensured by the Contractor and mention of any specific material or Plant does not necessarily imply that such is included in the Works. All component parts of the Works shall, unless otherwise specified, comply with the provisions of this part or be subject to the approval of the Engineer-in-Charge.

The names of the manufacturers of materials and equipment proposed for incorporation in the Works together with performance, capacities, certified test reports and other significant information shall be furnished by the Contractor.

### 9.2.2. COMPLIANCE WITH STANDARDS:

Where reference is made in the Specification to a British Standard Specification (hereinafter abbreviated to 'B.S.') issued by the British Standards or to an Indian Standard Specification (I.S.) issued by the Bureau of India Standards, American Society for Testing and Materials (ASTM) or American National Standards Institute (ANSI) or to any other equivalent standard it shall be to the latest revision of that standard at the tender opening date.

The specifications mentioned in the tender document shall be read in conjunction with relevant CPWD specifications.

The Contractor may propose at no extra cost to the SAU, the use of any relevant authoritative internationally recognized Reference Standard, including Indian Standard.

All details, materials and equipment supplied and workmanship performed shall comply with these standards. If Contractors offer equipment to other standards, the equipment / material should be equal or superior to those specified and full details of the difference shall be supplied.

In the event of conflict between this specification and the codes for equipment, provisions of this specification shall govern.

### 9.2.3. MATERIALS – GENERAL

- All materials used in the works shall conform to the specifications attached herewith and latest relevant Specifications.
- Unless otherwise specified and expressly approved in writing by the Engineer-in-Charge, materials of makes and specifications mentioned in this document/BOQ shall be used.
- Samples of all materials including all mechanical items shall be got approved before placing order and the approved samples shall be deposited with Engineer-in-Charge.
- If directed, materials shall be tested in an approved testing laboratory and the contractor shall produce the test certificate in original to the Engineer-in-Charge and the charges shall be borne as specified in CPWD specification and general condition of Contract.
- It shall be obligatory for the Contractor to furnish certificates if demanded by the Engineer-in-Charge from manufactures or materials suppliers, that the work has been carried out by using their material and installed/fixed as per their recommendations.
- M.S. Brackets/Hangers: All M.S. Brackets/Hangers for supports of C.I./G.I./P.V.C./H.D.P.E. Pipes shall be fabricated out of Mild Steel sections such as channels, angles, and tees, flats etc. as per drawings or as suitable as per I.S. Code. The welding shall show evenness of ripples or waves and well formed beeds with good fusion along the edges of welds. The welding should be done by qualified/approved welder. There should be no unfilled cavities, small pockets of slags or burned metal air or gas pockets.
- M.S. Brackets/Hangers shall be thoroughly cleaned by wire brush to make the surface clear from any rust before application of paint. The Brackets/Hanger shall be fixed .to the ceiling either by hooking or by Anchor dash fasteners as directed by the Engineer-in-Charge. In case the Brackets cannot be fixed by above methods, due to site, condition, they shall be grouted

with the permission and as directed by the Engineer-in-Charge.

- Sturdy hangers, brackets and saddles of approved design shall be installed to support all pipe lengths, which are not embedded, over their entire run. The hangers and brackets shall be of adjustable heights and primer coated with Zinc Chromate primer. Clamps, collars and saddles to hold pipes shall be provided with nuts, bolts and suitable gaskets. The brackets and hangers shall be designed to carry t he weight of pipes safely and without excessive deflections.
- All pipes and fittings shall be supported near every joint change of direction, or to a maximum of 3M run of pipe, unless otherwise specified. Where called for, pipe hangers shall also be supplied with proper sound and vibration dampening devices to minimize noticeable noise and vibration transmission.
- Details of piping supports both for horizontal and vertical pipes are shown in the relevant drawings and shall be strictly followed by the Contractor.

### 9.2.4. WORKMANSHIP – GENERAL

- Workmanship and general finish shall be of first class quality and in accordance with best workshop practice.
- All similar items of the Plant and their component parts shall be completely interchangeable. Spare parts shall be manufactured from the same materials as the originals and shall fit all similar items. Machining fits on renewable parts shall be accurate and to specified tolerances so that replacements made to may be readily installed.
- All equipment shall operate without excessive vibration and with minimum noise. All revolving parts shall be truly balanced both statically and dynamically so that when running at normal speeds at any load up to the maximum there shall be no vibration due to lack of balance.
- All parts which can be worn or damaged by dust shall be totally enclosed in dust proof housings.
- All materials incorporated in the work shall be most suitable for duty concerned, free from imperfections, selected for long life and minimum maintenance.
- All valves shall be closing on clockwise rotation of the hand wheel. The direction of opening / closing shall be cast on the hand wheel. All flanges shall be drilled in accordance with requirements of IS : 1538.
- All flanges shall be full or spot faces on the back side. The flange thickness shall be uniform throughout.
- Flange outside periphery shall be concentric with the bore. Flanges shall be finished smooth on periphery also.
- Castings and fabricated materials shall be finished smooth all over.

### 9.2.5. GENERAL:

- The work shall be carried out in the accordance with the drawings and design as would be issued to the Contractor by the Design Consultant duly signed and stamped by him. The Contractor shall not take cognizance of any drawings, designs, specifications etc. not bearing Design Consultant signature and stamp. Similarly the Contractor shall not take cognizance of instructions given by any other Authority except the instructions given by the Engineer-in-Charge in writing.
- The work shall be executed and measured as per metric dimensions given in the Bill of Quantities, drawings etc.
- The Contractor shall acquaint himself fully with the partial provisions for supports that may or may not be available in the structure and if are available then utilize them to the extent possible. In any case the Contractor shall provide all the supports regardless of provisions that they have been already made. Nothing extra shall be payable for situations where insert plates (for supports) are not available or are not useful.
- Shop coats of paint that may be damaged during shipment or erection shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with paint to match the finish over the adjoining shop painted surface.
- The Contractor shall protect / handle the material carefully and if any damage occurs while handling by the Contractor then the sole responsibility shall be of the Contractor. Such damages shall be rectified/recovered by the Contractor at no extra cost whatsoever.

- The Contractor shall, within twenty one (21) days of receipt of Direction from Engineer – in-Charge, where applicable, complete the submission of shop drawings to the Engineer-in-Charge for approval by the Design Consultants in order to conform to the contract schedule.
- MEASUREMENTS:
- All measurements shall be taken in accordance with relevant CPWD Specifications/ IS codes, unless otherwise specified.

### 9.2.6. QUALITY ASSURANCE AND QUALITY CONTROL:

- The work shall conform to high standard of design and workmanship, shall be structurally sound and aesthetically pleasing. Quality standards prescribed shall form the backbone for the quality assurance and quality control system
- At the site, the Contractor shall arrange the materials and their stacking/ storage in appropriate manner to ensure the quality. Contractor shall provide equipment and manpower to test continuously the quality of material, assemblies etc. as directed by the Engineer-in-Charge. The test shall be conducted continuously and the result of tests maintained. In addition the Contractor shall keep appropriate tools and equipment for checking alignments, levels, slopes and evenness of surface
- The Engineer-in-Charge shall be free to carry out such tests as may be decided by him at this sole direction, from time to time, in addition to those specified in this Document. The Contractor shall provide the samples and labour for collecting the samples. Nothing extra shall be payable to the Contractor for samples or for the collection of the samples.
- The test shall be conducted at Standard Laboratory selected by Engineer-in-Charge. Contractor shall keep the necessary testing equipment such as hydraulic testing machine, smoke testing machine, gauges and other necessary equipment required.
- The representative of Engineer-in-Charge shall transport the samples to the laboratory but the expenditure of transportation shall be borne by the Contractor.
- Testing charges shall be borne by the SAU as specified in tender document.
- Testing may be witnessed by the Contractor or his Authorized Representative. Whether witnessed by the Contractor or not, the test results shall be binding on the Contractor.

### 9.2.7. SCOPE

Work under this section consists of supplying, fixing, furnishing all labor, materials equipment and appliances necessary and required to completely install the water supply, Sanitary installation, sewerage & storm system and fire fighting system as required by the drawings, specified hereinafter and given in the bill of quantities.

## 9.3. SANITARY FIXTURES & C.P. FITTINGS

### 9.3.1. Scope:

Work under this section shall consist of providing, transportation, furnishing, installation, testing and commissioning and all labour as necessary as required to completely install all sanitary fixtures, brass and chromium plated fittings and accessories as required by the drawings and specified hereinafter or given in the Bill of Quantities.

### 9.3.2. General Requirements

**9.3.2.1.** All fixtures and fittings shall be fixed with all such accessories as are required to complete the item in working condition whether specifically mentioned or not in the Bill of Quantities, specifications, drawings.

**9.3.2.2.** All fixtures and accessories shall be fixed in accordance with a set pattern matching the tiles or interior finish as per architectural design requirements. Wherever necessary the fittings shall be centered to dimensions and pattern desired.

**9.3.2.3.** Fixing screws shall be half round head chromium plated brass with C.P. washers wherever required as per directions of Engineer-in-Charge.

**9.3.2.4.** All fittings and fixtures shall be fixed in a neat workmanlike manner true to levels and heights shows on the drawings and in accordance with the manufacturers recommendations. Care shall be taken to fix all inlet and outlet pipes at correct positions. Faulty locations shall be made good and any damage to the finished floor, wall or ceiling surfaces shall be made good at Contractors cost.

**9.3.2.5.** Wall flanges shall be provided on all walls, floors, columns etc. wherever supply and disposal pipes pierce through them. These wall caps shall be or chromium plated brass fittings and the receiving pipes and shall be large enough to cover the punctures properly.

**9.3.2.6.** All fixtures of similar materials shall be by the same manufacturers.

**9.3.2.7.** All fittings shall be of chromium plated materials.

**9.3.2.8.** Fixtures shall be installed by skilled workman with appropriate tools according to the best trade practice.

**9.3.2.9.** All appliances, fixtures and fittings shall be provided with all such accessories as are required to complete the item in working condition whether specifically mentioned or not in the Schedule of Quantities, specifications, drawings. Accessories shall include proper fixing arrangements, brackets, nuts, bolts, washers, screws and required connection pieces.

**9.3.2.10.** For the installation of the CP fittings, teflon tape shall be used.

**9.3.2.11.** All materials shall be rust proofed; materials in direct or indirect contact shall be compatible to prevent electrolytic or chemical (bimetallic) corrosion.

**9.3.2.12.** Sanitary appliances, subject to the type of appliance and specific requirements, shall be fixed in accordance with the relevant standards and the following :

i. Contractor shall, during the entire period of installation and afterwards protect the appliances by providing suitable cover or any other protection so as to absolutely prevent any damage to the appliances until handing over (The original protective wrapping shall be left in position for as long as possible)

ii. The appliances shall be placed in correct position or marked out in order that pipe work

can be fixed or partially fixed first.

iii. The appliance shall be fixed in a manner such that it will facilitate subsequent removal if necessary.

iv. The appliance shall be securely fixed. Manufacturer's brackets and fixing methods shall be used wherever possible. Compatible rust-proofed fixings shall be used. Fixing shall be done in a manner that minimizes noise transmission.

v. Appliances shall not be bedded (e.g. WC pans, pedestal units) in thick strong mortar that could crack the unit (e.g. ceramic unit)

vi. Pipe connections shall be made with demountable unions. Pipe work shall not be fixed in a manner that it supports or partially supports and appliance.

vii. Appliances shall be fixed true to level firmly fixed to anchor or supports provided by the manufacturer and additional anchors or supports where necessary.

**9.3.3.** Sizes of sanitary fixtures given in the Specifications or in the Schedule of Quantities are for identification with reference to the catalogues of make considered. Dimensions of similar models of other makes may very within + 10% and the same shall be provided if approved by the Engineer-in-Charge and no claim for extra payment shall be entertained nor shall any payment be deducted on this account.

**9.3.4.** The contractor shall fix all plumbing fittings such as water faucets, shower fittings, mixing valves etc. in accordance with manufacturer’s instructions and connect to piping system. The contractor shall supply all fixing materials such as screws, rawl plugs, unions, collars, compression fittings etc., as required.

**9.3.5.** Joints / gaps between all sanitary appliances / fixtures and the floor / walls shall be caulked with an approved mildew resistant sealant, having antifungal properties, of colour and shade to match that of the appliances / fixture and the floor / wall to the extent possible.

**9.3.6. European W.C:**

**9.3.6.1.** European W.C. of glazed vitreous china shall be wash down, double siphonic type, floor or wall mounted set, flushed by means of flush valve as specified in Bill of Quantities. Flush pipe/bend shall be connected to the W.C. by means of suitable rubber adopter. Wall hung W.C. shall be supported by C.I. wall /floor mounted chair.

**9.3.6.2.** Each W.C. seat cover shall be so fixed that it remains absolutely stationary in vertical position without falling down on the W.C. Seat cover shall be of white solid plastic, elongated open front with heavy duty hinges. Exposed fixture trims shall be Chrome plated, and trims of similar function shall be by the same manufacturer.

**9.3.6.3.** Flush valves shall be of the best approved quality procurable with C.P. control valve and C.P. flush pipe.

**9.3.6.4.** The flush pipe/bend shall be connected to the WC by means of a suitable rubber adopter.

**9.3.6.5.** The levels of the WC should be checked by placing spirit level on the W.C. W.C. should be tested on completion of fixing by putting small paper balls and flushing out. If all the paper balls are not flushed out. The fixing will have to be rectified / re-aligned.

**9.3.6.6.** Each WC shall be provided with 110 mm dia (OD) PVC Pan connector connecting the ceramic outlet of WC to CI pipe.

**9.3.7. Kitchen /pantry sinks:**

**9.3.7.1.** Sinks shall be of stainless steel material as specified in the Bill of Quantities/Drawings.

**9.3.7.2.** Each sink shall be provided with painted MS or CI brackets and clips and securely fixed. Counter top sinks shall be fixed with suitable painted angle iron brackets or clips as recommended by the manufacturer. Each sink shall be provided with 40mm dia CP waste and rubber plug with CP brass chain as given in the Schedule of Quantities. The MS angle shall be provided with two coats of red oxide primer and two coats of synthetic enamel paint of make, brand and colour as approved by the Engineer-in-Charge.

**9.3.7.3.** Sanitary fittings for sinks shall be deck mounted or wall mounted CP swivel faucets with or without hot and cold water mixing fittings as specified in the Schedule of Quantities.

**9.3.8. Wash Basins:**

**9.3.8.1.** Wash basin shall be of vitreous china of approved shade and of best quality manufactured by an approved firm and sizes as specified in the Bill of Quantities.

**9.3.8.2.** Wash basin shall be of under counter drop in type shall be supported on a pair of rolled steel brackets of approved design and shall be mounted on a countertop. So that rim and basin bowl is exposed from top.

**9.3.8.3.** Wash basin shall be fixed at proper location and height and truly horizontal as shown on drawing or as directed by Engineer-In-Charge.

**9.3.9. Hose bib's:**

Hose Bib of Chromium Plate tap is draw off tap with horizontal inlet and free outlet knurling on outer face to fix the hose pipe. Hose bib shall be of specified size and shall be of screw down type and shall conform to IS:781-1984. The closing device shall work by means of a disc carrying a renewable non-metalic washer which shuts against the water pressure on a seating at right angle to the axis of the threaded spindle which operate it. The handle shall be either crutch or butterfly type securely

**9.3.10. Urinals:**

**9.3.10.1.** Half stall wall hung urinals of glazed vitreous china shall be provided with 15mm dia, C.P. brass spreader, 32mm dia C.P. domical waste and C.P. cast brass bottle trap with pipe and wall flange and shall fixed to wall by one C.I. bracket and two C.I. clips as recommended by manufacturers complete as directed by the Engineer-In-Charge.

**9.3.10.2.** Flushing for urinals shall be by means of no hand operation, infrared electric flush valve with complete kit of plumbing, electrical and electronic items, infrared photo cells, solenoid valve transformer and electrical connection. The automatic flush sensor plate shall be flush and press fitted and be of high quality mirror polish finish. Each urinal shall be provided with one flush valve unit. Each Urinal flushing water supply line should be provided with ball valve for maintenance purpose.

**9.3.10.3.** Flush pipes shall be cpvc pipes concealed in wall chase but with chromium plated bends at inlet and outlet.

**9.3.10.4.** Urinal Partitions

Urinal partitions shall be fixed at proper heights with CP brass bolts, anchor fasteners and MS clips as recommended by the manufacturer and directed by the Engineer-In-Charge.

**9.3.11. Shower set:**

Shower set shall comprise of two CP brass concealed stop cocks, four/five way auto-diverter, adjustable type over-head shower with CP shower arm , all with CP wall flanges of approved quality

all as specified in the Schedule of Quantities. Bath spout, hand showers and pop up wastes shall also be provided wherever, specified. Wall flanges shall be kept clear off the finished wall. Wall flanges embedded in the finishing shall not be accepted.

**9.3.12. WC Pan Connector:**

**9.3.12.1.** The WC pan connector shall be flexible/soft and shall be made of single body construction with integral fins, made from EVA (Ethgl vingl Acetate). The pan connector must confirm to BS 5627: 1984. The pan connector must be supplied with one seal made of TPE (Thermo plastic Elastomeric). The pan connector must be supplied with factory fitted spring loaded seal guard.

**9.3.12.2.** The connector shall not be allowed to come in contact with mineral oil, grease, putty or any compound containing mineral oil or grease.

**9.3.12.3.** The pan connector must be stored away from direct sun light and flames.

**9.3.13. Fixing:**

The soil pipe must be reasonably clean and smooth, in case the soil piping is in C.I material then supplier supplied bush/adaptor shall be used. The connector socket is pushed fully home on to the pan spigot, there after the WC is placed in position gently pushing the fitment to ensure that the connector end fits into the spigot of the pipe. The pan connector must be pushed in such a way as to ensure that the seats and fins turn inward to ensure proper sealing.

**9.3.14. Accessories:**

**9.3.14.1.** Accessories shall be of the following types:

- Towel rails
- Towel rings
- Coat hooks
- Soap dispensers
- Soap dishes
- Air purifier container
- others

**9.3.14.2.** Accessories shall be fixed with stainless steel half round head screws and cup washers in wall with rawl plugs or nylon sleeves and shall include cutting and making good the walls.

**9.3.14.3.** Porcelain accessories shall be fixed in walls and set in cement mortar 1:2 (1 cement: 2 coarse sand) and fixed in relation to the tiling work. The flange of the recessed fixture shall cover the recess in the wall fully.

**9.3.15. Mock-up and trial assembly:**

The installation of the Sanitary fixtures and fittings shall be as per the shop drawings approved by the Engineer-In Charge

The contractor shall have to assemble at least one set of each type of sanitary fixtures and fittings in order to determine precisely the required supply and disposal connections. Relevant instructions from manufacturers shall be followed as applicable. This trial assembly shall be developed to determine the location of puncture holes, holding devices etc. which will be required for final installation of all sanitary fixtures and fittings. The above assembly shall be subject to final approval by the Engineer-In-Charge.

The fixtures in the trial assembly can be re-used for final installation without any additional payments for fixing or dismantling of the fixtures.

### 9.3.16. Supporting And Fixing Devices

The contractor shall provide all the necessary supporting and fixing devices to install the sanitary fixtures and fittings securely in position. The fixing devices shall be rigidly anchored into the building structure. The devices shall be rust resistant and shall be so fixed that they do not present an unsightly appearance in the final assembly. Where the location demands, the Architect may instruct the contractor to provide chromium plated or other similarly finished fixing devices. In such circumstances the contractor shall arrange to supply the fixing devices and shall be installed complete with appropriate vibration isolating pads, washers and gaskets.

### 9.3.17. Final Installation

The contractor shall install all sanitary fixtures and fittings in their final position in accordance with approved trial assemblies and as shown on drawings. The installation shall be complete with all supply and waste connections. The connection between building and piping system and the sanitary fixtures shall be through proper unions and flanges to facilitate removal/replacement of sanitary fixtures without disturbing the built in piping system. All unions and flanges shall match in appearance with other exposed fittings.

Fixtures shall be mounted rigid, plumb and to alignment. The outlets of water closet pans and similar appliances shall be examined to ensure that outlet ends are butting on the receiving pipes before making the joints. It shall be ensured that the receiving pipes are clear of obstruction. When fixtures are being mounted, attention shall be paid to the possibility of movement and settlement by other causes. Overflows shall be made to ensure that necessary anchoring devices have been provided for supporting water closets, wash basins, sinks and other appliances.

### 9.3.18. Protection Against Damage

The contractor shall take every precaution to protect all sanitary fixtures against damage, misuse, cracking, staining, breakage and pilferage by providing proper wrapping and locking arrangement till the completion of the installation. At the time of handing over, the contractor shall clean, disinfect and polish all the fixtures and fittings. Any fixtures and fittings found damaged, cracked chipped stained or scratched shall be removed and new fixtures and fittings free from defects shall be installed at his own cost to complete the work.

### 9.3.19. Testing:

All appliances, fixtures and fittings shall be tested before and after installation. Water seals of all appliances shall be tested. The contractor shall block the ends of waste and ventilation pipes and shall conduct an air test.

## 9.4. D.I. PIPE FOR DOMESTIC & FLUSHING WATER SUPPLY FOR EXTERNAL WORKS

### 9.4.1. Applicable codes

The laying of DI pipes and fittings / specials shall comply with all currently applicable statutes, regulations, standards and codes. In particular the following standards, unless otherwise specified herein, shall be referred. In all cases, the latest revision of the standards/codes shall be referred to. Other IS: Codes not specifically mentioned here but pertaining to the use of DI pipes shall be part of this Specification.

| I.S. Number | Title |
|---|---|
| IS: 8329: 2000 Amend No.-1 2000 | Centrifugally cost (spun) ductile iron Pressure pipes for water, gas and sewage (third revision) |
| IS: 9523: 2000 | Ductile iron fittings for pressure pipes for water, gas and sewage. |
| IS: 12288: 1987 | Code of practice for use and laying of ductile iron pipes. |
| IS: 5382: 1985 | Rubber sealing rings for gas mains, water mains and sewer (first revision) |
| IS: 11906:1986 | Cement Mortar lining in the pipe |

### 9.4.2. Ductile iron pipes

**9.4.2.1.** The pipes shall be centrifugally cast (spun) Ductile iron pipes for water and sewage confirming to the IS 8329: 2000. The pipes used shall be either with push on joints (Rubber Gasket Joints) or Flanged joints. The class of pipe to be used shall be of the class K-7/K-9 as specified in the BOQ.

**9.4.2.2.** The pipes shall be coated with bitumen and have factory provided cement mortar lining in the inside as per the provisions of the IS 8329:2000. The pipes are supplied in standard length of 4.00, 5.00, 5.50 and 6.00 meters length with suitably rounded or chamfered ends. Each pipe of the push on joint variety shall also be supplied with a rubber EPDM/(SBR) gasket.

**9.4.2.3.** The flanged joints shall confirm to the Clause 6.2 of IS: 8329.The pipe supply shall include one rubber gaskets for each flange.

**9.4.2.4.** Specifications of sockets and spigot pipes, classes K7 and K9 are mentioned below.

| Nominal Diameter | External Diameter | Barrel Wall thickness 'e' | |
|---|---|---|---|
| DN | DE | K7 | K9 |
| 80 | 98 | 5 | 6.0 |
| 100 | 118 | 5 | 6.0 |
| 125 | 144 | 5 | 6.0 |
| 150 | 170 | 5 | 6.0 |
| 200 | 222 | 5 | 6.3 |
| 250 | 274 | 5.3 | 6.8 |
| 300 | 326 | 5.6 | 7.2 |
| 350 | 378 | 6.0 | 7.7 |
| 400 | 429 | 6.3 | 8.1 |
| 450 | 480 | 6.6 | 8.6 |

### 9.4.3. Coating:

Pipe shall be supplied internally (cement mortar lining) and externally (bituminous coating) coated as under:

### 9.4.4. Cement Mortar Lining

Cement -the cement used for the lining shall conform to the existing standards on cement, The type of cement to be used is to be mutually decided between the purchaser and manufacturer, Normal recommendations are:

Portland cement (as per IS 8112 or IS 455) mortar lining perform rather well and have an expected life of approximately 50 years in soft water with moderate amount of aggressive Co2 and when Ph is within 6 to 9. Longer service life can be obtained by increasing the mortar lining thickness.

Where cement mortar lining may be exposed to sulphate attack, ordinary Portland cement should be replaced by sulphate resisting Portland cement (as per IS 12330 or IS 6909).

The sulphate concentration limit for sulphate resisting Portland in approximately 3000 mg/liter, the same as blast furnace slag cement which naturally possess a good resistant to sulphate attack.

High alumina cement (as per IS 6452) mortar lining is suitable for continuous use of pH between 4 and 12 and no sever damage occur after occasional exposure to pH 3 to 4 and 12 to 13.

### 9.4.5. Bituminous Coating

Coating shall not be applied to any pipe unless its surfaces are clean, dry and free from rust.

The coating material shall set rapidly with good adherence and shall not scale off.

The mean thickness of the coating shall be not less than 70 µm and the local. Minimum thickness shall be not less than 50 µm.

When the pipes to be used for conveying potable water the inside coating shall not contain any constituent soluble in such water or any ingredient which could impart any taste or whatsoever to the potable water after sterilization and suitable washing of the mains.

Pipes with or without sockets and flanges which are imperfectly coated or where the coating does not set or conform to the required quality, the coating shall be removed and the pipes/flanges recoated.

### 9.4.6. Hydrostatic site test pressures and hydraulic working pressure.

Hydrostatic site test pressures and hydraulic working pressure of the newly laid pipe line is specified as under in

Refer Amendment No.1, (Annex E -Table 1) : IS 8329-2000

| DN | Allowable operating pressure(excluding surge) AOP | | Allowable Maximum Operating pressure (Including surge) MOP | | Allowable site test Pressure (STP) | |
|---|---|---|---|---|---|---|
| | K7 | K9 | K7 | K9 | K7 | K9 |
| | MPa | | MPa | | MPa | |
| 80 | 0.8 | 6.4 | 1.25 | 7.7 | 1.75 | 9.6 |
| 100 | 0.8 | 6.4 | 1.25 | 7.7 | 1.75 | 9.6 |
| 125 | 0.8 | 6.4 | 1.25 | 7.7 | 1.75 | 9.6 |
| 150 | 0.8 | 6.4 | 1.25 | 7.7 | 1.75 | 9.6 |
| 200 | 0.8 | 6.2 | 1.25 | 7.4 | 1.75 | 7.9 |
| 250 | 0.8 | 5.4 | 1.25 | 6.5 | 1.75 | 7.0 |
| 300 | 0.8 | 4.9 | 1.25 | 5.9 | 1.75 | 6.4 |

### 9.4.7. Other Test of Pipes :

Mechanical test are carried out during the manufacture. One test shall be conducted for every batch of production.

Tensile Test shall be conducted by cutting a sample from the spigot end of the pipe. This sample may be cut perpendicular to or parallel with the pipes axis, but in case of dispute the parallel to axis sample shall be used.

Two methods of measuring the tensile strength may be used at the manufacturer's option.

Method 1 - Machine the test bar to its nominal diameter + 10 percent, measure the actual diameter before the test with an accuracy of 0.01 mm and use this measured diameter to calculate the cross-sectional area and the tensile strength; or:

Method 2 - Machine the test bar to its nominal area S0 within a specified tolerance on diameter and use the nominal area to calculate the tensile strength.

Brinell Hardness Test :

When tested in accordance with IS 1500, the Brinell hardness shall not exceed 230 HB on the external un-machined surface.

### 9.4.8. Marking

Each pipe shall have as cast or stamped or legibly and indelibly painted on it with the following appropriate marks:

(a) Indication of the source of manufacture:

(b) The nominal diameter:

(c) Class reference;

(d) The last two digits of the year of manufacturer:

(e) The non-standard length of the pipe if specially ordered:

(f) Where applicable, an indication of length over which the pipe is suitable for cutting on site:&

(g) A short white line at the spigot end of each pipe with push-on joint in sizes DN 700 and above, to indicate the major axis of the spigot.

### 9.4.9. Fittings

Dimensional and other requirement for fittings for specified Diameter shall conform to the details given in tables 15 to 31 section 3 of the IS specification code IS: 9523: 2000.

### 9.4.10. Hydrostatic Test

For hydrostatic test, the fittings shall be kept under pressure for 10 seconds. They shall withstand the pressure test without showing any sign of leakage, sweating or other defect of any kind. The test shall be conducted before the application of surface coating.

The fittings shall withstand the hydrostatic pressure given in below table

**Hydrostatic test pressure for castings**
**(Refer Table No. 2 IS 9523-2000)**

| **Nominal Diameter DN (mm)** | **Hydrostatic Test Pressure at works, MPa** |
|---|---|
| Up to and including 300 | 2.5 |
| Over 300 and up to and including 600 | 1.6 |

**9.4.11. Specification for Laying and jointing of Pipe Line System for water Supply.**

Code of practice for use and laying of DI Pipes should be as per IS 12288:1987.

**9.4.11.1.** Preparatory work:

The contractor will inspect the route along which the pipe line is proposed to be laid. He should observe/find out the existing underground utilities/construction and propose an alignment along which the pipeline is to be laid.

**9.4.11.2.** He should make all efforts to keep the pipe as straight as possible with the help of ranging rods. Wherever there is need for deviation, it should be done with the use for necessary specials or by deflection in pipe joints

**9.4.11.3.** The alignment as proposed should be marked on ground with a line of white chalk and got approved from Engineer-In-Charge. The contractor will than prepare an L-Section along this alignment showing the location of proposed pipe line. The L-section should also be got approved from the Engineer-in-Charge. The position of fittings, valves, shall be shown on the plan or as per site requirement.

**9.4.11.4.** Alignment and the L-sections:

The alignments-section (depth of laying) and location of specials, valves and chambers may be changed at site in co-operation with and after approval of the Engineer- in-Charge.

**9.4.11.5.** Transportation of pipes and specials:

The contractor has to transport the pipes and other materials form supplier to the site of laying as indicated by the Engineer-in-Charge. Pipes should be handled with care to avoid damage to the surface, internal lining and the socket and spigot ends, deformation or bending.

**9.4.11.6.** Pipes shall not be dragged along the ground or the loading end of a vehicle. Pipes shall be transported on flat bed vehicles/trailers. The bed shall be smooth and free from any sharp objects. The pipes shall rests uniformly on the vehicle bed in their entire length during transportation. Pipes shall be loaded and un-loaded manually or by suitable mechanical means without causing any damage.

**9.4.11.7.** Cranes or chain pulley block or other suitable handling and lifting equipment shall be used for loading and un-loading of heavy pipes. However, for pipes up to 400 mm nominal bore, skid timbers and ropes may be used.

**9.4.11.8.** Where using crane hooks at sockets and spigot ends hooks shall be broad and protected by rubber or similar material, in order to avoid damage to pipe ends and lining. Damage to lining must be repaired before pipe laying. **Pipes shall not be thrown directly on the ground.**

**9.4.12. Bedding of the pipes:**

**9.4.12.1.** The pipe shall be laid out along the proposed alignment in a such a manner that they do not create any problem to public and are not damaged.

**9.4.12.2.** The trench bottom shall be even and smooth so as to provide a proper support for the pipe over its entire length, and shall be free from stones, lumps, roots and other hard objects that may endure the pipe or coating. Holes shall be dug in the trench bottom to accommodate sockets so as to ensure continues contact between the trench and the entire pipe barrel between socket holes.

**9.4.13. Laying and jointing of DI pipes**

**9.4.13.1.** Pipes should be lowered into the trench with tackle suitable for the weight of pipes. For smaller sizes, up to 200 mm nominal bore, the pipe may be lowered by the use of ropes but for heavier pipes suitable mechanical equipment have to be used.

**9.4.13.2.** All construction debris should be cleared from the inside of the pipes either before or just after a joint is made. This is done by passing a pull-through in the pipe, or by hand, depending on the size of the pipe. All persons should vacate any section of trench into which the pipe is being lowered.

**9.4.13.3.** On gradients of 1: 15 or steeper, precautions should be taken to ensure that the spigot of the pipe being laid does not move into or out of the socket of the laid pipe during the jointing operations. As soon as the joint assembly has been completed, the pipe should be held firmly in position, while trench is back filled over the barrel of the pipe.

**9.4.13.4.** The designed anchorage shall be provided to resist the thrusts developed by internal pressure at bends, tees, etc.

**9.4.13.5.** Where a pipeline crosses a watercourse, the design and method of construction should take into account the characteristics of the watercourse to ascertain the nature of bed, scour levels, maximum velocities, high flood levels, seasonal variation, etc. which effect the design and laying of pipeline.

**9.4.13.6.** The socket and spigot end of the pipes shall be brushed and cleaned .The chamfered surface and the end of the spigot end has to be coated with a suitable lubricant recommended by the manufacturer of the pipes. Oil, petroleum bound oils, grease or other material which may damage the rubber gasket shall not be used as lubricant. The rubber gasket shall be inserted into the cleaned groove of the socket. It has to be checked for correct positioning.

**9.4.13.7.** The rubber gaskets shall be kept in their original packing and stored in cool conditions/not exposed to the direct sunlight, should only be taken out when needed.

**9.4.13.8.** The two pipe shall be aligned properly in the pipe trench and the spigot end shall be pushed axially into the socket either manually or with a suitable tool specially designed for the reassembly of pipes and as recommended by the manufacturer. The spigot has to be inserted up to the insertion mark on the pipe spigot. After insertion, the correct position of the socket has to be tested with a feeler blade.

**9.4.13.9.** Deflection of the pipes if-any-shall be made only after they have fully been assembled. The deflection shall not exceed 75% of the values indicated by the pipe manufacturer.

### 9.4.14. Joints

**9.4.14.1.** In the case of push-on with or without centering rings.

**9.4.14.2.** The lengths of the spigot necessary for jointing shall not be less than the length of the socket of the jointing pipe.

**9.4.14.3.** In case of push-on-joint the spigot end of fitting, if any, shall be suitably chamfered to facilitate smooth entry of spigot in the socket of the pipes or fittings fitted with rubber gasket.

**9.4.14.4.** In case of flange and mechanical joint casting, the flange shall be at right angle to the axis of the joint. The bolt holes shall be either cored or drilled.

**9.4.14.5.** The center of bolt holes circle shall be concentric with the bore circle and shall be located of the centre line. Unless otherwise specified by the purchaser. Where there are two or more flanges, the bolt holes shall be correctly aligned between them.

**9.4.14.6.** For high pressure mains, requiring working pressure greater than 2.4 MPa,suitable flexible joint may be preferred where the joint is restrained against axial movement.

**9.4.14.7.** Push-on-joint fittings are normally not used for sizes above DN 1600.

### 9.4.15. Rubber Gaskets

The material of rubber gaskets for use with mechanical joints and push-on-joints shall conform to IS: 5382. Unless otherwise agreed between the manufacturer and the purchaser. Dimensions of the rubber gasket shall be as per

### 9.4.16. Anchoring of the pipeline

Thrust block shall be provided at each bend, tee, taper, end piece to prevent undue movements of the pipeline under pressure. They shall be constructed as per design of Engineer-in-Charge according to the highest pressure during operation or testing of the pipes, the safe bearing pressure of the surrounding soil and the friction coefficient of the soil.

### 9.4.17. Measurement

The length of pipes as laid or fixed should be measured in running meters as per CPWD specifications.

## 9.5. HDPE PIPE FOR IRRIGATION WATER SUPPLY

### 9.5.1. Applicable Codes

The following standards, unless otherwise specified herein, shall be referred. In all cases the latest revision of the Codes shall be referred to. If requirements of this specifications conflict with the requirements of the standards /Codes, this specification shall govern.

| Code No. | Title/Specification |
|---|---|
| IS 4984 amendment No.2 1995 | High Density polyethylene pipes for Water Supply |
| IS 5382 | Rubber sealing rings for gas mains, water mains and sewers. |
| IS 7634 | Laying & jointing of polyethylene (PE) Pipes |
| ISO 4427 | Medium Density Polyethylene Pipes for Water Supply |
| IS 2530 | Methods of test for polyethylene moulding materials and polyethylene compounds |
| IS 4905 | Methods for random sampling |
| IS 9845 | Method of analysis for the determination of specific and/or overall migration of constituents of plastics material and articles intended to come into contact with foodstuffs. |
| IS 10141 | Positive list of constituents of polyethylene in contact with food stuffs, pharmaceuticals and drinking water. |

### 9.5.2. Specification of Pipes :

**9.5.2.1.** Colour

The colour of the pipe shall be black. Each pipe shall contain minimum three equispaced longitudinal stripes of width 3 mm (Min) in blue colour. These stripes shall be more than 0.2 mm in depth. The material of the stripes shall be of the same type of resin, as used in the base compound for the pipe.

**9.5.2.2.** Dimensions of pipes and ovality of pipe

Ovality shall be measured at the manufacturer's end as the difference between maximum outside diameter and minimum out-side diameter measured at the same cross section of the pipe, at 300mm away from the cut end. For pipes to be coiled, the ovality shall be measured prior to coiling For coiled pipes, however, re-rounding of pipe shall be carried out prior to the measurement of ovality.

**9.5.2.3.** Outside diameter, tolerance and ovality of pipes shall be as per below table. Tolerance and ovality is given below:-

**(Refer Table No. 2 IS 4984-1995)**

| Outside Diameter (mm) | Tolerance (only positive tolerances) (mm) | Ovality (mm) |
|---|---|---|
| 20 | 0.3 | 1.2 |
| 25 | 0.3 | 1.2 |
| 32 | 0.3 | 1.3 |
| 40 | 0.4 | 1.4 |
| 50 | 0.5 | 1.4 |
| 63 | 0.6 | 1.5 |
| 75 | 0.7 | 1.6 |

| | | |
|---|---|---|
| 90 | 0.9 | 1.8 |
| 110 | 1.0 | 2.2 |
| 125 | 1.2 | 2.5 |
| 140 | 1.3 | 2.8 |
| 160 | 1.5 | 3.2 |
| 180 | 1.7 | 3.6 |
| 200 | 1.8 | 4.0 |

**9.5.2.4.** Wall thickness as per allowable hydrostatic design stress-

The minimum & maximum wall thickness of pipe for the PE100 grade of pipe as per IS : 4984 for PN6, PN8 & PN10 shall be as per table below.

**(Refer Table No. 5 (Amendment No.2) IS 4984-1995)**

| **Nominal Dia** | **Wall Thickness of Pipes** | | | | | |
|---|---|---|---|---|---|---|
| | **PN 6** | | **PN8** | | **PN 10** | |
| **DN** | **Mix** | **Max** | **Mix** | **Max** | **Mix** | **Max** |
| **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| 20 | - | - | - | - | - | - |
| 25 | - | - | - | - | - | - |
| 32 | - | - | - | - | 2.4 | 2.9 |
| 40 | - | - | 2.4 | 2.9 | 3.0 | 3.5 |
| 50 | 2.3 | 2.8 | 3.0 | 3.5 | 3.7 | 4.3 |
| 63 | 2.9 | 3.4 | 3.8 | 4.4 | 4.7 | 5.4 |
| 75 | 3.5 | 4.1 | 4.5 | 5.2 | 5.6 | 6.4 |
| 90 | 4.1 | 4.8 | 5.4 | 6.2 | 6.7 | 7.6 |
| 110 | 5.0 | 5.7 | 6.6 | 7.5 | 8.1 | 9.2 |
| 125 | 5.7 | 6.5 | 7.5 | 8.5 | 9.2 | 10.4 |
| 140 | 6.4 | 7.3 | 8.4 | 9.5 | 10.3 | 11.6 |
| 160 | 7.3 | 8.3 | 9.6 | 10.8 | 11.8 | 13.2 |
| 180 | 8.2 | 9.3 | 10.8 | 12.1 | 33.3 | 14.9 |
| 200 | 9.1 | 10.3 | 12.0 | 13.4 | 14.8 | 16.5 |

**9.5.2.5.** Length of straight Pipe & marking on pipe

The length of straight pipe used shall be more than 6 m or as agreed by Engineer in charge. Short lengths of 3 meter (minimum) up to a Maximum of 10 % of the total supply may be permitted.

Each straight length of pipe shall be clearly marked in indelible ink/paint on either end and for coil at both ends or hot embossed on white base every meter throughout the length of pipe/coil with the following information:

(a)Manufacturers' name/Trade mark
(b) Designation of pipe
(c) Lot No./Batch No.
(d) BIS certification marking on each pipe.

**9.5.2.6.** Coiling

The pipes supplied in coils shall be coiled on drums of minimum diameter of 25 times the nominal diameter of the pipe ensuring that kinking of pipe is prevented. Pipe beyond 110 mm dia shall be supplied in straight length not less than 6m.

**9.5.2.7.** Appearance

Pipe shall be free from all defect including indentation, delaminating, bubbles, pinholes, cracks, pits, blisters, foreign inclusion that due to Their nature degree or extent detrimentally affect the strength and Serviceability of the pipe. 8.7.2 The pipe shall be as uniform as commercially practicable in colour opacity, density and other physical properties as per relevant IS code or equivalent International Code. The inside surface of each pipe shall be free of scouring, cavities, bulges, dents, ridges and other defects that result in a variation of inside diameter from that obtained on adjacent unaffected portions of the surface. The pipe ends shall be cut clearly and perpendicular to the axis of the pipe.

**9.5.3. Marking :**

**9.5.3.1.** Each straight length of pipe shall be clearly marked in indelible ink/paint on either end and for coil at both ends or hot embossed on white base every meter throughout the length of pipe/coil with the following information:

(a) Manufacturer's name/Trade-mark.
(b) Designation of pipe
(c) Lot number/Batch number.

**9.5.3.2.** BIS Certification Marking

Each pipe may also be marked with Standard Mark.

**9.5.3.3.** Testing of Pipe :

**9.5.3.4.** HDPE pipes are subjected to following tests :-

Internal pressure creep rupture test
Longitudinal Revision Test
Overall Migration Test
Density
Melt Flow Rate (MFR)
Carbon Black Content and Dispersion

**9.5.4. Handling, Transportation storage and Lowering of pipes.**

**9.5.4.1.** If transportation of HDPE pipes from a distance greater than 300km than pipes shall be received only when bare coils of pipe have been wrapped with hessian cloth.

**9.5.4.2.** The truck use for transportation of the HDPE pipes shall be exclusively used of HDPE pipes only with no other material loaded-especially no metallic, glass and wooden items. The truck shall not have sharp edges that can damage the pipe.

**9.5.4.3.** At the time of opening coils it must be remembered that the coiled under tension and must be open in control manner. Straight length should be stored on horizontal racks giving continuous support. Loss/damages during transit, handling, storage will be to the contractor's account.

**9.5.4.4.** During handling, transportation, storage and lowering, all sections shall be handled by such means and in such a manner that no distortion or damage is done to the section or to the pipes as a whole.

**9.5.4.5.** Pipes must no be stored or transported where they are exposed to heat sources likely to exceed 60º C.

**9.5.4.6.** Pipes shall be stored such that they are not in contact with direct sunlight, lubricating or hydraulic oils, petrol, solvents and other aggressive materials

**9.5.4.7.** Scores or scratches to a depth of greater than 10 % or more of wall thickness are not permissible; any pipes having such defects should be strictly rejected.

**9.5.4.8.** PE pipes should not be subjected to rough handling during loading and unloading operations. Rollers shall be used to move, drag the pipes across any surface.

**9.5.4.9.** Only polyester webbing slings should be used to lift heavy HDPE (>315mm dia) pipes by crane. Under no circumstances, chains, wire ropes and hooks be used on PE surface.

**9.5.4.10.** Pipes shall not be dropped to avoid impact or bump. If any time during handling or during installation, any damage, such as gouge, crack or fracture occurs, the pipe shall be repaired if so permitted by the competent authority before installation.

**9.5.5. Lowering, Laying of pipes**

**9.5.5.1.** IS: 7634 shall be applicable. Before using the pipe following precautions/check shall be taken.

**9.5.5.2.** Each pipe shall be thoroughly checked for any damages before laying and only the pipes which are approved by the Engineer-in-Charge shall be laid.

**9.5.5.3.** While installing the pipes in trenches, the bed of the trench should be level and free from sharp edged stones. In most cases, the bedding is not required, as long as the sharp and protruding stones are removed, by sieving the dug earth, before using the same as a backfill material. While laying in rocky areas suitable bed of sand or gravel should be provided. The fill to about 10 to 15 cm above the pipe should be fine sand or screened excavated material. Where hard rock is met with, bed concrete 15 cm thick of grade M-15 or 20 cm thick sand bed as approved by the engineer may be provided.

**9.5.5.4.** As PE pipes are flexible, long lengths of fusion-jointed pipes having joints made above ground can be rolled or snaked into narrow trenches. Such trenches can be excavated by narrow buckets.

**9.5.5.5.** During the pipe laying of continuous fusion jointed systems, due care and allowance should be made for the movements likely to occur due to the thermal expansion/contraction of the material. This effect is most pronounced at end connections to fixed positions (such as valves etc.) and the branch connections. Care should be taken in fixing by finishing the connections at a time the length of the pipe is minimal (lower temperature times of the day).

**9.5.5.6.** For summer time installations with two fixed connection points, a slightly longer length of PE pipe may be required to compensate for contraction of the pipe in the cooler trench bottom.

**9.5.5.7.** The final tie-in connections should be deferred until the thermal stability of the pipeline is achieved.

**9.5.5.8.** The flexibility of polyethylene pipes allows the pipe to be cold bend. The fusion jointed PE pipe is also flexible as the plain pipe. Thus the total system enables directional changes within the trench without recourse to the provision of special bends or anchor blocks. However, the pipe should not be cold bend to a radius less than 20 times the OD of the pipe.

**9.5.5.9.** The installation of flanged fittings such as connections to sluice/air/gate valves and hydrant tees etc., requires the use of stub ends (collars/flange adaptor complete with backing rings and gasket. Care should be taken when tightening these flanges to provide even and balance torque.

**9.5.5.10.** Provision should be made at all heavy fittings installation points for supports (such as anchoring of the flange in the soil) for the flange joint to avoid the transfer of valve wheel

turning torque on to the PE flange joint.

**9.5.5.11.** PE pipe is lighter than water. Hence care should be taken for normal installations where there could be a possibility of flooding of the trench thus the trench shall be kept free of water till the jointing has been properly done.

**9.5.5.12.** However, weights by way of concrete blocks (anchors) are to be provided so that the PE pipe does not float when suddenly the trench is flooded and the soil surrounding the pipe is washed away. Thus site conditions study is necessary to ensure the avoidance of flotation.

**9.5.5.13.** Pipe embedment backfill shall be stone-free excavated material placed and compacted to the maximum dry density.

### 9.5.6. Jointing of pipes

The pipe shall have a jointing system that shall provide for fluid tightness for the intended service conditions. Appropriate jointing for HDPE pipe as per IS 4984 shall be selected considering site and working conditions, pressure and flow or liquid.

### 9.5.7. Bedding

In case of sandy strata no separate bedding is required. However the bottom face/trench bed where pipe shall be placed shall be compacted to provide maximum dry density. The pipe bedding should be placed so as to give complete contact between the bottom of the trench and the pipe.

### 9.5.8. Back Filling

**9.5.8.1.** Backfilling should be placed in layers not exceeding 15cm thickness per layer, and should be compacted maximum dry density. The refilling should be done on both sides of pipe together & height difference in earth fill on each side should not be more to cause lateral movement of pipe.

**9.5.8.2.** Most coarse grained soil are acceptable. This may comprise of gravel or sand. However silty sand, clayey sand, silty and clayey gravel shall not be used unless proposed to be used in conjunction with gravel or clean sand.

**9.5.8.3.** It is very important that the pipe zone backfill material dies not wash away or migrate ink to the native soil. Likewise, potential migration of the native soil in to the pipe zone backfill must also be prevented.

**9.5.8.4.** Heavy earth moving equipment used for backfilling should not be brought until the minimum cover over the pipe is 90 cm in the case of wide tracked bulldozers or 120 cm in the case of wheeled roaders or roller compactors.

### 9.5.9. Compaction

Vibratory methods should be used for compaction. Compaction within distances of 15 cm to l45 cm from the pipe should be usually done with hand tempers. The backfill material should be compacted to maximum dry density.

### 9.5.10. Fittings and specials

All HDPE fittings/specials shall be fabricated or injection moulded at factory as per IS: 8360 (Part-I & Part-III) and as per IS: 8008 (Part-I to Part-IX) fittings will be butt welded on the pipes or other fittings by use of heat fusion.

**9.5.11. HDPE bends and tee**

HDPE bends and tee shall be plain square ended conforming to IS: 8360 (Part I,II&III). Bends may be fabricated by jointing several small section of pipe to reach the required angel. Tees may be moulded or fabricated from pipes elements.

**9.5.12. HDPE Reducer** must be moulded and shall be plain square ended as per IS: 8008 (Part-1 & VII)

**9.5.13. HDPE stub ends**

HDPE stub ends shall be square ended conforming to IS: 8008 (Part-I & VII) specification stub ends will be welded on the pipe. Flange will be of slip on flange type.

**9.5.14. Slip on Flanges**

Slip on flange shall be metallic flanges covered by epoxy coating or plastic powder coating. Slip-on-flanges shall be conforming to standard mating relevant flange of valves, pipes etc Nominal ressure rating of flanges shall be PN10.

**9.5.15. Jointing Procedure**

Jointing between HDPE pipes and specials shall be done as per the latest IS:7643 part II. Method of jointing between the pipes to pipes and pipes to specials shall be with butt fusion welding using automatic or semi automatic, hydraulically operated, superior quality butt fusion machines which will ensure good quality butt fusion welding up to of HDPE pipes.

The commonly used joints are as follows:-

a) Insert type joints.
b) Compression fittings.
c) Fusion welding.
d) Threaded Joints
e) Flanged joints, and
f) Telescopic joints.

There are insert type of fittings of both plastic and metals available for use with PE pipes. In corrosive locations plastic fittings are preferred because of their high resistance to corrosion. In less corrosive conditions gun metal fittings are frequently used and in normal or slightly corrosive environments, brass fittings are commonly employed. In certain cases, threaded malleable cast iron fittings are used.

**9.5.16. Compression Fittings**

**9.5.16.1.** They are used for MDPE and HDPE joints. They are detachable joints and are made of metals or plastics.

**9.5.16.2.** In the majority of cases the metal fittings are based on the type of compression fittings commonly used with copper tubes. In this type of joint the dimensions of the pipe are generally not altered. The joint is effected by an internal liner and a compression ring or sleeve which shrinks and therefore compresses the pipe wall on to the liner, thus gripping to the wall of the pipes. The liner and compression sleeve may also be a integral unit.

**9.5.16.3.** In other case the flared pipe wall is compressed on a conica insert either by two male and female threaded metallic nuts or by backing loose flanges. The water seal is made by compression of ends of PE flared pipe between sloping surface of metallic nuts/flanges and conical inserts.

**9.5.16.4.** Compression Joints with Collar/Pipe Ends and Flat Gaskets Aluminum alloy or brass fittings

with male and female coupling parts are available for jointing with metallic fittings. The male and female ends of the coupling are inserted face to face on two ends of the pipes to be jointed. Collars are made on the pipe ends by heating the ends with hot plate or electric coil. The two collars are brought together and the female end of the coupling is tightened on the male end. A water tight seal is made between the flanges. This is a detachable type of jointing and is practicable up to 50mm dia pipes.

### 9.5.17. Fusion Welding

Fusion welding is commonly used in HDPE and is permanent type of joint.

### 9.5.18. Procedure of Butt Welding of HDPE pipes.

**9.5.18.1.** The pipe should be cut square and the face of the pipe should be slightly scraped prior to welding to remove oxidized layer. At the time of welding, leveling of the pipes is essential particularly in case of larger diameter pipes. Welding temperature should be 2000C and surfaces of heating mirror should be 2100 ± 50C [heating mirror is a metallic plate heated up to the required temperature either by electrical coil embedded inside or by blow torch. The word mirror has come because this heating plate radiates heat. The pipes to be welded should be held on either side of the heating mirror with only contact pressure of about 20 kPa (0.2 kgf/cm²). When the rim of molten material is formed, the pipes are removed from the heating mirror and immediately the joint is made by application of moderate pressure of approximately 1 to 2 kg/cm² for 2 to 3 seconds. The initial heating time for achieving molten rim, varies from 1 to 5 min depending upon the pipe wall thickness and size.

**9.5.18.2.** Cautions

a) It is essential to see that the rim formed is not excessive.
b) While jointing, the pressure should be maintained until the joint is luke-warm and after the pressure is relived, the joint allowed to cool completely.
c) The mirror should be kept exactly around 2100C which needs about 30 minutes time (for electrical mirror). It is also essential to see that the temperature is maintained constant by the proper setting of regulator. For detecting the correct temperature crayon chalk is used. For example at 2100C the colour of crayon dot on the mirror changes within 2 seconds. But the dot made should be thin and if not, time taken will be more, indicating a wrong temperature.

Strength A satisfactory butt welded joint of HDPE will have the strength factor of one. Temperature is of primary importance and weld efficiency may decrease if the temperature does not fall with in the range of 200 ± 100C.

### 9.5.19. Flanged Joints

**9.5.19.1.** These are used for jointing MDPE and HDPE pipes particularly of larger size to valves and vessels and large size metal pipes where strength in tension is required.

**9.5.19.2.** It consists of flanges either loose or welded to the pipe ends. It is recommended that suitable metallic backing plates be used to support the polyethylene flanges to enable them to be bolted together. Injection moulded polyethylene flanges with metal inserts of 6 to 9 mm thickness may also be used. In most cases, sealing is improved by incorporating a natural or synthetic rubber gasket between polyethylene flanges.

### 9.5.20. Telescopic Joint

**9.5.20.1.** Any joint (socket and spigot type) that permits sliding of the free end (spigot end) inside the socket with a rubber or suitable gasket, without any leakage is called telescopic joint.

**9.5.20.2.** The socket could be an integral part of the pipe at one end or two ends or a special coupler into which the free ends (spigot ends) of the pipes are pushed to achieve a water tight joint.

**9.5.20.3.** These joints are normally weak in longitudinal pull and hence need anchoring wherever such a tendency of longitudinal pull is likely in the pipe line. In the case of telescopic joints, one external anchorage is generally necessary at each end of the pipe line, at valve and at all changes of direction. The supports of the side connection should ensure that excessive lateral bending does not occur. In small diameter the coupler itself could be modified to have a split, threaded grip type gasket of hard materials in addition to O ring type of rubber gasket (for water tightness) to prevent any slipping out of the free end of the pipe in longitudinal pull.

### 9.5.21. Test to Establish Perfectibility/portability of work

Specimen of pipe shall be tested to establish the suitability for use in carrying portable water

(i) Smell of the extract

(ii) Clarity of the colour of the extract

(iii) Acidity and Alkality

(iv) Global migration UV absorbing material Heavy metals

(v) Unreacted monomers (styrens) and biological test

### 9.5.22. Hydraulic Test

After laying the pipe hydraulic test shall be done to conform the quality of work and material. There shall not be any signs of localized swelling, leakage or weeping. It should conform to IS : 4984 & IS 7634.

## 9.6. GI PIPES & FITTINGS (HEAVY CLASS) FOR WATER SUPPLY

### 9.6.1. Scope

The scope of this section comprises the supply, installation, testing and commissioning of piping network for water supply for internal & external services as follows:

a. Water supply connections from ring main to overhead tanks with isolation valves and chambers.
b. Water supply connection from ring main to vertical shafts.
c. Domestic & Flushing Water Supply riser.
d. Pipe insulation, protection & painting
e. Connections to all plumbing fixtures, tanks, pumps etc.
f. Water meter installation with isolation valves.
g. Providing hot water pipe lines and supply point with isolation valves, wherever required.

**9.6.1.1.** Providing, laying, jointing, interconnection, testing & commissioning of G.I. / CPVC Pipe with valves, specials and fittings duly inspected including all allied civil works and in Distribution network of ring main.

**9.6.1.2.** Excavation in trenches in all types of strata for laying & jointing of above pipe line with required depth and width as per specification.

**9.6.1.3.** Providing and fixing of sluice valves and Non-return valves.

**9.6.1.4.** Providing and fixing following cast iron double flange ISI mark sluice valve fitted with cast iron cap including jointing and testing with cost of jointing materials.

**9.6.1.5.** Providing, laying & jointing fittings conforming to IS standard code.

**9.6.1.6.** Construction of valve chambers in all the places where sluice valve, Air valve and non return valve are provided, Anchor Blocks, Pedestal etc. as required as per specification.

**9.6.1.7.** Back filling of trench as per IS:12288-1987.

The Contractor shall make all necessary application and arrangements for his work to be inspected by the Local Authorities.

The Contractor shall be solely responsible for obtaining the Authorities approval of his works prior to the handing over of the complete water supply / distribution installation to the Engineer-in-Charge.

**a) Applicable Codes**

The laying of GI pipes and fittings / specials shall comply with all currently applicable statutes, regulations, standards and codes. In particular the following standards, unless otherwise specified herein, shall be referred. In all cases, the latest revision of the standards/codes shall be referred to. Other IS: Codes not specifically mentioned here but pertaining to the use of GI pipes, fittings & specials shall be part of this Specification.

| I.S. Number | Title |
|---|---|
| IS: 1239 (PT-1): 2004 | Mild steel tubes, tubular, and other wrought steel fittings, part 1 mild steel tubes. |
| IS: 1239 (PT-II): 1992 -- | Do part 2 mild steel tubular and other wrought steel |
| | pipe fittings. |
| IS: 1978: 1982 | Line pipes |
| IS: 4736: 1986 | Hot-dip zinc coatings on mild steel tubes. |
| IS 778: 1984 | Copper alloy gates, globe and check valves for water |

| Nominal Bore | Outside Diameter | | Thickness | Mass of Tube | |
|---|---|---|---|---|---|
| | Maximum | Minimum | mm | Plain End | Screwed and Socketed |
| mm | mm | mm | mm | Kg/m | Kg/m |
| (1) | (2) | (3) | (4) | (5) | (6) |
| 6 | 10.6 | 9.8 | 2.0 | 0.404 | 0.407 |
| 8 | 14.0 | 13.2 | 2.3 | 0.641 | 0.645 |
| 10 | 17.5 | 16.7 | 2.3 | 0.839 | 0.845 |
| 15 | 21.8 | 21.0 | 2.6 | 1.21 | 1.22 |
| 20 | 27.3 | 26.5 | 2.6 | 1.56 | 1.57 |
| 25 | 34.2 | 33.3 | 3.2 | 2.41 | 2.43 |
| 32 | 42.9 | 42.0 | 3.2 | 3.10 | 3.13 |
| 40 | 48.8 | 47.9 | 3.2 | 3.56 | 3.60 |
| 50 | 60.8 | 59.7 | 3.6 | 5.03 | 5.10 |
| 65 | 76.6 | 75.3 | 3.6 | 6.42 | 6.54 |
| 80 | 89.5 | 88.0 | 4.0 | 8.36 | 8.53 |
| 100 | 115.0 | 113.1 | 4.5 | 12.2 | 12.5 |
| 125 | 140.8 | 138.5 | 4.8 | 15.9 | 16.4 |
| 150 | 166.5 | 163.9 | 4.8 | 18.9 | 19.5 |

| | |
|---|---|
| | works purposes. |
| IS 2692: 1989 | Ferrules for water services. |

**b) Galvanized mild steel pipes**

- The pipes (tubes) shall be galvanized mild steel hot finished seamless (HFS) or welded (ERW) HRIW or HFW screwed and socketed conforming to the requirements of IS 1239 Part-1 for medium & heavy grade. They shall be of the diameter (nominal bore) specified in the description of the item, the sockets shall be designated by the respective nominal bores of the pipes for which they are intended.
- Galvanizing shall conform to IS 4736 : The zinc coating shall be uniform adherent, reasonably smooth and free from such imperfections as flux, ash and dross inclusions, bare batches, black spots, pimples, lumping runs, rust stains bulky white deposits and blisters. The pipes and sockets shall be cleanly finished, well galvanized in and out and free from cracks, surfaces flaws, laminations and other defects. All screw threads shall be clean and well cut. The ends shall be cut cleanly and square with the axis of the tube.
- Specifications of medium and heavy pipes shall be as below:

**Dimensions and Nominal Mass of steel Tubes- Medium**
**(Refer Table No.-4 IS 1239 (Part-1) -2004)**

| Nominal Bore | Outside Diameter | | Thickness | Mass of Tube | |
|---|---|---|---|---|---|
| | Maximum | Minimum | mm | Plain End | Screwed and Socketed |
| mm | mm | mm | mm | Kg /m | Kg/m |
| (1) | (2) | (3) | (4) | (5) | (6) |
| 6 | 10.5 | 9.8 | 2.6 | 0.487 | 0.490 |
| 8 | 14.0 | 13.2 | 2.9 | 0.765 | 0.769 |
| 10 | 17.5 | 16.7 | 2.9 | 1.02 | 1.03 |
| 15 | 21.8 | 21.0 | 3.2 | 1.44 | 1.45 |
| 20 | 27.3 | 26.5 | 3.2 | 1.87 | 1.88 |
| 25 | 34.2 | 33.3 | 4.0 | 2.93 | 2.95 |
| 32 | 42.9 | 42.0 | 4.0 | 3.79 | 3.82 |
| 40 | 48.8 | 47.9 | 4.0 | 4.37 | 4.41 |
| 50 | 60.8 | 59.7 | 4.5 | 6.19 | 6.26 |
| 65 | 76.6 | 75.3 | 4.5 | 7.93 | 8.05 |
| 80 | 89.5 | 88.0 | 4.8 | 9.90 | 10.1 |
| 100 | 115.0 | 113.1 | 5.4 | 14.5 | 14.8 |
| 125 | 140.8 | 138.5 | 5.4 | 17.9 | 18.4 |
| 150 | 166.5 | 163.9 | 5.4 | 21.3 | 21.9 |

**c) Tolerances on thickness and Mass of pipes**

The following manufacturing tolerances shall be permitted on the tubes and sockets.
A) Thickness:
(1) Welded tubes;

| | | | |
|---|---|---|---|
| | a. | Light tubes | + not limited |
| | | | - 8 percent |
| | b. | Medium and heavy | + not limited |
| | | Tubes | - 10 percent |
| | (2) | Seamless tubes | + limited |
| | | | - 12.5 percent |
| | B) | Mass: | |
| (1) | Single tube | | + 10 percent |
| | (Light series ) | | - 8 percent |
| (2) | Single tube | | ± 10 percent |

| | | |
|---|---|---|
| | (Medium and | |
| | Heavy series) | |
| (3) | For quantities per | + 7.5 percent |
| | Load of 10 tones, | - 5 percent |
| | Min (light series) | |
| (4) | For quantities per | ± 7.5 percent |
| | Load of 10 tones, | |
| | Min (medium and | |
| | heavy series) | |

**d) Joints**

- All screwed tubes shall be supplied with pipe threads conforming to IS 554. Gauging in accordance with IS 8999 shall be considered as an adequate test for conformity of threads of IS 554.
- Unless specified otherwise, tubes shall be supplied screwed with taper treads and fitted with one socket having parallel thread. The socket shall conform to all requirements (except 6.4) of IS 1239 (part 2).
- In case of light tubes the application of taper pipe threads may be modified by permitting the outside diameter of the tubes to be within the limits shown in col. 2 and 3 of table 7.6 . Where the tube approaches the lower limit of outside diameter, some incomplete threads (perfect at root and imperfect at the crest) may be expected from and beyond the gauge plane. Such incomplete treads, shall not be regarded as justification for rejection of the tubes. Also the minimum length of threads in light tubes shall be 80 percent of that specified in IS 554.
- The plain end pipes shall be supplied with square cut. However, bevel end may also be supplied on mutual agreement between the purchaser and the manufacturer

**e) Sampling of pipes:**

Lot for the purpose of drawing samples all tubes bearing same designation and manufactured under a single process shall be grouped together to constitute a lot.
Each lot shall be sampled separately and assessed for conformity to this specification. Sampling of tubes shall conform to IS 4711.

**f) Testing of Pipes :**

Following tests shall be conducted by the manufacturer on tubes.

- The tensile strength shall be at least 320 MPa (320 N/mm²). The test shall be carried out on full section or strip cut from the selected tubes in accordance with IS 1608 and IS 12278.
- Notes: 1.For welded tubes, the strip tensile test specimen shall not contain the weld. For galvanized tubes, zinc coating may be removed by stripping prior to tensile test.
- Bend Test on Tubes Up to and including 50 mm Nominal Bore.
- When tested in accordance with IS 2329 the tubes shall be capable of withstanding the bend test without showing any signs of fracture or failure. Welded tubes shall be bent with the weld at 900 to the place of bending. The tubes shall not be filled for this test.
- The maximum permissible pressure and temperature for tubes with screwed and socketed joints shall be as given under.
- For tubes fitted with appropriate flanges or suitably butt welded together, the maximum permissible pressure shall be 2.06 MPa and the maximum permissible temperature 2600C.

**Maximum Permissible Pressure and Temperature for Tubes with Steel Couplings or Screwed and Socketed Joints**
**(Refer Table No. 6 IS 1239 (Part-1) - 2004)**

| Nominal Bore | Maximum Permissible | Maximum Permissible |
|---|---|---|
| **Mm** | **Pressure** | **Temperature** |

| | MPa | $^0$C |
|---|---|---|
| 1 | 2 | 3 |
| Up to and including 25 mm | 1.20 | 260 |
| Over 25 mm up to and including 40 | 1.03 | 260 |
| Mm | | |
| Over 40 mm up to and including 80 | 0.86 | 260 |

| Nominal Bore Mm | Maximum Permissible Pressure MPa | Maximum Permissible Temperature $^0$C |
|---|---|---|
| Mm | | |
| Over 80 mm up to and including | 0.69 | 260 |
| 100 mm | 0.83 | 177 |
| Over 100 mm up to and including | 0.69 | 171 |
| 125 mm | | |
| Over 125 mm up to and including | 0.50 | 160 |
| 150 mm | | |

**Note :- 1 MPa = 1 N/mm² = 0.102 0 kg/mm²**

**g) Marking**

- Each tube shall be marked with manufacturer's name or trade-mark, IS NO. that is, IS 1239 (Part 1) and class of tubes, that is, L,M, and H, for light, medium and heavy class.
- The different classes of tubes shall be distinguished by colour bands, which shall be applied as follows before the tubes leave the manufacturer's works:

| | | | |
|---|---|---|---|
| | Light tubes | - | Yellow |
| | Medium tubes | - | Blue |
| | Heavy tubes | - | Red |

**h) Types of Fittings**

- Dimensions of the fittings shall be as per IS: 1239 (Part-II): 1992 Table 1, to 28.
- Manufacture: Tubular's conforming to this standard shall be made from tubes which comply with all the appropriate requirements of IS 1239 (Part 1): 1990
- Socket: Socket shall be manufactured from mild steel by any of the following processes:
  a) Hot-finished seamless (HFS),
  b) Electric resistance welded (ERW),
  c) High frequency induction welded (HFIW), and
  d) Hot-finished welded (HFW),

Where ever, tubular are supplied with sockets, the dimensions of socket shall be as under :-

| Nominal Bore | Minimum Outside Diameter | Minimum Length |
|---|---|---|
| | A | B |
| (1) | (2) | (3) |
| 6 | 15 | 19 |
| 8 | 18.5 | 27 |
| 10 | 22 | 28 |
| 15 | 27 | 37 |
| 20 | 32.5 | 39 |
| 25 | 39.5 | 46 |
| 32 | 49 | 51 |
| 40 | 56 | 51 |
| 50 | 68 | 60 |
| 65 | 84 | 69 |
| 80 | 98 | 75 |
| 100 | 124 | 87 |
| 125 | 151 | 96 |
| 150 | 178 | 96 |

Tapping of socket shall be done from one end only.

- Other Fittings

Other wrought steel pipe fittings shall be manufactured from mild steel by any approved process.

- Unless otherwise specified by the purchaser, all fittings shall be manufactured with thread connection, complying with the requirements of IS 554: 1985.

- The steel from which the fittings are made, when tested in accordance with IS 1894: 1972 shall show on test a minimum tensile strength of 320 MPa.

**i) Dimensions of tubular:**

- Pieces:

Pieces shall conform to the dimensions given in table 1 IS: 1239 (Part 2) : 1992

- Nipple:

Close taper and running nipples shall be make only from heavy tubes. Barrel nipples shall be made either from medium or heavy tubes. The dimensions of nipples shall be as given in table 2 IS: 1239 (Part 2) : 1992

- Long screws (Connectors)

Long screws (connection) shall be make only from heavy tube and shall be supplied single or double, as may be specified, and shall conform ok the appropriate dimensions given in Table No. 3 of IS: 1239 (Part 2) : 1992

- Bends and springs

Bends and springs shall conform to the appropriate dimensions given in Table 4. of IS: 1239 (Part 2) : 1992 shall be fitted with sockets sand back nuts conforming to the requirements given in 8.3.2.

- Return bends

Return bends shall be made from heavy tubes, supplied with socket at one end if so specified by the purchaser, and shall conform to the dimensions given in Table 5. IS 1239 (Part-2): 1992. The ends of the bends shall be parallel within $\pm 1.5^0$.

Fittings shall be of malleable cast iron galvanized of approved make. Each fitting shall have manufacturer's trade mark stamped on it. Fittings for G.I pipes shall include couplings, bends, tees, reducers, nipples, unions, bushes etc. Fittings etc. shall conform to

IS : 1879. (Part 1 to X) 1987.

Pipes and fittings shall be jointed with screwed joints using Teflon tape suitable for water pipes. Care shall be taken to remove burr from the end of the pipe after cutting by a round file. All pipes shall be fixed in accordance with layout and alignment shown on the drawings. Care shall be taken to avoid air pockets. Necessary vents and drains shall be provided at all high and low points respectively.

**j)Test on Fittings and Sockets**

- The fittings and sockets before they leave the works, shall be subjected to either of the following pressure tests, as mutually agreed between the purchaser and the manufacturer:
- The ends of fittings and sockets when subjected to the required pressure, after having been made up wrench tight with the prior application of lubricant, or sealant, or by any other appropriate method shall not show any leakage. The test shall be carried out after the fittings and sockets have been screwed and before any protecting coating other than galvanizing has been applied.
- The sample size and the acceptance criteria for the pressure test shall be given in Table 30 below.
- Expansion Test on Sockets
  At the option of the manufacturer any one of the tests described in 7.14.2.1 shall be carried out.
- Drift Expanding Test
  It shall be carried out on sockets, tubes, blanks, or sockets in accordance with IS 2335: 1963. On a conical mandrel having an included taper on diameter 1 in 16 and the minimum increase in outside diameter after expansion shall be as follows:

| Nominal Bore mm | Percentage of Expansion Min |
|---|---|
| Upto and including 25 | 2-0 |
| 32 to 40 | 1.5 |
| 50 to 80 | 1.0 |
| 100 to 150 | 0.5 |

**Scale of Sampling and Acceptance Criteria for Pressure Test**

| Lot Size | Stage | Sample Size | Cumulative Sample Size | Acceptance Number | Rejection Number |
|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | |
| Upto 1000 | First | 13 | 13 | 0 | |
| | Second | 13 | 26 | 1 | |
| 1001 to 3000 | First | 20 | 20 | 0 | |
| | Second | 20 | 40 | 1 | |
| 3001 to 5000 | First | 32 | 32 | 0 | |
| | Second | 32 | 64 | 3 | |
| 5001 to 10000 | First | 50 | 50 | 1 | |
| | Second | 50 | 100 | 4 | |
| 10001 and above | First | 80 | 80 | 2 | |
| | Second | 80 | 160 | 6 | |

- Taper Screw Plug Test

Sockets shall be capable of withstanding the expansion test as described below without showing any sign of fracture or failure.

- The test shall consist of screwing the selected socket on a taper screw plug.

- The threads of socket shall be thoroughly clean and free from foreign matter. Should the threads show sign of burr, this shall be removed by means of a pipe thread tap. The threads of the socket and the end of the test plug shall be lubricated with oil, and the socket shall then be screwed on to the test plug between the jaws of a vice, or other suitable fixtures, and by rotating the socket with both hands. The socket shall then be further rotated either by means of a pipe wrench of an adequate length to operative the test with gradual turning or by a power machine giving an appropriate leverage. The wrench shall not be hammered.
- The plugs shall be manufactured from steel and shall be hardened to give a Vickers hardness between 700 and 800 HV when determined by applying a load of 30 kgf in accordance with IS 1501 (Part 1) : 1984.
- The dimensions of plug shall conform with those given in Table 31. The threads shall be ground after the plugs are case hardened, and the thread form and angle of taper shall be in accordance with the appropriate dimensions and tolerances specified in IS 554:1985.
- For routine testing, use may be made, if so desired, of unhardened steel plugs in accordance with the dimensions given in Table 31 and having machined threads, the thread form and angle of taper being in accordance with the appropriate dimensions and tolerance specified in IS 554:1985.
- In case of dispute, however in the test shall be carried out with the hardened plugs specified in 7.14.2.3 and 7.14.2.4.

**k) Ferrules**

- The ferrules for connection with C.I./D.I. main shall generally conform to is 2692. It shall be of non ferrous materials with a C.I./D.I. bell mouth cover and shall be of nominal bore as specified. The ferrule shall be fitted with a screw and plug or valve capable of completely shutting off the water supply to the communication pipe, if and when required.
- Ferrules shall be of 8,10,15,20,25,32,40 and 50mm. nominal sizes.
- The nominal sizes of the ferrule shall be designated by the nominal bore of the inlet connection.

**l) Laying and jointing of GI pipes**

- The galvanized pipes and fittings shall be laid in trenches. The widths and depths of the trenches for different diameter of pipes shall be as given in Table below.

| Dia of pipe (mm) | Width of Trench (cm) | Depth of Trench (cm) |
|---|---|---|
| 15 to 50 | 30 | 60 |
| 65 to 100 | 45 | 75 |
| | | |

- At joints the trench width shall be widened where necessary. The work of excavation and refilling shall be done true to line and gradient in accordance with the general specifications for earth work in trenches.
- When excavation is done in rock, it shall be cut deep enough to permit the pipe to be laid on a cushion of sand minimum 7.5 cm deep.

**m) Jointing**

- The pipes shall be cleaned and cleared of all foreign matter before being laid. While jointing the pipes, the inside of the socket and the screwed end of the pipes shall be oiled and rubbed over with white lead and a few turns of spun yarn wrapped round the screwed end of the pipe.

- The end shall than be screwed in the socket, tee etc., with the pipe wrench. Care shall be taken that all pipes and fittings are properly jointed so as to make the joints completely water tight and pipes are kept at all times free from dust and dirt during fixing. Burr from the joint shall be removed after screwing. After laying, the open ends of the pipe shall be temporarily plugged to prevent access of water, soil or any other foreign matter.

**n) Testing of joints**

- The pipes and fittings after they are laid and jointed shall be tested to hydraulic pressure of 1.5 times of the operating pressure. The pipes shall be slowly and carefully charged with water allowing all air to escape and avoiding all shock or water hammer. The draw off taps and stop cocks shall then be closed and specified hydraulic pressure shall be applied gradually.

- Pressure gauge must be accurate and preferably should have been recalibrated before the test. The test plump having been stopped, the test pressure should be maintained without loss for at least half an hour. The pipes and fittings shall be tested in sections as the work of laying proceeds, having the joints exposed for inspection during the testing. Pipes or fittings which are found leaking shall be replaced and joints found leaking shall be redone, without extra payment.

### 9.6.2. Sand Filling

GI pipes in trenches shall be protected with fine sand 150mm all around before filling in the trenches.

### 9.6.3. Painting

G.I./C.I. pipes above ground shall be painted with one coat of red lead and two coats of synthetic enamel paint of approved shade and quality to give an even shade. Pipes shall be painted to standard colour code specified by the Architect/Consultants.

### 9.6.4. Pipe Protection

Where specified in the schedule of quantities all pipes in chase below ground shall be protected against corrosion by applying two coats of bitumen pain wrapping with polythene tape and finishing with one more coat of bitumen paint.

### 9.6.5. Civil Works

All the allied civil works necessary for laying and jointing of pipeline shall be a part of this contract; therefore, the contractor shall design and carry out the necessary civil works such as thrust blocks, anchor blocks, chambers for appurtenances and necessary earth work. All the civil works shall be designed and carried out as per the relevant Indian Standard Code of practice. All the materials used on civil work should be of a quality approved by Engineer-in-Charge. Rejected material shall be removed from the site immediately at the cost of contractor.

### 9.6.6. Thrust Blocks/ Pedestals/Pipe Support

- Thrust blocks are required to transfer the resulting hydraulic thrust from the fitting or pipe on to a larger load bearing soil section.
- Thrust blocks shall be installed wherever there is a change in the direction of the pipe line, size of the pipe line or the pressure-line diagram, or when the pipe line ends at a dead end. If necessary, thrust blocks may be constructed at valves also.
- Thrust blocks shall be constructed taking into account the pipe size, water pressure, type of fitting, gravity component shell when laid on slopes and the type of soil. The location of thrust blocks for various types of fittings is given.
- When a fitting is used to make a vertical bend, it shall be anchored to a concrete thrust block designed to have enough weight to resist the upward and outward thrust. Similarly at joints, deflected in vertical plane, it shall be ensured that the weight of the pipe, the water in the pipe and the weight of the soil over the pipe provide resistance to upward movement. If it is not enough, ballast or concrete shall be placed around the pipe in sufficient weight to counteract the thrust.
- When the line is under pressure there is an outward thrust at each coupling. Good soil, properly tamped is usually sufficient to hold pipe from side movement. However, if soft soil conditions are encountered, it may be necessary to provide side thrust blocks or other means of anchoring. In such cases only the pipe on each side of the deflected coupling shall be anchored without

restricting the coupling.

- Pipes on slopes need be anchored only when there is a possibility of the backfill around the pipe sloping down the hill and carrying the pipe with it. Generally for slopes up to 300 good well drained soil, carefully tamped in layers of 100 mm under and over the pipe, right up to the top of the trench will not require anchoring.
- For steeper slopes, one out of every three pipes shall be held by straps fastened to vertical supports anchored in concrete.
- Typical design and detail of thrust block to be provided in shop drawing by Contractor.

### 9.6.7. Disinfection Of Pipe Line Before Commissioning

Pipeline carrying potable water shall be suitably disinfected before commissioning. For this purpose guidance may be obtained from IS:3114-1965 or IS : 5822-1970.

### 9.6.8. Restoration Of Damaged Surface And Property

Where any pavement, shrubbery, fences poles or other property and surface structures have been damaged, removed or disturbed during the course of work, such property and surface structures shall be replaced or repaired after completion of work. The permanent pavement shall not be restored to a condition equal to that before the work began but the top surface of the removed pavement shall be levelled and finished in such a manner as the traffic may pass smoothly.

## 9.7. VALVES & SUBMERSIBLE PUMPS

### 9.7.1. Applicable codes

The Sluice valves, Butterfly valves, Ball valve, Air valves, PRV & Non return valves for water works purposes shall comply with all currently applicable statutes, regulations, standards and codes. In particular the following standards, unless otherwise specified herein, shall be referred. In all cases, the latest revision of the standards/codes shall be referred to. Other IS: Codes not specifically mentioned here but pertaining to the use of Sluice valves, Butterfly valves, Air valves & Non return valves pipes shall be part of this Specification.

**Table**

| I.S. Number | Title |
|---|---|
| IS 14846: 2000<br>Super seeding IS 780:1984 & IS 2906:1984 | Sluice valves for water works purposes (50 to 1200mm size) |
| IS 13095: 1996 | Butterfly valves for General purposes |
| IS 2685: 1971 | Code of practice for selection, installation and maintenance of sluice valves. |
| IS 5312: 2003 (Part I & II) | Non return valve/reflux valve |
| IS 14845: 2000 | For air valve. |

### 9.7.2. Sluice Valves for water works purposes.

**9.7.2.1.** The sluice valves are used in a pipe line for controlling or stopping flow of water. These shall be of specified size and class and shall be of inside non raising screw type up to 300mm size and raising or non-raising screw type above 300mm with either double flange or double socket ends and cap or hand wheel.

**9.7.2.2.** The body, domes covers, wedge gate spindle, nut, valve seat and stuffing box shall be of good quality. The bodies, spindles and other parts shall be truly machined with surface smoothly finished. The area of the water way of the fittings shall be not less than the area equal to the nominal bore of the pipe details of component are given in table below:

**Materials for component Parts of Sluice Valve**

| S.No. | Component | Preferred Material | Grade or Designation | Alternative Material | Grade or Designation |
|---|---|---|---|---|---|
| *(i)* | Body, bonnet, dome, stool cover, wedge, stuffing box, gland, thrust plate and cap. | Grey cast iron | FG 200 | Spheroidal or Nodular iron cast steel | 260-300/12 or 500/2 |
| *(ii)* | Hand wheel | Grey cast iron | FG 200 | Mild steel cast steel Nodular iron | F 410 WA 230-450W 400/12 |
| *(iii)* | Stem | Stainless steel | 12Cr 13 04Cr 18Ni 10 04Cr 17 Ni 12 MO 2 | High Tensile Brass<br><br>Stainless steel | HT 2<br>FHTB 2<br>20Cr13 |
| *(iv)* | Wedge nut, shoe, channel | Leaded tin bronze | LTB-2 | High Tensile Brass Phosphor bronze | HTB 2<br>FHTB -2 |
| *(v)* | Body seat ring, wedge | Leaded tin bronze | LTB-2 | Alloy steel | Gr. 1<br>Gr. 4 |

| | | | | | |
|---|---|---|---|---|---|
| | facing ring and bushes | | | | Gr. 10<br>04Cr 18Ni 10 |
| *(vi)* | Bolts | Carbon steel | Class 4.6 | Stainless steel | |
| *(vii)* | Nuts | Carbon steel | Class 4.0 | Stainless steel | |
| *(viii)* | Gasket | Rubber | Type B | Neoprene Rubber | |
| *(ix)* | Gland packing | Jute and hemp | | Rubber | Type B |
| *(x)* | Gear | Spheroidal graphite iron | Gr. 500/7 | Alloy steel | 40 Ni 2Cr M20<br>28 Gr B |
| *(xi)* | Gear housing | Grey cast iron | FG 200 | Cast steel S.G. iron | 230-450 W<br>400/12 |
| *(xii)* | Pinion & pinion shaft | Wrought carbon steel | C55 Mn 75 | Alloy steel Stainless steel | 40 ni 12Cr 1 MO<br>28 04Cr18 Ni10 |

**9.7.2.3.** The valve shall be marked with an arrow to show the direction of turn for closing of the valve.

**9.7.2.4.** Sluice valves are designated by nominal pressure (PN) as under Nominal Pressure MPa

| Nominal size | mm |
|---|---|
| PN 1.0 | 50 to 1200 |
| PN 1.6 | 50 to 600 |

**9.7.2.5.** The dimension of the sluice valve assemblies shall be as per table of IS 14846. The flanges and their dimensions of drilling shall be in accordance with IS : 1538.

**9.7.2.6.** Testing

The test pressure and maximum working pressure for the two classes of sluice valves shall be as tabulated below:-

| **PN rating of valve** | **Test pressure, MPa** | | **Max. working Pressure, MPa** | **Test Duration min** |
|---|---|---|---|---|
| | **Body** | **Seat** | | |
| | | | | |
| PN 1.0 | 1.5 | 1.0 | 1.0 | 5 |
| PN 1.6 | 2.4 | 1.6 | 1.6 | 2 |

**9.7.2.7.** Coating

a. All coatings shall be carried out after satisfactory testing of the valves prior to dispatch. All the un-machined ferrous surfaces of the valve (both inside and outside) shall be thoroughly clean, dry and shall be free from rust and grease before painting. All exposed machined ferrous surfaces shall be painted with one coat of aluminum red oxide primer conforming to IS 5660.

b. Two coats of black japan conforming to Type B of IS 341 or paint conforming to IS 9862 or IS 2932 shall be applied by brush or spray for exterior application in colour as approved by the purchaser.

**9.7.2.8.** Marking

a. The following information shall be cast on each valve body in raised letters.
   i. The manufacturers name or trade -mark:
   ii. The nominal pressure of valve (PN 1.0, PN 1.6 etc);
   iii. Size of valve (mm);

iv. Heat number of cast;
v. Year of manufacture;
In addition each valve shall bear conspicuously upon it prior to dispatch;
vi. Serial number in punch, on top of flanges: and
vii. Where a valve has been tested for only open end test, it should be marked "O" distinctly and permanently on flanges adjacent to serial number.

b. Each sluice valve shall be marked with the Standard Mark.

**9.7.2.9.** Installation of sluice valves:

i. Sluice valves shall normally be installed with spindle vertical on horizontal pipes except on vertical pipes spindle shall be horizontal. On slopes, the sluice valves may preferably be kept vertical if slope is nominal and gradient can be adjusted with the help of connecting pipes on either sides.
ii. It shall be ensured while fixing sluice valves in pipe line below ground level that a clear space of about 200 mm is available between the top of the sluice valve spindle and surface box, so that valve cap may be easily provided when surface box is kept in flush with road level.
iii. It is most important to ensure that:
a) All grit and foreign matters are removed from the inside of the
b) valves before placing in pipes, and
c) All the four faces are thoroughly cleaned and coated with a thin layer of mineral grease.
iv. It is important to check tightening of gland with a pair of inside calipers. Clearance between the top of the stuffing box and the underside of the gland should be uniform on all the sides.
v. Gland should not be tightened too hard. The pressure applied should be just enough to stanch leakage.
vi. Hemp packing should be adequately soaked in grease and should not be allowed to remain dry.
vii. The valves should be tightly closed when being installed, as this keeps the valves rigid and prevents any foreign matter from getting in between the working parts of the valves.
viii. While installing flanged valves, each flange bolt should be tightened a little at a time, taking care to tighten diametrically opposite bolts alternately. The practice of fully tightening the bolts one after the other is highly undesirable.
ix. After installation of the valve, the valve and the pipe line should be flushed with water to remove any foreign matter that may be present in them.
x. If any leak is detected at the valve seats, applying extra torque on the valve spindle to set right the valve is not good practice, the valve seats should be examined and, if necessary, repaired by scraping or replacing where necessary.
xi. Valves in exposed positions should be protected in cold weather where there is a likelihood of their becoming frozen and bursting.
xii. Surface boxes conforming to IS: 3950-1966 should be provided to cover the valve chamber for the safety and easy identification of the valves.
xiii. The direction of opening and closing should be clearly indicated.
xiv. Suitable identification plate should be provided as near to the actual location of valves as possible.
xv. Care should be taken to ensure that the joining material sits squarely between the flanges of the valve and pipe lines or tails without obstructing the water way. It is to be ensured that there are no kinks in the joints material as it might allow leakage in service.
xvi. Maintenance of sluice valve should be done periodically as per guide line in IS 2685:1971 chapter 4.

### 9.7.3. Air Release Valve

**9.7.3.1.** Air release valves are to be used for evacuation of accumulation of air in water mains under pressure, for the exhaust of air when such mains are being charged with water and for inlet of air when they are emptied of water.

**9.7.3.2.** There are two types of air release valves generally use. Single air valves with single ball and double Air release valve with double ball. The single ball type can have either large orifice or small orifice, the former being only suitable for emptying and filling of pipe line and latter for

discharging small quantities of entrained air in the pipe.

**9.7.3.3.** Double air valves are commonly available which are suitable for dual purpose with a large orifice and a small orifice in one unit, with a common connection with the main. For large aqueduct pipe line, a triple orifice Air release valve is available with two large orifices and one small orifice.

**9.7.3.4.** For high pressure, stainless steel floats are used instead of vulcanite-covered balls. In case of high velocity air discharge, special design of air release valves are also available. Under such situation if usual type of air valves are used there is danger that the ball might be carried to its seat by the air stream before the accumulated air has been completely exhausted.

**9.7.3.5.** Single air release valves of small sizes are provided with stop cock or peet valves with the inlet of the air valve, whereas double air valves are provided with a standard sluice valve fixed, with inlet flange of the Air release valve or with integral valve, Regular maintenance at least on annual basis in necessary to ensure that the balls are free to move and that the seat do not leak. In very cold weather it is necessary to drain the chamber of valves to avoid any damage due to frost.

**9.7.3.6.** Construction of water tight chamber around the Air release valve when fixed in street is necessary to avoid the admission of any polluted water.

**9.7.3.7.** The pressure ratings for single Air release valve and double Air release valve are as mentioned below :

| **Type of valve** | **Max working pressure, bar gauge** | **Hydrostatic test pressure in bar gauge** | |
|---|---|---|---|
| | | **Shell** | **Seat** |
| a) Single Air release valve(screwed) | (Size 1”) – 10<br>(Size ½ “-3/4 “)- | 16 | 10 |
| b)Double Air release valve(flange faced) | (size 40 to 200 mm)<br>-10 | 16 | 10 |
| c) Kinetic air release valve | (size 80 to 200 mm) 10 | 16 | 10 |

Note : 1 Bar = 0.9869 atm and
1 atmosphere = 1.000 kg/cm²
= 14.22 PSI

**Recommended Air Release Valve Sizes**

| Size DN | Air Valve Size |
|---|---|
| Up to 100 | 25 single |
| 100 – 200 | 50 double |
| 200 – 450 | 80 double |

**9.7.3.8.** Scour Valve:

Scour valves are located at low points or between valved sections of the pipeline. Their function is to allow periodic flushing of the lines to remove sediment and to allow the line to be drained for maintenance and repair work.

The scour valve should be sized to allow a minimum scour velocity of 0.6 m/s to be achieved in the main pipe. Scour tees over nominal size 100 should be offset tees to allow the debris to be taken from the invert of the pipe. In the absence of specific design criteria, the following sizes are generally acceptable.

Scour valves shall be flanged and have the following diameters :

Recommended Scour Valve Size

| Size DN | Scour Valve Size |
|---|---|
| Up to 100 | 80 |
| 100 – 200 | 100 |
| 200 – 450 | 150 |

**9.7.4. Butterfly valves**

**9.7.4.1.** Butterfly valves are used to regulate stop the flow especially in large size conduits. They are sometimes cheaper than sluice valves for larger sizes and occupy less space.

**9.7.4.2.** Butterfly valves with no sliding parts have the advantages of ease of operation, compact size, reduced chamber or valves house and improved closing and retarding characteristics.

**9.7.4.3.** These would involve slightly higher head loss than sluice valves and also are not suitable for continuous throttling. The sealing is sometime not as effective as for sluice valves especially at high pressures.

**9.7.4.4.** They also offer a fairly high resistance to flow even in fully open state because the thickness of the disc obstruct the flow even when it is rotated to fully open position. Butterfly valves as well as sluice valves are not suited for operation in partly open position as the gates and seatings would erode rapidly. Both types require high torques to open them against high pressure, they often have geared hand wheels or power driven actuator.

**9.7.4.5.** Butterfly Valves with loose sealing ring are sometimes not effective, especially at higher pressures. Butterfly valves with fixed liner can overcome this shortcoming, further the butterfly valves with fixed liner needs no frequent maintenance for replacement of sealing ring as in the case of butterfly valves with loose sealing ring.

**9.7.4.6.** Valve shall be placed on a support of concrete so that non shear stress is in the flanges. In case of axial thrust due to closure of a valves against pressure the valve shall be anchored in the support in a suitable manner to transfer the thrust into the floor slab of the chamber.

**9.7.4.7.** Nominal sizes : The range of nominal valve size (DN) in mm shall be as follows: 40, 50, 65, 80, 100, 125, 150, 200, 250, 300, 350, 400, 450, 500, 600, 700, 800, 900, 1000, 1200, 1400, 1600, 1800 and 2000.

**9.7.4.8.** Nominal Pressures :-

i. Valves shall be designated by nominal pressure (PN) defined as the maximum permissible working pressure (MPa) at 200C temperature as follows:
PN 0.25, PN 0.6, PN 1.0, PN 1.6, PN 2.5 and PN 4.0

ii. The class designations for valves specified by nominal pipe sizes shall be class 125, class 150 and class 300.

**9.7.4.9.** Direction

i. Unless otherwise specified manually operated valves shall be closed by turning hand wheel or lever in clockwise direction when facing the hand wheel or lever. The design of lever when fitted shall be such that the lever may only be assembled to the valve so that it is parallel to the direction of flow when the valve is open.

ii. All gear traveling nut operations shall be provided with suitable stops to prevent movement of the shaft beyond the limit corresponding to the fully closed position of the disc.

**9.7.4.10.** Testing

i. All valves (all types) shall be hydrostatically tested by the manufacturer before dispatch. The pressure shall be obtained without any significant hydraulic shock. Testing shall be carried on before application of paint or other similar treatment unless otherwise agreed between the purchaser and the manufacturer. There shall be no air entrapped within the part of the valves subjected to test pressure.
ii. Performance testing: Each valve shall be shop operated from fully closed to fully open position and reverse, under no pressure and no flow condition to demonstrate that the complete assembly is workable.
iii. Body Test: Completely assembled valve shall be tested as follows:

a) The body ends shall be blanked so that the valve as subjected to the full pressure in all directions induced by the test pressure. Wafer valves may be tested in any suitable manner agreed between the purchaser and the manufacturer.

b) The valve disc shall be in slightly open position and pressure equivalent to 1.5 times the maximum permissible working pressure shall be applied with water. The duration of this test shall be as in Table below.

| **Nominal Dia** | **Minimum Test Duration in Minutes for** | |
|---|---|---|
| | **Body Test** | **Seat Test When Applicable.** |
| Upto and including 50 | 0.25 | 0.25 |
| 65 to 150 | 1 | 1 |
| 200 to 300 | 2 | 2 |

**9.7.4.11.** Marking

Marking shall be cast integral on the body or on a plate securely attached to the body. The markings shall be in accordance with IS 9866 : 1981.

**9.7.5.** Non return valve

**9.7.5.1.** A device provided with a disc hinged on one edges so that it opens in the direction of normal flow and closes with reversal of flow. Non return valve are 3 types: 1 swing check type cast iron reflex valve. 2. Gun metal non return valve. 3. Cast steel reflex valve.

**9.7.5.2.** The reflux valves are swing type gate valves with a flap hinged at its top and the flow in the forward direction causing the flap to swing open. The amount of opening depends upon the velocity of flow and the weight of flap. With the decrease of velocity, the opening reduces and it closes down preventing any back flow during reversal of flow.

**9.7.5.3.** The main consideration for the selection of reflux valve should always be that it should not close down without heavy shock. If it closes with a shock it may lead to development of severe water hammer.

**9.7.6.** Single check-type Reflux Valves (Cast iron)

**9.7.6.1.** (Non-return valves) Single Door Pattern should conform to IS: 5312 (Part-I)

**9.7.6.2.** General

The body, door, cover and hinge are of cast iron to IS: 1210. Body ring, door faces, bearing bushes are of gun metal, hinge pins, door pins and door suspension pins are of high tensile brass or chromium steel (minimum 12 % chrome) and air release plugs galvanized cast iron. Reflux valves shall be designated by nominal pressure (PN) defined as maximum permissible gauge pressure.

**9.7.6.3.** Size of valve 50mm to 600mm.

**9.7.6.4.** Swing check type reflux (non return valves) multi door pattern conforming to IS 5312 (Part-2)

**9.7.6.5.** Class of valves Class of reflux valves shall be designated by nominal pressure (PN), defined as the maximum permissible gauge working pressure in MPa as follows: PN 0.6 and PN 1.

**9.7.6.6.** The materials used for the manufacture of different component parts of valves shall conform to requirements given in table below.

**Material for different component parts of reflux valves IS 5312 (Part-2)**

| S.No | Component | Basic Material | Alternative Materials |
|---|---|---|---|
| i | Body with hinge and diaphragm | Grey cast iron | a) S.G. iron<br>b) Cast steel |
| ii | Hinge pin | High tensile brass | Stainless steel |
| iii | Bolts | Carbon steel | ---------- |
| iv | Nuts, nuts for hinge pins | Carbon steel | ---------- |
| v | Bearing bushes | Leaded tin bronze | a) Austenitic iron<br>b) PTFE/Rein- forced PTFE |
| vi | Face and seat rings | Leaded tin bronze | a) Austenitic stainless steel<br>b) Stainless steel |
| vii | Flange jointing material | Rubber | |

**9.7.6.7.** Testing Before coating each valve shall be subject to hydrostatic test shall be carried out with water. Test pressures and duration of test shall be as specified in Table below:

**Test Pressure (Gauge) and test duration of Valves IS 5312 (Part-2)**

| **PN Rating of Valve** | **Test** | **Test Pressure (Gauge), Min** | **Test Duration (Min)** |
|---|---|---|---|
| | | MPa | Minutes |
| PN 1.0 | Body test | 0.9 | 2 |
| | Seat test | 0.6 | 2 |
| PN.1.6 | Body test | 1.5 | 2 |
| | Seat test | 1.0 | 2 |

**9.7.7. Brass Bib Cock & Stop Cock**

**9.7.7.1.** Bib cocks (bib tap) and stop cocks (stop tap) shall be of specified size & shall be of screw down type. The closing device should work by means of a disc carrying a renewable nonmetallic washer which shuts against water pressure on a seating at right angles to the threaded spindle that operates it. The handle shall be either crutch or butterfly type securely

fixed to the spindle.

Valve shall be of the loose leather seated pattern. The cocks (taps) shall open in anticlockwise directions.

**9.7.7.2.** The bib cock & stop cock shall be polished bright. The minimum finished weights of the bib tap (cock) & stop tap (cock) shall be as given in the IS specifications.

When the bib cocks or stop cocks are required to be chromium plated, the chromium plating shall be conforming to IS: 1068. The chromium shall never be deposition brass unless coating of nickel is interposed. In case these are required to be nickel plated, the plating shall be of first quality with a good thick deposit of silvery whiteness capable of taking high polish that will not easily tarnish for scale. In finish & appearance, the plated articles, when inspected shall be free from plating defects such as blisters, pits, and roughness. Unplated areas shall not be stained or discoloured. Before a plate is plated the washer plate shall be removed from the fittings. The gland packing shall be protected from the plating solution.

**9.7.8.** Gun Metal Bib Cock & Stop Cock:

These shall be of gunmetal screw down pattern of the size as specified. So far as the general requirements of material are concerned, these shall be similar to those as described above. The weight of these shall be the same as for brass bib cocks.

**9.7.9.** Brass Full Way Valve:

Full way valve shall be of brass fitted with a cast iron wheel & shall be of gate type, opening full way of the size as specified. The valve shall be of best quality as approved by the Engineer-in-Charge & shall have the standard weight as specified with a tolerance of 5%.

**9.7.10.** Gun Metal Full Way Valve:

These shall be of gun metal fitted with wheel & shall be of gate type opening full way & of the size upto 50 mm. These shall generally conform to IS.778 & their approximate weights shall be as specified earlier.

**9.7.11.** Check Valves (Non return valves)

Check valves of 40mm and smaller size shall be gunmetal conventional swing/lift check valve type used in all water services. Check valves larger than 40 mm shall be Bronze wafer/Dual plate check valve type used in all water services. The valves shall be supplied inclusive of M.S. Pipe flanges and high tensile steel bolts of dimension recommended by suppliers of valves.

**9.7.12.** Ball Valves

These shall be of brass fitted with handle upto 50 mm dia. These shall generally conform to latest revision of ASTM A105 & their approximate weights shall be as specified in the code.

**9.7.13.** Control Valves:

The design and manufacture of the valves shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. Nothing in this specification shall relieve the vendor of this responsibility. Valves shall be confirming to IS 778 PN 1.0 (Class 1). All valves shall be tested while installed in pipe by hydrostatic pressure of 1.5 time of the working pressure 7.5 Kg/Sq.cm whichever is more.

**9.7.14.** Pressure Reducing Valve:

The knob fitted on top of the PRV shall be turned toward (-) or (f) sign to reduce/ increase the outlet pressure as desired.

**RANGE:**

a. Inlet pressure : Max 16 bar

b. Outlet pressure : 1.5 to 6 bar adjustable

c. Operating temperature : Max to Degree C

d. Maximum pressure drip : 1 bar

**9.7.15.** Automatic Air Vent (AAV):

- Automatic air vents, shall be furnished at the top of main water risers, supply and return pipes.
- A shut-off valve shall be provided at the inlet of each automatic air vent. The outlet shall be piped to the nearest drain.
- Air Release Valves shall be capable of automatically releasing accumulated air from a fluid system while that system is in operation and under pressure.
- To assure drop tight shut-off, a viton orifice button shall be used to seal the valve discharge orifice when the valve is in a closed position. The orifice diameter will be sized for use within a given operating pressure range to insure maximum discharge capacity.

**9.7.16.** Branch Connections :

"T" outlet with manually operated sluice valves shall be provided in the Pressure Main for Branch connections.

**9.7.17.** Appurtenances:

The appurtenances shall be located in such a way that these are clearly and easily accessible for operation and maintenance.

**9.7.18.** Construction Of Chambers For Appurtenances:

**Chamber for Appurtenances:**
The suitable. chambers shall be constructed around the appurtenances and valves fixed on the line. The chamber shall have Pre cast RCC cover conforming to IS:456-2000 or as specified in the BOQ.

## 9.8. UPVC PIPES & FITTINGS FOR WASTE & RAIN WATER PIPES

### 9.8.1. Scope

The scope of work includes plain and socket end unplasticized polyvinyl chloride ( UPVC ) pipes with nominal outside diameters 32 mm to 200 mm for use for waste & rain water waste discharge system inside buildings.

### 9.8.2. uPVC pipes & fittings (for Rain water Pipes ) – IS 4985-1988

Where specified, rain water pipes shall be UPVC pipes confirming to I.S: 4985-1988. The details of the nominal outer diameter, weight and working pressure shall be as per the standards, for the respective pressure rating as specified in the B.O.Q.

The pipes shall be round and shall be supplied in straight lengths with socketed ends. The internal and external surfaces of pipes shall be smooth, clean, free from groovings and other defects. The ends shall be cleanly cut and square with the axis of the pipe. The pipes shall be designated by external diameter and shall conform to IS:4985-1981.

**The bottom end of pipe to be encased to ensure stability during high rain.**

### 9.8.3. Fittings

Fittings shall conform to the same Indian Standard as for pipes. Pipes and fittings must be of matching IS Specification. Interchange of pipes of one standard with fittings on the other standard will not be permitted.

Fittings shall be of the required degree of curvature with or without access door.

Access door shall be made up with 3 mm thick insertion rubber washer and white lead. The bolts shall be lubricated with grease or white lead for easy removal later. The fixing shall be air and water tight.

### 9.8.4. Fixing

All vertical pipes shall be fixed by MS clamps truly vertical. Branch pipes shall be connected to the stack at the same angle as that of the fittings. No collars shall be used on vertical stacks. Each stack shall be terminated at top with a cowl (terminal guard).

Horizontal pipes running along ceiling shall be fixed on structural adjustable clamps of special design shown on the drawings or as directed. Horizontal pipes shall be laid to uniform slope and the clamps adjusted to the proper levels so that the pipes fully rest on them.

Contractor shall provide all sleeves, openings, hangers, inserts during the construction. He shall provide all necessary information to the building Contractor for making such provisions in the structure as necessary. All damages shall be made good by the Contractor at his own cost to restore the surfaces.

### 9.8.5. Clamps

Holder bat clamps shall be of standard design and fabricated from painted M.S. standard flats 40x3 mm thick and 12 mm dia MS rod and 6 mm nuts and bolts. Holder bat clamps shall be fixed in cement concrete 1 : 2 : 4 mix blocks 10x10x10 cms deep.

Where holder bat clamps are to be fixed in RCC column or slotted angles, walls or beam they shall be fixed with MS painted 40x3 mm flat iron "U" type clamps with anchor fasteners of approved design or 6 mm nuts and bolts.

For SWR pipes conforming to IS 13592 shall be clamped to wall with approved type of uPVC saddle clamp/U-clamp or as given in the Bill of quantities.

Structural clamps shall be fabricated by electro-welding from MS structural members e.g. rods, angles, channels flats as per detailed drawing. Contractor shall provide all nuts & bolts, welding material. All fabricated clamps, nuts, bolts and washers shall be not dipped galvanized.

MS painted slotted angle/channel supports on walls shall be provided wherever shown on drawings. Angles/channels shall be of sizes shown on drawings or specified in schedule of quantities. Angles/channels shall be fixed to brick walls with bolts embedded in cement concrete blocks and to RCC walls with suitable anchor fasteners. The spacing of support bolts horizontally shall not exceed 1 m.

Wherever MS clamps are required to be anchored directly to brick walls, concrete slabs, beams or columns, nothing extra shall be payable for clamping arrangement and making good with cement concrete 1 : 2 : 4 mix (1 cement : 2 coarse sand : 4 mm stone aggregate 20 mm nominal size) as directed by the Engineer-in-Charge.

## 9.9. HIGH DENSITY POLYETHYLENE (HDPE) PIPING WORK FOR EFFLUENT DISCHARGE:

### 9.9.1. General

All pipes and specials shall be manufactured out of high density polyethylene in accordance with IS: 8360 (Part I & III). PE injection moulded fittings shall be as per IS: 8008 (Part I to IX), which shall be free from any cracks, surface flaws, laminations, excessive pitting or any other defects. The method of manufacture shall be in accordance with IS 14333:1996.The internal and external surfaces of the pipes shall be smooth to the satisfaction of the Engineer-in-Charge and the end shall be cleanly cut and shall be square with axis of pipes. The diameter and thickness shall be measured as per clause 6.3 of IS 14333:1996.

HDPE pipeline shall be designed in accordance to the criteria given in IS 14333:1996. Minimum required strength of resin grade PE 80 shall be 8.0 at 20 deg C, 50 years as per IS 14333. Maximum Melt flow rate shall be as per IS 14333. Carbon Black Content in the material shall be within 2.5±0.5 percent and dispersion of carbon black shall be satisfactory when tested according to the procedure described in IS 2530:1963. The percentage of Anti Oxidant used shall not be more than 0.3 percent by mass of finished resin.

### 9.9.2. Material

Raw material used to manufacture the HDPE pipes shall be virgin pre-compounded PE80 resin confirming to IS: 14333:1995 IS: 7328:1992 and ISO4427:1996. The resin proposed to be used for manufacturing of the pipes should also comply with the following norms as per ISO 9080:1992:

a. The resin should have been certified by the an independent laboratory of international repute for having passed 10,000 hour long term hydrostatic strength (LTHS) test extrapolated to 50 years to show that the resin has a minimum MRS of over 10/ 8 / 6 MPa for PE 100/PE80/Pe63 resin respectively.

b. Internal certificate of any resin manufacturer will not be acceptable.

c. Certificate for having passed the full scale rapid crack propagation test as per ISO 13478.

### 9.9.3. Quality Assurance Certificate

Quality assurance certificate, for the raw material proposed to be used for the project, from one of the certifying agencies such as Bodycoat or Slevan or Advantica or any other internationally reputed organization shall be submitted along with the bid.

The bidder should submit the above raw material certificates for proposed raw material along with his bid in the first cover. Bids without these certificates can be treated as non-responsive.

### 9.9.4. Dimensions and Tolerance

The pipe dimensions shall be as per latest revisions and amendment of IS14333.or as given in tender documents. The pipes shall be supplied in straight lengths of minimum 6m.

The dimension tolerances shall be as per IS: 14333 annex A.

Tolerance for pipes in respect of diameter and straightness shall be in accordance with IS: 14333 however negative tolerance in pipe wall thickness is not permissible.

The shell in the completed work shall be almost full round. The diameter shall be measured preferably by using a flexible tape or circometer, having an accuracy of not less than 0.1 mm.

Straight pipes shall have their faces perpendicular to the axis of the section with a maximum deviation of 2mm on either side of the plane.

For the shell thickness, the tolerances shall be as per table 1 of IS : 14333:1996 with no negative Tolerance on pipes wall thickness.

### 9.9.5. Performance requirements

During the whole process of manufacturing, department's representative shall be present to supervise the Quality Assurance process and witness the test performed.

The internal and external surfaces of pipe should be smooth, clean and free from grooving and other defects. The end shall be cleanly cut and shall be square with axis of the pipe.

The pipe supplied should have passed the acceptance tests at manufacturers works place, as per clause 8 and 9 given in IS 14333. The manufacturer should provide the test certificates for the tests conducted, as required in IS: 14333 along with the supply of pipes.

The pipe to be tested shall be given a serial no. which shall be painted on its inside together with details such as pipe No. thickness, diameter, length etc. It shall be entered in the register to be maintained by the Contractor. A copy of results of the tests shall be sent every week and another copy shall be sent along with the lot sent to the site for laying.

(i)Prior to testing, the pipe shall be inspected thoroughly and all the apparent defects in shall be repaired.

(ii)The performance tests as specified in IS 14333:1996 clause 8 shall be carried out under cover at the manufacturing workshop, in the presence of and to the satisfaction of the Engineer-in-Charge or the inspection agency appointed by the Engineer-in-Charge .

(iii)For indicating the pressure inside the pipe an accurate pressure gauge of approved make duly tested and calibrated for the accuracy of readings shall be mounted on one of the closures which close the pipe ends.

(iv)Nothing extra shall be paid for testing and for P/F of gauges and for filling the pipe with water and other equipments.

(v)The Engineer-in-Charge shall be supplied with two copies of the results of all the tests carried out for which nothing shall be paid.

### 9.9.6. Marking:

As per the provisions of clause given in IS-14333, each straight length of the pipe shall be clearly marked in inedible ink/ paint with the following information:
a. Name of Owner
b. The manufacturer’s name and/ trade mark
c. Designation of the pipe as per
d. Lot number/ Batch number

### 9.9.7. BIS License

The pipe manufacturer who is going to supply the pipes for the project has to have a valid BIS license for manufacturing of HDPE pipe of any size available in IS 14333.

### 9.9.8. Fittings/Specials

All HDPE fittings/ specials shall be fabricated in accordance with IS: 8360 (Part I & III). PE Injection moulded fittings shall be as per IS: 8008 (Part I to IX). All fittings/specials shall be fabricated or

injection moulded at factory only. No fabrication or moulding will be allowed at site, unless specifically permitted by the Engineer-in-Charge.

Fittings will be butt fusion welded on to the pipes or other fittings by use of heat fusion. All the other specials/fittings such as bends, tees, Reducers, Flanges, dismantling joints etc will be shall be fabricated from PE and shall be smooth in surface in accordance with IS :8008 (Part I & IX). The thickness and pressure shall be adequate to sustain field test pressure but shall not be less than the thickness and pressure of the pipe at that point.

### 9.9.9. Bends and Tees

HDPE bends shall be plain square ended conforming to IS: 8360 Part I & III Specifications. Bends may be fabricated by jointing several small sections of pipes to reach the required angle. HDPE Tees shall be plain square ended conforming to IS: 8360 Part I & II Specifications. Tees may be equal tees or reduced take off tees. Tees may be moulded or fabricated from pipes elements.

### 9.9.10. Reducers

HDPE Reducers shall be plain square ended conforming to IS: 8008 Part I & VII Specifications. Reducer must be moulded.

### 9.9.11. Flanged HDPE Pipe Ends

HDPE Stub ends shall be square ended conforming to IS: 8008 Part I & VII Specifications. Stub ends will be welded on the pipe. Flange will be of slip on flange type as described below.

### 9.9.12. Slip-On Flanges

Slip-on flanges shall be metallic flanges covered by epoxy coating or plastic powder coating. Slip-on-flanges shall be conforming to standard mating relevant flange of valves, pipes etc. Nominal pressure rating of flanges will be PN10.

### 9.9.13. Jointing between HDPE pipes

Jointing between HDPE pipes shall be done as per the relevant IS: 7634 Part II. Jointing between the pipes shall be with butt fusion welding.

### 9.9.14. Welding

Except for routine welding of joints, no other work shall be done in the absence of Contractor's engineer, either during the day time or at night.

Jointing between HDPE pipes and specials shall be done as per the latest IS: 7634 part II. Method of jointing between the pipes to pipes and pipes to specials shall be with butt fusion welding using automatic or semi automatic, hydraulically operated, superior quality butt fusion machines which will ensure good quality butt fusion welding of HDPE pipes. If approved by Engineer-in-Charge, jointing with PP compression fittings may be carried out for smaller diameters of PE pipes (up to 110mm). The bidder shall furnish along with his bid the detailed specifications, procedure, tools and equipments for butt fusion welding.

(i) Except for routine welding of joints, no other work shall be done in the absence of Contractor's engineer, either during the day time or at night.

### 9.9.15. Procedure of Butt Welding of HDPE pipes

The pipe should be cut square and the face of the pipe should be slightly scraped prior to welding to remove oxidized layer. At the time of welding, leveling of the pipes is essential, particularly in case of large diameter pipes. Welding temperature should be 200°C and surface of heating mirror should be 210 +- 5°C. (Heating mirror is a metallic plate heated upto the required temperature either by electrical coil embedded inside or by blow torch. The word mirror has come because this heating plate radiates heat). The pipe to be welded should be held on either side of the heating mirror with only contact pressure of about 20kPa (0.2 Kg cm2). When the rim of molten material is found, the pipes are removed from the heating mirror and immediately the joint is made by application of moderate pressure of approximately 1 to 2 Kg/cm2 for 2 to 3 seconds. The initial heating time for achieving molten rim, varies from 1 to 5 min depending upon the pipe wall thickness and size.

Precautions:

i) Prior to the start of jointing, the Contractor shall submit to the Engineer-in-Charge for his approval the “Welding procedure method statement”, he intends to use.
ii) It is essential, the pressure should be maintained until the joint is luke warm and after the pressure is relieved, the joint allowed to cool completely.
iii) The mirror should be kept exactly around 210 deg C which needs about 30 min times (for electrical mirror). It is also essential to see that the temperature is maintained constant by the proper setting of regulator. For detecting the correct temp, crayon chalk is used. For example at 210 deg C, the colour of crayon dot on the mirror changes within 2 seconds. But the dot made should be thin and if not, time taken will be more, indicating a wrong temp.

### 9.9.16. Strength:

A satisfactory butt welded joint of HDPE will have the strength factor of one. Temperature is of primary importance and weld efficiency may decrease if the temperature does not fall with in the range of 200 ± 10 deg C.

### 9.9.17. Jointing between HDPE pipes and valves / DI pipes / Specials

Jointing between HDPE pipes and valves / DI pipes and specials shall be flanged joint as per IS: 7634 (Part II). The gaskets for flange joints should be Neoprene. Fastener materials (nuts, bolts, washers) shall be of SS: 316 construction and other fasteners shall meet the requirement of relevant clauses of IS: 1363. The testing of joints to be as per standards or as specified by the Engineer-in-Charge.

### 9.9.18. Laying of Pipes

The pipes shall be carefully laid straight to the correct alignment in gradients as indicated in the drawing. All the pipe shall be used in standard length as far as possible. Cut length may be used only where it is necessary to make up exact length.

The entire length of pipe shall be evenly supported on bed of the trench through out. Care shall be taken to prevent any sand, earth or other materials from entering into the pipes during laying. At the end of day's work the open end shall be suitably plugged.

### 9.9.19. Installation and Commissioning of HDPE pipes:

**9.9.19.1.** Installation

Supplying, laying, jointing, testing and commissioning of pipes shall conform to relevant IS codes, as applicable. Any additions and/or modifications specified in this Section shall also be followed. The alignment of pipelines shown in drawings of the tender documents is only indicative and the exact alignment will be as per drawings and/or as directed by the Engineer-in-Charge. The HDPE Pipes shall be laid in accordance with the latest IS 7634 Part-2

The bottom of the trench shall be properly trimmed off to present a plain surface and shall be leveled. Sand bedding shall be provided for the entire stretch of pipeline with minimum 150 mm bedding

thickness at bottom of pipe trench. Width/Height of bedding shall be such that it shall subtend an angle of 120 deg at centre of pipe. The sand to be used shall be of approved quality and grade and shall be well rammed to form a fair and clean bed for pipes.

**9.9.19.2.** Sand Bedding

The bottom of the trench shall be properly trimmed off to present a plain surface and shall be leveled. Sand bedding shall be provided for the entire stretch of pipeline with minimum 150 mm bedding thickness at bottom of pipe trench. Width/Height of bedding shall be such that it shall subtend an angle of 120 deg at centre of pipe. The sand to be used shall be of approved quality and grade and shall be well rammed to form a fair and clean bed for pipes.

During the work of providing bedding and laying the pipeline over it, loose material from the sides or edges of the trench shall be prevented from falling inside the trench, by providing shoring and taking other measures. Also where necessary, trench shall be kept dry by pumping out seepage, leakage waters continuously at no extra cost. It shall include cost of shuttering also.

### 9.9.20. Dewatering

In case of under ground piping works, the contract rate shall include bailing or pumping out all the water till completion of work if accumulated during the progress of work either from seepage, springs, rain or any other cause .

### 9.9.21. Testing

The joints shall be tested by either smoke test for vertical stacks or 2.5 m head of water at the highest point of the section under test for horizontal drainage pipes. Smoke shall be pumped into the pipes at the lowest end from a smoke machine which consists of a below and burner .The material usually burnt is greasy cotton waste which gives out a clear pungent smoke which is easily detectable by sight as well as by smell, if there is leak at any point of the drain. The water head test shall be carried out by suitably plugging the lower end of the drain and the ends of the connection if any and filling the system with water. A knuckle bend shall be temporarily jointed to it so as to provide required test head , or the top may be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fixed suitable for observation. The leaky joints shall be remade and section re-tested at no extra cost.

## 9.10. SOLAR HOT WATER SYSTEM

### 9.10.1. Objective

a. It is proposed to install solar water heating system for supply of hot water in the Toilets and kitchen/ Pantry areas of the Building complex. Solar HWH system is planned to save power and to use solar energy.

b. Hot water shall be generated by Solar Panels during day time and stored in insulated hot water tanks for pre heated water supply to geysers.

c. To achieve GRIHA rating as per Green Building Norms.

### 9.10.2. Scope Of Work

Scope of work includes: -

1. Design, supply, installation, commissioning and maintenance of Solar Water direct/indirect Heating System in the designated area of the building.
2. The supplier shall after completion and commissioning of the work submit details of the same in the format.
3. The materials to be supplied should be as per the specification with at least two year warrantee period on the system commissioned by the firm.
4. The firm shall after completion and commissioning of the work submit details of the same in the format.
5. The Contractor will do necessary piping and stand/support structure as per the requirement.

**9.10.2.1.** Technical Specifications

**FPC SOLAR WATER HEATING SYSTEM**
The solar water heating system at 60 °C will be installed.

**STANDARDS**
The details of the standard which contain minimum performance requirement along with the test method are as follows.

a) Solar Flat Plate Collector

i. IS 12933 ( Part-1): 2003 , solar flat plate collector – Specification , part 1-requirement
ii. IS12933 ( Part-2):2003 , Solar flat plate collector-Specification, Part-2-Components
iii. IS 12933( Part-3):2003 Solar flat plate collector –Specification, part-3- Measuring Instruments
iv. IS 12933 ( Part-5) :2003 , Solar flat plate collector-Specification, part-5-test method

Collector specifications given are BIS specifications.

**MNRE Specification for test procedure**
Test procedure for Thermo-syphonic solar water heating systems are available on MNRE web sitewww.mnre.gov.in should be followed.

**Other requirement of water heating system**

b) Overall dimension of collector

| Size | Length ( in mm) | Height( in mm) | Width( in mm) |
|---|---|---|---|
| Collector | 2050± 10 | 100± 10 | 1040± 10 |

c) **Cover plate** :-The cover plate shall be single piece tempered / toughened glass and minimum of 3.2mm-4 mm thick ,free from bubbles and rough surface as per the latest specification. Glass shall have High transmittance > 92%.

d) **Collector Box:** - The collector box shall be made of extruded aluminium section only.

**e) Absorber:-**The absorber consists of risers, headers and sheet for absorber.

(a) Material **:-** Single sheet Aluminium absorber
(b) Thickness :- .51 mm
(c) Copper tubes (Riser) : Diameter = 8 mm
(d) Header Diameter = 18mm
Projection = 40mm (± .5mm) outside the collector box including the flanges.
(e) Bonding between riser and sheet.- Full length of all risers shall be laser welded with absorber sheet.
(f) Header- riser joints:-Brazing with special neck formation in the header for smooth flow of fluid & stronger joint.
(g) Absorber coating: - In all systems selective coating shall be ***used. The selective coating shall have emissivity <0.2 and absorbitivity> 0.92.***
(h) Absorber area:- 2 sqm per 125 LPD at 60 °C .

**f) Testing of riser –Header: -** Riser and header assembly designed for working pressure up to 245 kPa ( 2.5 Kg/cm²) shall be tested for leakage at a minimum hydraulic pressure of 490 kPa ( 5Kg/cm²) . The system designed for higher pressure than 245 kPa, the assembling shall be tested at a pressure twice times the designed pressure.

**g) Collector box installation:-**

(a) Back & side insulation: - Minimum 50mm thick insulation of rock wool/ glass wool/ mineral wool shall be provided, with a density of 48 KG per meter cube as back insulation.The side insulation should be polyurethane with minimum 25 mm thickness.
(b) Back and side insulation shall withstand at 175°C.

h) **Gaskets and grommets: -** The load of the absorber should not be on the insulation. It should be taken by the collector box. Insulation should not be allowed to slide. Gasket used for sealing the glass with collector box may be of Neoprene / Silicon/EPDM rubber channel section. Grommets for sealing the collector box and the header joint may be one of the following types and shall fit properly so that no dust can pass through the joints:

a) Neoprene rubber,
b) EPDM,
c) Silicon rubber

Grommet and gaskets shall be capable of withstanding temperature up 125° C and shall conform to thermal shock test.

**i) Header flanges: -** Copper/brass flanges of 62mm ± 3mm diameter and minimum thickness of 4mm shall be used. Flanges shall be brazed to header and brazing tested for leakage to test pressure. In no case crude solder flanges shall be used. Assembly of the flanges should be at right angle to the header area to ensure proper assembly at the side of the insulation.

**j) Assembly of the Collector:-**

i. The collector shall be assembled in such a way that the weight of the absorber is distributed uniformly on the side wall of the collector box.

ii. The entire assembly shall be free from surface defects. All sharp edges and corners shall be rounded off. The exposed surfaces shall be properly made corrosion resistant..

k) **Collector Support frame: -** The structure shall be in a position to withstand wind velocity of 100 Km/hr. The structure shall be made with angle iron stronger than 35mm X 35mm X 3mm The grouting blocks shall be minimum 25cm X 25cm X 15cm and finished properly.

The cement pedestals should be made after chipping of the existing rooftop to provide proper gripping and strength. Structure should be such that collector's bottom side is at least 30 cm above the ground/roof level. In case of inclined roof, the collector housing frame along with the vertical angle shall be mounted & fixed using suitable necessary structure keeping in view the load bearing capacity of the roof top ensure the stability against storm. The collector should be properly clamped and tightened with frame and supporting structure at both the ends by 20mmX 2mm size MS strip consisting rubber packing to avoid chemical reaction between the collector bodies and clamp.

l) **Painting of stand: -** Proper cleaning and degreasing of the surface should be done before painting. Two coats of zinc chromate red oxide primer shall be applied followed by one coat of enamel paint. Suitable anticorrosion paint should be applied after proper treatment.

**m) Storage tank**

**Materials: -** The storage tank should be low carbon Mild Steel. The thickness should be 2.5 mm suitable for mains pressure, with jacket type heat exchanger. The storage tank shall be internally glass enamelled with minimum coating thickness of 250 micron to resist corrosion against hard water.

**Insulation: -** Insulation should withstand temperature of 100°C. A 50 mm thick PUF insulation shall be provided. External of the tank should be properly insulated so that hot water temperature does not decrease by more than 5 degree C in about 16 hours times.

Hot water storage water tank shall be provided with a sacrificial magnesium anode.The anode shall be screwed to the tank from out side for easy replacement.

**n) Piping:-**

½ inch to 1 inch dia CPVC pipes of approved make /ISI marked GI pipe, heavy class shall be used for cold/hot water supply. The pipe line should be properly supported and fixed with clamp with the help of suitable size stand/civil structure (cement concrete ratio 1:4). ISI mark gunmetal strainer of standard make should be fitted in the main cold water supply line before the system. This includes testing of joints complete as per direction of the Engineer in charge.

**o) Valves/Nipple/tees/bend/taps:-**

Gunmetal valve as per ISI specification shall be used. Nipple/tees and bends shall be of medium class G I (B-class) /brass or copper. Gunmetal valve in each row shall be provided. TAPs of stainless steel ISI mark or reputed make shall be provided.

p) **Temperature gauge:-**

Temperature gauge (ISI mark) :- one for hot water storage tank/outlets – dial type – duly calibrated and suitable for temperature ranges ( 0 to 120 ° C)

**q) Cold water tank: -**

Only Sintex or equivalent materials and it should be as per the capacity of the solar water heating system. The supplier should supply, install /grouted on suitable stand and do necessary connection for proper function of the system.

**r) Heat Transfer Closed Circuit Fluid:**

Only Anti scaling, Anti-corrosion and Anti-freeze Hart gard Propylene Glycol food grade liquid shall be used on the primary closed circuit.

## 9.11. PUMPS AND WATER TREATMENT PLANT

### 9.11.1. General description:

**9.11.1.1.** Scope:

The scope of this Public Health Engineering work covers the complete, Domestic Water Treatment Plant Works for SAU**.** The installation shall be complete in all respects as indicated on the drawings or as per specifications.

Work under this section shall consist of furnishing all labour, materials, equipment and appliances necessary and required for the satisfactory supply, installation, completion and commissioning of water supply pumping system and allied works as described hereinafter, as specified in the schedule of quantities and/or shown on the plumbing drawings and described in the scope of work..

**9.11.1.2.** Building:

The **proposed site** is located in **Delhi.**

**9.11.1.3.** Applicable codes and standards:

All equipment, supply, erection, testing and commissioning shall comply with the requirements of Indian Standards and code of practice as amended upto the date of submission of Tender. All equipment and material being supplied shall meet the requirements of BIS and other relevant standard and codes.

**9.11.1.4.** General requirements:

i. All materials shall be new of the best quality conforming to specifications and subject to the approval of Engineer-In-Charge.
ii. All equipment shall be as per approved list of makes.
iii. All equipment shall be installed on suitable foundations, true to level and in a neat workmanlike manner.
iv. Equipment shall be so installed as to provide sufficient clearance between the end walls and between equipment to equipment.
v. Piping within the pump house shall be so done as to prevent any obstruction in the movement within the pump house.
vi. Each pumping set shall be provided with a butterfly valve on the suction and delivery side and a flap type non return valve on the delivery side.
vii. All pump couplings and belt guards shall be totally enclosed with 5 mm mesh.

### 9.11.2. Domestic water treatment plant:

**9.11.2.1.** Scope:

i. Scope of this section covers the design, manufacture, supply, erection, testing and commissioning of the Domestic Water Treatment Plant complete with all necessary equipments and inter-connecting pipe work etc.

ii. The supply of equipment and their erection including related electrical works and interconnecting pipe work shall be complete in all respects and any equipment or component not covered in this specification but considered essential by the Contractor in order to guarantee the proper operation of the plant shall be included in the quotation. The necessary equipment, their expected performance and disposition in the plant are all indicated in the specifications and drawings. However, if the Contractor desires he may suggest alternative equipment and their layout capable

of meeting the requirements of final water quality as well as the area and head room restrictions within the plant room. All pumps and other equipments shall be compatible with BMS System.

**9.11.2.2.** Water Supply and Treatment Process:

i. Water Requirement:
Water requirement for the Project is as under:
Domestic Water Requirement : 1400 $m^3$/day (approx.)

ii. Part of the water for Irrigation System other than Cooling tower makeup water shall be from the treated effluent after tertiary treatment from Sewer Treatment Plant.

iii. Source of Water Supply:

All the water supply requirement of the proposed buildings shall be met from municipal water supply augmented by tanker water supply.

iv. Quality of Water:
Inlet Water Quality
Inlet water quality may have following problems which need to be addressed:
i) Hardness
ii) Iron
iii) TDS

Vendor must ensure complete testing afresh to ensure that the treatment plant offered performs efficiently and delivers output water quality consistently.

**Outlet Water Quality**
Outlet water from treatment plant should deliver potable water quality as per relevant IS standards.

v. Treatment Scheme:

Water from all sources shall be first fed into fire water storage tanks after chlorination if coliforms count is more than 10 & overflow from the same shall be taken to Raw Water Tanks.

Suction to raw water pump shall be taken from raw water tanks. Water from raw water feed pump shall feed to multigrade sand filter. Outlet from multigrade filter shall pass to activated carbon filter to remove unwanted colour and odour and excess chlorine and the discharge from activated carbon filter shall be taken into softener to reduce the hardness of the water. By pass from the activated carbon filter shall be chlorinated before discharging into treated water storage tank. Softener is also proposed for soft water requirement for cooling tower makeup incase of emergency.

**9.11.2.3. Water Filtration Plant:**

i. **Capacity:**

The proposed filtration plant shall be capable of filtration 1400$m^3$ of raw water of given quality within a maximum of 18-20 hrs. time including backwash of filter and regeneration of softening plant.

ii. **Location:**

The water filtration plant shall be located in the plant room near water storage tanks.

**iii. Standards:**

The components of all equipment shall be designed assembled and tested in accordance with the latest standards of Bureau of Indian Standards.

iv. **Equipment:**

The equipment to be supplied and erected for the plant shall be constructed from first class material with first class workmanship to the satisfaction of the Engineer-in-Charge.

The items listed below are for the general guidance of the Contractor. The Contractor shall include all items essential for the complete water filtration plant and shall revise or modify the list and submit his tender alongwith the list which he considers suitable for guaranteeing the performance of the plant.

The above scheme as mentioned in clause no. 2.2.5 shall broadly include the following equipment as given below. All major/minor components necessary for completion of the system shall be deemed included in each item.

Filter feed pumps comprising of:

i) Monoblock centrifugal fresh water pumps with base frame.

ii) Suction isolation valves on each pump (C.I. butterfly valve not less than suction size of pump).

iii) Discharge side isolation valves on each pump (C.I. butterfly valve not less than discharge size of pump).

iv) Discharge side N.R.V's on each pump (C.I. wafer type or dual plate type not less than discharge size of pump).

v) All pipes and fittings, specials etc. as required to make common suction and common discharge. The M.O.C. of pipe shall be CPVC only.

a) Chlorine solution dosing on source inlet supply before fire tank if coliform is more than 10

b) Multi-grade pressure Sand Filter

c) Activated Carbon Filter

d) Water Softener

e) Brine Tank

f) Chlorine dosing system with electronic dosing pump in bypass from activated carbon filter.

### 9.11.3. Specifications of Pumps & Equipments

#### 9.11.3.1. Variable speed pumping system for water supply systems

**General :**

- This section of the specification covers the supply, installation, testing, commissioning of the Variable Speed Hydro pneumatic Booster system.
- Booster should consist of the components as per the below specifications as Minimum.

- Complete system shall be tested at the manufacturer's local factory, in accordance to the provisions of the appropriate standard before delivery.

Manufacturer should have facility of witness test with proper test bed.

### 9.11.3.2. System Descriptions :

- The variable speed booster system shall be supplied and installed as designed.
- The system shall comprise of number of pumps, as mentioned in BOQ, in parallel and it shall be a package system manufactured by the manufacturer of the pumps at their factory.
- **System assembled by the dealers locally will not be accepted.** The system shall consist of:
- Vertical In Line Multistage Centrifugal pumps. The quantity shall be as per BOQ.
- Variable Frequency Drives (VFD). The quantity shall be as per BOQ.
- Pre-pressurized bladder or diaphragm type pressure vessel complete with pre-charged dry air gas to the design pressure settings.
- Control panel complete with MCCB, MCB, fuses, microprocessor based dedicated Pump Logic with built in graphical display of VGA 240 x 320 pixels.
- Pipe work and valves, pressure transmitter, pressure gauge, check valve, ball valve/gate valve and all necessary fittings etc to the satisfactory operation of the system and to make system as complete. Only supply & delivery line will be connected to start the system

All these components should be as per the specifications written in 3.3.

### 9.11.3.3. Components of Variable Speed Booster :

**i. Pumps and Motors :**

**a)** Type of Pump :

- The pump shall be of approved make of vertical-in-line multistage centrifugal type suitable for speed up to 2900 rpm.
- The suction and discharge port shall be in line with each other. The maximum operating liquid temperature for the pump shall be up to 110 deg C.
- The motors shall be vertically stool mounted on top of the pump casing and the pump casing shall be designed to take the dynamic load of the motor. The motor shall be provided with thrust bearing to cater for the downward thrust of the pump.
- The manufacturer of the pump should have a local factory with at least 5 years of experience and able to provide after sales service. The factory must have a pump testing facilities with approved test bed to carry out pump as well as complete booster performance witness testing.

b) Pump Selection :

- Each pump shall have the stable characteristics and the operating point shall fall within the acceptable range on the pump curve. Duty point should not be selected at extreme right or left side of the curve.

- The pump performance curve shall be complying with the tolerance according to ISO 9906, Annex A.

c) Pump Head and Base :

- Pump head and base should be made of CED (Cataphorasis Electro deposit) coated Cast Iron.

- The motor terminal housing shall be of a completely watertight design with tight cable glands to prevent ingress of water. For bigger motor, the housing shall have provision for the lubrication of the motor bearing to enable the pump to run effectively with only periodic withdrawal for maintenance and lubrications, if required.

- For motor sizes more than 7.5 kw, extended coupling should be provided to enable the changing of the mechanical shaft seal without the need to lift up or dismantling of the motor. For pumps up to 7.5 Kw mechanical seal should be changeable without dismantling/opening pump.

d) Shaft, Impeller and Guide Vanes :

- All the inter stage components (impeller, intermediate chambers, diffusers) as well as sleeves and guide vanes shall be made of stainless steel 304 material.

- The impeller shall be fitted to a rounded shaft with split cone and split cone nut to prevent the stages of the pump been collapsed. For smaller pumps splined shaft is acceptable.

e) Mechanical Seal :

- The mechanical shaft seal shall be of cartridges type with seal faces of silicon carbide material.

- It should be possible to change mechanical seal without opening the pump to reduce downtime.

f) Motor :

- The electric motor shall be of total enclosed fan cooled (TEFC) squirrel cage induction type suitable for operation on a 415V / 3 ph/ 50 Hz voltage supply. The motor shall be designed based on 40 deg C ambient temperature and up to a maximum of 2900 rpm. The motor shall be of class F insulation and a minimum of IP 55 enclosure with a maximum surface temperature of 120 deg C.

- The motor shall comply with the requirement of BS 4999 or other compatible IEC standard.

- All motors shall be sized for pump operation based on non-overloading conditions for the full QH curve. The motor shall also be suitable for at least 40 start/stop per hour.

- Direct on line starting method is required for motor up to 5.5 kw and star delta starting is required from 7.5 kw onwards.

**All motor should be of minimum Class – II efficiency.**

**ii. Variable Frequency Drives (VFD) :**

- VFD shall be Pulse Width Modulation (PWM) type, microprocessor controlled design labelled as CE. Drive shall have customer modifiable adjustments of 2 to 600 seconds accel & decel time, Minimum & Maximum frequency, V/I ratio and Carrier frequency. Speed reference signal shall be customer selectable for 4-20 mA, 0-5 VDC and 0-10 VDC. The VFD shall be suitable for elevations up to 1005 meters above sea level without de-rating. Maximum operating ambient temperature shall be to 45 Deg C. shall be suitable for environment condition up to 95% non-condensing.

- Built-in DC link filters to avoid power factor correcting devices like Capacitors, line reactors etc.,

- Energy saving mode with boost function (Sleep/ Wake Mode), Quick set up menu.

- VFD should be mounted inside the panel cabinet.

**iii. Dedicated Pump Logic Controller (PLC) :**

PLC should of the same make, as of pump i.e. Pump manufacturer should provide dedicated pump logic controller for this application. **General purpose PLC programmed for boosting application will not be accepted.**

The microprocessor controller based Pump Logic controller (PLC) shall be of standard software configure type

**The PLC should have the following features as minimum:**

- Built-in PI-controller.
- External input signal both digital and analog.
- Alarm output.
- Operation output.
- Graphical Display VGA 240 x 320 pixels.
- Ethernet connection port (RJ 45).
- External BUS communication port.
- Service port.
- Built-in HELP TEXT.
- Built-in start up wizard.
- Upgradeable soft ware program.
- Back light for specific button to be light up only when applicable.
- Backlight to be dimmed when not used for more the 15 min.
- Adjustable contrast for display.
- Selectable service language.
- Selectable units between SI and US.
- Manual entry of pumps data.
- Primary and Standby sensors.
- Data logging.

**The PLC should be able to perform the following functions as minimum:**

- Selectable auto/manual mode for both system and individual pump from Controller
- Selectable pump speed (user define speed in %)
- Max speed
- Min speed
- Set point influence
- Additional set point up to 6 set point
- Adjustable number of start/stop
- Adjustable system time and error correction value
- Adjustable ON/OFF band (stop function)
- Selectable number of standby pump(s)

- Pump test function
- Security setting with pass word for operation and setting
- External fault input
- Selectable dry running protection for either digital or analog signal
- Selectable auto/manual reset for dry running protection
- Selectable open/close loop operation

**The PLC should be able to display the following alarms, whenever it occurs:**

- Alarm log up to 24 event
- Time and date of log alarm
- Current alarm with alarm code and description
- Water shortage
- Max pressure
- Min pressure
- Alarm all pump
- External Fault
- Dissimilar sensor
- Primary sensor
- Fault sensor
- Communication fault
- Over temperature, pump
- Other fault, pump
- VFD not ready
- Fault, Ethernet

**The PLC should be able to display the following values :**

- System status
- Individual pump status
- Pump hour run
- Individual pump speed
- Set pressure
- Actual pressure
- Date and Time
- Menu code and sub code for individual display

**iv. Control Panel :**

The panel shall be equipped with all the necessary electrical components, VFD and the PLC, as mentioned above. The control panel and the PLC shall cover the following functions as minimum:

a) Flexibility and simplicity in allowing the necessary re-adjustment of the booster system delivery pressure to operate the pumps within the specified maximum and minimum delivery ranges including built in set up wizard and help text.

b) Built-in frictional loss compensation or influence factor, which will automatically increase the delivery pressure setting according to the increase in flow demand. This shall be able to minimize the system pressure differences and provide a more constant pressure in the supply line. This is also to save the energy consumption of the motor when running and low speed.

c) Automatic changeover of the pumps to be controlled by the PLC to ensure equal running of all the pumps.

d) When the system is not operating for more than 24 hours, it shall automatically start the pumps for a few seconds per day. This will ensure the readiness of all the pumps at all

times. The standby pumps shall be activated upon failure of duty pump. In the event of PLC failure, the pumps shall be able to start/stop manually.

e) The PLC shall be able to cut off the booster system when excess pressure in the discharge common manifold is registered (maximum limit provision). In a reverse situation, the PLC panel shall be able to cut off the booster system when low pressure in the common suction manifold is registered (minimum limit).

f) Capability of receiving either analogue or digital input signal concerning shortage of water supply, preventing the pumps from dry running.

g) It should automatically start the pumps when the level is back to normal.

h) In case of pump failure due to motor overload, the standby pump is switched on automatically. Alarm signal is displayed on the VGA Display unit and alarm lights are activated.

i) The control panel door shall be displayed with at least the following components:
- Graphical display VGA 240 x 320 pixels with back light
- Pumps selections up to 6 pumps
- Pump status button (including individual pump speed, system Pressure and estimated flow rate)
- System status, alarm, operation & setting button
- Additional Buttons for changing values, accepting changes, help For scrolling data etc

j) Connection for necessary devices for programming, supervising and monitoring operation data/system, status shall be incorporated into the panel/PLC.

k) Pump Selector Mode

Selection should be provided to enable any pump to be the lead pump, first duty pump, second duty pump and standby pump as desired. There shall be alternating mode selection too, where all pumps are operated cyclically upon each call for pumping.

l) Liquid Level Control

To prevent dry running, electrode liquid level or float level control shall be provided in the suction tank to shut down the system in the event of low water level.

m) Pump Isolation

It shall be possible to isolate any pump for maintenance without affecting the performance of the system in the automatic mode.

n) Alarm

Alarm should be displayed in case of any problem. Alarms should be as per details given in PLC section.

All panels/controllers shall be tested at the factory according to the procedures stipulated, before dispatch. The manufacturer shall carry all spare-parts for the controllers. All spares of the controllers shall be readily available for a minimum period of 10 years after the production of the particular model of controller has been discontinued.

**v. Hydro Pneumatic Pressure Tank :**

The hydro-pneumatic tank shall be of bladder or diaphragm type with pre-pressurized air/nitrogen. It shall be capable of handling the designed effective system protection (ESP) Volume to protect pump and operating controls by ensuring that the actual pump operation

conform to the manufacturer's specified minimum running time and maintaining the designed pressure range.

The shell shall be constructed with deep-drawn carbon steel.

The diaphragm/membrane shall be of heavy-duty type. This diaphragm/membrane should be the only component in contact with the liquid.

The tank shall have a maximum operating pressure of 10 bars and shall be able to handle a maximum liquid temperature of 90$^{o}$C.

**vi. Pressure Transmitter :**

Pressure transmitters shall be field mounted and shall transmit an isolated 4-20mA DC signal indicative of process variable to the pump logic controller via standard two wire 24 DC system. Unit shall have stainless steel wetted parts and it should be installed at the discharge header. It should have watertight, electrical enclosure capable of withstanding minimum 10 bar static pressure.

**vii. Headers & Accessories :**

The suction and discharge manifolds shall be stainless steel fabricated of Hot Dipped Galvanized MS. Both manifolds shall be designed to attach to the system piping at either end of the manifold. Delivery manifold shall include a pressure gauge. The discharge manifold shall include a socket to install a pressure transducer with a 4-20mA output. The pressure transducer shall be factory installed and wired.

Isolation valves shall be installed on the suction and discharge of each pump. A check valve shall be installed on the discharge of each pump (optional on the suction side for suction lift applications). Base frame should also be made of galvanized sheet.

**9.11.3.4. Booster System Working :**

The system shall be under the control of a microprocessor based pump logic controller (PLC). 2 nos. of pressure transmitter (primary and standby) shall be incorporated into the system to detect the pressure at the discharge manifold and feedback to the PLC.

The system shall maintain a constant pressure at all times regardless of the system demand. The activation of the next duty pump in a high demand situation shall not base on a different set point. However the PLC should have a flow test function to determine the numbers of pumps in operation and a stop function into the controller to stop all pumps from operation, whenever there is no demand, which prevent and reduce wear and tear of the system as well as reduce energy consumption. The controller shall also ensure alternation of all pumps for even running hours.

The lead pump shall operate when the system pressure reduces to the preset point. If demand escalates, the lag pumps shall commence operation as required. During next operation lead pump to become lag and lag pump to become lead pump automatically. The system shall vary the frequency of each pump (in case of multi VFD system) and it will be equalized to ensure smooth operation to meet the specific demand. Under decreasing hydraulic demand, the reverse to the above description shall apply.

**Operations**

The control circuit shall enable automatic and manual operations of the system.

a. Automatic Operation
Everything will be controlled by PLC in this case.

b. Manual Operation

Either one or all pumps shall be capable of being started and stopped by their respective push buttons or MCB's.

The control panel should have starters for this purpose.

**9.11.3.5. Pumping sets for Water Transfer Pumps/Feed Pumps**

i. Water supply pumps shall be suitable for clean filtered water. Pumps shall be single or multistage, monobloc horizontal/ vertical centrifugal pumps with cast iron body and bronze impeller, stainless steel shaft, mechanical seal and coupled to a TEFC electric motor mounted on a common M.S. structural base plate. Each pump should operate up to a curve 15m below specified head or range specified in the BOQ.
ii. Each pump shall be provided with a totally enclosed fan cooled induction motor of suitable H.P. The motors shall be suitable for 415 ± 10 % volts, 3 phase, 50 cycles A.C. power supply and shall conform to I.S. 325.
iii. Each pumping set shall be provided with a 100 mm dia gunmetal "bourden" type pressure gauge with gunmetal isolation cock and connecting piping.

**9.11.3.6. Filters for Domestic Water.**

i. Water filter shall be sand/gravel pressure filters downward or upward flow type suitable for a flow rate of filtration given in the schedule of quantities.
ii. Filters shall be vertical type of required diameter. The shell and dished ends shall be fabricated from MS sheet as per IS 2825 suitable to with stand a working pressure given in schedule of quantities. The vessel shall have a minimum thickness suitable for pressure as given in the schedule of quantities as per manufactures recommendations.
iii. Each filter shall have at least one pressure tight manhole cover, and one side hole with cover for inspection and repairs.
iv. Each filter shall be provided with screwed or flanged frontal piping comprising of inlet, outlet back wash and rinse with valves efficient under drain system and raw water distributor, 100mm dia dial bourden type gun metal pressure gauges with gun metal isolation cock and connecting piping on inlet, outlet, sampling cock on raw water inlet and filtered water outlet.
v. Face piping shall be of GI (heavy duty)/ non corrosive uPVC of 10kg/sqcm with injection moulded fittings and solvent weld joints.
vi. Filter media
Graded aggregate, selected coarse and fine sand as per latest water treatment practice. Aggregate to be acid washed and having purity of 99.9%.
vii. Depth of filter
Depth of filter media shall be 750-900 mm deep or as per manufacturer's design.
viii. Back washing
By air scouring through air blower as specified (2.2 cfm/m$^2$) or as specified in the schedule of quantities.
ix. Output Water Quality for Domestic Filters: To conform to IS 10500 for the relevant design criteria
x. Multi Port Valves
a) Each vessel will be provided with multi port valves to operate and regulate the normal flow, backwash and rinsing, rapid washing, on the face piping.
b) Provide suitable sampling cocks to draw water samples for raw water and treated water.
xi. Face Piping

a) Each vessel shall be provided with GI (heavy duty)/ non-corrosive face piping from the inlet to the outlet. Face piping shall be GI (heavy class) /uPVC (IS 4985) 10 kg/cm2 class with injection moulded fittings and solvent weld and flanged joints

b) All valves shall be butterfly valves as specified in the piping section over 65 mm dia and for pipe dia below 50 mm dia shall be provided with ball valves.

**9.11.3.7. Back wash pumps for Filter Back Wash**

i. Back wash with TEFC electrical motor, belt driven or direct drive, all mounted on a common structural based plate.

ii. Back wash pumps will be used for back washing operations. The pumps shall be designed for operation of one filter at a time.

**iii.** The electrical switchgear shall be included in the respective MCC panel of the system.

**9.11.3.8. Water softener.**

i. Softeners shall be vertical up flow type, designed to give required hardness. Softener shall be provided with suitable grade of Cation exchange resins in quantity to be indicated by the contractor at the time of tendering.

ii. Softener vessel shall be MS as per IS 2825 with dished ends and self supporting arrangement. The vessel shall have a minimum thickness suitable for pressure as given in the schedule of quantities as per manufactures recommendations.

iii. The vessel shall have minimum two pressure type manhole covers, efficient under drain system comprising of sufficient numbers of PP strainers, raw water distributor at the top and one number (PVC) regenerate distributor at required level. The strainer plate shall be accessible as per manufacturer's design.

iv. Softener shall have a set of face piping of G.I. (heavy duty) / non corrosive uPVC of 10kg/sqcm with injection moulded fittings and solvent weld joints comprising of inlet, outlet and backwash regeneration and rise complete with valves and piping, 100 mm dial bourden type gunmetal pressure gauges with gunmetal isolation cock and connecting piping on inlet and outlet, sampling cock on raw water inlet and softened water outlet, drain connection with valve.

v. One set of regeneration assembly comprising of power valve, ejector, brine suction valve and all necessary piping.

vi. One orifice board for indicating wash and rinse rate to be filtered in drain sump.

vii. One charge of supporting gravel, sand and "Cation" resin in requisite quantity.

viii. One water testing kit with instructions for testing water samples.

**9.11.3.9. Brine Tank.**

i. The brine tanks up to 200 litres capacity shall be virgin HDPE chemical grade tanks. The brine tanks larger than 200 litres capacity shall be M.S. vertical cylindrical self supporting open tank in M.S. plate welded construction. Brine tank shall have nozzle for inlet, outlet,

drain and overflow etc. with proper support structures. Tank shall be internally rubber lined outside finished with high gloss enamel paint over two coats of zinc chromate primer.

ii. For all brine tanks larger than 600 litres shall have the brine saturation with air agitation arrangement which shall comprise of the following:

iii. Air distributor laid in the brine tank (Made of G.I. heavy class pipes) Twin lobe rotary air blower of required capacity at required head. Piping interconnection between the air blower and the air distributor fabricated stair case (step case) with the brine tank to facilitate the manual dumping of solid salt into the tank. The brine tank capacity and size should be so designed that a reasonable free board and under board is available after filling up the required volume for two regenerations and also to allow for agitation.

### 9.11.3.10. Chemical Dosing Pump

i. Pump applications
Chlorination of raw water from tube wells

ii. Dosing system comprising of an electronic metering pump with uPVC/HDPE solution tank with level gauge and lid on top.

iii. Electronic driven metering pumps with mechanically actuated diaphragm with oil lubricated gear mechanism. The output of the pump should be adjustable for operation from 10-100%. Pump construction shall be corrosion resistant polypropylene or similar material. Pump electrical circuit shall be interlocked with the main raw water /pool recirculation pumps so that they operate only when the pumps are operating.

### 9.11.3.11. Level Controllers

i. Level controllers shall be electronic magnetic type using required number of stainless steel type probes, shrouded in PVC sheath or encapsuled in a stainless steel pipe. The level controller will be used for following applications:-

**ii. Sump Pump level controller & high water alarm (Drainage & Sewage Pumps)**

To cut off the drainage sump pump when the sump is empty and to start when :-
a) Duty pump No. 1 at pre-determined level.No.1
b) Duty pump No.2 at a higher pre-determined level.No.2
c) Provide a audible high water alarm when water level in the sump reaches a pre-determined high level in the sump location at MCC panel installed in wall near sump location

iii. Overhead tank level controller cum indicators

a) Each OHT to be provided with required number of stainless steel electronically operated probes (housed in a stainless steel protective housing) and connected by a control cable to a central junction box connected to MCC panel located in the pump house at basement. A common multi-core cable from each group of buildings will be laid to the pump room in basement. The probes will function as follows:

- To cut off the water supply pumps when all the OHT is full and to start the pump if any OHT level reaches at pre-determined low level.

- Provision shall be made to enable the operation of the second duty pump in case the water level does not rise above a pre-determined level in the tank due to water demand which is higher than capacity of duty pump no.1 to meet.

- Indicate the water level in each OHT in the level indicating panel installed in the pump room

- Each OHT are also provided with a float valve to stop the supply in individual OHT when level reaches a cut off high level.

iv. Control & Indicating Panel (For overhead and underground water tanks)

A centralized indicating stand–alone wall mounted panel fabricated from 14 g. MS sheet and painted inside and outside with stove enameled finish with clear vertical panels for each group of buildings & tanks shall indicate water level in each tank by means of digital display unit to indicate water level in each tank in four levels ( ¼th,½, ¾ and full). The panel shall be installed on the control console panel located in the pump room or as directed by the Engineer-in-Charge.

The panel shall have:

a) Digital level indicator panel meter for each water tank.
b) Etched plate identification plates.
c) Control cabling from MCC to the panel installed in the control room as directed by the Engineer-in-Charge.
d) Cabling from PHT sensing probes to the panel

**9.11.3.12. Submersible pumps**

i. Submersible pumps for sewage/drainage shall be single stage, single entry pump. Pump shall be with C.I. casing and C.I. two vane open type dynamically balanced impeller connected to a common shaft to the motor. The vane for sewage pump will be open type, while for drainage pump, etc. It will be of semi open type.

ii. Stuffing box shall be provided with mechanical seals

iii. Each pump shall be provided with water-cooled squirrel cage induction motor suitable for 415 ± 10 % volts, 3 phase, 50 cycles A.C. power supply.

iv. Each pump shall be provided with liquid level controller for operating the pump between predetermined levels. Operation of level controller shall be similar to as discussed below.

v. The pumping set shall be for stationary application and shall be provided with pump connector in it. The delivery pipe shall be joined to the pump through a rubber diaphragm, and bend and guide pipe for easy installation, without disturbing delivery pipe the pump unit shall have a back pull out design. A rust proof chain shall be provided for each pump.

vi. Pump shall be provided with all accessories and devices i.e., column pipes, flanges, nuts, bolts, clamps of required M.S. structural member of required length necessary and required for the pump to make a complete working system.

**9.11.3.13. Painting and cleanup**

i. On completion of the installation contractor shall scrub clean all pumps, piping, filters and equipment and apply one coat of primer.
ii. Apply two or more coats of synthetic enamel paint of approved make and shade on steel pipes.
iii. Provide painted identification legend and direction arrows on all equipment and piping including GI/uPVC, as directed by Engineer-in-Charge .
iv. On final completion of the work, contractor shall cleanup the site and filter room of all surplus materials rubbish and leave the place in a broom-clean condition.

### 9.11.3.14. Electrical Installations:

**i.** Scope

The scope of this section comprises of fabrication, supply, erection, testing and commissioning of Motor Control Centre (MCC), wiring and earthing of all water Treatment Plant equipment, components and accessories.

**ii.** General

Work shall be carried out in accordance with the accompanying specifications and shall comply with the latest relevant Indian Standards and Electricity Rules and Regulations.

All motor control centres shall be CPRI approved and shall be suitable for operation on 3 phase / single phase 415/230 volts, 50 cycles power supply system.

**iii.** Constructional Features

The Motor Control Centre (MCC) electrical panels shall be sheet steel cabinet for indoor installation, dead front, floor mounting/wall mounting type. The control panel shall be totally enclosed, completely dust and vermin proof and shall be with hinged doors with Neoprene gasket. Control panel shall be suitable for the climatic conditions as specified in Specifications. Steel sheets used in the construction of Control panel shall be 2 mm thick and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal. The general construction shall confirm to relevant BIS Codes. Each panel should have padlocking facility to be available for each feeders/isolaters. All PCC's and MCC's should conform to 3b construction.

All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with wing nuts. Self threading screws shall not be used in the construction of Control panels. A base channel of 75 mm x 40 mm x 5 mm thick shall be provided at the bottom for floor mounted panels. Minimum clearance of 275 mm shall be provided between the floor of control panel and the lowest unit.

The control panel shall be of adequate size with a provision of 25% spare space to accommodate possible future breakers. Breakers shall be arranged in multi-tier. Knockout holes of appropriate size and number shall be provided in the Motor Control Centre in conformity with the location of cable/conduit connections. Removable sheet steel plates shall be provided at the top to make holes for additional cable entry at site if required.

Every cabinet shall be provided with Trifoliate or engraved metal name plates. All panels shall be provided with circuit diagram mounted on inside of door shutter protected with Hylam sheet. All live accessible connections shall be shrouded and shall be finger touch proof and minimum clearance between phase and earth shall be 20 mm and phase to phase shall be 25 mm.

This section covers the general requirements for electrical work to be installed under this specification.

The Contractor shall supply and install all electric wiring, switchgear etc., necessary for the complete, safe and satisfactory operation of the plant covered by the Specification. All electrical wiring and cables shall be properly tagged to the satisfaction of the Engineer-in-Charge.

All equipment provided shall be 'tropicalized', i.e. designed for use in conditions up to 50°C ambient air temperature and 100% relative humidity.

All equipment, materials, workmanship and fittings shall comply with the appropriate Indian Standard or Code of Practice as listed in the relevant paragraphs of this Section, or any approved equivalent international standards.

**ELECTRICAL SUPPLY:**

The electricity supply shall be 415/240 Volts, 50 Hz, 3 phase, 4 wire. All equipment shall be designed to operated with a ± 10% voltage tolerance without a loss of rated output.

All equipment shall be connected to ensure that the phases are balanced, to the requirements of the local supply authority.

**SWITCHBOARDS AND SWITCHBOARD EQUIPMENT:**

a) Motor Control Panel:

Control panels shall be self-contained suitable for the location indicated and an operating environment of 50 degree C, built up of enclosed compartments conforming to form 3B as per BS 5486 Part-I : 1990 and IEC 439-1 to preclude fault transference between sections of the switchboard.

Control panels shall be arranged for the maximum safety of personnel. All power wiring and busbars shall be fully enclosed with isolating and insulating barriers and interlocks provided to ensure maximum safeguards. All switches shall be lockable in both of the 'OFF' or 'ON' positions.

Control panel shall be of the floor standing, type tested modular design, totally enclosed "dead front" type, consisting of dished front panels and doors built up on an approved mild steel angle or channel frame with no cross-struts, and shall be fitted with removable rear and end panels held in position with six fixing points.

All panels and doors shall be constructed of best quality, dead-flat CRCA MS sheet not less than 2 mm thick. Neat cutouts shall be provided in dished panels to allow the exposure of circuit breaker escutcheons and toggles, and switch operating handles and indicators only. The edges of all outlets and drilled holes shall be burr free.

Doors shall be stiffened and provided with metal based neoprene gaskets and concealed non-ferrous door hinges. Door handles shall be chrome plated and incorporate a barrel type locking mechanism and shaft adjustment for increasing sealing pressure.

All switches/MCCB shall be provided with mechanical interlocks to prevent any positive access to any equipment inside the cubicle when the switch is in the 'ON' position.

Dished panels shall be stiffened and held in place with chrome plated castle head nuts attached to fixed studs of not less than 10mm nominal diameter. All fixing hardware shall be cadmium plated.

The removable rear panels shall be provided with a pair of handles for easy fixing/removal of the panels.

Provision shall be made for lifting cubicle switchboards. Eye bolts shall not be used when subjected to shear stresses.

Adequate provision and space shall be provided for bending and connecting cables, which shall be separated from switchboard busbars.

All internal small wiring shall be PVC insulated, neatly, bunched and run on supporting cleats or in trunking, colour coded and labeled or sleeved for identification. All switch-board small wiring is to terminate on labeled terminal boards or strips to which external connections are made.

Insulators, including busbar supports, shall be non-hygroscopic and non-deteriorating. The use of fibrous materials, linseed oil, varnish, “Presspalin”, etc is prohibited.

Low voltage switchboards shall be constructed to withstand a system fault level of 25 KA at 415 volts for 1 seconds. Low voltage switchboards shall be designed to comply IS : 13947-1993.

Type test certificates, issued by a reputable and independent testing authority such as CPRI certifying the circuit breaker, busbar and its enclosure shall be submitted for review.

Ventilating water-proof louvers are to be provided on the sides and back and are to be of approved design with internal dust baffles.

Where ventilating fans are installed, a low level, filtered air intake shall be provided. The filter shall be removable from outside the switchboard.

Current transformers shall be mounted without reduction of busbars or connections and arranged for ease of removal.

b) Wall Mounted Panel :

Wall mounted panels with an appropriate rating and number of circuits shall be provided to supply power to plant located throughout the building.

Panel enclosures are to be fabricated from CRCA sheet metal of minimum 2 mm thickness and finished in enamel of a colour to the approval of the Architect. Inside the enclosure door, a circuit chart indicating the number of ways, location of equipment, loading and protection rating shall be fixed.

All wiring terminations, busbars, and live parts within the panel board shall be adequately shrouded and an insulating front shield of minimum 1.6mm thickness shall be provided to completely screen the unit’s interior. Only the operating dolly and insulated surround shall project through the shield.

The units are to be provided with sufficient wiring ways for outgoing circuits at both the top and bottom of the board. Space for future ways shall be provided.

c) Bus bars:

Bus bar and interconnections shall be of high conductivity electrolytic aluminum complying with requirement of grade 91E of IS:5082-1981 and shall be of rectangular cross section suitable for carrying the rated full load current and short circuit current without overheating of phase and neutral bus bar and shall be extendable on either side. Bus bar and interconnections shall be insulated with heat shrinkable sleeve and shall be colour coded and shall be supported on glass fiber reinforced thermosetting plastic insulated supports at regular intervals to withstand the force arising from in case of short circuit in the system. All bus bar shall be provided in a separate chamber and all connections shall be done by bolting. Additional cross sectional area shall be added to the bus bar to compensate for the holes. All connections between bus bar and breaker shall be through solid aluminium strips of proper size to carry full rated current as per approved for construction shop drawing and insulated with insulating sleeves. Bus bar shall be rated for current density of 1.0 amps/mm$^2$ cross section area.

All busbars shall be made of hard drawn high conductivity aluminium. Conductor conforming to grade 91E of IS 5082-1981, making and arrangement of the busbars, connections and

auxiliary wiring shall be to relevant Indian Standard. Bus bars shall be insulated with heat shrunk PVC sleaving of 1.1 KV grade and Bus bar joints shall be provided with clip on shrouds.

Busbars shall be adequately rated and supported by porcelain or moulded insulators spaced at suitable intervals, the complete assembly being capable of withstanding the maximum mechanical stress to which it may be subjected under fault conditions. Full size neutral bars shall be provided.

Busbars shall be so arranged that all conductors can be brought onto the bars without undue bending. Conductors between the busbars and MCCBs or isolators are to be high conductivity aluminium bar having a current rating of not less than that of the switches to which they are connected. The conductors are to be insulated with PVC sheathing and colour coded for phase identification.

Removable bolted links shall be provided for the accommodation of current transformers for metering and protection facilities without affecting the mechanical and electrical properties of the busbars as a whole.

d) Moulded Case Circuit Breakers (MCCBs) :

All MCCB's shall be motor duty and Current Limiting type, and comprise of Quick Make - break switching mechanism, preferably Double Break Contact system, arc extinguishing device and the tripping unit shall be contained in a compact, high strength, heat resistant, flame retardant, insulating moulded case with high withstand capability against thermal and mechanical stresses. All MCCB's shall be capable of defined Variable overload adjustment. All MCCB's rated 250 Amps and above shall be microprocessor based MCCB.

The trip command shall override all other commands. MCCB shall employ maintenance free double break contact system to minimise the let thru' energies and capable of achieving discrimination upto full short circuit capacity of downstream MCCB. The manufacturer shall provide both discrimination tables and let thru energy curves.

The breaking capacity of MCCB's shall be asked for in the schedule of quantities. The breaking capacities specified will be as per relevant codes.

The MCCB's shall be provided with rotary handle operating mechanism. The handle position shall give positive indication of 'ON', 'OFF' or 'Tripped' thus qualifying to Disconnection as per the IS/IEC indicating the true position of all the contacts. In case of 4 pole MCCB the neutral shall be defined and capable of offering protection.

All moulded case circuit breakers shall conform to IS : 13947-1993, and be of one approved manufacture throughout the project.

The body and base of the units are to be moulded and the units are to be sealed after assembly.

The load handling contacts are to be silver/tungsten and the contacts and operating mechanism so designed as to give a wiping action both at make and break.

The breaker operating mechanism is to be of the trip-free type so designed to prevent the load handling contacts from closing on a fault.

The toggle handle shall open and close all poles of a multipole circuit breaker simultaneously. A fault on one pole shall open all poles.

The MCCBs shall have the fault level rated as per schedule of quantities.

Circuit protection against overload and fault conditions is to be provided by means of a thermal-magnetic device designed to give thermal operation on overload and magnetic

operation under fault conditions.

The position of the breaker operating dolly is to be clearly indicated for 'ON' and 'OFF'.

MCCBs shall be suitable for use at temperatures of 50°C Ambient.

e) Miniature Circuit Breaker :

Miniature Circuit Breaker shall comply with relevant IS Codes and shall be quick make and break type for 230/415 VAC 50 Hz application with magnetic thermal release for over current and short circuit protection. The breaking capacity shall not be less than 10 KA at 415 VAC. MCBs shall be DIN mounted. The MCB shall be Current Limiting type (Class-3). MCBs shall be classified (B, C,D ref IS standard) as per their Tripping Characteristic curves defined by the manufacturer. The MCB shall have the minimum power loss (Watts) per pole defined as per the IS/IEC and the manufacturer shall publish the values.
The housing shall be heat resistant and having high impact strength. The terminals shall be protected against finger contact to IP20 Degree of protection. All DP, TP and TPN miniature circuit breakers shall have a common trip bar independent to the external operating handle.

Single pole or triple pole miniature circuit breakers (MCB) are to be used for sub-circuit protection.

All MCBs shall conform to IS : 8828-1996. The body and base of the units are to be moulded bakelite or similar material and the units are to be sealed after assembly.

The load handling contacts are to be silver/tungsten, and the contacts and operating mechanism shall be so designed as to give a wiping action both at make and break.

The breaker operating mechanism is to be the trip free type. A thermal-magnetic time tripping mechanism is to be included for circuit protection against overload and short circuit. Short circuit level of MCBs shall not be less than 10 KA.

Tripping characteristics of MCBs shall be able to discriminate with up stream breakers.

f) Isolators :

All isolators whether mounted in a cubicle type switchboard or separately mounted shall be heavy duty type conforming to the requirements of IS : 13947-1993. All contacts are to be fully shrouded and are to have a breaking capacity on manual operation as required by British Standards.

Operation of switches shall be independent of the operator's control, with a quick make/quick break action.

The links for switch are to be high rupturing capacity.

The category of duty of the main switchboard, submain switches and cable tee-offs shall be as indicated in the schedules.

Switches and isolators mounted in cubicle type switch-boards are to be enclosed in separate sheet metal compartments, and mechanical interlocks are to be provided between the cubicle doors and the switch operating mechanisms, so arranged that the cubicle door may not be opened with the switch in the 'ON' position. Similarly it shall not be possible to close the switch with the cubicle door open, except that provision shall be made within the cubicle for authorized persons to defeat the mechanical interlock for test purposes, and close the switch with the door in the open position.

The 'ON' and 'OFF' positions of all switches and isolators shall be clearly indicated by a mechanical flag indicator or similar device.

In TPN switch units, bolted neutral links are to be fitted. For single pole and neutral switches and isolating switches, the neutral conductor is to be taken through a bolted link.

g) Contactors :

Contactor shall be built into a high strength thermoplastic body and shall be provided with an arc shield for quick arc extinguishing. Silver alloy tips shall be provided to ensure a high degree of reliability and endurance under continuous operation. The magnet system shall consist of laminated yoke and armature to ensure clean operation without hum or chatter.

Starters contactors shall have 3 main and 2 Nos. NO / NC auxiliary contacts and shall be air break type suitable for making and breaking contact at minimum power factor of 0.35. For design consideration of contactors the starting current of connected motor shall be assumed to be 6 times the full load current of the motor in case of direct-on-line starters and 3 times the full load current of the motor in case of Star Delta Starters. The insulation for contactor coils shall be of Class “E”.

Coil shall be tape wound vacuum impregnated and shall be housed in a thermostatic bobbin, suitable for tropical conditions and shall withstand voltage fluctuations. Coil shall be suitable for 220/415±10% volts AC, 50 cycles AC supply
Contactors or control relays are to be single or triple pole, conforming to IS : 13947-1993 (part IV Section 3). The rating shall be as noted on the drawing but in any case, shall not be less than 10A or the rating of the circuit, whichever is the greater. All ratings shall be “continuous” and all contacts shall be silver plated. Contactor coils shall operate from the supply provided.

h) Measuring Instruments and Protection Relays :

All ammeters and voltmeters for use in conjunction with switch-gear are to be of digital type and comply with relevant Indian Standard.

Unless otherwise specified, all meters are to be 96mm dial square flush pattern.

All ammeters shall have a continuous overload capability of 120% of the upper limit of the scale for two hours.

Ammeters shall be provided for motors of 5.5KW or larger and they shall be capable of starting current. Motor current reading shall be provided on one phase only.

Voltmeters shall be of accuracy Class 2.

Voltmeters shall be connected to the incoming side of the power supply through 6 ampere MCB’s.

Mechanical zero adjustment shall be provided for voltmeters and ammeters by means of a screw slot at the face of the meters.

Energy and maximum demand meters shall be installed as specified. Energy meters shall provide a direct, single, digital reading, without the need to apply multiplication factors.

Earth fault and overcurrent protection relays shall be as specified in the drawings.

Current transformers for measurement and protection shall be of ring pattern, clamped on readily removable, bolted copper links with accessible terminals.

Instrument MCB shall be mounted on the panel adjacent to their associated instruments.

All instrument and indicating lamp wiring behind hinged front panels shall be protected by clear acrylic sheets.

i) Labelling :

All items of equipment on the switchboard shall be labeled to indicate function with black Traffolyte labels and white engraved lettering securely fixed with chrome plated screws. Lettering shall be at least 10mm high. Labels to all switches , isolators and the like shall indicate the supply and cable details. All labels shall be approved prior to engraving.

The use of adhesive labels will not be permitted. All electrical equipment not mounted on the switchboard shall also be labeled as specified above.

j) Time Delays.

Time delays shall be provided to prevent the simultaneous starting of any two motors above 3.5 kW and to prevent short cycling of automatically controlled motors.

k) Control Switches.

All control switches shall be of the rotary type of approved manufacturer.

Each control switch shall be panel mounted and engraved to clearly indicate the equipment controlled or function of the switch.

l) Indicating Lamps. :

Indicating lamps shall be individual flush mounted units circular in shape of approximately 22 mm diameter.

Indicating lamps shall be of 240/110 V and rated to withstand not less than 20% continuous over voltage.

Lamps shall be well ventilated and the design shall permit removal of lamp glasses and bulbs from the front of the unit without the need of any special tool.

A push button lamp test facility shall be provided for all switchboards.

Indicating lamps shall be colour coded as follows:

Green - Motor stopped, circuit breaker OFF.
Amber - Supply available.
White - Valve open, circuit breaker auto trip.
Red - Motor running, circuit breaker ON.
Blue - Valve closed.
Control circuit shall be of 240V supply.

m) Push Button Switches:

Contactor shall be built into a high strength thermoplastic body and shall be provided with an arc shield for quick arc extinguishing. Silver alloy tips shall be provided to ensure a high degree of reliability and endurance under continuous operation. The magnet system shall consist of laminated yoke and armature to ensure clean operation without hum or chatter.

M.V. Cables shall be PVC insulated aluminum/ copper conductor and armoured cables conforming to IS Codes. Cables shall be armoured and suitable for laying in trenches, ducts, and on cable trays as required. M.V. Cables shall be termite resistant. Cable glands shall be double compression glands with earthing facility. Control cables and indicating panel cables shall be multi core PVC insulated copper conductor and armoured cables.

Power cabling shall be of the following sizes:

Upto 5 HP motors 3 x 4 sq. mm copper conductor cable.

From 6 HP to 10 HP motors-3 x 6 sq. mm copper conductor cable.

From 12.5 HP to 15 HP wires 2 Nos. 3 x 6 sq. mm copper conductor cable.

From 20 HP to 25 HP motors 2 Nos. 3 x 10 sq. mm copper conductor cable.

The minimum size of control wiring shall be 1.5 sq. mm PVC insulated stranded soft drawn copper conductor wires drawn through conduit to be provided for connecting equipment and control panels.

All the switches, contactors, push button stations, indicating lamps shall be distinctly marked with a small description of the service installed. The following capacity contactors and overload relays shall be provided for different capacity motors or as per manufacturer's recommendation.

| TYPE OF CURRENT | CONTACTOR RELAY | OVERLOA Capacity | STARTER Range |
|---|---|---|---|
| 5HP Motors | D O L | 16 amps | 6-10 amps |
| 7.5 HP motors | Star Delta | 16 amps | 9-15 amps |
| 10 HP Motors | Star Delta | 25 amps | 9-15 amps |
| 12.5 HP Motors | Star Delta | 16 amps | 9-15 amps |
| 15 HP Motors | Star Delta | 25 amps | 9-15 amps |
| 20 HP Motors | Star Delta | 32 amps | 14-23 amps |
| 25 HP Motors | Star Delta | 32 amps | 14-23 amps |

Two speed motors when specified, shall be provided with DOL starter irrespective of it rating.

Starters contactors shall have 3 main and 2 Nos. NO / NC auxiliary contacts and shall be air break type suitable for making and breaking contact at minimum power factor of 0.35. For design consideration of contactors the starting current of connected motor shall be assumed to be 6 times the full load current of the motor in case of direct-on-line starters and 3 times the full load current of the motor in case of Star Delta Starters. The insulation for contactor coils shall be of Class "E".

Coil shall be tape wound vacuum impregnated and shall be housed in a thermostatic bobbin, suitable for tropical conditions and shall withstand voltage fluctuations. Coil shall be suitable for 220/415±10% volts AC, 50 cycles AC supply

Push button switches shall comply with and be tested and certified to relevant Indian standard. Electrical rating shall be 500V AC or 250 V DC as appropriate. Push buttons for alarm duty shall be minimum of 2 amp rated Push buttons for control duty shall be 10 amp rated.

Unless specified otherwise, push buttons shall be colour coded as follows :

| | | |
|---|---|---|
| Green | - | Start motor |
| White | - | Open valve |
| Red | - | Stop motor |
| Blue | - | Closed valve. |
| Black | - | Reset protection/alarm, lamp test |
| Yellow | - | Accept alarm |

n) <u>Earth System :</u>

Earthing shall be provided in accordance with relevant BIS Codes and shall be copper strips / wires. The main panel shall be connected to main earthing system of the power supply. All single phase metal clad switches and control panels be earthed with minimum 3

mm diameter copper conductor wire. All 3 phase motors and equipment shall be earthed with 2 numbers distinct and independent copper wires / tapes as follows:

| | |
|---|---|
| i. Motor upto and including 10 HP rating. | 2 Nos. 3 mm dia copper wires. |
| ii. Motor 12.5 HP to 40 HP capacity | 2 Nos. 4 mm dia copper wires |

All switches shall be earthed with two numbers distinct and independent copper wires' tapes as follows:

| | |
|---|---|
| i. 3 phase switches and control panels upto 60 amps rating. | 2 nos. 3 mm dia copper wires. |
| ii. 3 phase switches, and control panels 63 amps to 100 amps rating. | 2 Nos. 4 mm dia copper wires. |
| iii. 3 phase switches and control Panels 125 amps to 200 amps rating. | 2 Nos. 6 mm dia copper wires. |

The earthing connections shall be tapped off from the main earthing of electrical installation. The overlapping in earthing strips at joints where required shall be minimum 75mm. These straight joints shall be rivetted with brass rivets & brazed in approved manner. Suitable lugs of adequate capacity and size shall be used for all termination of wires. Lugs shall be bolted to the equipment body to be earthed after the metal body is cleaned of paint and other oily substance, and properly tinned. Earthing should not be connected to base bolts of motor or terminal block covers. Door earthing should be provided in control panel.

All metal work associated with the switchboard installation not forming part of a phase or neutral circuit shall be bonded together and shall be solidly and effectively earthed through the system provided by the Main Electrical Contractor. Continuous earth bus suitable to withstand prospective short circuit current shall be provided. Hinged doors shall be connected to earth through adequately sized flexible braids. It shall be the responsibility of this Contractor to ensure that adequate means of earthing are provided.

o) Cabling:

Cable shall be laid in accordance with IS code of Practice. Cables shall be laid on 14 gage factory fabricated perforated galvanized sheet steel cable trays, and cable drops / risers shall be fixed to ladder type cable trays factory fabricated out of galvanized steel angle. Access to all cables shall be provided to allow cable withdrawal / replacement in the future. Where more than one cable is running on a cable tray, one dia spacing shall be provided between cables to minimise the loss in current carrying capacity. Cables shall be suitably supported with Galvanized saddles when run on walls / trays. When buried, they shall be laid in 350 mm wide and 750 mm deep trench and shall be covered with 250 mm thick layer of soft sifted sand & protected with bricks/tiles. Special care shall be taken to ensure that the cables are not damaged at bends. The radius of bend of the cables when installed shall not be less than 12 times the diameter of cable.

Allowable specification of cable tray:

Width: 150mm, 300mm, 450mm, 600mm. Height: 100mm. Length: 2500mm.

A cabling zone clear of bus bars, switch and circuit breaker chambers shall be provided in such a manner to give minimum difficulty in connecting sub-main cables entering the

switchboard for connection to switch units or circuit breakers. The cabling zone shall be fully isolated from any live metal part so that future cabling and alterations can be carried out in complete safety without the necessity of shutting down the complete switchboard.

p) Terminal Blocks:

Terminal blocks for control wiring shall be rated not less than 20 amp and shall clamp the wire securely between two plates secured by a captive screw.

Terminal blocks shall have easily removable copper links to short circuit adjacent terminals or shall be fitted with suitable holders where required. Pinch screw type terminal blocks will not be acceptable.

Cables having the same number shall be terminated at adjacent terminals and connected by means of cable links at the terminal block. The incoming cable cores shall be terminated at the lower or outer side of the block, and the outgoing cable cores at the upper or inner side of the terminal block, and cable links on any free side.

Terminal blocks at different voltage, shall be segregated into groups, distinctively labeled and provided with permanent rigid barriers. Terminals in groups shall have separate non-combustible transparent plastic covers.

100% spare terminals shall be provided on each terminal block.

q) Wiring Diagrams :

Prepare construction layouts and functional wiring diagrams of all switchboards, which shall be reviewed prior to commencement of any work thereon.

The wiring diagrams shall show control circuits separate from main circuits and shall indicate the size of each conductor and the colour, number and/or terminal connection designation of each control conductor.

Switchboard drawings shall include a schedule of all equipment mounted therein, including make, model, and where applicable, fuse rating and set point of all variable adjustors.

Circuit diagrams shall be mounted near the switchboard in an approved location and shall be covered with either glass or clear Perspex sheet not less than 3mm thick.

r) General Requirements :

The Contractor shall ensure that the switchboards ordered can be accommodated (together with the control cubicles) in the space provided.

A rubber insulating mat shall be placed in front of the switchboard for its entire length.

## iv. PVC INSULATTED ARMOURED COPPER CABLE:

Cables of this type are to be 1100 volt grade complying to IS-1554-1998 with each conductor of the same cross sectional area.

PVC insulated and colour coded cores shall be sheathed with PVC which shall serve as a bedding for galvanized strip armouring. The armouring shall be covered with an outer PVC sheath.

Cables shall be terminated in a gland fitted with an armour clamp. The gland body shall be provided with an internal conical seating to receive the armour wires ensuring that the armour wires are tightly clamped between the armour cone and conical armour seating.

The minimum bending radius for power cables shall be twelve times the overall cable diameter.

When cables are run on a wall they shall be cleated at distances not exceeding 1 metre.

**v. XLPE INSULATED ALUMINIUM CABLES :**

XLPE insulated aluminium cables shall comply with IS:7098 Part –II, 1985. Cables are to be 1100 volt grade depending on size.

**vi. WIRING :**

The current carrying capacity is to be in accordance with IEE Wiring Regulations and is to be limited by the allowable voltage drop.

All wiring shall be carried out on the loop-in system. For conduit wiring systems, wiring shall be drawn into the conduits after the whole of the conduit installation has been completed. No joints or connectors will be allowed in any such cables, except that connectors may be used in accessible positions within lighting fittings or device outlet boxes.

All cables shall be colour coded consistently over their entire length . Red, yellow and blue shall be used for phase conductor and black and green for neutral and earth respectively.

The maximum number of cables that may be accommodated in a given size of conduit, cable tray, trunking is not to exceed the number given in the Indian Standard.

Where wiring penetrates fire walls, then these shall be sealed using fire retardant pillows packed tightly on both sides of the penetration. Internal fire barriers within trunking shall also be provided. All fire retardant materials used shall be to the approval of the Architect and local authorities.

Floor penetrations for cable risers shall be made weatherproof progressively during construction to minimize damage due to the weather.

Where wiring penetrates vapour barriers, adequate air tight seals shall be provided. Wiring shall enter the low temperature area via conduit and the conduit itself shall be sealed internally to provide an airtight barrier within the conduit.

All wiring associated with equipment necessary for fire and smoke control shall be provided.

**vii. CONDUIT :**

All conduits shall be heavy gauge galvanized/black enameled ERW steel complying with relevant Indian Standard. No conduits shall be less than 25 mm nominal diameter.

Conduit shall be concealed in concrete as construction proceeds, and so arranged as to drain naturally to outlet boxes. Prior to laying, this Contractor shall check with the Contractor responsible for the building work that conduits of the sizes proposed will not affect the structural integrity of the concrete. Sealing caps shall be placed on all conduits before concrete pouring commences to ensure no water enters the conduit. Expansion couplings shall be fitted at all building expansion joints.

Surface conduits shall in no circumstances be fixed to floor slabs.

All conduit systems are to be installed fully in accordance with the requirements of the IEE Regulations.

All conduits shall be swabbed through to clean out all dirt, burrs and moisture.

All sets and bends in conduit runs are to be formed on site with bending machines. Distortion of conduits due to bending is not acceptable.

Runs between draw-in boxes are not to have more than two right angle bends or their equivalent and the length of such runs shall be limited to 12 m to permit easy drawing-in of cables.

GI Flexible conduit shall be used for final connections to equipment subject to vibration.

The conduit shall be watertight with the provision of separate earth wire enclosed for earth continuity. All flexible steel conduit shall be PVC sheathed.

The contractor shall make good any damage to the finish of all conduits including threads cut at site, by painting damaged areas with two coats of aluminium primer paint.

Supply for review prior to installation conduit layout drawings for the entire installation. The approved set shall be kept upto date on site and on completion, three sets of record drawings shall be provided for record purposes.

## viii. CONDUIT BOXES:

All conduit junction boxes are to be malleable iron (surface mounted) or mild steel (concealed) and of standard pattern.

Standard pattern boxes are to be used with conduits up to and including 25 mm diameter. Rectangular pattern boxes are to be used for conduits of 25 mm diameter and larger. For the drawing-in of cables, standard pattern through boxes are to be used. All conduit boxes are to be galvanized finish.

Adaptor boxes are to be of galvanized zinc passivated mild steel not less than 3 mm thick. Boxes are to be not less than 50 mm deep and of such dimensions as will enable the largest size cable for which the conduit run is suitable to be drawn in without excessive bending of the cables. Covers of approved material with fixing screws are to be provided. All boxes are to be drilled for holes according to the conduit entries required.

All conduit entries to adaptor boxes, outlet boxes and switchgears are to be made with couplings and hexagonal male bushes.

The protective coating of the boxes shall be heavy both inside and outside.

## ix. CABLE TRUNKING :

Metal trunking shall comply with BS 4678 and shall be manufactured in minimum lengths of 2 m from 2 mm thick zinc sprayed sheet steel finished with rust resisting primer and sprayed overall grey enamel. Covers are to be held in place by screws. Trunking shall be terminated with end flanges bolted directly to switch or distribution boards. Connecting pieces are to be used and bolted with cadmium plated mushroom head steel screws, nuts and shake-proof washers. Each joint is to have a copper link to ensure electrical continuity.

Conduit entries to trunking shall be made with couplings and brass make bushes. Knockouts will not be required and trunkings may be drilled on site.

Trunking shall not contain more cable than allowed by the space factors described in the IEE Regulations.

Each joint shall have a copper bond bolted to each adjacent trunking to ensure electrical continuity. All frayed and sharp edges shall be removed from trunking before installation.

Conduit entry to trunking shall be by coupling and male bush. Knock-outs shall not be provided, and trunking shall be drilled on site.

Where trunking crosses expansion joints, a trunking system which will allow for expansion and maintain earth continuity shall be used. The system used shall be reviewed by the Architect prior to manufacture.

Where the trunking passes through floors or fire compartments, fire resisting barriers shall be provided.

All supports and hangers shall be of hot-dipped galvanized mild steel construction with min. coating thickness of 85 micron and 210 micron for indoor and outdoor installation respectively. All bolts and nuts shall be electroplated with zinc or cadmium with min. plating thickness of 25 micron.

## x. CABLE TRAYS:

Cable trays are to be of perforated pattern 1.6mm minimum mild steel with returned edges galvanized overall.

Trays shall be supported from the soffit of structural slabs and beams by mild steel rods not less than 6mm diameter and underslung mild steel angles, or alternatively, supported on steel angle brackets secured to walls. The former method shall be preferred where practicable. All supports and hangers shall be hot-dipped galvanized with bolts and nuts electroplated.

## xi. MOTORS:

All motors shall be of a type constructed to relevant Indian Standard.

Motors shall be selected to obtain the most suitable drive for the specified equipment, as recommended by the equipment manufacturers. Squirrel cage indication motors are preferred. Motors shall generally be three phase. Motors 1 KW or less may be single phase.

Ratings shall be based on continuous duty in the prescribed environment or an ambient temperature of 43 degree C whichever is the more demanding.

Motors in all cases shall be entirely suitable for the duty. A margin of not less than 10% shall be provided between the continuous rating of the motors (without overloading) and the maximum power absorbed by the item of equipment (as installed) under its most arduous operating condition, taking account of the characteristics of the driving machine. All motors up to 30 KW shall have full load efficiency of not less than 85% and power factor of not less than 85. Motors of rating greater than 30 KW shall have full load efficiency of not less than 90% and power factor of not less than 0.85.

Winding insulation and general construction of the motor casing, terminal block etc. shall be to Class F, allowing 80 degree C temperature rise above ambient, unless otherwise specified.

All motors shall have an isolating switch adjacent to and within sight of the motor. The switch shall be such that all conductors to the motor are isolated in one operation.

Motors up to and including 3.7 KW shall be fitted with ball bearings at both ends. Larger motors shall be fitted with roller or deep groove ball bearings. Motors operating with vertical shafts shall be equipped with bearings designed to counter unbalanced end thrust. Except

where noted, motors shall have a synchronous speed not exceeding 1500 rpm.

All motors rated at 22 KW or more shall be fitted with thermistors or other sealed, temperature sensitive devices embedded in the windings and suitable for connection to motor protection control circuits.

Terminal blocks enclosed in cast iron or aluminium boxes shall be provided for all wiring connections to motors. The blocks shall be arranged to enable easy access for maintenance.

Motors shall be mounted on a common bed plate with the driven machine wherever possible. The whole assembly shall be supported on vibration isolating material or springs to eliminate the transmission of noise and vibration into the structure. All holding down bolts required shall be supplied and fixed by this Contractor.

Motors rated in excess of 5.5KW shall be supplied with anti-condensation heaters, controlled such that the heater is only 'ON' when the motor is 'OFF'.

The drive selected for any machine shall be the type recommended by the manufacturer of the driven machine and subject to approval. All drives shall be fitted with safety guards.

For multi-winding motors there shall be no way that the motor isolating switch can be operated whereby any winding may be energized whilst another winding is isolated.

Terminal boxes shall be of such dimensions as will ensure access to the terminals and allow room for the supply leads.

Each box shall be fitted with normal bottom or top cable entry. With exception of motors with ratings less than 1 KW, all boxes shall be capable of being turned to a further 3 positions, 90 degrees apart without affecting the terminal base or terminals. Standardize frame sizes for all applications so that the minimum practical number of motors need be carried as spares. Ensure that motors of different frame sizes spared by a single motor be provided with adaptor plates, oversize couplings, oversize terminal boxes, standard keyways etc to facilitate replacement.

Motors of a particular type or application shall be of the same manufacturer.

Motors above 7.5 KW shall be provided with suitably sized tinned brass cable sockets. The type of cable terminations shall be as shown on the drawings. Three phase motors shall be fitted with separate earthing terminals.

On all motors over 25 kg in weight, lifting eyes or lugs shall be supplied.

Unless specified otherwise, enclosures for motors shall be as follows :-

| | | |
|---|---|---|
| Hazardous areas | : | Flame proof |
| External | : | TEFC – Tropical |
| In forced air flow | : | TE non-fan cooled or TEFC |
| Areas subject to hosing | : | Hoseproof |
| All other areas | : | TEFC |

All motors shall be provided with name plates. Motors shall have a maximum SPL of 85db(A) at 1 metre.

Overloads and thermistor protection shall not be provided for smoke exhaust fan motors or stair pressurization fan motors which operate only under a fire alarm condition and are essential for fire and smoke control.

Motors for fans having a dual function, e.g. smoke spil/return air fans, which are essential for fire and smoke control, shall be protected as specified above. However, such protection shall be overridden in a fire alarm condition.

Protection for supply air fan motors shall be provided as indicated above and shall remain in circuit at all times.

## xii. STARTERS :

Contractors used in starters shall be of Class AC3 type provided with silver alloy contacts. Auxiliary contacts shall be provided to facilitate the connection of interlocks, status indication and auxiliary controls. Unless explicitly described, a minimum of one normally open and one normally closed contact shall be provided.

Each starter shall be completed with protection incorporating the following features :

Overload protection in each supply phase adjustable from 80 to 120% of full rated load.

Manual reset
Phase failure protection
Ambient temperature compensation
An auxiliary contact to signal an overload condition.

Contactors or complete starters not mounted in switchboards shall be contained in metal or approved plastic enclosures with conduit entries, shrouded “stop” and “start” push buttons and a manual “reset” button, which may be combined with the “stop” button.

Generally, reduced voltage starters of the following type shall be selected :-

Motors above 7.5 kW to 150 KW Star delta
Each starter of the open transition “Star-Delta” (OT.SD) type shall include the following:-

One (1) main-line contactor suitably rated for the motor.

Star and Delta configuration contactors suitably rated for the motor, mechanically and electrically interlocked to prevent simultaneous operation.

One (1) triple pole overload relay meeting the requirements as specified previously in this clause under ‘Generally’.

One (1) approved time delay relay, with at least 0-30 second adjustable time delay period, to control the star to delta switching contactors.

Closed transition reduced voltage starters shall be approved type and manufacture and shall be capable of starting the motor from stopped to full load speed without interruption and in such a manner that the torque developed by the motor increases as uniformly as practicable during the whole starting sequence.

Closed Transition “Star-Delta” Starters (CT. SD)

Each starter of this type shall include the following equipment:-

- The equipment as specified in Clause “Open Transition Star-Delta Starters (OT.SD)”.
- A suitably rated transition resistance bank such as to allow approximately full load supply current when in circuit prior to opening of the star point. The short time rating of the resistors shall also be considered in relation to the length of their “in circuit” requirements.

- A transition contactor suitably rated to facilitate connection of the resistance bank during the transition period.

  Any additional auxiliary contacts, timers, etc required for the transition sequencing operation.

**xiii. EARTHING :**

All metal work associated with the electrical installation but not forming part of a phase of neutral circuit shall be bonded together and solidly and effectively earthed.

Metal conduit, ducts and cable armour shall be earthed at the switch-board at which they originate by means of locknuts, screwed connection or cable gland.

The electrical resistance of metallic enclosures or framework to earth shall be low enough to permit the passage of current necessary to operate the device protecting the associated circuit.

The size of all earth continuity and bonding conductors shall be in accordance with the Local Regulations.

All earth conductors fixed or run outside the building shall be protected against corrosion and mechanical damage.

**xiv. SPARES :**

The Contractor shall supply the following items as spares :-

a) 20% indicating lamps of all colours and sizes.
b) Any other spares as indicated in the Schedules.

**xv. MOTOR CONTROL CIRCUITS :**

For each motor provide the following :-

a) On-off-auto test switch
b) Blue power on light
c) Green pilot light
d) Red fault light
e) Auxiliary contacts for remote stop-start.
f) Auxiliary contacts for remote status indication.

(Items e and f to be connected to a labeled terminal strip in the switchboard).

**xvi. RADIO INTERFERENCE :**

All equipment and systems shall be properly designed to ensure that there is no interference caused to any transmitters, receivers or other electronic equipment in the near vicinity. Should interference be detected, the Contractor shall provide free of charge devices capable of eliminating such interference.

**xvii. ISOLATING SWITCHES :**

All items of equipment shall be provided with isolating switches adjacent to the item of equipment in an accessible position.

Isolators shall be capable of being padlocked in either the on, auto or off positions.

Isolators for motors and equipment which are essential for fire and smoke control shall be labelled as specified elsewhere and in addition a second label with white lettering on a red background reading :

WARNING – ESSENTIAL FOR LIFE SAFETY
Do not switch off except in absolute emergency shall be provided.

**xviii. DDC/BAS INTERFACING :**

For installations incorporating a DDC/BM system, a separate terminal strip shall be provided in each switchboard for connection of DDC/BM interface cabling for monitoring and for control. Terminals shall be segregated from other terminals in the same panel and shall be of a different colour.

Contacts for monitoring of status and alarm conditions shall be potential free and arranged to close when the item of plant runs or when an alarm condition occurs. Contacts shall incorporate a wiping action to provide a consistently very low contact resistance and eliminate “open circuit” (high resistance) conditions due to oxide build up on contact surfaces. Contacts shall provide positive indication, compatible with the extra low voltage monitoring supply from the DDC/BM.

This Contractor shall co-ordinate with the DDC/BM Contractor to determine the control output voltage from the DDC/BM. Interface relays shall be mounted within each panel and controlled direct from the DDC/BM at this voltage. Relay coil current and relay characteristic shall be completely compatible with the DDC/BM system.

Status and alarm contacts and relay interface connections shall be individually connected to terminals (that is, two connections per item). Any looping required for common connections shall be made at the terminal strip as required.

All DDC/BM point numbers shall be shown on the wiring diagrams consistent with the DDC/BASM numbering system.

**xix. COMMISSIONING AND GUARANTEES :**

**a)** Scope of work **:**

Work under this section shall consist of pre-commissioning, commissioning, testing and providing guarantees for all equipment, appliances and accessories supplied and installed by the contractor under this contract.

b) General Requirements :

- The rates quoted in this tender shall be inclusive of the works given in this section.
- Contractor shall provide all tools equipment, metering and testing devices required for the purpose.
- On award of work, contractor shall submit a detailed proposal giving methods of testing and gauging the performance of the equipment to be supplied and installed under this contract.

c) Pre-commissioning :

On completion of the installation of all pumps, piping, valves, pipe connections, and water level controlling devices the contractor shall proceed as follows :-

Pipe work :

- Check all clamps, supports and hangers provided for the pipes.
- Fill up pipes with water and apply hydrostatic pressure to the system as given in the relevant section of the specifications. If any leakage is found, rectify the same and retest the pipes.

d) Commissioning & testing :

- Handing over :
  - All commissioning and testing shall be done by the contractor to the complete satisfaction of the Engineer-in-Charge, and the job handed over to the Engineer-in-Charge.
  - Contractor shall also handover, to the Engineer-in-Charge, all maintenance & operation manuals and all other items as per the terms of the contract.
- Guarantees :
  - The contractor shall submit a warranty for all equipment, materials and accessories supplied by him against manufacturing defects, malfunctioning or under capacity functioning.
  - The form of warranty shall be as approved by the Engineer-in-Charge.

## 9.12. SEWAGE TREATMENT PLANT

### PHYTORID SYSTEM FOR ETP/STP ( ROOT ZONE / WETLAND SYSTEM APPROACH)

In order to conserve water, the treatment plant shall be designed to ensure that treated effluent (water) characteristics are well below the permissible limits, even under varying flow conditions which are typical for such systems. This implies that the selected process shall be able to withstand the shock load situation.

The proposed waste water disposal and recycle system is a decentralized system based on NEERI (CSIR – Nagpur) called the phytorid system in which the waste water is collected in a bio-digester and treated in an enclosed chamber using plants. Three such systems are proposed for each functional zone – academic, student and faculty housing.

The technology is based on a bio-conversion process where fundamental reactions of nature, namely respiration, photosynthesis & mineral weathering take place in a media housing micro & macro organisms which bring about the desired purification. The system is an oxygen supplying biological engine and so the process can treat all types of water – domestic municipal & industrial.

### 9.12.1. The STP shall be designed based on the following parameters:

**RAW WATER CHARACTERISTIC: -**

- PH : 6.0 – 8.5
- BODS : 250 – 400 mg/l
- S. Solids: 200 – 450 mg/l
- COD : 600 – 800 mg/l
- Oil and Grease: upto 20 mg/l
- Ecoli : $>10^6$ MPN

**EFFLUENT DISCHARGE STANDARD AFTER TREATMENT: -**

- PH : 6.5 – 8.5
- BODS : Less than 10 mg/l
- S. Solids: Less than 20 mg/l
- COD : Less than 30 mg/l
- Oil and Grease: Less than 5 mg/l
- Ecoli : $<10^3$ MPN

Treated water quality will meet the specified norms of CPCB / Delhi Pollution Control Board for water reuse.

The PHYTORID processes contain four elements viz. i) media which houses the micro& macro organisms of soil ecology which supports aerobic/ including nitrogen fixation and active oxygen production ii) culture which also includes bioactive plants and organisms serves as the top carnivore to regulate soil population iii) additives- a natural mineral mix which regulates pH, iv) green plants to serve as bio-indicator of the health of process. In view of the ecology of soil & engineered natural oxygen supply highly aerobic environment exists in the bioreactor. Accordingly in the said process three fundamental reactions of this planet viz. i) respiration brings about removal of organics by oxidation of the organic molecules, ii) mineral weathering brings about pH regulation iii) while photo synthesis serves to regulate the process at work. 1: Primary Treatment.

The technology is based on a bio-conversion process where fundamental reactions of nature, namely respiration, photosynthesis & mineral weathering take place in a media housing micro & macro organisms which bring about the desired purification. The system is an oxygen supplying biological engine and so the process can treat all types of water – domestic municipal & industrial.

The waste water after passing through primary treatment in the Pre settling tank is passed horizontally through the rhizosphere of the wetland plants. During the passage of the waste water through the rhizosphere, the waste water is cleaned by the microbial degradation and by physic-chemical processes. The wetland plants supply oxygen to the heterotrophic micro organisms in the

rhizosphere and stabilize the hydraulic conductivity of the soil. Nitrogen is removed by denitrification and phosphorus and heavy metals are bound in the soil.

**9.12.2. The basic components of Phytorid system is :**

(1) Sewage Collection Tank
(2) Settler/Screen
(3) Phytorid Bed
(4) Treated Water Storage

**9.12.3. Processes:**

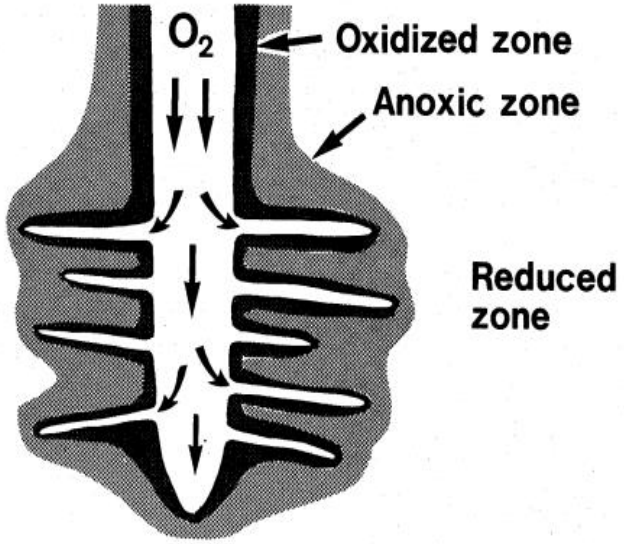
(1) Sedimentation
(2) Bacterial Action
(3) Filtration
(4) Adsorption
(5) Precipitation
(6) Decomposition
(7) Nutrient Uptake
(8) Vegetation System
(9) Chlorination (1+1)
(10) Sand Filter Backwash arrangement

**9.12.4. Stages of Treatment:**

- **Collection & bar screen channel:**
  The sewage is collected into the collection chamber from where it is transferred via solids handling submersible sewage pumps to the pre settling cell.
- **Primary Settling Cell (PSC)**
  For the purpose of anaerobic pre-treatment of suspended solids. There is no need for daily disposal of sludge generated. The PSC is designed to be adequate to contain sludge for at least 1.5 years after which de-sludging process is required by simple means of vaccum extraction.
- **Secondary Advanced Filter Cell (SAFC**), that supports a permutation of different sizes of stones and gravel wherein anaerobic digestion occurs.
- **Tertiary Biological Wetland Cell (TBWC)** made up of different layers of life supporting media such as those used in SAFC and planted with aquatic flora such as Typha, Scirpus, Cyperus, Peltandra and Phragmites

**9.12.5. Operating Principle**

***Role of Macrophytes ( Phragmytes Australis, Typha Latifolia, Carex Acutiforms)***
The macrophytes or wetland plants have a key role in the functioning of the root zone treatment. The Phragmites Australis or common reed is the most effective wetland plant has several properties which render this specie specially suitable. The most striking is the highly proliferative rhizosphere zone existing upto 1 mtrs which enable fast root growth and penetration deep into the filter media bed thus enhancing the oxygen dissolution in the waste water.




Simplified representation of the redox-conditions around roots of wetland plants. Oxygen is transported from the atmosphere to the roots via the aerenchyma. A part of the oxygen diffuses into the substrate creating an oxidized zone (+oxygen) and an anoxic zone (-oxygen, +nitrate) around the roots in the otherwise reduced substrate (-oxygen, -nitrate).

This is highly analogous to the artificial aerated electromechanical systems with high oxygen diffusion per unit surface area. Also apart from that the macrophytes have important roles as:

- To supply oxygen to the heterotrophic microorganisms in the rhizosphere acting as a support for them to grow and proliferate
- To increase/ stabilize the hydraulic conductivity of the soil.

Wetland plants are morphologically and anatomically made to adapt via pre treatment with root zone enhancers and plant growth promoters prior to plantation in the Phytorid bed. They are enabled to survive under High organic load conditions. Arenchyma which is the air pockets developed in the plant system enable oxygen supply to the buried plant parts in the water and roots or rhibozomes leak oxygen into the substrate thus imitating mechanical aeration process.

The root networks expand deeply and attach on to the gravel media and function as stabilizer of hydraulic conductivity in the Phytorid bed.

**Role of MicroOrganisms** *Campylobacter* sp., one genus of Gram-negative aerobic rod,*Pseudomonas* sp., 16 genera of Gram-negative facultative anaerobic rods, *Actinobacillus* sp., *Aeromonas* sp., *Citrobacter* sp.,*Edwardsiella* sp., *Enterobacter* sp., *Escheri chia* sp., *Flavobacterium* sp., *Hafnia* sp., *Klebsiella* sp., *Pasteurella* sp., *Proteus* sp.,*Salmonella* sp., *Serratia* sp., *Shigella* sp., *Vibrio* sp. and *Yersinia* sp., one Gram-negative anaerobic bacterium, *Bacteroides* sp., three Gram-positive cocci, *Micrococcus* sp., *Staphylococcus* sp. and *Streptococcus* sp., two endospore-forming rods, *Bacillus* sp. and*Clostridium* sp., and one Actinomycete, *Corynebacterium* sp.

The degradation of organic matter and the denitrification of nitrogen in the root zone treatment plant are mediated by micro organisms. The leakage of oxygen from the roots of the macrophytes creates oxidized zone around the root. Most of the organic matter is decomposed to carbon di oxide and water in these zones using oxygen as the terminal electron acceptor. In addition ammonia is oxidized to nitrates facilitated by nitrifying bacteria in these zones. At some distance from the root-surface free oxygen is depleted but nitrate is still present( anoxic zone). Here degradation can take place by denitrifying bacteria. By these processes nitrates are converted to free nitrogen which evaporates in the atmosphere. In the reduced areas in the rhizosphere, organic matter may be decomposed anaerobically to carbon-di oxide and methane by fermentative method. The simultaneous existence of oxidized, anoxic and reduced zones and the interaction between the different kinds of microbial degradation processes in these zones, is essential for an efficient decomposition of organic matter and nutrient removal in root-zone treatment plants. In addition such interactions may be favourable for the decomposition of rather persistent compounds such as chlorinated hydrocarbons.

Classification & details of Micro organisms for the Biofilm formation:
**Ammonia Oxidizing Bacteria** (Conversion of Ammonia to Nitrite)
*Nitrosomonas, Nitrosospira and Nitrosococcus*

**Nitrite Oxidizing bacteria** ( Conversion of nitrite to Nitrates)
Nitrobacter, Nitrospira, Nitrococcus and Nitrospina

**Denitrifying bacteria** ( Reduction of nitrate to Nitrogen)
*Pseudomonas, Alcaligenes, Acinetobacter, Paracoccus, Methylobacterium, Bacillus and Hyphomicrobium (The enzymes involved are nitrate reductase (NAR), nitrite reductase (NIR), nitric oxide reductase (NOR) and nitrous oxide reductase (N2OR).*

**Phosphate Uptaking Bacteria** (*Candidatus Accumulibacter phosphatis Acinetobacter calcoaceticus, Acinetobacter iwoffi and Aeromonas hydrophila)*
*Biological phosphorus removal is achieved by intracellular accumulation of polyphosphates in combination with cell uptake for growth. The most efficient phosphate removal bacteria are called polyphosphate accumulating organisms (POAs). PAOs require alternating anaerobic and aerobic environments to obtain a high net uptake of phosphorus. . The phosphorus content in bacterial cells is usually around 1-3 % of the dry weight while the corresponding percentage for PAOs can reach 10%.*

**Chemicals for Attached growth & Biofilm Formation**
A structured community of microorganisms encapsulated within a self-developed polymeric matrix and adherent to a living or inert surface is called Biofilm.
Microorganisms in biofilms produce extracellular polymeric substances (EPS) that hold the cell aggregates together and form the structural biofilm matrix scaffold
The production of an extracellular matrix is a prerequisite for biofilms formation. The biofilm matrix generally consist of up to 97% water, 2-5% microbial cells, 3-6% EPS and ions. The EPS, in turn, is normally composed of 40-95% polysaccharides, 1-60% proteins, 1-10% nucleic acids and 1-40% lipids. The composition of the EPS varies with the composition of the microbial consortia and the environmental condition. Biosynthesis of exopolysaccharides is generally performed at the cell membrane, although exceptions where the synthesis is extracellular are known. Precursors for exopolysaccharide synthesis, nucleoside diphosphate mono-sugars (UDP-sugars), are manufactured in the cytoplasm. At the periplasmic membrane different glycosyl transferases assembles the precursors to repeating units. Another group of enzymes located outside the cell membrane polymerizes the macromolecules forming extruding polysaccharides.

Bacterial polysaccharides are made up of a variety of mono-sugar derivates. Among the more common ones are D-glucose, D-galactose, D-mannose, L-fucose, L-rhamnose,.

**Tertiary treatment:**
- Rapid Pressure Sand Filter
- Activated Carbon Filter
- Disinfection using Hypochlorite

| Stage | Detention Time | Water quality |
|---|---|---|
| **Collection Chamber** | <30 minutes for only storage. | Removal of grits |
| **Pre Settling Chamber** | Detention time<20 hours | Solid settling , BOD removal by 40%.<br>Removal of 70% settlable TSS.<br>Non settlable TSS passes on to the Secondary treatment |
| **SAFC** | Detention Time<12 Hours | Removal of BOD further by 20%. |
| **TBWC** | Detention Time<12 Hours | Removal of BOD by furtther38% . End quality will be BOD<15mg/ltr.<br>Pathogen content <100 CFU |
| **Rapid** | Detention time<5 | BOD<10mg/ltr |

| | | |
|---|---|---|
| **Pressure sand filter & Activated Carbon filter** | minutes | COD<25mg/ltr<br>TSS<20mg/ltr |
| **Disinfection by Hypo dosing** | Injection in the storage tank | Pathogen content : untraceable<br>Ecoli: Untraceable<br>BOD<10mg/ltr<br>COD<25 mg/ltr<br>TSS<20mg/ltr |

### 9.12.6. Technical Specifications of Plant Chemicals:

Description:
Maximizes root oxygen absorption, nutrients and water, used during early seeding & transplantation stage.

Type: Plant Growth Hormones & promoters
Specific Gravity: 1.05g/ml
Ph;7.5-8
organic matter: 20g/l
Dosage: 200ml/ltr of water with direct root exposure.
Origin Extract: Sea Weed Extract

### 9.12.7. Technical Specification of Biomedia

Type :Mixt of facultative, aerobic , polyphosphate accumulating bacteria & denitrifying
Ph Tolerance: 5-8.5 tolerance
Exponential/Logarithmic growth phase: 10-20 minutes
Active bacteria content: 50-100 CFU

# 9.13. LIST OF APPROVED MAKE FOR PLUMBING & SANITARY WORKS

All materials and equipment shall conform to the relevant standards and shall be of approved make and design. The list of approved manufacturers/vendors is given in clause herein below.

List of approved makes for Equipment and materials:

| S. No. | Details of equipment/ material | MAKE |
|---|---|---|
| 1. | Indian / Wall Mounted WC | HINDWARE/KOHLER/ ROCA/JAQUAR/CERA |
| 2. | Concealed Cistern | HINDWARE/KOHLER/ ROCA/JAQUAR/CERA |
| 3. | Flush Plate | HINDWARE/KOHLER/ ROCA/JAQUAR/CERA |
| 4. | Waste Couple | JAQUAR/ KOHLER/ ROCA/ HINDWARE/CERA |
| 5. | Bottle Trap | JAQUAR/ KOHLER/ ROCA/ HINDWARE/CERA |
| 6. | Undercounter Lavatory | HINDWARE/KOHLER/ ROCA/ JAQUAR/CERA |
| 7. | Urinal | HINDWARE/ KOHLER/ ROCA/ JAQUAR/CERA |
| 8. | Automatic flushing system | HINDWARE/ KOHLER/ ROCA/ JAQUAR/CERA |
| 9. | Single lever wall mounted lavatory faucet | JAQUAR/ KOHLER/ ROCA/ HINDWARE/CERA |
| 10. | Kitchen Sink | JAYNA/ KINGSTON/ CERA |
| 11. | Sink Mixer | JAQUAR/ KOHLER/ ROCA/ HINDWARE |
| 12. | Shower | KOHLER/ GROHE/ JAQUAR/ROCA/CERA |
| 13. | Ceiling shower arm | KOHLER/ GROHE/ JAQUAR/ ROCA/CERA |
| 14. | Shower Mixer | KOHLER/ GROHE/ JAQUAR/ ROCA/CERA |
| 15. | Wall mounted bath spout | KOHLER/ GROHE/ JAQUAR/ ROCA/CERA |
| 16. | Hand Shower Health Faucet | KOHLER/ GROHE/ JAQUAR/ ROCA/CERA |
| 17. | Robe Hook | JAQUAR/ KOHLER/ GROHE/ ROCA/CERA |
| 18. | Toilet Paper Holder | JAQUAR/ KOHLER/ GROHE/ ROCA/CERA |
| 19. | Brass Bib Cock | JAQUAR/ KOHLER/ GROHE/ ROCA/CERA |
| 20. | Soap dispenser | JAQUAR/ GROHE/ EURONICS |
| 21. | Angle Stop cock | JAQUAR/ KOHLER/ GROHE/ ROCA/CERA |
| 22. | Shower tray | JAQUAR/ KOHLER/ GROHE/ ROCA/CERA |

| | | |
|---|---|---|
| 23. | Janitor Sink | JAYNA/ KINGSTON/ CERA |
| 24. | C.P Copper connection of 375 mm long | PARRYWARE/ HINDWARE/ CERA |
| 25. | Geyser | AO SMITH/ RACOLD/JAQUAR/VENUS |
| 26. | Water Dispenser | EUREKA/ OASIS/SUNROC |
| 27. | uPVC Pipes & fittings | SUPREME/FINOLEX/PRINCE/AKG |
| 28. | CPVC Pipes | ASTRAL/AJAY FLOW/ AASHIRWAD |
| 29. | CI Pipes/fittings (I.S: 3989-1984) | NECO / KAPILANSH / RIF / SKF/ BIC |
| 30. | SS Grating | NEER/CAMRY/CHILLY/DAKSHA |
| 31. | HDPE Pipes & fittings | JAIN /SUPREME /POLO PLAST |
| 32. | DI Pipes & fittings | ELECTROSTEEL/BALAJI/JINDAL SAW/ TATA |
| 33. | DI Manhole cover | NECO / DAKSHA / TRU FORM/ BIC |
| 34. | Flanges | TABLE ‘H’/CLASS 150/ OR ISI MARKED |
| 35. | Cast Brass Clean Out Plugs | CAMRY /NEER / CHILLY |
| 36. | G.I. Pipes | TATA / JINDAL HISSAR / SURYA PRAKASH |
| 37. | G.I. Fittings(malleable Cast Iron) | DRP - M / ZOLOTO/ UNIK / JAINSONS |
| 38. | G.I. Pipe jointing material | LOCTITE 55/DR.FIXIT / M- SEAL |
| 39. | Lead Caulked Joint | NECO / KAPILANSH / RIF |
| 40. | Rubber Insulation | THERMAFLEX/ARMAFLEX/ KFLEX/ AFLEX |
| 41. | SS Hinged Grating | NEER/CAMRY/CHILLY/DAKSHA |
| 42. | Stoneware Pipes and Gully Traps | PERFECT / ANAND/ BURN/ PRAGATI |
| 43. | RCC Pipes | J K SPUN / PRAGATI / LAXMI SPUN |
| 44. | Gunmetal Valves (Full way valve) Class-I | ZOLOTO/ LEADER/ SANT/ IBP/ DANFOSS |
| 45. | C.I. S&S / Double flanged fittings specials | NECO/NATIONAL/ KESORAM/ ELECTROSTEEL |
| 46. | SFRC Manhole Cover & Frame | K.K.MANHOLE/JAIN SPUN PIPE/ PRAGATI |
| 47. | C.I Manhole Cover (IS: 1726–1991) | NECO/ KK / RIF/ BIC |
| 48. | Butterfly Valve | ZOLOTO / ADVANCE/ AUDCO/SANT/AIP |

| | | |
|---|---|---|
| 49. | Gate Valve | ZOLOTO / ADVANCE/ AUDCO/SANT/AIP |
| 50. | Non Return Valve (C.I) | ZOLOTO / ADVANCE/ AUDCO/SANT/AIP |
| 51. | Ball Valves | ZOLOTO / ADVANCE/ AUDCO/SANT/AIP |
| 52. | Foot Rest | KGM EXPORT / OR ISI MARKED |
| 53. | Sluice Valve/ Air Valve/ Scour Valve | LEADER / KIRLOSKAR/ ZOLOTO |
| 54. | Two way GM Solenoid Valve | V.K. VALVES / DANFOSS |
| 55. | Dash Fastners | HILTI/ FISHER/ LOVELY |
| 56. | Automatic Air Vent | ZOLOTO/TBS/ KARTAR/ DANFOSS |
| 57. | Pipe Clamps/ Hangers/ Support | EUROCLAMP/ CHILLY/ LOVELY |
| 58. | Anti Corrosive Bitumastic Paint | SHALIMAR/ BERGER/ ASIAN |
| 59. | Epoxy Paint | SHALIMAR/ BERGER/ ASIAN |
| 60. | Pipe Protection anti corrosive tape treatment | PYPKOTE / HIND / COATEK |
| 61. | C.I Floor Trap | NECO / KAPILANSH / RIF/ SKF / BIC |
| 62. | Pressure Switch | INDFOSS/ASTER (USA)/ DANFOSS / PORTER |
| 63. | Level Switches | V. AUTOMAT/PUMPTROL/TECNIKA |
| 64. | Pressure Gauge/Dial Thermometer | H GURU/FIEBIG/PRICOL |
| 65. | Vibration Elimnation / Vibration Isolaters | RESISTOFLEX / KANWAL |
| 66. | Y-Strainer | ZOLOTO/EMERALD/SANDHU/SMI |
| 67. | Submersible Sump Pump | GRUNDFOS/WILO/ DP HOLLAND/XYLEM /IIT LOWARA |
| 68. | Foot Valve | KIRLOSKAR / KALPANA / DANFOSS |
| 69. | Anti Corrosion Tape | PYPKOTE/COATEK |
| 70. | Strainer (Y Strainer/Bucket Strainer) | ZOLOTO/EMERALD/SANDHU/SMI |
| 71. | Clamps & Support | HILTI / EASY FLEX |
| 72. | Water level indicator & controller | ITAL / TECHNIKA / MINILEC |
| 73. | Insulation for pipes | THERMAFLEX/LLOYD / MIN WOOL ROCK |
| 74. | Water Flow Meter | KENT/ KRANTI |

| | | |
|---|---|---|
| 75. | Solar Panels, collector boxes, support frames, water tank and integral piping | EMVEE SOLAR/ SOLAHART/ SOLPOWER/ BOSCH |
| 76. | PRV | RB (ITLY)/ HONEYWELL/ ZOLOTO/CASTLE |
| 77. | Filter Feed Pumps/ Water transfer pumps | KIRLOSKAR/ KSB/ GRUNDFOSS/ WILO/DP/ IIT LOWARA |
| 78. | Submersible Sump Pump | GRUNDFOS / WILO/ KSB/ LOWARA/DP |
| 79. | Hydropneumatic pumps | GRUNDFOS / WILO/ LOWARA/ DP |
| 80. | FRP Filter | AVENTURA/AQUANOMICS / PENTAIR |
| 81. | MS Filter | THERMAX / ION EXCHANGE |
| 82. | Multiport Valve (Auto) | PHARER (U.S.A.) / FLACK (U.S.A.)/ INITIATIVE |
| 83. | Multiport Valve (Manual) | MIDAS / INITIATIVE |
| 84. | PH Meter | VATS / HANNA (italy) |
| 85. | Controls | HONEYWELL / STEAFA / PENN |
| 86. | Control Cable | UNIVERSAL/ HAVELLS/BATRA HANLEY |
| 87. | Control Cable Termination | ELEMEX/ WEGA/PHONEX |
| 88. | Selector Switch | SULZER – L&T/ KAYCEE/SIEMENS |
| 89. | Contactor | L&T/SIEMENS/MG/GE/ABB |
| 90. | Indication Lamps/Push Button | L&T/TRINITY/BCH/ABB |
| 91. | WTP Panel/DB | TRICOLITE / ADVANCE / SPC ELECTROTECH /KEPL/ ADLEC |
| 92. | Copper Wires | NATIONAL / FINOLEX / BONTON |
| 93. | Cables | HAVELLS/GRANDLAY / BATRA HANLEY |
| 94. | Electo-Magnetic Flow Meter | ELECTRANET/FORBES MARSHELL/CIRRUS` |
| 95. | SS Channels | ACO/ CAPRI BATH/ NUGREEN |
| 96. | DI Manholes & Gratings | NECO/ KAPILANSH / ACO / NEER |
| 97. | FRP Grating | THERMODRAIN/ ACO/ KT FRP |
| 98. | Lawn Hydrants | JAIN/ HARVEL |
| 99. | HDPE Pipe | SUPREME/ JAIN / POLOPLAST |
| 100. | Motorized Butterfly Valve | AIP / CASTLE/ ZOLOTO |

# 10.0 FIRE PROTECTION & FIRE FIGHTING WORKS TECHNICAL SPECIFICATIONS

## 10.1. SCOPE OF WORK:

**10.1.1. The scope of this section consists of, but is not necessarily limited to supply, installation, testing and commissioning of the fire protection system. The contractor to note the indicated scope shall be included in price bid & extra shall not be payable on account of items/scope as detailed as follows:**

a. The Fire Suppression System shall comprise the Fire Hydrants System and the Sprinkler System (Wet type), Water Curtain System, Portable Fire extinguisher and Gas suppression system for Server room and electrical panels.
b. Water from the underground mains two no's RCC fire storage Tanks of 2 lac & 3 lac ltr. capacity at two locations, for the uses listed below:

   i Fire Hydrant system (pressurized) both for the internal and external hydrants
   ii Sprinkler System (Wet Type)
   iii Water Curtain System

c. The Hydrant System and the Sprinkler System, under normal conditions, shall be lowest pressurized by means of the electric motor driven Jockey Pumps.
d. The Fire Protection pumping system shall be provided with electrical driven pumps for hydrant and sprinkler system, diesel engine driven pump and jockey pumps of electric motor driven at two locations. Electric driven fire pump at two locations shall also be proposed for the water curtain system to the project.
e. The piping and valve connections shall be done so that the water from the discharge of the Hydrant Pump sets is able to supply water, automatically to the Sprinkler System whenever, the Sprinkler Pump is unable to maintain the pressure or fails and not vice versa.
f. The starting and stopping of the Jockey pump shall be automatic based on the pressure switches at preset low and high pressure.
g. The electric motor driven Hydrant Pump starts automatically at a preset pressure by means of a pressure switch. As soon as the Hydrant Pump starts, the Jockey Pump Stops. If for any reason the electric motor driven Hydrant Pump does not start at the preset pressure or is unable to maintain the pressure, the diesel engine driven Hydrant Pump starts automatically at the preset pressure.
h. The Sprinkler Pump shall start automatically at a preset pressure but shall be stopped only manually.
i. Contractor shall ensure that all false ceiling voids (gap between slab soffit and false ceiling) greater than 800 mm are provided with sprinklers. Drawings will be provided by Architect.
j. Wiring & earthing from electrical panels to fire-fighting system, control wiring & interlocking shall be in the scope of Contractor.
k. Contractor shall ensure Hydro Testing for the complete system.
l. The Contractor shall obtain the necessary approval of the drawings and the schemes from the local authority as called for.
m. The contractor shall design and after approval of Engineer-in-Charge display near each staircase landing at floor levels, a glass covered framed floor plan clearly showing the locations of all landing valves, hose reels, hand appliances, as well as the DO's and DON'T's for the personnel and the exit direction in case of an emergency. The dimensions of the floor plan, its scale, lettering size, colour scheme etc shall be as directed by the Engineer-in-Charge.
n. The contractor shall arrange the necessary Scaffolding Ladder and other arrangement for execute the firefighting works at height/ at site. No extra payment will be claimed for the same.
o. Contractor shall be fully responsible for attending the point raised by fire officer during fire inspection for FIRE clearance of all the buildings.
p. The Contractor shall be responsible for providing fully detailed hydraulic calculations of sprinkler and hydrant system to comply with NFPA Standards and to the requirements of Local Fire Authorities.
q. Balancing, testing & commissioning of the entire Fire Fighting system.

r. Test reports, list of recommended spares, as-installed drawings, operation & maintenance manual for the entire firefighting system.
s. Maintenance of entire system for DLP of 2 years free of cost. Maintenance of entire system for 3 years after DLP on payable basis as per BOQ item. Operation of the entire system for 5 years from date of handing over on payable basis as per BOQ item.

### 10.1.2. BUILDING AUTOMATION SYSTEM

**The scope of Firefighting Contractor shall include the following for the interface to Building Automation System and no additional cost shall be paid for providing the interface feasibility:**

a. Stop/Manual/ Auto switches along with potential free contacts for monitoring the manual operation status, to be provided for those equipment whose start / stop is controlled by Building Automation System.
b. Potential frees 'NO' contacts for monitoring 'Run' status of equipment wherever required.
c. Necessary contactor with potential free contacts and Stop/Manual/ Auto switches to be provided for all 1-phase equipment wherever the starter is not provided and which requires starting / stopping through Building Automation System.
d. Sockets /Nipples including shut-off valve for mounting sensors/transmitters on pipe lines.
e. The space provision in the entire equipment panel (MCC) for mounting Current/Potential transformers & transducers and power supply to the transducer shall be provided by the Firefighting contractor. Separate current transformers shall be provided by firefighting contractor for monitoring current / KWH (wherever required) through BAS.
f. The installation of current transformer & Transducer along with wiring between Current Transformer & Transducer up to the terminal block shall be provided by the Firefighting contractor. All transducers shall be supplied by BAS contractor.
g. The low voltage BAS Cables shall be brought upto the electric panel by BAS contractor and all terminations into the electrical panels shall be made by Firefighting contractor after satisfying himself of the wiring system. It is to be clearly understood that the final responsibility for the sufficiency, adequacy and conformity to the contract requirements, of the Firefighting system, lies solely with the contractor.
h. All necessary Hardware/ Software shall be made available by the Firefighting Contractor on the Microprocessor based panel for the integration of such panel to Building Automation System for remote monitoring / controlling of marking /equipment thru BAS.

## 10.2. PIPE WORK

### 10.2.1. General Requirements

a. All materials shall be of the best quality conforming to the specifications and subject to the approval of the Consultants.

b. Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.

c. Pipes shall be securely fixed to walls and ceilings by suitable clamps and supports (galvanised after fabrication) at intervals specified. Only approved type of anchor fasteners shall be used for RCC slabs and walls / floors etc.

d. Valves and other appurtenances shall be so located that they are easily accessible for operations, repairs and maintenance.

e. Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workman like manner.

f. Pipe accessories such as gauges, meters, control devices, etc. shall have the same working pressure rating as the associated pipe work. All pipe work shall be free from burrs, rust and scale and shall be cleaned before installation. All personnel engaged on welding operations must possess a certificate of competence issued by an acceptable / recognized authority.

### 10.2.2. Piping

a. Pipes of following types are to be used:

   Mild Steel pipelines up to 150 mm dia shall be as per IS: 1239, Part-II (heavy grade) while pipelines above 150 mm dia. shall be as per I.S.:3589.

b. All pipe clamps and supports shall be galvanized or fabricated from MS steel sections and shall be factory galvanized before use at site. Welding of galvanized clamps and supports shall not be permitted. Hangers and supports shall be thoroughly galvanized after fabrication. The selection and design of the hanger & support shall be capable of carrying the sum of all concurrently acting loads. They shall be designed to provide the required supporting effects and allow pipeline movements as necessary. Contractor to note, building is high rise and any specific requirement of support for seismic aspect to be considered in installation with compliance certificate to be issued. All guides, anchor braces, dampener, expansion joint and structural steel to be attached to the building/structure trenches etc. shall be provided. Hangers and components for all piping shall be approved by the Engineer-in-Charge.

c. Pipes shall be hung by means of expandable anchor fastener of approved make and design. The hangers and clamps shall be fastened by means of galvanised nuts and bolts. The size/diameter of the anchor fastener and the clamps shall be suitable to carry the weight of water filled pipe valves and dead load normally encountered.

d. The piping system shall be tested for leakages at 2 times the operating pressure or 1.5 time shut-off pressure, whichever is higher including testing for water hammer effects for a period of 4 hour minimum.

e. Flanged joints shall be used for connections for vessels, equipment, flanged valves and also on two straight lengths of pipelines and at strategic points to facilitate erection and subsequent maintenance work.

### 10.2.3. Piping Installation & Support

a. Tender drawings indicate schematically the size and location of pipes. The Contractor, on the award of the work, shall prepare detailed working drawings, showing the cross-sections, longitudinal sections, details of fittings, locations of isolating and control valves, drain and air release valves, and all pipe supports. He must keep in view the specific openings in buildings and other structure through which pipes are designed to pass.

b. Piping shall be properly supported on, or suspended from, on stands, clamps, hangers as specified and as required. The Contractor shall adequately design all the brackets, saddles, anchor, clamps and hangers, and be responsible for their structural stability.

c. Pipe work and fittings shall be supported by hangers or brackets so as to permit free expansion and contraction. Risers shall be supported at each floor with Galvanized steel brackets / clamps. To permit free movement of common piping support shall be from a common hanger bar fabricated from Galvanized steel sections.

d. Pipe hangers shall be provided at the following maximum spacing's:

| **Pipe Dia. (mm)** | **Hanger Rod Dia. (mm)** | **Spacing between Supports** (m) |
|---|---|---|
| Up to 25 | 8 | 2 |
| 32 to 50 | 8 | 2.5 |
| 65 to 80 | 8 | 2.5 |
| 80 to 100 | 10 | 2.5 |
| 125 to 150 | 10 | 3.0 |
| 200 to 300 | 12 | 3.5 |

e. All pipes shall be accurately cut to the required sizes in accordance with relevant BIS codes and burrs removed before laying. Open ends of the piping shall be closed as the pipe is installed to avoid entrance of foreign matter. Where reducers are to be made in horizontal runs, eccentric reduces shall be used for the piping to drain freely. In other locations, concentric reducers may be used. Air cushion tank (ACT) shall be provided on each riser at High end. Discharge from the Air cushion tank (ACT) shall be piped through a pipe to the nearest drain provision. Pressure gauges shall be provided as shown on the approved drawings. Care shall be taken to protect pressure gauges during pressure testing.

### 10.2.4. Pipe Fittings

a. Pipe fittings mean tees, elbows, couplings, unions, flanges, reducers etc. and all such connecting devices that are needed to complete the piping work in its totality.

b. Ductile Iron (ASTM A536) or Cast Iron (ASTM A126) or Forged Steel screwed type fitting shall be used for pipes of 50 mm dia. & below.

c. Fabricated fittings shall not be permitted for pipes diameters 50mm and below.

d. Fabricated fittings used on pipe size 65 mm & above shall be fabricated, welded in workshops. They shall be inspected by Engineer-in-Charge if required, before dispatch from the workshop/manufacturers. The welding procedures of the workshop should have been approved by the rules for sprinkler system and applicable to hydrant and sprinkler system.

### 10.2.5. Procedure for Pypkote / Coatek Application

a. Surface Preparation - The pipe surface shall be cleaned by a wire brush.

b. Application of Primer - Primer is to be applied on pipes immediately after cleaning. This is to prevent any further accumulation of rust on the pipe. This is a cold applied primer and is applied by brush.

c. Application of 4 mm bit mastic Tape - After the primer is applied on the pipe, it is allowed to dry for about 30 min. till it becomes touch dry. Before adhering the tape to the pipe, it is advisable to gently heat the primer coated pipe by a run of LPG torch. Remove the bottom polyethylene from the tape & then heat bottom surface of the tape by LPG torch or any heat source & start wrapping the tape to the pipe by heating the primer coated pipe & by removing the bottom polyethylene from the tape before wrapping better adhesion between the tape & pipe is obtained. Overlaps are maintained with a minimum of 15.0 mm.

d. Tape coating of weld joints - The tape is applied over the weld joints after the necessary welding & testing methods of the joints is completed. The procedure for application of tape shall be the same as bare pipe procedure. Overlaps on each side of the weld joints shall be 50 mm.

e. A final coat of White wash with water based cement paint is done immediately over the entire coated pipe.

### 10.2.6. Jointing

a. Welded Joints:

i Joints between MS pipes and fittings shall be butt joint made with the pipes and fittings having “V” groove and welded with electrical resistance welding in an approved manner. Butt welding without “V” groove shall not be permitted.

b. Flanged joints (65 mm dia. and above):

**Flanged joints with flanges conforming to IS: 6392 shall be provided on:**

i Straight runs at intervals not exceeding 25-30m on pipe lines of 50 mm dia and above and as directed by the Engineer-in-Charge.

ii For jointing all types of valves, appurtenances, pumps, connections with other type of pipes, to water tanks and other places necessary and as required for good engineering practice and as shown/noted on the drawings.

iii Flanges shall be with GI bolts and nuts and 3mm insertion gasket of natural rubber conforming to IS: 11149.

c. Unions (up to 50 mm dia):

Approved type of dismountable unions shall be provided on pipe lines of 40 mm dia and smaller dia, in locations similar to those specified for flanges.

## 10.3. AIR VESSEL

**10.3.1.** The air vessel shall be provided to compensate for slight loss of pressure in the system and to provide an air cushion for counter-acting pressure, surges, whenever the pumping sets come into operation. Air vessel shall conform to IS:3844. It shall be normally half full of water, when the system is in normal operation. Air vessel shall be fabricated with 8 mm thick M.S. plate with dished ends and suitable supporting legs. It shall be provided with one 100 mm dia flanged connection from pump, one 25 mm drain with valve, one water level gauge and 25 mm sockets for pressure switches. The air vessel shall be tested to pressure for 12 hours at 2 times the operating pressure or 1.5 times the shut-off.

## 10.4. AIR CUSHION TANK

**10.4.1.** Every wet riser shall be provided with an air cushion tank at its top most point. The air cushion shall be provided with an automatic air release cock, 25 mm dia drain pipe, drain valve and shut off valve.

## 10.5. FIRE BRIGADE CONNECTION

**10.5.1.** The storage tank shall be provided with a 150 mm fire brigade pumping connection to discharge at least 2275 liters / minute into it. This connection shall not be taken directly into the side of the storage tank, but arranged to discharge not less than 150 mm above the top edge of the tank such that the water flow can be seen. The connection shall be fitted with stop valve in a position approved by the Engineer-in-Charge. An overflow connection discharging to a drain point shall be provided from the storage tank.

**10.5.2.** The fire brigade connection shall be fitted with four numbers of 63mm instantaneous inlets in a glass fronted wall box at a suitable position at street level, so located as to make the inlets accessible from the outside of the building. The size of the wall box shall be adequate to allow hose to be connected to the inlets, even if the door cannot be opened and the glass has to be broken. Each box shall have fall of 25mm towards the front at its base and shall be glassed with wired glass with" FIRE BRIGADE INLET" painted on the inner face of the glass in 50 mm size block letter. Each such box shall be provided with a steel hammer with chain for breaking the glass.

**10.5.3.** In addition to the emergency fire brigade connection to the storage tank, a 150mm common connection shall be taken from the four 63mm instantaneous inlets direct to hydrant main so that the fire brigade may pump to the hydrants in the event of the hydrant pumps being out of commission. The connection shall be fitted with a sluice valve. Location of this valve shall be as per the approval of the Engineer-in-Charge.

**10.5.4.** Two way collecting head with two numbers 63 mm instantaneous type inlets shall be connected to the sprinkler header. All other details shall be as described above.

## 10.6. SYSTEM DRAINAGE

**10.6.1.** The system shall be provided with suitable drainage arrangement with drain valves complete with all accessories.

## 10.7. VALVE CHAMBERS

**10.7.1.** Provision of suitable brick masonry chambers in cement mortar 1:5 (1 cement: 5 coarse sand) on cement concrete foundations 150 mm thick 1:5:10 mix (1 cement:5 fine sand: 10 graded stone aggregate 20 mm nominal size) with 15 mm thick cement plaster inside and outside finished with a plaster inside and outside finished with a floated coat of neat cement inside with cast iron surface box approved by fire brigade including excavation, back-filling complete shall be made.

## 10.8. VALVES

**10.8.1.** Butterfly Valve

a. The butterfly valve shall be suitable for waterworks and rated for PN 16 pressure rating. The body shall be of cast iron to IS:210 in circular shape and of high strength to take the water pressure. The disc shall be heavy duty cast iron with anti-corrosive epoxy or nickel coating. The valve seat shall be integrally molded EPDM lined or nitrile rubber with hard backing. The valve is closed position shall have complete contact between the seat and the disc throughout the perimeter. The elastomer rubber shall have a long life and shall not give away on continuous applied water pressure. The shaft shall be EN 8 grade carbon steel.

b. The valve shall be fitted between two flanges on either side of pipe flanges. The valve edge rubber shall be projected outside such that they are wedged within the pipe flanges to prevent leakages.

c. Contractor to consider MOC for PN 16 & 20 and shall submit catalogue (make & model) with tender technical bid.

**10.8.2.** Ball Valve

a. The ball valve shall be suitable for waterworks and rated for PN 16 pressure rating.

b. The ball valve shall be made forged brass and suitable for test pressure of pipe line. The valve shall be internally threaded to receive pipe connections.

c. The ball shall be made from brass and machined to perfect round shape and subsequently chrome plated. The seat of the valve body-bonnet gasket and gland packing shall be of Teflon.

d. The handle shall be provided with PVC jacket. The handle shall also indicate the direction of ‘open’ and ‘closed’ situations. The gap between the ball and the teflon packing shall be sealed to prevent water seeping.

e. The handle shall also be provided with a lug to keep the movement of the ball valve within 90°. The lever shall be operated smoothly and without application of any unnecessary force.

f. Contractor to consider MOC for PN 16 & 20 and shall submit catalogue (make & model) with tender technical bid.

**10.8.3.** Flap Type - Non-Return Valve

a. The valve shall be suitable for waterworks and rated for PN 16 pressure rating.

b. Non-Return valves shall be cast iron double flanged with cast iron body and gun metal/ S.S. internal parts conforming to IS: 5312.

**10.8.4.** Sluice Valves

a. Sluice valves shall be double flanged valves with cast iron body. The spindle, wall seat and wedge nuts shall be of bronze. They shall generally have non-rising spindle and shall be of the particular duty and design called for. Where specified O&Y valve will be provided.

**b. The valves shall be supplied with suitable flanges, non- corrosive bolts and asbestos fibre gaskets. Sluice valves shall conform to Indian Standard IS : 780-1969 and IS : 2906 .**

## 10.9. PAINTING

**10.9.1.** All Hydrant and Sprinkler pipes shall be painted with post office red colour paint. All M S pipes shall first be cleaned thoroughly before application of primer coat. After application of primer coat two coats of enamel paint shall be applied. Each coat shall be given minimum 24 hours drying time. No thinners shall be used. Wherever required all pipe headers shall be worded indicating the direction of the pipe and its purpose such as "TO RISER NO.1" etc.

**10.9.2.** Painting shall be expertly applied; the paint shall not over run on surfaces not requiring painting such as walls, surfaces etc. Nuts and bolts shall be painted black, while valves shall be painted blue.

## 10.10. EXCAVATION

**10.10.1.** Excavation for pipe lines shall be in open trenches to levels and grades shown on the drawings or as required at site. Pipe lines shall be burried with a minimum cover of 1 meter or as shown on drawings.

**10.10.2.** Wherever required Contractor shall support all trenches or adjoining structures with adequate timber supports, shoring and strutting.

**10.10.3.** On completion of testing in the presence of the Engineer-in-Charge and pipe protection, trenches shall be backfilled in 150 mm layers and consolidated.

**10.10.4.** Contractor shall dispose of all surplus earth as directed by the Engineer-in-Charge.

## 10.11. FIRE HYDRANTS

**10.11.1.** Internal Hydrants

a. Contractor shall provide landing valves with 80 mm dia inlet as per IS:5290, with shut off valves having cast iron wheels as shown on the drawings. Landing valve shall have flanged inlet and instantaneous type outlets as shown on the drawings/or as per BOQ.

b. Instantaneous outlets for fire hydrants shall be standard pattern and suitable for fire hoses.

c. Contractor shall provide for each internal fire hydrant station two numbers of 63 mm dia 15 m long rubberized fabric lined hose pipes with gun metal male and female instantaneous type coupling with GI wire (hose to IS:636 type 2 and couplings to IS:903 with IS certification), fire hose reel, gun metal branch pipe with nozzle to IS:903.

d. Contractor shall provide standard fire hose reel of 30 Mtr Long 20mm (Nominal internal) dia high pressure hose reel tubing as per IS: 444 with gun metal (GM) shut off nozzle having 6.5 mm dia orifice. The hose reel shall be conforming to IS : 884-1985. Hose reel shall be connected directly to the wet riser with an isolating valve. Hose reel shall be mounted vertically.

e. Each internal hydrant hose cabinet containing items as above shall also be provided with a nozzle spanner and a Fireman's Axe as required. The cabinet shall be recessed in the wall as directed.

f. Each hose cabinet shall be painted stove enamelled fire red paint (shade No. 536 of IS:5) with the letters "FIRE HOSE".

**10.11.2.** Hose Reel

a. Hose reel high pressure tubing as per IS: 444 with gun metal (GM) shut off nozzle having 6.5 mm dia orifice shall be provided. The hose reel shall be conforming to IS : 884-1985. fitted with gun metal chromium plated nozzle, mild steel pressed reel drum which can swing upto 180 degree with wall brackets of cast iron finished with red and black enamel complete.

**10.11.3.** Fire Hose

a. All hose pipes shall be of 63 mm diameter RRL/ CP as required, conforming to IS : 636 or IS : 8423. The hose shall be provided with GM delivery coupling. The hose shall be capable of withstanding a bursting pressure of 35.7 Kg/Sq.cm without undue leakage or sweating. Hose shall be provided with instantaneous spring-lock, type couplings.

**10.11.4.** Branch Pipe, Nozzle

a. Branch pipes shall be of Gun metal with loaded ring at the discharge and to receive the nozzle and provided at the other with a leaded tin GM ring to fit into the instantaneous coupling. Nozzle shall be of spray type of diameter of not less than 16 mm and not more than 25 mm. Nozzle shall be of loaded tin bronze branch pipe and nozzle shall be of instantaneous pattern conforming to Indian Standard - 903.

**10.11.5.** Hose Cabinet

a. Hose cabinet shall be provided for all internal and external fire hydrants. Hose cabinets shall be fabricated from 16 gauge MS/SS (as per BOQ) powder coated sheet of fully welded construction with hinged double front door partially glazed (4 mm glass panel) with locking arrangement, stove enamelled fire red paint (shade No. 536 of IS:5) with “FIRE HOSE” written on it prominently (size as given in the schedule of quantities). Cabinet surfaces in contact with the walls shall not be powder coated but instead given two coats of anti-corrosive bitumastic paint.

**10.11.6.** Internal Hose Cabinet

a. Hose cabinet shall be of glass fronted with hinged door & lock. The cabinet shall be made of 16 gauge thick MS/SS (as per SOQ) sheet and spray painted to shade No. 536 of IS:5. The hose cabinet shall be of size to accommodate the following:
   i Landing Valves
   ii Hose pipe (2 lengths of 15 meters)
   iii Hose reel (30 meters.)
   iv Branch pipes, nozzles (1/2 sets)
   v Fire man's axe
   vi Two Fire Extinguishers

## 10.12. SPRINKLER SYSTEM

### 10.12.1. General Specification

a. The scope of work shall include supply, commissioning, testing of the system as a whole. The sprinkler heads are to be fixed into heavy quality black steel pipes, conforming to IS 1239 or any other approved specification. The size of pipe will vary from 25 mm to 150mm to suit the hydraulics of the system. The System shall conform to CFO Rules for the installation of sprinkler systems in general for 'Ordinary Hazard' category-in respect of design, density and spacing of sprinkler heads.

b. Reduction in pipe sizes shall not be made by use of bushings. All pipe joints shall be done by means of welding, screwed & flanged jointing as per codes.

c. Due care shall be taken that sprinklers are not applied with paint at the time of applying paint to piping and fittings.

d. All control, drain, test and alarm valves shall be provided with signs to identify their purposes, functions, direction of flow to the entire satisfaction of the Engineer-in-Charge.

### 10.12.2. Quartzoid Bulb Automatic Sprinkler

a. Sprinkler heads shall be made of brass/quartzoid bulb sufficiently strong, in compression to withstand any pressure, surge or hammer likely to occur in the system. The yoke & body shall be made of high quality gun metal brass with arms stream lined to ensure minimum interference with the spread of water. The deflector of suitable design shall be fitted to give even distribution of water over the area commanded by the sprinkler.

b. The bulb shall contain a liquid having a freezing point below any natural climatic figure and a high coefficient of expansion. The temperature rating of the sprinkler shall be stamped on the deflector & the color of the liquid filled in the bulb shall be according to the temperature rating as per HFPA standard. The sprinkler heads shall be of type & quality approved by the local fire brigade authority. The inlet shall be screwed.

c. The sprinklers shall have 15mm nominal size of the orifice for ordinary hazard.

d. The orifice size shall be marked on the body or the deflector of the sprinkler.

e. Metal guards for protection of sprinkler against accidental or mechanical damage shall be provided as desired by the Engineer-in-Charge.

f. Contractor shall submit detailed submittal and discharge spray pattern for the Sprinkler for the approval of consultant.

g. Operating Temperature:

   i The Operating temperature, at which the quartzoid bulb of the sprinkler head shall actuate, shall be 79 deg./ 68 degree C or as specifically mentioned in BOQ.

h. Sprinkler Installation:

   i Sprinkler heads shall be located in positions shown on the drawings. While slight relocation may result from building construction features or interference from other services, the maximum spacing between sprinkler heads and coverage area shall not exceed those stipulated in the TAC regulations and the NFPA 13Rules.

   ii Allowance shall be made for such relocations within a radius of 1500 mm of the indicated positions without additional cost. The Fire Protection Services Trade shall co-ordinate with

the ceiling Trade to set out the sprinkler locations to suit the site location of the unit grid. In general, all sprinklers shall be located at the centre of the ceiling unit and a provision of about 10% more sprinklers and pipe work than required in TAC and NFPA Rules shall be included in this sub-contract. Chrome plated wire mesh guards shall be used to protect the sprinkler heads which are liable to accidental or mechanical (at no extra cost) damage.

### 10.12.3. Flow Requirements

a. The flow requirement for sprinkler heads shall be specifically approved for the designated area of installation.

### 10.12.4. Installation Control Valves

a. Each installation shall be provided with a set of installation control valves comprising: -

   i An Alarm Valve.
   ii A Water Motor Alarm & Gong.
   iii Installation valves shall be installed on the sprinkler circuits as shown on the drawings.
   iv Contractor shall submit detailed shop drawings showing the exact location, details of installation of the valves/alarm in all respects.
   v Installation valve shall comprise of a cast iron body with gunmetal trim, and double seated clapper check valves, pressure gauges, test valve and orifice assembly and drain valve with pressure gauges, turbine water gong including all accessories necessary and required and as supplied by original equipment manufacturer and required for full and satisfactory performance of the system. A cast iron isolation valve with lock and chain at the inlet of the installation valve shall be provided.

### 10.12.5. Inspection and Test Valve Assembly

a. Inspection and testing of automatic starting of the sprinkler system shall be done by providing an assembly consisting of gunmetal valves, gunmetal sight glass, bye-pass valve and orifice assembly to meet sprinkler K factor as per approved drawing.

### 10.12.6. Flow Switch

a. Vane-type water flow detectors shall be installed on system piping as designated on the drawing.
b. Detectors shall mount on any clear pipe span of the appropriate nominal size, horizontal run, at least 6″ from any fittings which may change water direction, flow rate, or pipe diameter or no closer than 24″ from a valve or drain.

c. Detectors shall have sensitivity in the range of 4 to 10 gallons per minute. The detector shall respond to water flow in the specified direction after a preset time delay which is field adjustable. Further, it shall have a ‘Retard’ to compensate for line leakage or intermitted flows.

d. The delay mechanism shall be a sealed mechanical pneumatic unit with visual indication of actuation. The actuation mechanism shall include a polyethylene vane inserted through a hole in the pipe and connected by a mechanical linkage to the delay mechanism. Outputs shall consist of dual SPDT switches (Form C contacts). Two conduit entrances for standard fittings of commonly used electrical conduit shall be provided on the detectors.

e. The Switch shall be potential free in either N O or N C position as required. The switch shall be able to trip and make / break contact on the operation of a single sprinkler head. The terminal box shall have connections for wiring to the Monitor module. The flow switch shall have connections for wiring the seat shall be of S.S to the Monitor module. The flow switch shall have IP: 55 protections. The wiring connection from the temper switch shall not be in the contractor scope.

### 10.12.7. Pipes for Drainage

a. Sprinkler pipes shall be so installed that the system can be thoroughly drained. As far as possible all pipes shall be arranged to drain to the installation drain valve as shown in the drawing for ordinary hazard system.
b. In the case of basement & other areas where sprinkler pipe-work is below the installation drain valve & in other trapped points in the system, auxiliary valves of the following sizes shall be provided.
c. -20 mm valves for pipes up to 50mm dia.
d. -25 mm valves for 80mm dia. pipe.
e. -50 mm valves for pipes larger than 80mm dia.

### 10.12.8. System Design

a. The entire sprinkler installation shall be designed to make it a hydraulically balanced system. The pressure requirement at typical floors shall be designed between 3 bar to 3.5 bar.

## 10.13. FIRE PUMPS AND ALLIED EQUIPMENTS

### 10.13.1. Scope

a. Work under this section shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely install electrically operated and diesel driven pumps and as required by drawings and specified hereinafter or given in the schedule of rates.
b. Electrically operated pumps with motors and diesel engine driven pumps with diesel engine, common base plates, coupling, coupling guard and accessories.
c. Automatic starting system with all accessories, wiring and connections and pressure switches.
d. Motor control centre.
e. Annunciation system with all accessories wiring and connections.
f. Pressure gauges with isolation valves and piping, bleed and block valves.
g. Suction strainers and accessories.
h. Vibration eliminator pads and foundation bolts.
i. Leak-off drain shall be led to the nearest floor drain.

### 10.13.2. General Requirements

a. Pumps shall be installed true to levels on suitable concrete foundations. Base plate shall be firmly fixed by properly grouted foundation bolts.

b. Pumps and motors shall be truly aligned by suitable instruments. Record of such alignment shall be furnished to the Engineer-in-Charge.

c. All pump connections shall be standard flanged type with number of bolts as per relevant standard requirement for the working pressure. Companion flanges shall be provided with the pumps.

d. Manufacturers' instructions regarding installation, connections and commissioning shall be strictly followed.

e. Contractor shall provide necessary test certificates, type test certificates, performance curves and NPSH curves of the pumps from the manufacturer when called for. The contractor shall provide facilities to the Engineer-in-Charge for inspection of equipment during manufacturing and also to witness various tests at the manufacturer's works without any cost to the Engineer-in-Charge.

f. Seismic isolation and clamping for each pump and flexible connection on the suction as well as the discharge side shall be provided.

g. The contractor shall submit with this tender a list of recommended spare parts for three years of normal operation.

### 10.13.3. Electric Fire Pump

a. General
The electric fire pump shall be suitable for automatic operation complete with necessary electric motor and automatic starting gear, suitable for operation on 415 volts, 3 phase, 50 Hz. A.C. system. Both the motor and the pump shall be assembled on a common base plate, fabricated M.S. channel type or cast iron type. The fire pump efficiency shall be in acceptable range of 65 – 70%.

b. Drive
The pump shall be direct driven by means of a flexible coupling. Coupling guard shall also be provided.

### 10.13.4. Fire Pump

a. The fire pump shall be horizontally mounted single/ multistage, multi outlet centrifugal type. It shall have a capacity to deliver 2850 lpm as specified, and developing adequate head so as to ensure a minimum pressure of 3.5 Kg/Sq.cm at the highest and the farthest outlet.

b. The pump shall be capable of giving a discharge of not less than 150 per cent of the rated discharge, at a head of not less than 65 per cent of the rated head. The shut off head shall be within 120 per cent of the rated head.

c. The pump casing shall be of cast iron to grade FG 200 to IS: 210 and parts like impeller, shaft sleeve, wearing ring etc. shall be of non-corrosive metal like bronze/brass/gun metal. The shaft shall be of stainless steel. Provision of mechanical seal shall also be made.

d. Bearings of the pump shall be effectively sealed to prevent loss of lubricant or entry of dust or water. The pump shall be provided with a plate indicating the suction lift, delivery head, discharge, speed and number of stages. The pump casing shall be designed to withstand 1.5 times the working pressure.

e. Provision of Jockey Pump shall be made for pressurization of fire lines. The pump shall be vertical SS type/end suction and of detail as in schedule of quantity. Contractor shall verify that the capacity of the Jockey pump shall not be less than 3% (Minimum 180 LPM) and not more than 10% of the installed pump capacity.

**f. Motor**

i The motor shall be squirrel cage A.C. induction type suitable for operation on 415 volts 3 phase 50 Hz. system. The motor shall be totally enclosed fan cooled type conforming to protection clause IP 55. The class of insulation shall be F. The synchronous speed shall be 2900 RPM as specified. The motor shall be rated for continuous duty and shall have a horse power rating necessary to drive the pump at 150 per cent of its rated discharge with at least 65 per cent rated head. The motor shall conform to I.S.325-1978.

**g. Motor Starter**

i The motor starter shall be as per detail in MCC. The unit shall include suitable current transformer and ammeter of suitable range on one line to indicate the current. The starter shall not incorporate under voltage, no voltage trip overload or SPP.

ii The starter assembly shall be suitably integrated in the power and control panel for the wet riser system & sprinkler system.

### 10.13.5. Diesel Fire Pump

**a. General**

i The diesel pump set shall be suitable for automatic operation complete with necessary automatic starting gear, for starting on wet battery system and shall be complete with all accessories. Both engine and pump shall be assembled on a common base plate.

**b. Drive**

i The pump shall be only direct driven by means of a flexible coupling. Coupling guard shall also be provided. The speed shall be 1500 RPM as specified or as per manufacturer.

**c. Fire Pump**

i The fire pump shall be horizontally mounted centrifugal single/ multi stage, single/ multi outlet. It shall have a capacity to deliver as specified in the BOQ, and developing adequate head so as to ensure a minimum pressure of 3.5 Kg/Sq.cm at the highest and the farthest outlet. The pump shall be single/ multi stage as specified. The pump shall be capable of giving a discharge of not less than 150% of the rated discharge at a head of not less than 65% of the rated head. The shut off head shall be within 120% of the rated head.

ii The pump casing shall be of cast iron to grade FG 200 to IS 210 and parts like impeller, shaft sleeves, wearing-ring etc. shall be of non-corrosive metal like bronze/brass/gun metal. The shaft shall be stainless steel. Provision of mechanical seal shall also be made.

iii The pump casing shall be designed to withstand 1.5 times the working pressure.

iv Bearing of pump shall be effectively sealed to prevent loss of lubricant or entry of dust or water.

**d. Diesel Engine**

i **Engine Rating** - The engine shall be cold starting type without the necessity of preliminary heating of the engine cylinders or combustion chamber (for example, by wicks, cartridge, heater, plugs etc.). The engine shall be multi cylinder/vertical 4 stroke cycles, water cooled, diesel engine, developing suitable HP at the operating speed specified to drive the fire pump. Continuous capacity available for the load shall be exclusive of the power requirement of auxiliaries of the diesel engine, and the after correction for altitude, ambient temperature and humidity for the specified environmental conditions. This shall be at least 20% greater than the maximum HP required to drive the pump at its duty point. It shall also be capable of driving the pump at 150% of the rated discharge at 65% of rated head. The engine shall be capable of continuous non-stop operation for 8 hours and major overhaul shall not be required before 3000 hours of operation. The engine shall have 10% overload capacity for one hour in any period of 12 hours continuous run. The engine shall accept full load within 15 seconds from the receipt of signal to start. The diesel engine shall conform to BS 649/IS 1601/IS 10002, all amended up to date.

ii **Engine Accessories -** The engine shall be complete with the following accessories:-

1. Fly wheel dynamically balanced.
2. Direct coupling for pump and coupling guard.
3. Corrosion Resistor.
4. Air cleaner.
5. Fuel service tank support, and fuel oil filter with necessary pipe work.
6. Elect. starting battery (2X24 v).
7. Exhaust silencer with necessary pipe work.
8. Governor.
9. Necessary safety controls
10. Instrument panel housing all the gauges, including Tachometer, hour meter and starting switch with key (for manual starting).

iii **Fuel System -** The fuel shall be gravity fed from the engine fuel tank to the engine driven fuel pump. The engine fuel tank shall be mounted either over or adjacent to the engine itself or suitably wall mounted on bracket. The fuel filter shall be suitably located to permit easy

servicing. All fuel tubing to the engine shall be with copper, with flexible hose connections where required. Plastic tubing shall not be permitted.

The fuel tank shall be of welded steel construction (3 mm. thick) and of capacity sufficient to allow the engine to run on full load for at least 4 hours. The tank shall be complete with necessary wall mounted supports, level indicator (protected against mechanical injury) inlet, outlet, overflow connections and drain plug and piping to the engine fuel tank. The outlet shall be so located as to avoid entry of any sediment into the fuel line to the engine.

**As semi rotary hand pump for filling the daily service tank together with hose pipe 5 mtr. long with a foot valve etc. shall also form part of the scope of supply.**

iv **Lubricating Oil System-** Forced feed Lub. Oil system shall be employed for positive lubrication. Necessary Lub. oil filters shall be provided, located suitably for convenient servicing.

v **Starting System-** The starting system shall comprise necessary batteries (2x24v), 24 volts starter motor of adequate capacity and axle type gear to match with the toothed ring on the fly wheel. Bi metallic relay protection to protect starting motor from excessively long cranking runs suitably integrated with engine protection system shall be included within the scope of the work. The capacity of the battery shall be suitable for meeting the needs of the starting system.

The battery capacity shall be adequate for 10 consecutive starts without recharging with cold engine under full compression.

The scope shall cover all cabling, terminals, initial charging etc.

vi **Exhaust System -** The exhaust system shall be complete with silencer suitable for outdoor installation and silencer piping including bends and accessories needed for a run of 15 metre from the engine manifold.(Adjustment rates for extra lengths shall also be given). The total back pressure shall not exceed the engine manufacture's recommendation. The exhaust piping shall be suitably supported.

vii **Engine shut down mechanism-** This shall be auto/ manually operated and shall return automatically to the starting position after use.

viii **Governing System-** The engine shall be provided with an adjustable governor to control the engine speed within 5% of its rated speed under all conditions of load up to full load. The governor shall be set to maintain rated pump speed at maximum pump load.

ix **Engine Instrumentation-** Engine instrumentation shall include the following:-

1. Lub. oil pressure gauge.
2. Lub. oil temperature gauge.
3. Water pressure gauge.
4. Water temperature gauge.
5. Tachometer.
6. Hour meter.

The instrumentation panel shall be suitably resident mounted on the engine.

x **Engine Protection Devices**- Following engine protection and automatic shut down facilities shall be provided:-

7. Low lub.oil pressure.
8. High cooling water temp.
9. High lub.oil temperature.
10. Over speed shut down.

xi **Pipe Work -** All pipe lines with fittings and accessories required shall be provided for fuel oil, lub.oil and exhaust systems, copper piping of adequate sizes, shall be used for Lub.oil and fuel oil. M.S. piping will be permitted for exhaust.

xii **Anti-Vibration Mounting-** Suitable vibration mounting duly approved by Engineer-in-Charge shall be employed for mounting the unit so as to minimise transmission of vibration to the structure. The isolation efficiency achievable shall be clearly indicated.

xiii **Battery Charger-** Necessary float and boost charger shall be incorporated in the control section of the power and control panel, to keep the battery in trim condition. Voltmeter to indicate the state of charge of the batteries shall be provided.

### 10.13.6. Pump Sets Assembly

a. On the main fire sprinkler and hydrant headers near pump sets a 150 mm dia by-pass valve located in an accessible location shall be provided along with a rate of flow rota meter calibrated in 1 pm and able to read 200% of the rated pump capacity. The delivery shall be connected to the fire tank.

b. Each and every pump set assembly shall be provided with suction valve (only for positive suction head), discharge valve, non-return valve and 150 mm dia Bourdon type pressure gauge with isolation valve.

### 10.13.7. Flexible Connectors

a. On all suction and delivery lines double flanged reinforced neoprene flexible pipe connectors shall be provided. Connectors should be suitable for maximum working pressure of each pipe line on which it is mounted and tested to a test pressure of 1:5 time the operating pressure. Length of the connector shall be as per manufacturer's standard.

### 10.13.8. Interlocking

a. The following inter-locking between the two main fire pumps (i.e. wet riser pump & sprinkler pump), the jockey pump and the diesel engine driven pump.

b. Only one category of pumps will work at a time i.e. either jockey pump or main fire pumps (wet riser and sprinkler, both the wet riser and sprinkler can come up at a time) or diesel driven pump.

| JOCKEY PUMP | WET RISER PUMP | SPRINKLER PUMP | DIESEL DRIVEN PUMP |
|---|---|---|---|
| i. ON | OFF | OFF | OFF |
| ii. OFF | ON | OFF | OFF |
| iii. OFF | OFF | ON | OFF |
| iv. OFF | ON | ON | OFF |
| v. OFF | OFF | ON | ON |
| vi. OFF | OFF | OFF | ON |
| vii OFF | ON | OFF | ON |
| viii OFF | OFF | OFF | ON |

### 10.13.9. Annunciation Panel

a. One solid state electronic annunciation panel, fully wired with visual display and audible alarm unit shall be provided to indicate:

i Flow condition in any flow switch indicating the area of distress and fire alarm.
ii Starting and stopping of each hydrant pump.
iii Starting and stopping of each jockey pump.

iv Starting and stopping of each sprinkler pump.
v Failure of Hydrant / Sprinkler pump to start.
vi High level in fire water storage tank compartment.
vii Low level in fire water storage tank compartment.
viii Low level in HSD day tank of the fire pump.

b. The panel shall be factory fabricated, wired and tested. All details shall be submitted with the tender.

c. The annunciation panel shall be located in the security office / reception on the ground floor or as instructed by the Engineer-in-Charge.

### 10.13.10. Vibration Isolation

a. The pump set shall be mounted on rolled steel channels and 150 mm thick inertia block spring and ribbed neoprene vibration isolation mounting shall support the inertia block onto a 100 mm thick concrete plinths. The spring mountings shall have a maximum deflection of15 mm. Reference shall be made to the section on “Nose and Vibration” for further technical requirements. The design shall be provided by the Contractor.

## 10.14. COMMISSIONING & GUARANTEE

Work under this section shall be executed without any additional cost. The rates quoted in this tender shall be inclusive of the works given in this section.

Contractor shall provide all tools, equipment, metering and testing devices required for the purpose.

On award of work, Contractor shall submit a detailed proposal giving methods of testing and gauging the performance of the equipment to be supplied and installed under this contract.

All tests shall be made in the presence of the Engineer-in-Charge or his representative or any inspecting authority.

At least five working days' notice in writing shall be given to the inspecting parties before performing any test.

Water flow rates of all equipment and in pipe lines through valves shall be adjusted to design conditions. Complete results of adjustments shall be recorded and submitted.

Contractor shall ensure proper balancing of the hydraulic system and for the pipes / valves installed in his scope of work by regulating the flow rates in the pipe line by valve operation. The contractor shall also provide permanent Tee connection (with plug) in water supply lines for ease of installing pressure gauge. Contractor shall also supply all required pressure gauge for system commissioning and balancing. The balancing shall be to the satisfaction of Engineer-in-Charge.

Three copies of all test results shall be submitted to the Engineer-in-Charge in A4 size sheet paper within two weeks after completion of the tests.

### 10.14.1. Pre-commissioning

On completion of the installation of all piping, valves, pipe connections, insulation etc. the Contractor shall proceed as follows:

i Prior to start-up and hydraulic testing, the Contractor shall clean the entire installation including all fitments and pipe work and the like after installation and keep them in a new condition. All systems shall be flushed and drained at least once through to get rid of contaminating materials.

ii All strainers shall be inspected and cleaned out or replaced.

iii Check all clamps, supports and hangers provided for the pipes.

iv Check all the piping under hydro test.

v Open bypass valve and allow the pressure to drop in the system. Check that the jockey pump cuts-in and cuts-out at the preset pressure. If necessary adjust the pressure switch for the jockey pump. Close by-pass valve.

vi Contractor shall arrange jockey pump if same is not available at time of commissioning.

vii Check all annunciations by simulating the alarm conditions at site.

**b. Fire Protection System**

i Check all hydrant valves by opening and closing : any valve found to be open shall be closed.

ii Check all the piping under hydro test.

iii Check that all suction and delivery connections are properly made for all pump sets.

iv Check rotation of each motor after decoupling and correct the same if required.

v Test run each pump set.

vi All pump sets shall be run continuously for 8 hours (if required with temporary piping back to the tank).

**c. Commissioning and Testing**

i Pressurize the fire hydrant system by running the jockey pump and after it attains the shutoff pressure of the pump.

ii Open bypass valve and allow the pressure to drop in the system. Check that the jockey pump cuts-in and cuts-out at the preset pressure. If necessary adjust the pressure switch for the jockey pump. Close by-pass valve.

iii Open hydrant valve and allow the water to below into the fire water tank in order to avoid wastage of water. The main fire pump shall cut-in at the preset pressure and shall not cutout automatically on reaching the normal line pressure. The main fire pump shall stop only by manual push button. However the jockey pump shall cut-out as soon as the main pump starts.

iv Switch off the main fire pump and test check the diesel engine driven pump in the same manner as the electrically driven pump,

v When the fire pumps have been checked for satisfactory working on automatic controls, open fire hydrant valves simultaneously and allow the hose pipes to discharge water into the fire tank to avoid wastage.

vi Check each landing valve, male and female couplings and branch pipes, for compatibility with each other. Any fitting which is found to be incompatible and do not fit into the other properly shall be replaced by the Contractor free of cost. Each landing valve shall also be checked by opening and closing under pressure.

vii Check all annunciations by simulating the alarm conditions at site.

**d. Sprinkler System Commissioning**

i Start the sprinkler pump and develop the required pressure in the sprinkler pipes.

ii Open the test valve to test the automatic starting of the pump. If necessary, make necessary adjustments in the setting of pressure switch. The sprinkler water gong alarm shall also operate when the test valve is open. This operation is to be done for each and every section of the sprinkler system and the alarm for each section (via flow switch) shall be checked for operation.

iii After satisfactory operation of the pump the Contractor shall set up mock fire and test the system.

iv Check all annunciations by simulating the alarm conditions at site.

v Close the floor isolation valve (fitted with tamper switch) and check for annunciation in Fire Panel in control room / BMS. Also check in Fire panel in control room / BMS, whether the flow switch indication is registered for the particular floor / zone with test drain open.

### 10.14.2. Statutory authorities' tests and inspections

a. As and when notified in writing or instructed by the Engineer-in-Charge, the Contractor shall submit shop drawing and attend all tests and inspections carried out by Local Fire Authorities, Water Authority and other Statutory Authorities, and shall forthwith execute free of charge any rectification work ordered by the Engineer-in-Charge as a result of such tests and inspections where these indicate non-compliance with Statutory Regulations.

b. Some of these tests may take place after the issue of Practical Completion of the Main Contract and the Contractor shall make all allowances in this respect.

c. The Contractor shall be responsible for the submission of all necessary forms and shop drawings to the Statutory Authorities which shall conform in layout to the latest architectural plans submitted to and kept by these Authorities.

d. The submission shall comply with the requirements set forth in the current Codes of Practice and circular letters of the Statutory Authorities. The shop drawings to be submitted shall be forwarded to the Architect for checking before submission.

e. The Contractor shall allow for at least two submissions of complete sets of shop drawings to the Authorities. The Engineer-in-Charge may at his discretion instruct the Contractor for additional submissions to the Local Authorities whenever necessary.

f. The Contractor shall notify the Engineer-in-Charge at least seven days in advance of his application for local Authority tests and inspections. On receipt of a confirmed date for test and inspection the Contractor shall inform the Engineer-in-Charge without delay.

### 10.14.3. Final Acceptance Tests

a. Following commissioning and inspection of the entire installation, and prior to issue of the Completion Certificate, the Contractor shall carry out final acceptance tests in accordance with a program to be agreed with the Engineer-in-Charge.

b. Should the results of the acceptance tests show that plant, systems and/or equipment fail to perform to the efficiencies or other performance figures as given in this Specification, the Contractor shall adjust, modify and if necessary replace the Equipment without any extra cost in order that the required performance is obtained.

c. Where acceptance tests are required by the relevant Authorities having jurisdiction, these tests shall be carried out by the Contractor prior to the issue of Completion Certificate to the acceptance of the Authorities.

### 10.14.4. Rejection of Installation / Plant

a. Any item of plant or system or component which fails to comply with the requirements of this Specification in any respect whatsoever at any stage of manufacture, test, erection or on completion at site may be rejected by the Engineer-in-Charge either in whole or in part as he considers necessary/appropriate. Adjustment and/or modification work as required by the Engineer-in-Charge so as to comply with the Authority's requirements and the intent of the Specification shall be carried out by the Contractor at his own expense and to the satisfaction of the Engineer-in-Charge.

b. After works have been accepted, the Contractor may be required to carry out assist in carrying out additional performance tests as reasonably required by the Engineer-in-Charge.

### 10.14.5. Approval

a. The scope includes having the entire installation to have approval obtained from the Local Authorities. Contractor shall have all paper and fee deposited for the purpose and the work shall be deemed to be completed upon Contractor obtained approval from Authorities and after the successful testing, commissioning and handing over of the system.

### 10.14.6. Warranty and Handover

a. The Contractor shall warrant that all plant, materials and equipment supplied and all workmanship performed by him to be free from defects upto completion of defect liability period of 2 years whatsoever nature before handover to the Engineer-in-Charge.

### 10.14.7. Handing Over Of Documents

a. All testing and commissioning shall be done by the Contractor to the entire satisfaction of the Owner's site representative and all testing and commissioning documents shall be handed over to the Engineer-in-Charge.

b. The Contractor shall also hand over all maintenance and operation manuals, all certificates and all other documentation as per the terms of the contract to the Engineer-in-Charge.

## 10.15. CHECK LIST FOR COMMISSIONING

### 10.15.1. Fire Protection System

a. Check all hydrant & other valves by opening and closing. Any valve found to be open shall be closed.

b. Check all clamps, supports and hangers provided for the pipes.

c. All the pump sets shall be run continuously for 30 minutes (with temporary piping back to tank from the nearest hydrant, using canvas hose pipes).

d. Fire Hydrant System - Pressurise the fire hydrant system by running the jockey pump and after it attains the shutoff pressure of the pump, then Open bypass valve and allow the pressure to drop in the system. Check that the jockey pump cuts-in and cuts-out at the preset pressure. If necessary adjust the pressure switch for the jockey pump. Close by-pass valve.

e. Open hydrant valve and allow the water to flow into the fire water tank in order to avoid wastage of water. The main fire pump shall cut-in at the preset pressure and shall not cutout automatically on reaching the normal line pressure. The main fire pump shall stop only by manual push button. However the jockey pump shall cut-out as soon as the main pump starts,

f. Operate booster pump continuously for 30 minutes with piping back to underground tanks from the hydrant nearest to plant room.

g. Check each landing valve, male and female couplings and branch pipes, for compatibility with each other. Any fitting which is found to be incompatible and do not fit into the other properly shall be replaced by the Contractor. Each landing valve shall also be checked by opening and closing under pressure.

h. Check air cushion tanks on the terrace for proper functioning.

## 10.16. ELECTRICAL INSTALLATION:

### 10.16.1. GENERAL:

a. Work shall be carried out in accordance with the specifications, Indian Electricity Act 1910 as amended upto date, and rules and regulations of local electricity authority and Indian Standard Code of practice No. IS: 732-1963 (revised).

### 10.16.2. MV SWITCHGEARS/PANELS/SUB-PANELS/DISTRIBUTION BOARDS:

**a. <u>System Rating:</u>**

All the Main MV switchgears/Panels/Motor control centres shall be suitable for operation on three phase/ single phase, 415/230 volts, 50 Hz neutral solidly grounded at transformer and short circuit level not less than 50 kA /35 kA at 415 Volts.

The Distribution boards shall be designed to withstand heaviest condition at site, with maximum expected ambient temperature of 45 degree Celsius, 80 percent humidity and dusty weather.

**b. <u>Standards And Codes:</u>**

The Distribution boards shall comply with the latest edition of relevant Indian Standards and Indian Electricity Rules and Regulations. The following Indian Standards shall be complied with :

i IS 1394 - L.V. switchgear and control gear Part-I Part I -1993 General rules.

ii IS 5578-85 Guide for marking of insulated conductors.

iii IS 11353-85 Guide for uniform system of marking and identification of conductors and apparatus terminals.

iv IS 2147-62 Degree of protection provided by enclosures for low voltage switch gear and control gears.

v IS: 2675-83 Enclosed distribution fuse boards and cutouts for Voltages not exceeding 1000 V.

vi IS 2551-82 Danger notice plates.

vii IS 13947-1993 Circuit breakers.(Part-II)

viii IS 13947-1993 Switches, Disconnectors, switch disconnector (Part-III) and fuse combination units.

ix IS 1818-72 Alternating current isolators (disconnectors) and earthing switches.

x IS 8623-77 Factory built assembles of switchgear and control gear for voltages upto and including 1000 V AC & 1200 V DC.

xi IS 8828 Miniature air break circuit breakers for voltages not exceeding 1000 V.

xii IS 9926 Fuse wires used in rewirable type Electric fuses upto 650 Volts.

xiii IS 2208 HRC fuse links

xiv IS 2705 (Part- I, II & III) Current Transformers

xv IS 3156 (Part- I, II & III) Voltage Transformers

xvi IS 1248 Indicating Instruments

xvii IS 13947-93(Part - 5) Control devices and switching elements.

xviii Section-1

xix IS 13947-93 (Part - 4) Contactors and motor starter section 1
xx Section-1 Electromechanical.

xxi IS 3231 Relays

xxii IS 375 Marking and arrangement of bus-bars
xxiii Indian Electricity Act and Rules.

**c. <u>Shop Drawings:</u>**

i Prior to fabrication of the Switchgears, Distribution boards, the contractor shall submit for Construction manager/Client/Engineer approval the shop/ vendor drawing, and design calculations, indicating type, size, short circuit rating of all the electrical components used, details & schedule of components & model Nos. type, rating etc., busbar size, internal wiring size, Distribution board dimension, colour, mounting detail etc., The contractor shall submit manufacturer's catalogues of the electrical components installed in the distribution.

**d. <u>Inspection:</u>**

i At all reasonable times during production and prior to transport of the distribution boards to site, the contractor shall arrange and provide all the facilities at their plant for inspection by Client/Engineer /Construction manager or authorized representative.

**e. <u>Test Certificates:</u>**

i Testing of Distribution boards shall be carried out at factory and or at site as specified in Indian Standards in the presence of Construction manager/Client/Engineer s the test results shall be recorded on prescribed forms. The test certificates for the test carried out at factory or at site shall be submitted in six copies to the Construction manager/Client/Engineer for approval.

**10.16.3. CONSTRUCTION FEATURES:**

a. The power supply and control panel shall be metal enclosed sheet steel cubical indoor type, dead front, floor mounting/wall mounting type. The panel shall be totally enclosed, completely dust and vermin proof, Gaskets between all adjacent units and beneath and all covers shall be provided to render the joints dust proof. These Panels shall be arranged in multitier formations. All doors and covers shall be lockable.

b. All mild steel sheets used in the construction of panels shall be 2mm thick and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all slag grounded off and welding pits wiped smooth with plumber metal.

c. All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with check nuts. Self-threading screws shall not be used in the construction of control panels. Base channel shall of 75mm x 75mm x 5mm thick shall be provided at the bottom. Minimum clear space of 200mm between the floor of panel and bottom most units shall be provided.

d. The panels shall be of adequate size with a provision of 25% spare space to accommodate possible future additional switchgear. Knockout holes of appropriate size and number shall be provided in the control panels in conformity with the location of incoming and outgoing conduits/cables, all equipment such as meters and indicating lamps, etc shall be located adjacent to the unit with which it is associated and care shall be taken to achieve a neat and symmetrical arrangement. Facility shall be provided for termination of cables from both above and below the control panel. Where cables enter below, cables boxes shall be fitted at the rear and arranged in tiers to facilitate making connections to the upper and lower units. Clamps shall be provided to support the weight of the cables. All incoming and outgoing feeders shall be brought out to a terminal block of adequate size at suitable location inside the control panel. All wiring inside the control panel shall be colour coded and labelled with approved plastic beads for identification. Circuit diagrams showing the arrangement of circuits shall be pasted on the inside of the panel door and covered with transparent plastic sheet and all labeling shall be provided on the front face of the panel board.

**e. <u>Circuit Compartments:</u>**

i Each circuit breaker, contactor and relay shall be housed in a separate compartment and shall be enclosed on all sides. Sheet steel hinged lockable door shall be duly interlocked with the breaker in the `ON' position. Safety interlocks shall be provided to prevent the breaker or Contactor from being drawn out when the breaker is in ON position. Instruments and indicating lamps shall not be mounted on the panel compartment door. Sheet steel barriers shall be provided between the tiers in a vertical section.

**f. <u>Instrument Compartment:</u>**

i Separate and adequate compartments shall be provided for accommodating instruments, indicating lamps, control contactors and control fuses etc. These shall be accessible for testing and maintenance without any danger of accident contact with live parts of the circuit breaker and bus bar.

**g. <u>Bus Bars and Bus Bar Connection:</u>**

i The bus bar and interconnections shall be of aluminium and of rectangular cross sections suitable for full load current for phase bus bars and half rated current for neutral bus bars and shall be extensible on either side. The bars and interconnections shall be insulated with PVC sleeve tapes and colour coded. All bus bars shall be supported on unbreakable, non-hygroscopic insulated supports at regular intervals, to withstand the forces arising in case of short circuit in the system. Bus bars shall be provided in separate chamber main control panels shall be done by clamping, no holes shall be drilled in bus bars. If holes have to be drilled for making connections, extra cross section of busbars shall be provided.

ii All bus bar connections in smaller control panels shall be done by drilling hole and connecting by brass bolts and nuts. Additional cross section of bus bars shall be provided in small control panels to cover up the holes drilled in the bus bars.

iii All connections between the bus bar and breaker and between breaker and contactor, shall be through aluminium strips of proper size to carry full rated current and shall be insulated with PVC sleeves.

**h. <u>Terminals:</u>**

i The outgoing terminals and neutral links shall be brought out to a terminal block suitably located in the control panels. The current transformer for instruments, metering and for protection shall be mounted on the bus bars. Separate cable compartment shall be provided for incoming and outgoing cables.

**i. <u>Wire Ways:</u>**

i A horizontal wire way screwed covers shall be provided at the top to take in the connecting control wiring different vertical sections.

**j. Cable Compartments:**

i Cable compartments of adequate size shall be provided in the control panels for easy termination of all incoming and outgoing cables entering from bottom or top. Adequate and proper supports shall be provided in cable compartments to support cables. All incoming and outgoing terminals shall be brought out to terminal blocks in the cable compartment.

**k. Materials:**

i All materials shall be of the best quality complying with the appropriate Indian Standard specifications, Materials used shall be subject to the approval of the Client/Engineer and sample of the same shall be furnished where required.

**l. Moulded case circuit Breaker (MCCB):-**

i MCCBs shall satisfy the requirements of IS-2516 and shall be of current limiting type. MCCB shall provide type `C' protection to the contactors as per IEC 158-1B. MCCBs shall be quick make, quick break, independent manual type with trip free feature with mechanical ON, OFF, and TRIP indications. A trip button shall be provided for tripping the breaker.

**m. Rotary Switches:**

i Switches upto 60 amps shall be rotary type with compact and robust construction, built up from one or more stacks with contacts and a positioning mechanism, with stop as required. The terminals shall be shrouded with insulation to prevent accidental contact with live parts. Rotary switches shall be backed up with moulded type HRC fuse fittings of appropriate rating.

**n. Selector Switch:**

i When called for, selector switches of rated capacity shall be provided in control panels, to give the choice of operating equipment in selective mode.

**o. Switches:**

i Switches beyond 60 amps shall be panel mounted double break type and suitable for load break duty, quick make and break action, manufactured in accordance with IS: 4047 - 1967. Switch contacts shall be silver plated and shall be backed up with HRC fuses of appropriate rating. The switch handles shall be located at the front.

**p. HRC Fuses:**

i Fuses shall be high Rupturing capacity and shall be in accordance with IS: 3208 - 1962 and having rupturing capacity of not less than 20 MVA at 415 volts. The back up fuse rating of each motor/heater/equipment shall be so chosen that the fuse does not operate on starting of motor/heater/equipment. Fuses shall be of the same make as the switches.

**q. Starters:**

i Each motor shall be provided with a starter of suitable rating. Starter shall be in accordance with IS: 1822 - 1967. Direct on line starters shall be provided for motors.

ii All starters shall have auxiliary contacts for inter locking, control & indication. Starters (contactors) shall have 3 main and 4 auxiliary contacts and shall be air break type suitable

for making and breaking contact a minimum power factor of 0.35. For design consideration of contactors, the starting current of connected motor shall be assumed to be 6 times the full load current of the motor in case of direct-on-line starters and 3 times the full load current of the motor in case of star delta/reduces Voltage starters. In case of soft starters the current shall be limited to 1.8 times.

iii Main and auxiliary contacts shall be silver or silver alloy. The insulation for contactor coils shall be of class "E". Operating coils of contactors shall be suitable for 230 ± 10% volts AC, 50 cycles supply system. The contactor shall drop out when voltage drops to 90% of the rated voltage. The housing of the contactors shall be heat resistant and having high impact strength. Each starter shall have thermal overload protection on all three phases.

**r. <u>Over Load Relays:</u>**

i Contactors shall be provided with a three element, positive acting ambient temperature compensated time lagged hand-reset/self reset type thermal over load relay with adjustable setting. Hand reset button shall be flush with the front door for resetting with starter compartment door closed, Relays shall be directly connected for motors below

ii 35 HP capacity. C.T. operated relays shall be provided for motors above 35 HP capacity. Heater circuit contactors may not be provided with overload relays.

**s. <u>Current Transformers:</u>**

i Current Transformer shall be of minimum accuracy class 1.5 and suitable VA burden for operation for the connected meters and relays.

**t. <u>Single Phase Preventers:</u>**

i Single phase preventers shall be provided as per schedule of quantities and shall be in conformity with relevant ISI standards. Single phase preventers shall act when the supply voltage drops down to 90% of the rated voltage or on failure of one or more phases.

**u. <u>Time Delay Relays:</u>**

i Time delay relays shall be adjustable type with time delay adjustment from 0-180 seconds and shall have one no. auxiliary contacts for indicating lamp connection.

**v. <u>Indicating Lamp and Metering:</u>**

i All meters and indicating lamps shall be in accordance with the relevant ISS. The meters shall be flush mounted and draw out type. The indicating lamp shall be neon type and of low burden. Each main panel shall be provided with operated ammeter of suitable range with three Nos. CTs of suitable ratio with three way and off selector switch, phase indicating lamps, and other indicating lamps as called for. Each phase indicating lamp shall be backed up with 5 amps fuse and toggle switch. Other indicating lamps shall be backed up with fuses as called for.

**w. <u>Toggle Switch:</u>**

i Toggle switches, where called for, shall be in conformity with IS: 3854-1969 and shall be of 5 Amps rating.

**x. <u>Push Button Stations:</u>**

i Push button station shall be for manual starting and stopping of motors/equipment as called for. Red and Green colour push buttons shall be provided for starting and stopping operations. Start or stop indicating flaps shall be provided for push buttons. Push buttons shall be suitable for panel mounting/projection mounting and accessible from front without opening

door, lock lever shall be provided for stop push button. One set of normally open and one set of normally closed contacts shall be provided in push button stations. The push buttons contacts shall be suitable for 15 Amps current capacity.

**10.16.4. CABLING/WIRING SYSTEM :**

a. All power cabling shall be carried out with 650/1100 volt grade PVC insulated PVC sheathed, armoured, aluminium conductor cables laid on the cable tray/racks/pipes. Cables shall be sized for starting current and by applying proper derating factor. All control wiring shall be carried out by using 650/1100 volts PVC insulated copper conductor wires in wire ways or in conduit. Minimum size of control wiring shall be 1.5 sq.mm. Wherever control wiring in the Scope of AC contractor has to be done in conduits (exposed or concealed) no additional cost for conduiting shall be paid.

**10.16.5. CABLE LAYING:**

a. Cable shall be laid generally in accordance with Indian Standard Code of practice. Cable shall be laid on 2 mm thick perforated M.S. sheet cable trays as approved by the Client/Engineer. Easy access to all cables shall be provided to allow cable withdrawal/replacement in the future. Where more than one cable is running, proper spacing shall be provided to minimise the loss in current carrying capacity.

b. Cable shall be suitably supported with wooden cleats when run on wall/floor ducts. When buried, they shall be covered with a layer of fine sand and protected with cement concrete tiles bricks. Special care shall be taken to ensure that the cable are not damaged at bends. The radius of bend of the cables when installed shall not be less than 12 times the diameter of the cable.

**10.16.6. CABLE/WIRE/STARTER SIZES:**

a. For all single phase/3 phase wiring, 650/1100 volts grade PVC insulated copper conductor wires shall be used. The equipment inside plant room shall be connected to the control panel by means of insulated aluminium conductor wires of adequate size in exposed conduits. Final connections to the equipment shall be through wiring enclosed in M.S. flexible conduits rigidly clamped at both ends.

b. An isolator shall be provided near each motor/equipment wherever the motor/equipment is separated from the supply panel through a partition barrier of through ceiling construction. PVC insulated single strand aluminium conductor wires shall be used inside the control panel for connecting different components and all the wires inside the control panel shall be neatly dressed and plastic beads shall be provided at both ends for easy identification.

i The minimum size of control wiring shall be 1.5 sq.mm. PVC insulated stranded soft drawn copper conductor wires drawn through conduit to be provided for connecting equipment and control panels.

ii All the switches, conductors, push buttons stations, indicating lamps shall be distinctly marked with a small description of the service installed. Circuit wiring diagram of control panel shall be fixed to the cover of control panel for verification.

**10.16.7. EARTHING:**

Shall be carried out with galvanised Iron Strips/wires, or copper strips /wires as specified below:

a. G.I. Earthing:

The main panel shall be connected to the main earthing system of the building by means of 32mm x 6mm GI strips. All single phase metal clad switches and control panels shall be earthed with minimum 3mm diameter GI conductor wire. All 3 phase motors and equipment shall be earthed with two numbers distinct and independent GI wires/tapes as follows:

| | | |
|---|---|---|
| i. | Motors upto and including including 10 HP rating. | 2 Nos. 4mm dia GI wires |
| ii. | Motors 12.5 HP to 40 HP capacity. | 2 Nos. 6mm dia GI wires |
| iii. | Motors 50 to 75 HP capacity. | 2 Nos. 25 x 3mm GI strips |
| iv. | Motor above 75 HP | 2 Nos. 25 x 6mm GI strips |

All the switches shall be earthed with two numbers distinct and independent GI wires/tapes as follows:

| | | |
|---|---|---|
| i. | 3 phase switches and control panels upto 60 Amps rating. | 2 Nos. 4mm dia GI wires |
| ii. | 3-phase switches and control panel 63 Amps to100 Amps rating. | Nos. 8mm dia GI wires |
| iii. | 3 phase switches and control panels 125 Amps to 200 Amps rating. | 2 Nos. 25 x 3mm GI tapes. |
| iv. | 3 phase switches and Control panels, 200 Amps rating. | 2 Nos. 25mm x 6mm GIbus ducts above tapes. |

**10.16.8. DRAWINGS:**

a. Shop drawings for control panels and wiring of equipment showing the route of conduit/cable shall be submitted by the electrical contractor for approval of Client/Engineer before starting the fabrication of panel and starting the work. The Fire Fighting contractor shall co-ordinate, interact and furnish necessary engineering information of the motor thermal curves, starting time, requirement of protection & interlocking & other miscellaneous requirement so that same can be incorporated before manufacture is taken up. On completion, four sets of completion "As-installed" drawings incorporating all details like, conduit routes, number of wires in conduit, location of panels, switches, junction/pull and cable route etc. shall be furnished by the Contractor.

**10.16.9. TESTING:**

a. Before commissioning of the equipment, the entire electrical installation shall be tested in accordance with Code of practice IS: 732-1963 (Revised) & Indian Electricity Rule and test report furnished by a qualified and authorised person. The entire electrical installation shall be got approved by Electrical Inspector and a certificate from Electrical Inspector shall be submitted. All tests shall be carried out in the presence of Owner/his authorised representative. At the completion of the works, the entire installation shall be subject to following tests:-

i Wiring continuity checks with respect to approved wiring diagram.

ii Insulation resistance test with 500V megger between phase to phase and phase to earth.

iii Earth continuity test.

iv Electrical current readings in Amps of full & average load running and starting together with name plate current of each electrical motor.

v Operating tests on all protective relays to prove their correct operation before energizing the main equipment including secondary injection test at site.

vi Operating tests on all starters, circuit breakers etc.

All tested and calibrated equipments for testing, labour, materials and incidentals necessary to conduct the above tests shall be provided by the contractor at his own cost.

**10.16.10. PAINTING:**

a. All sheet steel work shall under go a process of degreasing, through cleaning, and painting with a high corrosion resistant primer. All panels shall then be backed in an over the finishing treatment shall be by application of synthetic enamel paint of approved shade. The panels in the erection scope of Fire Fighting contractor shall be given 2 coats of suitable paint of approved colour when all work has been completed. Various feeder & panel name shall be painted with approved colour as per the single line diagram details.

**10.16.11. PRECOMMISSIONING :**

a. On completion of the installation of all pumps, piping, valves, pipe connections, and water level controlling devices the contractor shall proceed as follows :-

**10.16.12. Electrical works:**

The following tests shall be carried out on the MCC:

a. Insulation resistance test with 500 V megger, before and after high voltage test, on all power and control wiring.
b. High voltage test at 2000 V AC for one minute on all power and control wiring.
c. Low Voltage continuity test (6 V) on power wiring of each feeder, between bus bars and the outgoing terminals with switches and contactors in closed position.
d. Low voltage continuity test (6 V) on all control wiring.
e. Operation test for all feeders with only control supply made “ON” to ensure correctness of control wiring, operation of the various equipment used such as push buttons, protective devices, indicating lamps and relays etc. All contactors shall be checked for the presence of humming and chattering.
f. Earth continuity test with voltage not exceeding 6 V between various non-current carrying metallic parts of equipment, steel work etc. and the earth bus provided in the MCC.
g. Operation of all instruments and meters provided on the MCC.

**10.16.13. Pipe Works :**

a. Check all clamps, supports and hangers provided for the pipes.

b. Fill up pipes with water and apply hydrostatic pressure to the system as given in the relevant section of the specification. If any leakage is found, rectify the same and retest the pipes.

**10.16.14. Fire Protection System :**

a. Check all hydrant valves by opening and closing any valve found to be open shall be closed.

b. Check all the piping under hydro test.

c. Check that all suction and delivery connections are properly made for all pump sets.

d. Check rotation of each motor after decoupling and correct the same if required.

e. Test run each pump set.

f. All pump sets shall be run continuously for 8 hours (if required with temporary piping back to the tank).

## 10.17. HAND APPLIANCES:

### 10.17.1. SCOPE:

a. Work under this section shall consist of furnishing all labour, material, appliances and equipment necessary and required to install fire extinguishing hand appliances.

b. Without restricting to the generality of the foregoing the work shall consist of the following:

c. Installation of fully charged and tested Fire Extinguishing Hand Appliances CO2, Foam, Dry chemical powder type as required by these specifications and drawings.

### 10.17.2. GENERAL REQUIREMENTS:

a. Fire extinguishers shall conform to the following Indian Standard specifications and shall be with BIS approved stamp as revised and Amended upto date.

| | |
|---|---|
| i CO2 Type | : IS:2878-1986 |
| ii Foam Type | : IS:933-1989 |
| iii Dry Powder Type | : 2171-1985 |

b. Fire extinguishers shall be installed as per Indian Standard Code of practice for selection, installation and maintenance of portable first aid appliances IS:2190-1979.

c. Hand appliances shall be installed in readily accessible locations with the Appliance brackets fixed to wall by suitable anchor fasteners.

d. Each appliances shall be provided with an inspection, testing, change of charge and other relevant data.

e. All appliances shall be fixed in a true workman like manner truly vertical and at current locations.

## 10.18. WATER CURTAIN SYSTEM FOR FIRE-FIGHTING

### 10.18.1. DELUGE VALVE

| | |
|---|---|
| Model | A |
| NOMINAL SIZE | 200,150,100,80 & 50NB |
| MAXIMUM SERVICE PRESSURE | 12 Bar (175 psi) |
| THREADED OPENING | BSPT |
| MOUNTING | 90◦ pattern inlet to outlet vertical mounting. |
| FACTORY HYDROSTATIC TEST PRESSURE | 25Kg. / sq. cm. (350 psi) |
| FLANGE CONNECTION | ANSI B 16.1 FF # 125 |
| TRIM | Galvanized steel with brass valves |
| RECOMMENDED FLOW TATE | 200NB - 300 TO 1150 $M^3$/HR<br>150NB - 170 TO 650 $M^3$/HR<br>100NB - 50 TO 225 $M^3$/HR<br>80NB - 30 TO 110 $M^3$/HR<br>50NB - 10 TO 55 $M^3$/HR |
| FRICTIONAL LOSS IN TERMS OF EQUIVALENT LENGTH OF PIPE (C-120) | 200NB - 26.00 Meter<br>150NB - 19.00 Meter<br>100NB - 11.00 Meter<br>80NB - 5.50 Meter<br>50NB - 1.80 Meter |
| WET PILOT SPRINKLER HEIGHT LIMITATION | As per graph in the catalogue |
| NET WEIGHT WITHOUT TRIM | 200NB - 214 Kg.<br>150NB - 136 Kg.<br>100NB - 76 Kg.<br>80NB - 52 Kg.<br>50NB - 47 Kg. |
| FINISH | Fire red PU painted |
| APPROVAL | UL listed |
| ORDERING INFORMATION | Size of valve, flange connection and trim details. |

### 10.18.2. TRIM DESCRIPTION

a. BASIC TRIM

i The basic trim is required on deluge valve regardless of the release system. It contain those components which are required in all types of installation, such as the main drain valve, priming connection, drip check valve, emergency release valve and pressure gauges.

b. DRY PILOT TRIM (PNEUMATIC RELEASE)

i Dry pilot operation uses a pilot line of closed Sprinklers/OB detectors containing air under pressure, located in the area to be protected. It requires regulated dry air supply with main supply point through restricted orifice. The pilot line is connected directly to the top of POSITIVE DRAIN ACTUATOR (PDA). The bottom of PDA is connected to the top chamber of the deluge valve.

ii When the air pressure drop, due to release of any of the release devices on detection of fire, the diaphragm of PDA is lifted and allows the water to drain. This reduces the water pressure in the top chamber of the deluge valve and when the pressure in the top chamber reaches 50% of the supply pressure, the deluge valve opens. The direct drain of PDA start when the top chamber pressure of deluge valve reaches approximately 0.5Kg/Sq. cm. This positive

drain will not permit the deluge valve to close unless the PDA is set manually. The recommended air supply pressure is a s per

**1 TABLE-1**

| 2 LINE WATER PRESSURE Kg./Sq.cm. MAXIMUM | 3 AIR PRESSURE IN DETECTION 4 LINE Kg./ Sq. cm | |
|---|---|---|
| 5 | 6 MINIMUM | 7 MAXIMUM |
| 8 2 | 9 1.2 | 10 3.0 |
| 11 4 | 12 1.5 | 13 3.0 |
| 14 6 | 15 2.0 | 16 3.5 |
| 17 8 | 18 2.5 | 19 3.5 |
| 20 10 | 21 3.0 | 22 3.5 |
| 23 12 | 24 3.5 | 25 4.0 |

c. WET PILOT TRIM (HYDRAULIC RELEASE)

i Wet pilot operation uses a pilot line of closed sprinklers containing pressurized water, supplied through the upstream side of the deluge valve, through a restricted orifice. All the release lines are connected to a common release line. Due to release of any one of the release devices, the water pressure in the top chamber of the deluge valve reaches 50% of the supply pressure, the deluge valve opens.

d. ELECTRIC RELEASE TRIM

i To actuate a deluge valve electrically, a solenoid valve is provided to drain the water from the top chamber of the deluge valve. A pressure switch is provided to activate an electric alarm, to shut down the desired equipment or to give" Tripped" indication to the panel. In addition to this two nos. of pressure switches can be used to monitor "Low air pressure" and "Fire condition" when used in dry pilot air line.

e. TEST AND ALARM TRIM WITH SPRINKLER ALARM

This trim is supplied with the sprinkler alarm bell, which bells on actuation of the deluge valve. A test valve is provided to test the normal operation of the sprinkler alarm bell.

### 10.18.3. SYSTEM TESTING PROCEDURE

a. Keep the upstream side of the stop valve partially open. Open the upstream side of the drain valve, to maintain a minimum pressure of 3 Kg/Sq. cm on the upstream side of the deluge valve. To avoid water damage close the system side stop valve. This valve is to be kept in open position after the testing is completed.
b. Open the system side drain valve of the deluge valve.
c. Let any of the release devices to trip. This will result in a sudden drop of water pressure in the deluge valve top chamber resulting the deluge valve to open. The water flowing through the down stream side drain valve confirms that the deluge valve has actuated, immediately close the upstream side stop valve.
d. Once testing is over reset the valve as per procedure give under heading "RESETTING PROCEDURE FOR THE DELUGE VALVE".

### 10.18.4. INSPECTION AND MAINTENANCE

a. All the newly installed system piping network must be flushed properly before placing the deluge valve in service.

b. A qualified and trained person must commission the system. After few initial successful tests and authorized person must be trained to perform inspection and testing of the system. It is recommended to have regular inspection and test run the system as per NFPA guidelines or in accordance with the guidelines or in accordance with guideline laid down by the organization having local jurisdiction.

**NORMAL CONDITION**

c. All main valves are open and are sealed with tamper proof seal.
d. Drain valves must be kept closed.
e. No leak or drip is detected from the drip valve.
f. All the gauges except the system side water pressure gauge, should show the requirement.
g. There should be no leakage in the system.

**NORMAL CONDITION TEST**

a. The system should be checked normal condition at least once a month.
b. Test the sprinkler alarm bell or electric alarm by turning the alarm test valve to the test position. The alarm should sound. This test should be carried out at least once in a week.
c. Depress the drip valve knob. Significant water accumulation indicates a possible seat leakage.
d. Conduct the water flow test as per the procedure of system teting at least once in a month.

**PERIODIC CHECK**

a. Conduct the water flow test by actuating few of the release devices provided in the system. Clean all strainer(s) and priming line restriction. This test is to be carried out at least once in six months.

**ABNORMAL CONDITION**

a. ALARM FAILS TO SOUND
   i Check for any obstruction in the alarm in the alarm test line, ensure that the sprinkler alarm is freely operating.
   ii If an electric alarm is provided, check the electrical circuitry to the alarm.

b. FALSE TRIPS
   iii Check for clogging in priming line, restriction orifice check valve, priming valve and strainer.
   iv Leakage in the release system
   v The deluge air panel orifice clogged or low supply pressure.

c. LEAKAGE THROUGH THE DELUGE VALVE
   vi Damaged deluge valve seat or obstruction on the seat face by foreign object.
   vii Leakage in release system.
   viii Partly clogged priming line, restriction check valve.
   ix Low air pressure on release system line or leakage in release system.
   x PDA seat leakage due to seat damage or obstruction on seat face by foreign objects (in dry pilot system only.)

## 10.18.5. WATER CURTAIN NOZZLE

**TECHNICAL DATA**

| | |
|---|---|
| Model | WC-15 & WC-20<br>in Brass construction<br>WC-15S & WC-20S<br>in S.S. construction |
| RATED WORKING PRESSURE | 12.3 Kg/Sq. cm (175 PSI) |
| MINIMUM EFFECTIVE WORKING | 1.4 Kg/Sq. cm (20 PSI) |

| | |
|---|---|
| PRESSURE | |
| END CONNECTION | WC-15 & WC-15S<br>with ½" BSPT (NPT optional)<br>WC-20 & WC-20S<br>With ¾" BSPT (NPT optional) |
| K-FACTOR | Model : WC-15/WC-15S<br>K23, K30, K37, K45,K53 & K72<br>Model : WC-20/WC-20S<br>K98,K20,K140 |
| APPROXIMATE WEIGHT | Model WC-15-0.180 Kg.<br>Model WC-20-0.250 Kg. |
| 26 FINISH | 27 Nickel chrome or Brass finish for WC-15 & WC-20<br>28 Natural finish for WC-15S & WC-20S |
| 29 ORDERING INFORMATION | 30 Please specify Model, K factor and finish. |

**DIMENSION** in millimeter (Approximate)

| Model | A | B |
|---|---|---|
| WC-15 &WC-15S | ½" BSPT | 42 |
| WC-20 & WC-20S | ¾" BSPT | 46 |

d. Water Curtain Nozzle distributes water in a flat curtain extending all the way to the ground. Water Curtain Nozzle when mounted in pendent position acts as a window spray nozzle to protect interior walls, windows and other opening of the building which are affected by fire. The nozzles when mounted in horizontal position with flow towards ground, a flat water curtain are produced to segregate the area which is under fire.

## 10.19. NOVEC 1230 CLEAN AGENT GAS FLOODING SYSTEM

### 10.19.1. SCOPE

a. The scope covers Supply, Installation, Testing and Commissioning of Automatic Novec 1230 Clean Agent Flooding System complete for electrical panels with Linear Pneumatic Heat Sensing tube, cylinder, valves, integration with Main Fire Alarm Control Panel for status monitoring etc. The work to be executed by experienced and specialized company dealing in Clean Agent Linear Pneumatic Heat Sensing Tube System shall cover:
   i. Providing Direct Panel Clean Agent Gas Novec 1230 Flooding System with Linear Pneumatic Heat Sensing tube inside the panels.
   ii. Audio-visual annunciation devices for indicating incidence of fire.
   iii. Any other item required to the successful commissioning of the system.

b. The electrical panel fire suppression system shall be complete with Direct Release Clean agent storage cylinders for required capacities, extinguishing agent as specified, Linear Pneumatic Heat Sensing tube, filling and end-of-line adaptors, pressure switches, control equipment and all necessary accessories and push in fittings to form a complete and working installation to protect the Electrical panel in case of fire. The panels to be protected shall be determined as per the approval of the engineer-in-charge. The system will have an interface with Main Fire Alarm and Control Panel. In case of fire in the concerned Panel, indication of Linear Pneumatic Heat Sensing System discharge status should come in Main Fire Alarm and Control Panel.

c. Clean Agent should be used with below mentioned properties
   i. The Clean Agent should have Zero Ozone Depletion Potential. (ODP = 0)
   ii. The Clean Agent should be a low pressure agent.
   iii. The Clean Agent should be UL /FM approved
   iv. The Clean Agent should have Global Warming Potential of less than 1.

### 10.19.2. SYSTEM DESCRIPTION

a. Each Novec 1230 Clean Agent extinguishing unit, when installed, is a self-contained system, meaning that it is equipped with its own automatic (non-electric) detection system, which when actuated, automatically releases the suppression agent into the Electric panel.

b. The Novec 1230 Clean Agent Automatic Direct System consists of the following major components:
   i. Clean Agent Cylinder/Valve Assembly.
   ii. Cylinder Mounting Bracket.
   iii. Linear Pneumatic Heat Detector, Actuation and Discharge Tubing and Fittings (Red Colour, 6 mm OD, 4mm ID).
   iv. Pressure Switch
   v. End of Line Adapter with Pressure Gauge.
   vi. Push in Tube Fittings.
   vii. Audio Visual Alarm

c. The Novec 1230 Clean Agent Automatic Direct System utilizes unique Linear Pneumatic Heat Sensing flexible tubing that is attached to the top of the cylinder valve. This Linear Pneumatic Heat Sensing tube is pressurized with dry nitrogen is temperature sensitive and acts as a continuous linear thermal detector that ruptures upon Flame impingement when the Temperature reaches 100ºC – 120ºC. Once the detector tubing is ruptured forming a nozzle at the rupture point, it allows the Clean Agent to flow through, distributing the extinguishing agent into the protected area. Upon system actuation, the pressure switch can be used to indicate system discharge, shutdown ventilation, shut-off electrical power etc may be required.

d. The Novec 1230 Clean Agent Automatic Direct System is designed and listed as an Automatic unit. No manual or electric means is provided for simultaneous actuation of multiple systems.
e. The Novec 1230 Clean Agent is stored in steel cylinders as a liquefied compressed gas, super-pressurized with Dry Nitrogen to 13.5 Kg/cm2. The ambient operating temperature range for all system components is (0oC to 54.4oC).

f. Each container is equipped with a Stainless Steel / nickel–plated brass valve, a pressure gauge to monitor container pressure, and a quarter-turn ball valve that interfaces with the Linear Pneumatic Heat Sensing tube. The ball valve must be kept closed at all times when the container is not in service.

g. A wall-mounted painted steel bracket is used to mount the container/valve assembly in a vertical (upright) position.

h. For the direct Novec 1230 Clean Agent systems, the tubing performs three functions: Heat Detection, System Activation, and Clean Agent discharge. The tubing is installed throughout the Electrical Panel volume, with one end connected to the top of the Clean Agent container valve. The tubing is pressurized with Dry Nitrogen to 13.5 Kg/cm2 and maintains the system in the “OFF” position.

i. A pressure switch is connected at the Valve to monitor system pressure, system actuation and/or to energize de-energize electrically operated equipment. Manufacturer recommends that all systems use a pressure switch coupled with some other devices To alert personnel in the event of a system discharge

j. The system should have means to close the exhaust fans if installed in the panel at the time of system activation.

k. As desired by the engineer-in-charge the main supply of panel can be shut off with the system.

l. The Detection Tubing should be red in colour, have outer diameter not less than 6 mm.

m. The Detection Tube should burst at Temperature of 100$^{o}$C to 120$^{o}$C

n. The cylinders (without valve) should be tested in accordance with IS 15683.

## 10.20. TECHNICAL DATA (TO BE FILLED BY BIDDERS) :

### 10.20.1. Diesel Engine Driven Fire Pump:

| | |
|---|---|
| Quantity | |
| Make | |
| Model | |
| Fluid Handled | |
| Type | |
| Suction | |
| Delivery | |
| Impeller Type | |
| Coupling | |
| Base Plate with Foundation Bolt | |
| No. of Stage | |
| Flow Rate ($m^3$/hr) | |
| Total Head (m) | |
| Speed of Pump (rpm) | |
| Efficiency at rated duty point | |
| Material of construction (MOC) | |
| Casing material | |
| Impeller material | |
| Shaft material | |
| Shaft sleeve | |
| Casing Ring | |
| Impeller Ring | |

### 10.20.2. Engine for Diesel Pump:

| | |
|---|---|
| Quantity | |
| Make | |
| Model | |
| Horse Power | |
| Engine | |
| RPM | |
| Engine overspeed setting | |
| Operating Cycle | |
| Number of Cylinder | |
| Accessories | |
| Dynamically balanced fly wheel | |
| Flexible coupling and coupling guard | |
| Electrical standing equipment and starting system | |
| Governer | |
| Fuel pump and water pump | |
| Lubricating oil pump | |
| Fuel, Air and Lubrication Oil Filter | |
| Instrument and Protection Device complete as per Engine Model | |
| Lubricating oil pressure | |
| High Cooling Water Temperature | |
| High Lubricating Temperature | |
| Engine Cooling and Oil System | |
| Capacity of Diesel Tank | |
| Detail of Batteries | |
| Battery Charger | |
| Other necessary accessories as per Model No in order to make the Diesel Engine Functional | |

### 10.20.3. Electrical Motor Driven Fire Pumps:

| Description | Hydrant Pump | Sprinkler Pump | Jockey Pump | Water Curtain Pump |
|---|---|---|---|---|
| Quantity | | | | |
| Make | | | | |
| Model | | | | |
| Fluid Handled | | | | |
| Type | | | | |
| Suction | | | | |
| Delivery | | | | |
| Impeller Type | | | | |
| Coupling | | | | |
| Base Plate with Foundation Bolt | | | | |
| No. of Stage | | | | |
| Flow Rate ($m^3$/hr) | | | | |
| Total Head (m) | | | | |
| Speed of Pump (rpm) | | | | |
| Efficiency at rated duty point | | | | |
| Material of construction (MOC) | | | | |
| Casing material | | | | |
| Impeller material | | | | |
| Shaft material | | | | |
| Shaft sleeve | | | | |
| Casing Ring | | | | |
| Impeller Ring | | | | |

### 10.20.4. Electric Motor For Main Fire Pumps :

| Description | Hydrant Pump | Sprinkler Pump | Jockey Pump | Water Curtain Pump |
|---|---|---|---|---|
| Make | | | | |
| Model | | | | |
| Type of Motor | | | | |
| Horse Power | | | | |
| Vattage (V) | | | | |
| Full Load Amps – A | | | | |
| Speed of Motor | | | | |
| Enclosure | | | | |
| Mounting | | | | |
| Class of Insulation | | | | |
| Ambient Temperature/Temp in Degree | | | | |
| Starting Temperature as % of full temp | | | | |
| Efficiency at 100% load efficiency at 75% load | | | | |
| Type of rotating movement | | | | |
| Coupling | | | | |
| Type of lubrication | | | | |
| Frequency | | | | |
| Make and type of starter | | | | |

# 10.21 ANNEXURE I- APPLICABLE CODES, STANDARDS AND PUBLICATIONS

## 10.21. ANNEXURE- I - APPLICABLE CODES, STANDARDS AND PUBLICATIONS

a. All equipment, supply, erection, testing and commissioning shall comply with the requirements of Indian Standards and code of practices. All equipment and material being supplied by the Contractor shall meet the requirements of IS., Tariff advisory committee's regulation (fire insurance), electrical inspectorate and Indian Electricity rules and other Codes/Publications as given below.

**b. General:**

| | |
|---|---|
| IS : 325 | Three phase induction motors |
| IS : 694 | PVC insulated cables for working voltages up to and including 1100 V. |
| IS : 1554 (Part- 1) | PVC insulated (heavy duty) electric cables : Part 1 for working voltages up to and including 1100V. |
| IS : 1554 (Part- 2) | PVC insulated (heavy duty) electric cables : Part 2 for working voltages from 3.3 kV up to and including 11 kV. |
| IS : 2379 | Color code for identification of pipe lines |
| IS : 2629 | Recommended practice for hot dip galvanizing on iron and steel |
| IS : 4853 | Recommended practice for radiographic inspection of fusion welded butt joints in steel pipes |
| IS : 6159 | Recommended practice for design and fabrication of material prior to galvanizing |
| IS : 9668 | Code of practice for provision and maintenance of water supplies and firefighting. |
| IS : 9912 | Coal tar based coating materials and suitable primers for protecting iron and steel pipe lines. |
| IS : 10221 | Code of practice for coating and wrapping of underground mild steel pipelines |
| IS : 11790 | Code of practice for preparation of butt-welding ends for pipes, valves, flanges and fittings. |

**c. PIPES AND FITTINGS:**

| | |
|---|---|
| IS : 1239 (Part 1) | Mild steel tubes, tubulars and other wrought steel fittings Part 1 Mild Steel tubes |
| IS : 1239 (Part 2) | Mild steel tubes, tubulars and other wrought steel fittings: Part 2 Mild steel tubulars and other wrought steel pipe fittings. |
| IS : 1879 | Malleable cast iron pipe fittings |
| IS : 3468 | Pipe nuts |
| IS : 4711 | Methods for sampling steel pipes, tubes and fittings |
| IS : 6392 | Steel pipe flanges |

**d. VALVES:**

| | |
|---|---|
| IS : 778 | Specification for copper alloy gate, globe and check valves for water works purposes |
| IS : 14846 | Specification for sluice valves for water works purposes (50 mm to 1200 mm size) |
| IS : 1703 | Specification copper alloy float valves (horizontal plunger type) for water supply fittings |
| IS : 2906 | Specification for sluice valves for water works purposes (350 mm to 1200 mm size) |
| IS : 3950 | Specification for surface boxes for sluice valves |
| IS : 5312 (Part 1) | Specification for swing check type reflux (non-return) valves : Part 1 Single door pattern |
| IS : 5312 (Part 2) | Specification for swing check type reflux (non-return) valves : Part 2 Multi door pattern |

| | |
|---|---|
| IS : 12992 (Part 1) | Safety relief valves, spring loaded : Part 1 – Design |
| IS : 13095 | Butterfly valves for general purposes. |

**e. FIRE FIGHTING EQUIPMENT:**

| | |
|---|---|
| TAC | Tariff advisory committee fire protection manual Part I |
| TAC | Rules of Tariff Advisory Committee for Automatic Sprinkler system |
| NFPA : 12, 1993 | Standards on Carbon Dioxide Extinguishing System |
| IS : 636 | Non- percolating flexible firefighting delivery hose |
| IS : 884 | Specification for First Aid Hose Reel for fire fighting |
| IS : 901 | Specification for first aid hose reel for fire fighting |
| IS : 902 | Specification for couplings, double male and double female, instantaneous pattern for fire fighting |
| IS : 903 | Suction hose coupling for firefighting purposes |
| IS : 904 | Specification for fire hose delivery couplings, branch pipe, nozzles and nozzle spanner |
| IS : 905 | Specification for 2-way and 3-way suction collecting heads for firefighting purposes |
| IS : 907 | Specification for delivery breechings, dividing and collecting instantaneous pattern for firefighting purposes |
| IS : 908 | Specification for suction strainers, cylindrical type for firefighting purposes. |
| IS : 909 | Specification for underground fire hydrant, sluice valve type |
| IS : 910 | Specification for combined key for hydrant, hydrant cover and lower valve. |
| IS : 933 | Specification for portable chemical foam fire extinguisher |
| IS : 1648 | Code of practice for fire safety of building (general) : Firefighting equipment and its maintenance. |
| IS : 15683 | Specification for portable fire extinguishers dry powder (cartridge type) |
| IS : 2190 | Selection installation and maintenance of first-aid fire extinguishers- Code of practice |
| IS : 2871 | Specification for branch pipe, universal for firefighting purposes. |
| IS : 15683 | Specification for fire extinguishers, carbon dioxide type (portable and trolley mounted) |
| IS : 3844 | Code of practice for installation and maintenance of internal fire hydrants and hose reel on premises |
| IS : 5290 | Specification for landing valves |
| IS : 5714 | Specification for hydrant, stand pipe for fire fighting |
| IS : 8090 | Specification for coupling, branch pipe, nozzle, used in hose reel tubing for fire fighting |
| IS : 8423 | Specification for controlled percolation type hose for fire fighting |
| IS : 10658 | Specification for higher capacity dry powder fire extinguisher (trolley mounted) |
| IS : 11460 | Code of practice for fire safety of libraries and archived buildings |
| IS : 13039 | External hydrant system – provision and maintenance – Code of practice. |
| IS : 5514 (Parts 1 to 7) | Reciprocating internal combustion engines : performance. |

**f. PUMPS AND VESSELS :**

| | |
|---|---|
| IS : 1520 | Specification for horizontal centrifugal pumps for clear cold fresh water |
| IS : 2002 | Steel plates for pressure vessels for intermediate and high |

| | |
|---|---|
| | temperature service including boilers |
| IS : 2825 | Code for unfired pressure vessels |
| IS : 4682 (Part 1) | Code of practice for lining of vessels and equipment for chemical processes Part 1 : Rubber lining |
| IS : 8418 | Specification for horizontal centrifugal self priming pumps |

## g. QUALITY ASSURANCE AND QUALITY CONTROL

i The work shall conform to high standards of design and workmanship, shall be structurally sound and aesthetically pleasing quality standards prescribed shall form the backbone for the quality assurance and quality control system.

ii At the site level the Contractor shall arrange the materials, their stacking/storage in appropriate manner to ensure the quality. Contractor shall provide equipment and manpower to test continuously the quality of materials, assemblies etc. as directed by the Engineer-in-Charge. The test shall be conducted continuously and the result of tests maintained. In addition the Contractor shall keep appropriate tools and equipment for checking alignments, levels, slopes and evenness of surface.

iii The Engineer- in-Charge shall be free to carry out tests as may be considered necessary by him at his sole discretion, from time to time, in addition to those specified in this document. The Contractor shall provide the samples and labour for collecting the samples nothing extra shall be payable to the Contractor for samples or for the collection of the samples.

iv The test shall be conducted at the site laboratory that may be established by Engineer-in-Charge or at any other standard Laboratory selected by Engineer- in-Charge.

v The contractor shall transport the samples to the laboratory for which nothing extra shall be payable. In the event of Contractor failing to arrange transportation of the samples in proper time Engineer-in-Charge shall have them transported and recover two times the actual cost from the Contractor's bills.

vi Testing charges shall be borne by the Engineer-in-Charge.

vii Testing may be witnessed by the Contractor or his authorized representative. Whether witnessed by the Contractor or not, the test results shall be binding on the Contractor.

# 10.22 ANNEXURE II - SHEET FOR LISTING DEVIATIONS

## 10.22. ANNEXURE – II - SHEET FOR LISTING DEVIATIONS

a. **Although deviations are generally not acceptable, but in case it becomes pertinent as per Vendor, then he is requested to specifically give the details of deviations, if any on this sheet and continuation thereof in the below mentioned format only.**

**31 Deviation mentioned at any other place shall not be considered.**

| S.No. | Item Description<br>As per Tender | Deviation by Tenderer |
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# 10.23 LIST OF APPROVED MAKES – FIRE PROTECTION AND FIRE FIGHTING WORKS

## 10.23. LIST OF APPROVED MAKES FOR FIRE PROTECTION & FIRE FIGHTING WORKS :

| S.No. | Description | PREFERRED MAKES |
|---|---|---|
| 1. | Fire Pumps | KIRLOSKAR/ MATHER & PLATT / GRUNDFOSS |
| 2. | Motor | SIEMENS / CROMPTON /ABB/ KIRLOSKAR |
| 3. | Diesel Engine | KIRLOSKAR/ CUMMINS / CROMPTON GREAVES |
| 4. | MS Pipes | JINDAL (HISSAR)/ TATA / SAIL |
| 5. | M.S. Seamless pipes. | MAHARASHTRA SEAMLESS / KALYANI / ITL |
| 6. | Screwed Fittings ( Malleable) | JAINSONS /UNIK/ ZOLOTO/ / DRP-M |
| 7. | Forged Steel Fittings/ DI Fittings (UL/FM) | JAINSONS/ V.S.FORGE / B&M/ DRP-M |
| 8. | Butt welded fittings | JAINSONS/ V.S.FORGE / FABRICATED |
| 9. | Ductile Iron Valves | JAINSONS/ KIRLOSKAR |
| 10. | Butterfly Valve | AUDCO/ ADVANCE/SANT/ZOLOTO |
| 11. | Dual Plate type NRV (C.I.) | ADVANCE/ SANT / ZOLOTO |
| 12. | Non Return Valve (CI) | ADVANCE/ SANT / ZOLOTO |
| 13. | Gun metal Gate valves | ZOLOTO / ADVANCE/ SANT |
| 14. | Ball Valve | JAINSONS /ZOLOTO/ ADVANCE/ SANT |
| 15. | Air release valve | JAINSONS/ RB/ ADVANCE/AUDCO/ZOLOTO |
| 16. | Single/Double headed Hydrant valves, Fire Brigade inlet/draw out, Hose reel drum, shut off nozzle, Branch Pipe, Fire Man Axe | MINIMAX / NEWAGE / SAFE GUARD / SAFEX/ SUPEREX |
| 17. | 20 mm dia rubber pipe for hose reel | MINIMAX / MITRA/ PADMINI |
| 18. | Pressure switch | INDFOSS/ DANFOSS/ MORBEY |
| 19. | Pressure Gauges | H GURU/ FEIBIG / PADMINI / VIKING |
| 20. | Strainers | SANDHU/ SANT / EMRALD / DASHMESH |
| 21. | Fire Extinguishers (ISI Branded only) | MINIMAX / NEWAGE / CEASEFIRE / SAFE GUARD / SAFEX |
| 22. | Anti-corrosive pipe treatment (As per IS:10221 – 1982) | PYPKOTE (IWL)/HIND/ PIPE WRAP/ COATEK |

| S.No. | Description | PREFERRED MAKES |
|---|---|---|
| 23. | RRL/CP Hose | NEWAGE / MINIMAX/ PADMINI |
| 24. | Mechanical Seal | SEALOL/BURGMAN/HINDUSTAN |
| 25. | Foot Valve/Sluice valve | JAINSONS / KALPANA/ KIRLOSKAR/ ZOLOTO/ AIP |
| 26. | Antivibration mounting | RESISTOFLEX/ KANWAL |
| 27. | Anchor Fasteners | HITECH / ALFA/ HILTI/ FISHER/ LOVELY |
| 28. | Paint | NEROLAC /BERGER/ SHALIMAR |
| 29. | Welding Electrodes | ADVANI / ADOR/ FUSION |
| 30. | Pendant / Upright / Powder coated Pendant Sprinkler Heads | TYCO/ HD / VIKING |
| 31. | Pipe Clamps/ Hangers/ Support | EUROCLAMP/ CHILLY/ LOVELY |
| 32. | GI Fittings | JAINSONS/V.S. FORGE/B&M/DRP-M |
| 33. | Gaskets | GASKETS INDIA PVT. LTD. / GP ENGG / MECHANICAL PACKING IND. |
| 34. | Bolts & Nuts | TVS/ UNBRAKO / INDUSTRIAL FASTENERS |
| 35. | MS Cabinet | PADMINI/ EXFLAME/ NEWAGE/ MINIMAX |
| 36. | Flow Switch | SYSTEM SENSOR/ INDFOSS/ VIKING/ TYCO |
| 37. | TEST ASSEMBLY | GIACOMINI/ AGF/ VIKING/ TYCO |
| 38. | Exit Sign | GLOW LIGHT/ LEGRAND/ TYCO |
| 39. | Electrical Panel | VIDYUT/ADVANCE/SPC/ APPLICATION/ ADLEC |
| 40. | Molded Case Circuit Breakers | L&T (D-SHINE) /SIEMENS (3VT) / ABB (T-MAX) /MERLIN GERIN (COMPACT NS) |
| 41. | MCB / ELCB/MPCB/SFU/DB | ABB / SIEMENS / HAGER/GE /SCHNEIDER |
| 42. | Current Transformers | AUTOMATIC ELECTRIC/ KAPPA / PRAGATI / PRECISE |
| 43. | Meters (Digital type) | POWER MEASUREMENT / SIEMENS / ALAN BRADLEY/ YOKOGAWA / HONEY WELL |
| 44. | Indicating lamps and push buttons | TELEMECHANIC / CONCORD / L&T/ SIEMENS / GE / RAS CONTROL (C&S) / PRECIFINE |
| 45. | MV Contactors/Timer/Starters | ABB/SIEMENS/SCHNEIDER/GE |

| S.No. | Description | PREFERRED MAKES |
|---|---|---|
| 46. | Energy Meter (Direct type) | ENERCON / SIEMENS / AE / POWER MEASUREMENT / ALAN BRADLEY/ YOKOGAWA / HONEY WELL |
| 47. | Relays | ALSTOM / ABB / GE / SIEMENS |
| 48. | Change Over Switch | HPL/L&T/SIEMENS/C&S |
| 49. | Control / Power Wires | UNIVERSAL/POLYCAB/HAVELLS/GRANDLAY |
| 50. | Bus bar | JINDAL/HINDALCO/CENTURY |
| 51. | LT Capacitors / Panel | GE/ SIEMENS / KHATAU JUNKER / L&T |
| 52. | Starter | L&T/SIEMENS |
| 53. | MV Cables | SKYTONE/ RPG/ UNIVERSAL |
| 54. | Cable Gland/ Termination | DOWELLS/COMET/ LAPP KABEL / WAGO |
| 55. | Discharge Nozzle | CHEMETRON / SHT/LPG |
| 56. | Spray Nozzles | HD / M & P / TYCO / VIKING |
| 57. | Sight Flow indicator | TECHNO FLOW/ TECHNIKA |
| 58. | Water Level Indicator & Controller | ELECTRONET / AQUA INTELTECH/ ELEGANT/ CIRRUS |
| 59. | Deluge Valve | HD/MINIMAX/SAFEGUARD/ SAFEX |
| 60. | Flexi Drops | MONSHER / PARADISE / VIKING / SAFEX |
| 61. | Gong Bell Alarm | HD/ TYCO/ VIKING |
| 62. | Fire Detection Tube | FIREDEC/ FIRE TRACE |
| 63. | Cylinder | MINIMAX/ CEASEFIRE |

# 11.0 ELECTRICAL & LV WORKS TECHNICAL SPECIFICATIONS

## 11.1 INTERNAL WIRING

The internal wiring shall be as per latest CPWD norms.

1. System of Wiring

The system of wiring shall consist of PVC insulated copper stranded conductor flexible FRLS wires in metallic conduits in exposed and concealed.

2. General

Prior to laying and fixing of conduits, the contractor shall mark the conduit route, carefully examine the working drawings prepared by him and approved by the Consultant indicating the layout, satisfy himself about the non-interference in the route, sufficiency of number and sizes of conduits, location of junction boxes, sizes and location of switch boxes and other relevant details. Any discrepancy found shall be brought to the notice of the Owner's site representative. Any modifications suggested by the contractor should get written approval before the actual laying of conduits is commenced.

In laying of conduits it is important that not more than two right angle bends are provided for each circuit without a pull box. No junction box shall be provided in the entire length of conduit run for drawing of wires. Only switch outlets, lighting fixture outlets, equipment power outlets and socket outlets shall be considered for drawing of wires.

3. Metal Conduits & Accessories

3.1 Conduits

Conduits and Accessories shall conform to latest edition of Indian Standards IS-9537 part 1 &2. Joints between conduits and accessories shall be securely made by standard accessories, as per IS-2667, IS-3837 and IS-5133 to ensure earth continuity. All conduit accessories shall be threaded type only.
Only approved make of conduits and accessories shall be used.
Conduits shall be delivered to the site of construction in original bundles and each length of conduit shall bear the label of the manufacturer.

3.2 FLEXIBLE CONDUITS

Flexible conduits shall be made of heavy gauge MS strip galvanized after making the spiral. Both edges of the strip shall have interlocking to avoid opening up. Flexible conduit shall be heat resistant, lead coated steel, water leak, fire and rust proof. The flexible conduit shall be heat resistant on continuous temperature up to 150 deg. C and intermittent temperature up to 200 deg. C. The flexible conduit shall be corrosion resistant as per IS-3480 & BS-731.

Please follow CPWD norms for the following heads

i. Bends in Conduit
ii. Fixing of Conduits
iii. Switch outlets and Junction Boxes
iv. Inspection Boxes

50 mm dia inspection boxes and pull boxes of cast iron shall have smooth external and internal finish to facilitate removal and replacement of wires, where required.

v. Fish Wire

To facilitate subsequent drawing of wires in the conduit, GI fish wires of 2.0 mm (14 SWG) shall be provided along with the laying of recessed conduit.

vi. Conductors

All PVC insulated copper conductor flexible FRLS wires shall conform in all respects to Standards as listed under sub-head Regulations and Standards and shall be IS/IEC approved and ISI marked.

vii. Bunching of Wires

viii. Drawing Conductors

Only licensed wiremen (Before doing the work or before appointing him on site contractor has to submit his wiring license to Owner) and cable jointers shall be employed to do jointing work. Before entrusting cable jointing work to any technician, or before appointing Cable Jointers or Wiremen on Site, Contractor has to submit such Technicians' / Wireman's / Cable Jointer's licensee to Owner.

All wires and cables shall be embossed with the manufacturer's label with ISI mark and shall be brought to site in original packing. For all internal wiring, FRLS PVC insulated wires of 1100 volts grade shall be used.

The sub-circuit wiring for point shall be carried out in loop system and no joints shall be allowed in the length of the conductors. No wire shall be drawn into any conduit until all work of conduit installation of any nature that may cause injury to wire is completed. Care shall be taken while pulling out the wires so that no damage occurs to conduits/wire itself, the conduits shall be thoroughly cleaned of moisture, dust , dirt or any other obstruction. The minimum size of PVC insulated copper conductor wires for all sub-circuit wiring for light points shall be minimum 1.5 sq.mm copper (as specified in BOQ). Separate neutral to be pulled for each circuit. Please follow CPWD norms for Maximum permissible numbers of 1100 volt grade FRLS insulated wires that may be drawn into metallic Conduits.

ix. Joints

x. Mains and Sub-Mains

Mains and sub-mains cable or wires where called for shall be of the rated capacity and approved make.

xi. Load Balancing

Balancing of circuits in three phase installation shall be as planned by the contractor and shall be checked by the consultant before the commencement of wiring and shall be strictly adhered to.

xii. Colour Code of Conductors

Colour code shall be maintained as indicated by the Consultant for the entire wiring installations. Red, yellow, blue shall be for three phases, black for neutral and green with yellow band shall be for earthing.

## 11.2 SWITCHES, RECEPTACLES (MODULAR) & LIGHTING FIXTURES

1. Switches

   All switches shall be enclosed type flush mounted suitable for 240 volts AC. All switches shall be fixed inside the switch boxes on adjustable flat MS strips/plates with tapped holes and brass machine screws, leaving ample space at the back and sides for accommodating wires. Switch controlling the light point shall be connected to the phase wire of the circuit and load on each switch shall be restricted to maximum 800 watts for lighting & maximum 1500 watts for power per circuit. All wiring accessories shall be BIS approved. Perfect alignment shall be maintained while fixing of the back boxes.

2. Wall Socket Outlet

   Wall socket outlets shall be of the three pin. The switch controlling the socket outlet shall be on the phase wire of the circuit and not more than two socket outlets of 16 amps shall be connected on one circuit. An earth wire shall be provided along with the circuit wires and shall be connected to earthing screw inside the box. The earth terminal of the socket shall be connected to the earth terminal provided inside the box. All sockets shall be shuttered type.

   a. Every socket outlet shall be controlled by an individual switch unless mentioned otherwise.
   b. The switch controlling the socket outlet shall be on the `Live' side of the line.

   6 amps and 16 amps socket outlet shall normally be fixed at any convenient height above the floor level as desired by the Architect. The switch for 6 and 16 amps, socket outlet shall be kept along with the socket outlet. However, in special case, if desired by the Architect the 6 amp. Socket outlet can be placed at the normal switch level.

   16 amps socket outlet in the kitchen of the residential or commercial buildings shall be fixed at any convenient height above working platform or as specified in drawings / schedule of equipments.

   In a room containing a fixed bath or shower, there shall be no socket outlet and there shall be no provision for connecting a portable appliance. Any stationary appliance connected permanently in the bath room shall be controlled by an isolator switch or circuit breaker having outlets at such location where water / moisture does not effect.

a. Where socket outlets are placed at lower level, they shall be enclosed in a suitable metallic box with the system of wiring adopted or shutter type sockets shall be provided as specified.
b. In an earthed system of supply, a socket outlet and plug shall be of three pin type, the third terminal shall be connected to earth.
c. Conductors connecting electrical appliance with socket outlet shall be flexible twin cord with an earthing cord which shall be secured by connecting between the earth terminal of plug and the metallic body of the electrical appliance.
d. Where use of shutter type of interlocking type of socket is required for any special installation, the items should be separately and specifically listed in the Schedule of Quantities of that particular work.

## 11.3 LIGHTING FIXTURES & ACCESSORIES

The light fixtures and fittings shall be assembled and installed in position complete and ready for service, in accordance with details, drawings, manufacturer's instructions and to the satisfaction of the Engineer In-charge.

1.1 Scope :

Scope of work under this section shall include inspection at suppliers/manufacturer's premises at site, receiving at site, safe storage, transportation from point of storage to point of erection and commissioning of light fittings, fixtures and accessories including all necessary supports, brackets, down rods and painting etc as required.

1.2 Standards :

The lighting and their associated accessories such as lamps, reflectors, housings, ballasts etc., shall comply with the latest applicable standards, more specifically the following:

General and safety requirements for Luminaires :

| | | |
|---|---|---|
| Part-1 Tubular fluorescent lamps | - | IS – 1913 (Part-1) |
| Industrial lighting fittings with metal reflectors | - | IS – 1777 |
| Decorative lighting outfits | - | IS – 5077 |
| Bayonet lamp holders | - | IS – 1258 |
| Bi-pin lamp holders for tubular fluorescent lamps | - | IS – 3323 |
| Electronic Ballasts for fluorescent lamps – General & Safety requirement | - | IS – 13021 (Part-1) |
| Electronic Ballasts for fluorescent lamps – Performance requirement | - | IS – 13021 (Part-2) |
| Tubular Fluorescent lamps | - | IS – 2418 (Part-1 to 4) |
| A luminary – General requirement | - | IS – 10322 (Part-1) |
| A luminary – Constructional requirement | - | IS – 10322 (Part-2) |
| Luminaries – Screw and Screw less termination | - | IS – 10322 (Part-3) |
| A luminary – Methods of Tests | - | IS – 10322 (Part-4) |
| Particular requirement – General purpose Luminaries | - | IS – 10322 (Part-5/Sec-1) |
| Particular requirement – Recessed Luminaries | - | IS – 10322 (Part-5/Sec-2) |
| Particular requirement – Luminaries for Road & Street lighting | - | IS – 10322 (Part-5/Sec-3) |
| Particular requirement – Portable General purpose Luminaries | - | IS – 10322 (Part-5/Sec-4) |
| Particular requirement – Flood Lighting | - | IS – 10322 (Part-5/Sec-5) |

1.3 Light Fittings-General Requirements:

a. Fittings shall be designed for continuous trouble free operation under atmospheric conditions without reduction in lamp life or without deterioration of materials and internal wiring. Degree of protection of enclosure shall be IP-65 for outdoor fittings including bulkhead fitting.
b. Fittings shall be so designed as to facilitate easy maintenance including cleaning, replacement of lamps/ ballasts.
c. All fittings shall be supplied complete with lamps. Outdoor type fittings shall be provided with weather proof junction boxes (IP-65) and IP-65 Control gear boxes. All fluorescent and CFL fittings shall be provided with electronic ballast as per schedule of quantities.

d. Each fitting shall have a terminal block suitable for loop-out connection by 1100 V PVC insulated copper conductor wires upto 4 sq.mm. the internal wiring should be completed by the manufacturer by means of standard copper wire and terminated on the terminal block.
e. All hardwares used in the fitting shall be suitably plated or anodized and passivated.
f. Earthing : Each lighting fitting shall be provided with an earthing terminal. All metal or metal enclosed parts of the housing shall be bonded and connected to the earthing terminal so as to ensure satisfactory earthing continuity throughout the fixture.
g. Painting/Finish : All surfaces of the fittings shall be thoroughly cleaned and degreased and the fittings shall be free from scale, rust, sharp-edges, and burns.
h. The housing shall be powder coated/stove-enamelled or anodised as required. The surface shall be scratch resistant and shall show no sign of cracking or flaking when bent through 90 deg. Over 12 mm dia mandrel.

Metal used in BODY of lighting fixtures shall be not less than 22 SWG or heavier if so required to comply with specification of standards. Sheet steel reflectors shall have a thickness of not less than 20 SWG. The metal parts of the fixtures shall be completely free from burns and tool marks. Solder shall not be used as mechanical fastening device on any part of the fixture.

1.4. Light Fittings – Special Requirements
28W T5, Light Fittings
Surface mounted, modular fluorescent lighting fixture made of CRCA Sheet steel powder coated (white) housing, electro chemically brightened and anodised reflector, three dimensional cross louvers with concave contours, fresnel top at louver saddle to increase efficiency.

1.5 Accessories for Light Fittings – Reflectors
The reflectors shall be made of CRCA sheet steel/aluminium /Silvered glass/Chromium plated sheet copper as specified. The thickness of reflectors shall be as per relevant standards. Reflectors made of steel shall have stove enameled/ vitreous enameled/epoxy coating finish. Aluminium used for reflectors shall be anodized/epoxy stove enameled /mirror polished. The finish for the reflector shall be as specified. The reflectors shall be free from scratches / blisters and shall have a smooth and glossy surface having optimum light reflecting coefficient. Reflectors shall be readily removable from the housing for cleaning and maintenance without use of tools.

1.6 Compact Flourescent Lamps
Compact fluorescent lamp shall have same luminous flux and power consumption as fluorescent tubes but less than half the length and more compact than U-shaped and circulator lamps.

A) LED Lamp
The driver shall be CCCV isolated driver (Constant current constant voltage driver). All light fixtures should be with Opex lighting fixture. Type of PCB is MCPCB for External & FRPCB for external light.

General requirements for LED lighting:

| S.N. | Types of Test/Specifications | Test Method |
|---|---|---|
| 1 | High bright white power LEDs shall be used in the luminaires and the wattage of these LEDs shall be >1W and <3W.<br>*LED Technical datasheet for the LED source intended for supply of the project including packaging details to be submitted. | Specify Make |
| 2 | Manufacturer should submit proof of procurement of LEDs and LM-80 Test Reports of specific LED used in the proposed. (No other chip details to be offered). | LM-80/IS 16105 test report including technical data sheet of LED Chip. |
| 3 | Life span of the LEDs used in the Luminaire shall be more than 50,000 hours at 70% light output. (Manufacturer shall submit the proof – L70 & TM 21 Test Report. | |
| 4 | Color Rendering Index of the LEDs used in the luminaire shall be greater than 80. | |
| 5 | LED chip efficiency shall be more than 100 Lumens/Watt | |

| S.N. | Types of Test/Specifications | | Test Method |
|---|---|---|---|
| | at Tj 25 C (Manufacturer shall submit the proof – LED Technical Data Sheet to be submitted). | | |
| 6 | Power Factor | >0.95 | |
| 7 | System Efficacy (Lumens/Watt) | System Lumen output supported by LM79 report shall be submitted. | |
| 8 | CRI of Luminaires | >70 (LM 79 report to be submitted) | |
| 9 | The luminaire light output shall be constant. The voltage variations/ fluctuations in the specified voltage range shall not impinge upon the lumen it produces. Maximum +/- 2% is allowed throughout in the input operating voltage range. | | Test Report from NABL Accredited Lab |
| 10 | Operating Voltage | 140 V to 270 V universal electronic driver with internal surge protection of 2.5 KV (Applicability IS 15885, Driver Safety 16104-1/2). | |
| 11 | Total harmonic Distortion | <10% THD – Test Method IEC:610003-2 | |
| 12 | LED Driver Efficiency | >85% | |
| 13 | The outdoor luminaire housing shall be made up of corrosion free High Pressure Aluminum die casting thus conforming the luminaire to minimum IP-65 for luminaire at 60 W or below/ IP-66 for wattage above 60 W- protection and safety as per IEC 60598/IS 10322. (NABL accredited Lab Report supporting the same shall be furnished at the time of supply). Necessary Guarantee & Warranty certificate must be submitted at the time of bid submission. (Only single housing fixtures allowed). Embossing of supplier logo on housing. | | NABL Accredited Lab report as per IS: 10322 part 5 Sec-3 / IEC: 60598-2-3. |
| 14 | The luminaire shall be equipped with distortion free, clear, heat resistant, toughened, UV stabilized glass cover or Polycarbonate cover in the front fixed to the die cast Aluminum frame which shall be fixed to the housing by means of stainless steel screws. | | |
| 15 | Frequency | 50 Hz +/- 3% | |
| 16 | Protections | IP65 up to 60 W and IP-66 for wattage above 60 W, IP-20 for Indoor areas and IP-65 for kitchen area. Surge protection 2.5 KV, IEC61000-4-5 | To be confirmed by the vendor |
| 17 | Conformation Standards of luminaire (Test Reports of Luminaire) | The luminaire should conform to IEC 60598/ IS: 10322 The luminaire should be tested as per IEC 60598-2-3: 2002/ IS: 10322 Part 5 Sec-3 standards and following test reports should be submitted: Heat Resistance Test, Thermal Test, Ingress Protection Test, Drop Test, Electrical/ | From NABL Certified lab Report TEST REPORT as per IS: 10322 part 5 Sec-3/ IEC: 60598-2-3. |

| S.N. | Types of Test/Specifications | | Test Method |
|---|---|---|---|
| | | Insulation Resistance Test, Photometry Test (LM 79 report), Vibration Test | |
| 18 | Conformation Standards of luminaire | LM80 (IS16105) NABL Acc. Lab certificate for LED And LM79 (IS16106), IEC60598/ IS: 10322 for LED Luminaire | To be confirmed by the vendor |
| 19 | Conformation Standards of luminaire | IS 16101/2/3/8 and 7 | To be confirmed by the vendor |
| 20 | Surge Protection | Surge protection of 10 KV to be separately installed housed inside fixture for all wattages >= 35 W. | |
| 21 | Replacement Warrantee | 05 YEARS | |
| 22 | Working Temperature | -5 to +50 degree C | |
| 23 | Heat Sink | Good thermal management System should be provided & LED Must be mentioned on heat sink Conductive Al. bars with Suitable large Surface area by means Of fins to dissipate the heat to ambient temperature. | |

Contractor shall submit all following test reports for LED lighting fixtures before dispatching of material at site. All tests shall be carried as per IES approved methods defined (LM-82). The replacement warranty for LED shall be 5 years.

B) APPLICABLE CODES & STANDARDS

a) 2006/95/EC, Low Voltage Directive (LVD)
b) 2004/108/EC, EMC Directive
c) 1999/5/EC, R&TTE Directive
d) 2002/95/EC, RoHS Directive
e) 2006/121/EC, REACH directive
f) UL 916
g) FCC part 15 B & RSS132, issue1, RSS133, issue3
h) IS 3646 &1944 (Part 1& 2)
i) IEC 61215, EN 50530, IEC 62124, IEC 61347-2-13, IEC 62384, CISPR 15, IEC 61547, IEC 60598

1.7 High Frequency Electronic Ballast

High frequency electronic ballast shall be used with fluorescent / Compact Fluorescent Lamps wherever specified in the schedule of quantities. High frequency electronic ballast shall comply to the following:

- IEC 927, IEC 928 for ≤10% total harmonic distortion.
- EMI / RFI – Confirming to FCC / VDE Class A/B.
- Line Transient as per IEEE C62.41.
- Ballast Crest Factor C1.7%.
- No Stroboscopic Effect
- Constant Wattage / Light output between 240 V ± 10%.
- Circuit protection for surge current and inrush current.
- Short circuits, open lamp protection
- PF > 0.99 for fluorescent / T5 lamp and 0.95 for CFL.
- Deactivated lamp protection
- Suitable for use with single and twin lamps
- RFI < 30 MHz EN 55015
- Total Harmonic Distortion (THD) ≤10%
- Immunity to interference EN 61547

- Safety EN 60928 / IEC 928 / IS 13021 (Part I)
- Performance EN 60929 / IEC 929 / IS 13021 (Part II)
- Vibrations & Bump tests IEC 68-2-6 FC,IEC 9001
- Quality Standard ISO 9001
- Environmental Standard ISO 14001
- DC Operation EN 60924
- Emergency Lighting Operation VDE 0108

Total System consumption (lamps + ballast) for
1 x 28 W T-5, shall not exceed 30 W

## 11.4 DISTRIBUTION BOARDS AND PANELS

1. TYPE TESTED LT PANELS

- Scope

The scope of supply covers design, manufacture, testing and supply of L V PCC Panels up-to 1000 V. Panels must conform to Totally Type Tested (TTA) as per IEC 61439-1&2. Type Test Certificates for short circuit withstand for 1sec as specified in BOQ/SLD along with ACB mounted in the Switchboards is mandatory for submission.

Switchboard shall be suitable for Seismic Zone IV. The same shall be tested at ERDA / CPRI/ accredited international Lab for seismic test.
These shall be branded and/or assembled/fabricated from a factory of repute. All switchgears shall be fully rated at an ambient of **50° C** – for this, Vendors shall provide de -ration Charts for their Switchgears

- Type of Panel

The medium voltage switch board panel shall comprise of any one of the following types of switchgears or combination thereof as specified. The panels shall be internal arc tested for 65kA/ 50kA for 0.3 second as per IEC.

Air Circuit breakers draw out of suitable Icu=Ics=Icw for 1 second ratings, Switch Fuse units fixed type, MCCBs of suitable Icu=Ics ratings. MCCBs shall invariably be Current Limiting type. Features like Double Break, Positive Isolation functions, class II front facia shall be Integral feature of the device.

The Panels & Main Distribution Board which are to be extended in future, shall be extensible on both sides by the addition of side section after removal of end covers

The Panel shall be indoor type having incoming sectionalization and outgoing switchgears as specified. The design shall be cubical type. The degree of enclosure protection shall be IP 52 for indoor and IP55 for outdoor as per IS: 13947 (Part-I).

- LT Panel

Main Distribution Panels, Sub-Distribution Panels and Final Distribution shall be covered under this section. Panels/Boards shall be suitable for operation on 3 Phase/single phase, 415/240 volts, 50 cycles, 4 wire system with neutral grounded at transformer. All Distribution panels shall be CPRI tested design and manufactured by an approved manufacturer. CPRI certificate shall be made available.
Distribution panels shall comply with the latest International Standards and Electricity Rules and Regulations and shall be as per Low Voltage switchgear & control gear IEC 60947.

1.1 Construction Features

Distribution panels shall be 2 mm thick sheet steel cabinet for indoor installation, dead front, floor mounting/wall mounting type and shall be form 4b construction. For operator safety IP2 X (touch proof) protection to be available even after opening the feeder compartment door. The compartmentalization to be achieved by using metal separators, use of PVC sheet / Hylem sheets shall not be allowed. The Distribution panels shall be totally enclosed, completely dust and vermin proof and shall be with hinged doors and folded covers, Neoprene gasket, padlocking arrangement and bolted back. All removable/ hinged doors and covers shall be grounded by flexible standard connectors. Distribution panel shall be suitable for the climatic conditions as specified in Special Conditions. Steel sheets used in the construction of Distribution panels shall be 2 mm thick and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal..The LV switchboards shall be as per the standards IEC 61439. The switchboards and the associated equipment including switchgear, control gear, Busbar supports, Busbar orientation, Busbar links etc shall be identical in construction to the assembly which has undergone the type test. The drawings of the type-tested assemblies shall be made

available for inspection. The designs of the switchboards should be with switchgear manufacturer, and all the mechanical drawings must be available in the factory beforehand & for voltage up to and including1000 V AC.

All ACB panels shall be single/multi tier only. The design of the Main Distribution Board/Sub Distribution Board shall be such that each fuse switch/switch fuse units/MCCB shall be fully compartmentalized

All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with wing nuts. Self threading screws shall not be used in the construction of Distribution panels. A base channel of 75 mm x 40 mm x 5 mm thick shall be provided at the bottom for floor mounted panels. Minimum operating clearance of 275 mm shall be provided between the floor of Distribution panels and the lowest feeder compartment.

Distribution panels shall be of adequate size with a provision of spare switchgear as indicated on the Single Line Diagram. Knockout holes of appropriate size and number shall be provided in the Distribution panels in conformity with the location of cable/conduit connections. Removable sheet steel plates shall be provided at the top to make holes for additional cable entry at site if required.

Every cabinet shall be provided with Trifoliate or engraved metal name plates. All panels shall be provided with circuit diagram engraved on PVC sheet. And Clearances between phases to phase is 25.4mm and phase to Earth is 19.4mm as per IEC.

1.2 Type test reports.

Vendor shall submit all following type test report which are less than 5 years old and as per latest IS & IEC Standards:

- Short Circuit withstand test for main Busbar and neutral Busbar
- Temperature rise test
- IP test
- Seismic test
- Dielectric Properties
- Continuity of Protective Circuit
- Clearance &Creepage Distances
- NO. Of Mechanical Operations
- Internal arc containment test as per IEC-61641.
- Impact resistance test IK09 with glass door & IK10 with blind door

Bidder shall be able to provide Test Certificates with AluminumBusbars which should not be more than 2 years old as per IS/IEC.

- Bus Bar Connections

Busbars shall be made of high conductivity, and high strength Aluminum E91 grade Busbars shall be of rectangular cross sections better suitable for full load current for phase bus bars and half/ full rated current for neutral bus bar or as stipulated in schedule of quantities. Busbar shall be suitable to withstand the stresses of fault level as specified in schedule of quantities.

The bus bars shall be supported on non-breakable, non-hygroscopic epoxy resin or glass fiber reinforced polymer insulated supports able to withstand operating temperature of $110^{O}$ C at regular intervals, to withstand the forces arising from a fault level as stipulated in schedule of quantities. The material and the spacing of the Busbar supports should be same as per the type tested assembly (TTA). All bus bars shall be provided in a separate chamber and all connections shall be done by bolting

The temperature rise shall be as per IEC 61439-1&2.

All main distribution panels and sub distribution panels shall be provided with MCCB of appropriate capacity as per Single Line Diagram. All final Distribution boards shall be provided with Miniature Circuit Breakers. Final Single Phase Distribution boards shall be connected to the incoming supply through double pole MCB units & earth leakage circuit breakers.

All wiring for final distribution boards shall be concealed behind 5 mm thick Bakelite sheet or M S sheet cover. All Distribution boards shall be completely factory wired, ready for connection. All the terminals shall be of proper current rating and sized to suit individual feeder requirements. Each circuit shall be clearly numbered from left to right to correspond with wiring diagram. All the switches and circuits shall be distinctly marked with a small description of the service installed.

Continuous earth bus sized for prospective fault current shall be provided with arrangement for connecting to station earth at two points. Hinged doors/ frames shall be connected to earth through adequately sized flexible braids.

Cable Compartments

Cable compartment of adequate size shall be provided in the Distribution panels for easy clamping of all incoming and outgoing cables entering from the top/bottom. Adequate supports shall be provided in cable compartment to support cables.

1.3 Instruments

All Multi-Function Meters, voltmeters and ammeters shall be flush mounted of size minimum 96 mm conforming to class 1 of IS: 1248 for accuracy. All voltmeters shall be protected with MCB. They shall be suitable for semi-flush with only flanges projecting on vertical panels.

1.4 Indicating Lamps

On all the incomers of M.V panels, ON/OFF indicating LED lamps shall be provided and shall be suitable for operation on AC supply. Phase indicating LED lamps shall be associated with necessary ON/OFF toggle switch.

1.5 Small Wiring

All small wiring for Controls, Indication etc, shall be of with suitable FRLS/HFFR (halogen free fire retardant) copper conductor cables. Wiring shall be suitably protected within switch board. Runs of wires shall be neatly bunched, suitably supported and clamped. Means shall be provided for easy identifications of the wires. Where wires are drawn through steel conduits, the works shall conform to CPWD General Specifications for Electrical works (Part I- Internal) - 2005 and IS:732 as the case may be. Identification ferrules shall be used at both ends of the wires. All control wiring meant for external connections are to be brought out of terminal board.

- Operational Requirements

  The indoor type LT panel shall conform to the following: -
- The panel shall comprise of incomers, outgoing feeders and bus coupler as specified. The incomer shall be either contact repulsion MCCB or an Air Circuit Breaker. The bus coupler shall be either a circuit breaker or a contact repulsion MCCB, ACB, switch disconnector fuse unit, as specified. The outgoing feeders shall be circuit breakers/MCCBs as specified.
- Bus bars for phase and neutral shall have a rating as specified in SLD and BOQ.
- The entire switch panel shall be cubical type generally conforming to IEC 61439 for factory assembled switch board.
- The incomer panel shall be suitable for receiving bus trunking or LT cable of size specified either from top or from bottom.
- All incoming AIR CIRCUIT BREAKER / MCCB shall have suitable adjustable tripping current and the time delay settings.
- The entire panel shall have a common earth bar of size as specified with two terminals for earth connections.
- Panel should be Ethernet (TCP/IP) ready i.e. ACB/MCCB/ Multi-function meter as per architecture mentioned below.

II LT Switchgears

LT Switchgears covers the specification of ACBs, MCCBs Contactors & metering etc.

Standards and Codes

The latest amended up to date Indian Standard Specifications and Codes of Practice will apply to the equipment and the work covered by the scope of this contract. Wherever appropriate Indian Standards are not available, relevant British and/or IEC Standards shall be applicable.

1) Air Circuit Breaker

Selectivity should be provided based on SLD design and actual Load Connected between the breakers up to the maximum level of adjustable delayed Short Circuit Pick-up.

General:

Air circuit Breaker shall comply with latest IEC/IS standards. ACB shall be fully rated up to 50$^{O}$C. In case of 4P ACB, the Neutral Conductor capacity should be 100% of that of Phase.

Breaking Capacity of Breaker in Main LT Panel shall be Ics = Icu =Icw= as per BOQ for 1 second.

Operating Voltage of the Circuit breakers shall be minimum 415 V AC .

The circuit breaker shall comply with the isolating function requirements of IEC60947-2 section 7.1.2.to facilitate safety of person in use.

ACB shall have physical indication of mechanical wear indication, enabling visible indication of Contact life.

All ACBs should have the molded case design ACB shall have built-in thermal memory. **& zone selection interlocking (ZSI) features. All ACBs shall have inbuilt display for all power parameters and harmonics**

The accessories like shunt trip, closing trip coils should be continuously rated to avoid the Burning due to sustained command. The Accessories shall be accessible from the front and should not need removing of the breaker from its panel for the replacement.

a. Operating Mechanism

The operating mechanism shall be of the Open/Closed/Open stored-energy type. The closing springs shall be able to be manually charged by operating the front lever

The ACB (draw out) shall provide as a standard feature the following mechanical or electrical indicator on the front panel:-

- Contact position indicator (ON / OFF)
- Stored energy status indicator
- Connected / Test / Disconnected position. (DO version)
- Trip indication on fault
- OK Indicator (Mechanical) on the front panel of the Circuit breaker when the trip or OFF conditions are cleared and

The Circuit breaker can be closed on “ON” command (Manual or Electrical).

Breaker position (Isolated, Service, Test) shall be available through Communication module without hardwiring.

The circuit breaker shall be of trip free type and shall be provided with built-in mechanical Anti Pumping feature. Closing coil & other auxiliary devices shall be available in sufficient number for the purpose of indication, alarms, annunciations on switch boards as well as on respective remote control panel in control room & for the purpose of interlocking scheme shall be provided

There shall be three distinct & separate positions of the circuit breakers on the cradle as – Service / Test / Isolated. All position shall be positively achieved only through the racking motion of draw out mechanism & not by trail & error. There shall be indicator clearly showing the above 3 conditions

Circuit breaker shall be convertible from MDO to EDO at site. The closing spring shall be manually charged, if EDO if failed.

b. Protection Function :

All ACBs shall have Microprocessor based releases capable of sensing true RMS value of Current based on Digital Technology

Protection unit shall offer following as standard in all breakers excluding bus couplers

- Long time protection with adjustable time delay.

- Short circuit protection with time delay. The short circuit setting (Isd) should necessarily be the function of the nominal current (In) of the ACB. The instantaneous protection shall have the option of OFF position in case of certain conditions of discrimination.
- Earth fault protection with adjustable current settings in absolute values of the fault current. The adjustable time setting for tripping on earth fault shall be within 100 – 400ms. Also there should be a provision for time delay and disable the Earth Fault Protection if required.
- Separate adjustable setting for instantaneous short circuit protection.
- Neutral Protection with a provision of Setting range off – 50% - 100%

All the adjustments should be on line & the circuit breaker need not be switched off while adjusting the settings.
The tripping time of the breaker should be less than 40ms. The ACB should have safety Interlock for draw out to prevent Attempt to rack out the ACB in ON condition.
The ACB should have a release over temperature inside the cubicle and inside the breaker for auto protection of breaker.

Trip indicators shall be provided to display the exact nature of fault (i.e. O/L, S/C, and E/F) that caused tripping at least last tripping history of circuit breakers. The circuit breaker will have to be necessarily with mechanical re-closing lockout. The trip indication shall need no external power supply for display The control unit shall have thermal memory for repetitive over current faults for protecting the cables & loads.

The ACB shall be equipped with an integral self-powered microprocessor based current release, which works on true R.M.S values for ensuring accurate protection. The microprocessor based release should have integral LCD/ LED display of phase and neutral currents and also the percentage (%) loaded all phase. The display should be visible with a minimum 40% loading of the phase currents.
Integral Test facility to test healthiness of release and the trip circuitry shall be provided on the Overcurrent release.
Separate Communication module to ensure safe storage of data should be provided.

c. Communication

- Release Feature:
  All the Breakers shall be able to -
  - Communicate and display current voltage values, switching states, reasons for tripping, Harmonics capture with minimum 31st level for remote display (at incoming breakers of panels)
  - LCD Display with angular adjustment
  - I2t characteristic curve for overload protection
  - Rating Plug option to reduce the Nominal current for optimum adaptation to the system
  - The Breakers Shall be compatible for integration with SCADA System
  - The ACB shall be able to communicate the following via an integral Device / Release
    - status of the main contacts,
    - spring charge and
    - Readiness to close depending on the status of the various internal auxiliary releases and interlocks to the upper level network.
    - Remote status monitoring and breaker controlling should be possible

- Implementation Architecture:
  ACB The vendor must define and submit the implementation architecture along with details of all devices/modules needed for implementation of the same, and to achieve the desired real-time data transmission speed on the network.

  ACB breaker status (ON/OFF & Trip & release measuring data) shall be upgradable to Ethernet communication inside the LT Panel. Necessary hardware shall be provided by OEM/Panel builder.

2). Molded Case Circuit Breaker (MCCB)

A. General

1.1 Molded-Case Circuit Breakers (MCCB) shall comply with IEC 60947-1, IEC 60947-2 & IEC 60947-3 standards

- MCCB shall be of category A with a rated service breaking capacity (Ics) equal to the ultimate breaking capacity (ICU) on all the ratings.
- MCCB shall have a rated operational voltage of 415 V AC (50/60 Hz)
- MCCB shall have a rated insulation voltage of 690 V AC (50/60 Hz)
- MCCB shall be suitable for isolation, as defined by IEC 60947 –1 and -2
- MCCB should be fully rated up to 40 Deg C

1.2 MCCBs shall be available in fixed, 3-pole and 4-pole versions.

1.3 MCCBs shall be insensitive to Vibrations and meet requirements on mechanical & electromechanical vibration strength according to IEC/EN 60068. Also, suitable for Shock resistance without tripping up to 10g (IEC / EN 60068-2-27)

1.4 Incomer MCCB shall have overload, shport circuit & earth fault protection & thermal setting adjustability.

1.5 Outgoing MCCB shall have over load, short circuit protection.

B. Construction & Operation

2.1 For maximum safety, the power contacts shall be insulated in an enclosure made of a thermosetting material from other functions such as the operating mechanism, the case, the trip unit and auxiliaries

2.2 MCCBs shall be actuated by a toggle or handle that clearly indicates the three positions: ON, OFF and TRIPPED.

2.3 The operating mechanism shall be designed such that the toggle or handle can only be in OFF position (O) if the power contacts are all actually separated & in OFF position, the toggle or handle shall indicate the isolation position.
Isolation shall be provided by a double break mechanism on the main circuit.

2.4 MCCBs shall be equipped with a “push to trip” button in front to test operation and the opening of the poles.

2.5 MCCBs shall be suitable for IP40 in accordance to IEC 60529 & IEC 60947-1 Appendix C

2.6 The MCCB should be have a trip-free mechanism that ensures the trip process is not prevented even if the operating mechanism is blocked or manually held in the "ON” position. It should have sure to trip technology.

2.7 The Microprocessor Release MCCBs should be equipped with non saturable type Rogoswki CTs for reliable & accurate protection.

2.8 Current Limit & Selectivity

2.8.1 MCCBs shall be Current Limiting type.

2.8.2 MCCB should have cross bolted termination to ensure safety against higher short circuit.

2.9 Accessories

2.9.1 MCCBs shall have uniform Internal Accessories platform across the range

2.9.2 MCCBs Door Mounted Rotary Handle shall have an option of Illumination Kit to indicate three stable mechanism positions (ON, OFF and TRIPPED).

2.9.3 MCCBs with TMTU Release should have provision for separate Short Circuit Signal facility.

2.9.4 MCCBs shall be snap fit type to enable safe on-site installation of auxiliaries, voltage releases, signal contacts etc. It shall be color coded for easy identification.

2.9.5 MCCBs should have symbols engraved in the lid of the accessories compartment to indicate possible mounting position of internal accessories.

2.9.6 The addition of a motor module or manual rotary handle etc., shall not block device settings.

C. Protection functions

3.1 General recommendations

MCCBs entire range shall be available in both the release type

- Thermal-Magnetic Release
- Microprocessor Release

3.2 Common features

3.2.1 The MCCB Trip units shall comply with Electromagnetic Compatibility as per the following standards:

CISPR 11, Class A & B
IEC / EN 60947-1, Appendix S
IEC / EN 60947-2, Appendix B, F, J & N

3.2.2 Protection settings shall apply to all circuit breaker poles

3.2.3 The MCCB shall have in-built overload and short circuit protection. E/F if required should be provided and should be suitable for 3Phase 4 wire system to avoid nuisance tripping because of unbalance. There should have time delay associated with E/F device.

3.3 Thermal-Magnetic Trip Units (up to and including 250 A)

3.3.1 Characteristics:
FTFM: Fixed Thermal, Fixed Magnetic
ATFM: Adjustable Thermal, Fixed Magnetic
ATAM: Adjustable Thermal, Adjustable Magnetic

3.3.2 It shall be possible to ensure neutral protection. The tripping threshold shall be equal to that of the phases or to a reduced value (half of that of the phases).

3.3.3 Incomer MCCB up to and including 250A shall have over load, short circuit & earth fault protections and thermal setting adjustability.

3.3.4 Outgoing MCCB shall have overload & short circuit protection.

3.4 Electronic (Microprocessor) trip units (above 250 A)

3.4.1 Characteristics
All the release settings should have settings in absolute values. All incoming MCCBs rated above 250 amp with microprocessor release shall have built-in Over current, Short Circuit & Earth Fault (O/C +S/C & E/F) and current and time adjustability for the three parameters along with digital (LCD/LED) display **for last trip history & last fault trip history & separate indication of earth fault or by integration through software.** Both earth fault & electrical fault indication in all incomings (thermal & microprocessor both) shall be provided.

3.4.2 N Protection should be possible in 3 pole as well as 4 pole MCCB execution. The Neutral Pole should be 100% protected neutral. (N Protection – 0.5, 1, Off)

MCBs: Miniature circuit breakers for use on motor space heater control circuits shall comply with the requirements of applicable standards, unless otherwise mentioned in Data Sheet.

CONTACTORS: Motor starter contactor shall be of the electromagnetic type rated for uninterrupted duty as defined in applicable standards. Main contacts of motor-starter contactors shall be of silver plated copper. Contactors shall be of the double break, non-gravity type.

- Instruments & Relays

a) Indicating instruments
All electrical indicating instruments will be 96 mm square, with 240-degree scale (Taut band type). They shall be suitable for semi-flush with only flanges projecting on vertical panels.

Instruments shall have accuracy class of 1.0 or better. The design of the scales shall be such that it can read to a resolution corresponding to 50% of the accuracy class index. KWH meter mentioned in the SLDs shall have pulse output to be integrated with the BAS system and an accuracy class of 1.

4.1 Wiring And Accessories
Cubicles shall be completely wired up to equipment / terminal block. Inter panel and inter-cubicle looping of control and cubicle space heating supplies to be carried out by CONTRACTOR. Wiring to be carried out with 650V grade single core PVC insulated FRLS, stranded copper conductor of following sizes :

- All circuits except CT circuit : 1.5 sq.mm.

- CT circuit : 2.5 sq.mm.
- DC circuit : 2.5 sq.mm.

Longitudinal troughs extending throughout the full length of the panels to be provided for inter panel wiring, AC-DC supplies, PT circuits, annunciator circuits, etc. Ferrules for wire termination to be provided. Wire connected to trip circuit will have red colored ferrule.

4.2 Terminal Blocks

a) Terminals blocks for CT and PT secondary leads shall be provided with test links and isolating facilities. CT terminals shall have shorting facility

b) All terminal blocks shall be stud type

c) All spare contacts and terminals of the panel mounted equipment and devices shall be wired to terminal blocks. At least 20% spare terminals shall be provided.

d) Terminal blocks to be suitable for connecting the following conductors of the PURCHASER's cables on each side:-

| | |
|---|---|
| All circuits except CT circuit | Minimum of two 1.5 $mm^2$ copper |
| CT Circuits | Minimum of four 2.5 $mm^2$ copper |

4.3 Cable Terminations

a) Power and control cable glands and crimping type lugs shall be supplied to suit the cable sizes. All control wires shall have round lug (Not pin type)

b) Glands shall be heavy duty, double compression type made of brass and plated.

4.4 Control Supply

230 or 110V AC supply be provided for the switchgear. Suitable control transformer shall be provided to derive 110V AC control supply voltage. All inter panel wiring required shall be included in the scope.

4.5 Tests To Be Conducted

a) Functional test, temperature rise test, high voltage test, limits of operation test, insulation test. PURCHASER will have the option to witness the tests at the MANUFACTURER'S work before dispatch.

b) TENDERER shall furnish the type test certificates along with the Tender. In the absence of the same, the CONTRACTOR shall arrange to carry out the type test without any cost implication to the EMPLOYER.

4.6 Data To Be Furnished By The Vendor

A. List Of Drawings

The CONTRACTOR shall furnish the following drawings for the switchgear:

- Overall outline dimensions and general arrangement including plan, front elevation, rear & side elevations, clearances recommended in front and back.
- Switchgear layout plan including floor openings, fixing arrangements and loading details.
- Schematic control diagrams to cover controls, protection, interlocks, instruments, space heaters, etc. for each type of module.
- Detailed wiring diagram of each type of module, including terminal block numbers, ferrule numbers and the external cable connection designations
- Item wise bill of material for each module, listing all devices mounted and also otherwise furnished like cable glands, indicating the MANUFACTURER's type, rating, quantity & special notes, if any.
- Inter panel interconnection wiring diagram including terminal numbers and ferrule numbers.
- Each type of protection relay and circuit breaker release characteristics

NOTES:

- The CONTRACTOR shall be entirely responsible for the correctness of the internal wiring diagrams
- The CONTRACTOR shall ensure that the characteristics of the CTs, fuses, protection relays, VTs and all other devices offered by him are such as to be suitable for the purpose for which they are intended.

B. Test Certificates

Type test certificates of all standard component parts, e.g. contactors, breakers, switches, fuses, relays, CTs, VTs, and for the standard factory built assembly shall be submitted by the CONTRACTOR.

C. Instruction Manuals

The CONTRACTOR shall furnish specified number of copies of the instruction manual which would contain detailed instructions for all operational & maintenance requirement. The manual shall be furnished at the time of dispatch of the equipment and shall include the following aspects:

- Outline dimension drawings showing relevant cross-sectional views, earthing details and constructional features.
- Rated voltages, current, duty-cycle and all other technical information which may be necessary for correct operation of the switchgear.
- Catalogue numbers of all components liable to be replaced during the life of the switchgear.
- Storage for prolonged duration.
- Unpacking.
- Handling at site.
- Erection.
- Pre-commissioning tests.
- Operating procedures.
- Maintenance procedures.
- Precautions to be taken during operation and maintenance work.

D. Installation

The installation work shall cover assembly of various sections of the panels lining up, grouting the units etc. In the case of multiple panel switch boards after connecting up the bus bars etc., all joints shall be insulated with necessary insulation tape or approved insulation compound. A common earth bar as per these specifications shall be run inside at the back of switch panel connecting all the sections for connection to frame earth system. All protection and other small wirings for indication etc. shall be completed before calibration and commissioning checks are commenced. All relays, meters etc. shall be mounted and connected with appropriate wiring.

E. Testing And Commissioning

Commissioning checks and tests shall include all wiring checks and checking up of connections. Relay adjustment/setting shall be done before commissioning in addition to routine Megger tests. Checks and tests shall include the following: -

a) Operation checks and lubrication of all moving parts.
b) Interlock function checks.
c) Continuity checks of wiring, fuses etc. as required.
d) Insulation test: When measured with 500V Megger the insulation resistance shall not be less than 100 mega ohms.
e) Trip tests and protection gear test.

- Metering Devices

Current Transformers

CTs shall confirm to latest IS codes in all respects. All CTs used for medium voltage application shall be rated for 1 kV. CTs shall have rated primary current, rated burden and class of accuracy as specified in schedule of quantities/drawings. Rated secondary current shall be 5A unless otherwise stated. Minimum acceptable class for measurement shall be 0.5 to 1 and for protection class 5. CTs shall be capable of withstanding magnetic and thermal stresses due to short circuit faults. Terminals of CTs shall be paired permanently for easy identification of poles. CTs shall be provided with earthing terminals for earthing chassis, frame work and fixed part of metal casing (if any). Each CT shall be provided with rating plate indicating :

- Name and make
- Serial number
- Transformation ratio
- Rated burden
- Rated voltage
- Accuracy class

CTs shall be mounded such that they are easily accessible for inspection, maintenance and replacement. Wiring for CT shall be with copper conductor PVC insulated FRLS wires with proper termination works and wiring shall be bunched with cable straps and fixed to the panel structure in a neat manner.

Potential Transformer

PTs shall confirm to latest amendment up to date IS Codes.

Measuring Instruments

Direct reading electrical instruments shall conform to latest IS codes in all respects. Accuracy of direct reading shall be 1.0 of voltmeter and 1.5 for ammeters. Other instruments shall have accuracy of 0.5. Meters shall be flush mounting and shall be enclosed in dust tight housing. The housing shall be of steel or phenolic mould. Design and manufacture of meters shall ensure prevention of fogging of instrument glass. Pointer shall be black in colour and shall have Zero position adjustment device operable from outside. Direction of deflection shall be from left to right. Selector switches shall be provided for ammeters and volt meters used in three phase system.

**ANNEXURE-III**

**Multifunction meter for Incomers**

1. **Applicable Standards**

   **The meters shall conform in all respects to the following standards**

   - **IEC 61557-12,**
   - **IEC 62053-22,**
   - **IEC 62053-23**

2. **General Requirements**

- **The meter shall be suitable for operation in single - or multi- phase networks, balanced as well as unbalanced load**
- **It shall be possible to use the multifunction meter directly in 690V networks**
- **The current inputs shall be configurable at site for measuring on x/1 A or x/5 A current transformer**
- **The multifunction meters shall be suitable for operation up to 55 Deg C**
- **The meters shall be suitable for operation with AC auxiliary power and shall have wide tolerance band of 95V to 240 V (±10%)**
- **The multifunction meters shall have high degree of protection (IP65 from the front) against ingress of dust & water**
- **The multifunction meters shall have backlit LED display with adjustable contrast**
- **The meter shall be tamper-proof (password protected) to avoid mishandling by unauthorized person**
- **The entire multifunction meter should be IP based and can be hooked up to existing Intranet of the company.**
- **No external Converter should be used with the meter.**
- **Meters should comply to ISO50001.**

3. **Communication**
   **The meter must have Ethernet port onboard for Modbus TCP/IP communication. It should support at least 10Mbps speed for data transfer. It shall be possible to parameterize the device either by the keys on the device or through parameterization software. Every breaker should have one unique address for communication.**

4. **Measured Values requirement**
   **All metered values will be in "true RMS" values. The monitor shall include a keypad allowing for the viewing of different selected values. The monitor shall display the following values**

| | |
|---|---|
| **Voltages** | **Phase-phase / phase-neutral** |
| **Currents** | **Per phase** |
| **Apparent, active and reactive power** | **Per phase and total** |
| **Power factor** | **Per phase and total** |
| **Frequency** | **45...64 Hz** |
| **THD for voltage and current** | **Per phase** |
| **Min. / max. values** | **Voltage - phase-phase, phase-neutral, Current / Power / Power factor / THD per phase, Frequency, Three phase average voltage and current** |
| **Average values** | **Voltage - phase-phase, phase-neutral<br>Voltage min. / max. for phase-phase, phase-neutral<br>Current<br>Current min. / max.** |
| **Active energy** | **Import / export; high / low tariff** |
| **Reactive energy** | **Positive / negative; high / low tariff** |
| **Apparent energy** | **High / low tariff** |
| **Energy demand per measuring period** | **Three phase average rating for active and reactive power: 1 to 60 min.** |
| **Min. / max. rating values within the measuring period** | **Should be possible to be measured** |
| **Meter running counter** | **Uptime in hours** |
| **Universal counter** | **Pulse counting of external devices like water, gas, etc.** |

**a. Measurement Accuracy**

**The multifunction meters shall be of high accuracy type and shall have the following levels of accuracy.**

| | |
|---|---|
| **Voltage** | **± 0.3 %** |
| **Current** | **± 0.2 %** |
| **Power** | **± 0.5 %** |
| **Power factor** | **± 0.5 %** |
| **Active energy** | **Class 0.5S in accordance with IEC 62053-22:2003-01** |
| **Reactive energy** | **Class 2 in accordance with IEC 62053-23:2003-01** |

**i. The meter shall have at least 1 Digital Input and 1 Digital Output as standard. It shall be possible to switch between High-tariff and Low-tariff via the digital input or the communication interfaces.**

**ii. The device shall allow for monitoring of upper or lower limit values for parameters like V, I, p.f. etc. It should be also possible to build in logics so that multiple limit criteria are addressed. In case of limit violation, it shall be possible for triggering specified actions through the digital output of the meter**

**All Meters should be TUV Certified.**

Multi-Function Meters **(For Outgoing Feeders) :**

1.1. Applicable Standards

The meters shall conform in all respects to the following standards

- IEC 61557-12,
- IEC 62053-22-0.5S as per BOQ
- IEC 62053-23

1.2. General Requirements

- The meter shall be suitable for operation in single - or multi- phase networks, balanced as well as unbalanced load
- It shall be possible to use the multifunction meter directly in 690V networks
- The current inputs shall be configurable at site for measuring on x/1 A or x/5 A current transformers
- The multifunction meters shall be suitable for operation up to 55 Deg C
- The meters shall be suitable for operation with AC auxiliary power and shall have wide tolerance band of 95V to 240 V (±10%)
- The multifunction meters shall have high degree of protection (IP65 from the front) against ingress of dust & water
- The multifunction meters shall have backlit LCD/LED display with adjustable contrast
- The meter shall be tamper-proof (password protected) to avoid mishandling by unauthorized person
- The Multi-function meters at all incomer shall be with minimum accuracy class of 0.5s and should have capturing of individual harmonics with RS-485 communication.

1.3. Communication

The meter must have serial port on-board for Modbus RS485 communication.

1.4. Measured Values requirement

All metered values will be in "true RMS" values. The monitor shall include a keypad allowing for the viewing of different selected values. The monitor shall display the following values

1.5.

| | |
|---|---|
| Voltages | Phase-phase / phase-neutral |
| Currents | Per phase |
| Apparent, active and reactive power | Per phase and total |
| Power factor | Per phase and total |
| Frequency | 45...64 Hz |
| THD for voltage and current | Per phase |
| Min. / max. values | Voltage - phase-phase, phase-neutral, Current / Power / Power factor / THD per phase, Frequency, Three phase average voltage and current |
| Average values | Voltage - phase-phase, phase-neutral<br>Voltage min. / max. for phase-phase, phase-neutral<br>Current<br>Current min. / max. |
| Active energy | Import / export; high / low tariff |
| Reactive energy | Positive / negative; high / low tariff |
| Apparent energy | High / low tariff |
| Energy demand per measuring period | Three phase average rating for active and reactive power: 1 to 60 min. |
| Min. / max. rating values within the measuring period | Should be possible to be measured |
| Meter running counter | Uptime in hours |
| Universal counter | Pulse counting of external devices like water, gas, etc. |

Measurement Accuracy

The multifunction meters shall be of high accuracy type and shall have the following levels of accuracy.

| | |
|---|---|
| Voltage | ± 0.3 % |
| Current | ± 0.2 % |
| Power | ± 0.5 % |
| Power factor | ± 0.5 % |
| Active energy | Class 0.5S in accordance with IEC 62053-22:2003-01 |
| Reactive energy | Class 2 in accordance with IEC 62053-23:2003-01 |

1.6. The device shall allow for monitoring of upper or lower limit values for parameters like V, I, pf etc. It should be also possible to build in logics so that multiple limit criteria are addressed. In case of limit violation, it shall be possible for triggering specified actions through the digital output of the meter

**11.5 EARTHING SYSTEM**

A complete earthing system comprising earthing conductors, earth electrodes and earth connections necessary for effective and permanent bonding to earth, all non-current carrying metal work and for termination of the earthing conductors of all electrical 415V switchboards, sub boards, distribution boards, etc., installed for the Electricity Distribution System for this project shall be supplied, erected and connected under this section of the specification and the associated drawings.

Earthing conductor shall be as follows

| | | |
|---|---|---|
| Conductors above ground level and in cable trenches/ Hume pipe | : | Galvanized |
| Conductor buried in earth | : | GI |
| Electrodes | : | Galvanized Steel Pipe/GI plate /Cu plate |

The earthing conductor sizes shall be as follows

Main earthing conductor: Refer Earthing layout

Equipment earthing lead

| | | | |
|---|---|---|---|
| (a) | 415 V Switchgear, Motor control centre | : | Refer relevant drawings |
| (b) | Sub board, distribution boards, control panels, cable trays, 3/1 phase | : | Refer relevant drawings |

| | | | |
|---|---|---|---|
| | receptacles | | |

Earthing main conductor shall be provided around the buildings and interconnected as shown in the drawings. The Main Conductor and tap off Conductors length buried in soil shall be wrapped with bitumen tape for protection against corrosion.

Layout of earthing conductor inside the building shall be planned to provide earthing connection to all equipment and structures by short and direct earth leads. Grid riser in electrical shafts with tap-offs at each floor shall be provided. It shall be provided in ring formation.

The joints in the run of the earthing conductors shall be welded type. Connections with equipment/ structure shall be of bolted type.

Cable trays, steel pipes / conduits, steel columns, etc., shall not be used as earth continuity conductors. Earth connections for all sections of installation shall be electrically and mechanically sound.

All electrical equipment rated 240 Volts and above shall be earthed at two points except the 3-phase / 1 phase receptacles, cable trays lighting fixtures, conduits, hand rails, metallic non-current carrying structures, which shall be earthed at one point.

All works performed under this section shall also comply with the requirements of the local authority, IS 3043, 1987 and Earthing and Lightning Protection System- Notes and Details.

All three phase equipment shall be double earthed.

Chemical Earthing
In maintenance free earthing copper bonded earthing rod electrode shall be of 14.35 mm in diameter and 3 meter length. The rod shall be placed in a 150 mm dia an augured hole in the ground and then surrounded by ground enhancement material in either a dry form or pre mixed in slurry. Once set, ground enhancement material becomes hard and as such holds positively to the rod as well as surrounding ground.

Earth rod offered shall have passed the test required of BS7430/ ANSI/ UL467 and confirm to the adhesion of the copper coating to the steel core ( Design feature that prevents the ingress of moister and subsequently the integrity of the rod.

Minimum 0.25 mm thickness of copper shall be deposited over the steel core as per BS 7430/ UL 467. Average life of the ground rod shall be 30 years in most soil.

Ground enhancement material shall be as per IEEE-80 clause 14.5d with a resistivity of less than 0.12 ohm-meter. The ground enhancement material shall be permanent and not leach any chemicals in to the ground. The pH value of the ground enhancement material shall be 6.9 to 7.2 of 100 gm/ lit @ 20 deg.C.

Minimum 30 Kg of ground enhancement material shall provided for each earth electrode.

Inspection chamber shall be of 400 x 500 mm with concrete base CI manhole cover with frame painted with bitumastic paint. 2 Nos. of 50 x 6 mm cross section & 300 mm long copper strip to be clamped with copper claded rod electrode have sufficient nos( But not less than 4 Nos.) of 10 mm GI nuts & bolts for connection to the equipment / interconnection to the other pits to form equi-potential bonding.

1. Earth for UPS / Low volt / Servers

Clean earth shall be used for earthing UPS / Low volt / Server systems and shall be separate from safety earthing. Separate earthing electrode shall be provided in the ground and from this electrode, single core copper cable of required size shall be taken as earth conductor to be laid in the vertical

shaft. This cable shall be terminated on each floor in a earth terminal box located in the shaft. The earth terminal box shall have 50x6mm copper busbar mounted on insulators. The busbar shall have facility to terminate the incoming earth cable as well as required number of outgoing earth conductors.

Each down conductor shall be directly connected at the dedicated earthing pit and the dedicated earth pit shall be connected to the other earth pits in the earthing grid.

2. Earthing Systems – Installation Notes

General

a) These notes shall be read and considered in conjunction with earthing drawings and specification. In case of any conflict between these notes and drawings/ specification, the later shall prevail.

b) Earthing system layouts are diagrammatic only. Exact location of earthing conductors, earth electrodes and test pits and connection may be changed to suit the site conditions. Major modification should be referred to EMPLOYER for clearance.

c) Neutral point of the system of the different voltages, metallic enclosures and frameworks associated with all current carrying equipment and extraneous metal works associated with electric system shall be connected to a single earthing system unless stipulated otherwise.

d) Earthing system installation shall be in strict accordance with the latest editions of Indian Electricity Rules, Relevant Indian Standards and codes of practice and Regulations existing in the locality where the system is installed.

3. Earthing Conductor Layout

a) Earthing conductor in outdoor area shall be buried at least 600mm below finished floor level unless stated otherwise.

b) The spacing between adjacent rod / pipe electrode shall be twice the length of the electrode, unless otherwise stated elsewhere. The spacing between adjacent plate electrodes shall be 5000 mm minimum, unless otherwise stipulated otherwise.

c) Earthing conductor around the building shall be buried in earth minimum distance of 1500mm from the outer boundary of the building. All the electrical buildings will have earth conductors around the building.

d) Earthing conductors embedded in the concrete floor of the building shall have at least 50mm concrete cover.

e) Earthing conductor along their run on the columns, walls, etc., shall be fixed by suitable welding or cleating at intervals of 1000mm and 750mm respectively.

f) Tap connections from the floor earthing grid to the equipment / structure to be earthed shall be terminated on the earthing terminals of the equipment, if the equipment is available at the time of laying the grid. Otherwise “earth raiser “ or “earthing pads” shall be provided near the equipment foundation / pedestal for future connection to the equipment earthing terminals.

g) In outdoor areas, buried conductors shall be brought 500mm above the ground level for making tap connections to the equipment (above ground level)

h) Earthing conductors crossing the road shall be either installed in Hume pipes are laid at greater depths to suit the site conditions.

i) Wherever earthing conductor cross underground service ducts, pipes, trenches, tunnels, railway tracks etc., it shall be laid in Hume pipes and minimum 300mm below them. The earthing conductor shall be re-routed in case it fouls with equipment foundation.

j) Wherever earthing conductor passes through walls, floors etc., galvanized conduit / HDPE pipe sleeves shall be provided for the passage of the conductor. Both ends of the sleeve shall be sealed to prevent the passage of water through the sleeves. The seals in addition shall be fire proof if the specification / project drawings call for the same.

k) Water stops shall be provided wherever earthing conductors enters the building from outside, below the ground level.

l) Separate / isolated earthing system, if required, shall be provided for instrumentation and control and control systems in the plant, including dedicated earth pits.

m) Earth conductor shall be laid in the GI pipe for wall crossing.

4. Equipment And Structure Earthing

a) Earthing pads / terminals will be provided by the manufacturer of the apparatus/ equipment at accessible positions. The connection between the earthing pads/ terminals and earthing grids shall be made by short and direct earthing leads free from kinks and splices.

b) Whether specifically shown in drawing or not, Steel / RCC columns, metallic stairs, Hand rails etc., of the building housing electrical equipment shall be connected to the nearest earthing grid conductor by at least one earthing lead. Electrical continuity shall be assured by bonding the different sections of the handrails and metallic stairs.

c) Electrical conduits, pipes and cable tray sections shall be bonded to ensure electrical continuity and connected to earthing conductors at regular intervals. Apart from intermediate connections end and beginning points shall also be connected to earthing system. These details are covered separately under cabling installation notes and details which shall apply.

d) Steel / RCC columns, metallic stairs, Hand rails, Cable trays, metallic conduits, and pipes etc. shall not be used as earth continuity conductor.

e) A separate earthing conductor shall be provided for earthing lighting fixtures, receptacles, switches, junction boxes, lighting conduits, poles etc. This conductor in turn shall be connected to the main earth. These details are covered separately under lighting installation notes and details, which shall apply.

f) Whenever earthing conductor crosses or runs at less than 300mm distance along metallic structures such as gas, water, steam pipes, conduits etc., and steel reinforcement in concrete, it shall be bonded to the same. In case earthing connection to pipe and conduit etc. at a distance higher than 300mm is required, the same shall be marked on the drawing.

g) Miscellaneous items such as junction boxes, field switches, cable end boxes/ glands, fitting and fixture shall be earthed whether specifically show or not.

h) In general minimum two earth leads shall be used for earthing each equipment / structure enclosing the power conductor operating at more than 250V and one earth lead if the voltage level is 250V or less.

5. Jointing

a) Earthing connections to equipment earthing pads / terminals shall be bolted type with GI bolts and nuts. Contact surfaces shall be free from scale, paint, enamel, grease, rust or dirt. Two bolts (min.) shall be provided for making each connection. Equipment bolted connections, after being checked and tested, shall be painted with anti corrosive paint/ compound.

b) Connection between equipment earthing lead and main earthing conductors and between main earthing conductors shall be welded / brazed type. For rust protection the welds shall be treated with red lead and afterwards thickly coated with bitumen compound to prevent corrosion.

c) Steel to copper, copper to copper connections should be brazed type. Welding shall be adopted in case of steel. Welding to be done as per IS: 816.

d) The jointing whether welded, brazed of bolted shall be such that the resistance of the joint is not more than the resistance of the equivalent length of the conductor.

e) Welding / brazing surfaces shall be cleaned and made free of all oxide films, grease, oil or any foreign material. However, the joining surfaces should not be made too smooth / highly polished, to prevent the joining material from flowing away.

f) All brazing should be done by oxy- acetylene torch flame.

g) All welded connections shall be made by electric arc welding. All welded joints shall be allowed to cool down gradually to atmospheric temperature before putting any load on it. Artificial cooling shall not be allowed.

h) Bending of large diameter rod / thick conductors shall be done preferably by gas heating.

i) All arc welding with large diameter conductor shall be done with low hydrogen content electrodes.

j) For brazing alloys of silicon bronze/ phosphor or copper/ phosphor-silver-copper shall be used.

1.1 Cable Earthing

Metallic sheaths, screens and armour of all multicore power/ control cables shall be earthed at both equipment and source / switchgear end. Sheath and armour of single core power cables shall be earthed at source /switchgear end only, unless otherwise stated elsewhere.

1.2 Testing & Commissioning

After completion of erection works before equipment is charged, the following minimum test shall be carried out. All test shall be recorded in the format as approved by Architect/Consultant besides the test mentioned below any other tests specified by the local authority shall also be carried out. All tools and celebrated instruments for testing, labour, materials and incidentals necessary, to conduct the tests mentioned below shall be provided by the contractor at his own cost.

- Insulation resistance test of all the feeders by 500 V megger.
- Insulation resistance test of all LT cables with 500 V megger.
- Continuity test of all the cores and the armour cables.
- Sheathing continuity test.
- Testing of Wiring:
- All wiring systems shall be tested for continuity of circuits, short circuits, and earthing after wiring is completed and before installation is energized.
- Testing of Earth Continuity Path:
- Insulation resistance Test
- Polarity test of switches

The above test reports shall be submitted by contractor to Engineer incharge.

6. Lightning and Surge Voltage Protection

a) Scope

This specification describes the electrical and mechanical requirements for a high energy Transient Voltage Surge Suppressor (TVSS).The specified TVSS/SPD system shall be connected in parallel to the facility's electrical main incoming (main LT panel) as well as final distribution boards, shall provide effective high energy surge current diversion, and shall be suitable for application in ANSI/IEEE C62.41 Category A, B and C environments or IEC 61643-1 Class I, II and III.

b) Codes & Standards

The specified system shall be designed, manufactured, tested and installed in compliance with the following codes and standards:

IEC 61643-1: Surge Protective Devices connected to low voltage power distribution systems.
Underwriters Laboratories: (UL 1449, 2nd edition) Standard for Transient Voltage Surge Suppressors. International Standards Organization (ISO) Company certified ISO9001 for manufacturing, design and service and the applicable portions of the American National Standards Institute and Institute of Electrical and Electronic Engineers standards (ANSI/IEEE 1100 ,C62.11, C62.41, C62.45)

c) Electrical Requirements

- Nominal system operating voltage

  The single phase TVSS system shall be suitable for installations operating between 220VAC and 240VAC.

  The three phase TVSS system shall be suitable for installations operating between 380VAC to 415VAC, Star (Y) Configuration: 3 Phase 4 Wire Plus Ground or Delta Configuration: 3 phase 4 wire including Ground.
- Maximum Continuous Operating Voltage (MCOV):

The maximum continuous operating voltage of the complete TVSS, as well as all components in the suppression path shall be greater than 125% of the nominal system operating voltage to ensure the ability of the system to withstand temporary RMS over voltages (swell conditions).

- Operation Frequency:

  The operating frequency range of the system shall be 50 Hz.
- Protection Modes:

  Note: L = Line, G = Ground, N = Neutral

The SPD shall provide protection in all modes (L-N or L-L, L-G and N-G where applicable)

Surge Current Capacity:

| Location | Class | Surge Current |
|---|---|---|
| Main Distribution Feeders | Class B | 100/160 KA |
| Sub distribution Panels | Class A | 50 KA |

Short-circuit Withstand Capability:
The TVSS shall be able to carry the power short circuit current until it is interrupted by external over-current disconnect or by the backup over current protection. The minimum Short Circuit Withstand of the TVSS shall be according to the table below:

| Class | Minimum Short Circuit Withstand Capability |
|---|---|
| Class B | 35 to 65KA |
| Class A | 14KA |

Over current Protection (fusing)
All components, including suppression, filtering, and monitoring components, shall be individually fused at the component level with the fuses rated so as not to impede maximum specified surge current capacity. The fuse shall be capable of opening in less than one millisecond and clear both high and low impedance faults.

Clamping Voltage:
The TVSS shall able to clamp the voltage:

| System Voltage | Max Let Through Voltage |
|---|---|
| 120, 120/208 or 120/240 | 400 volts |
| 208, 240, 277, 230/400 or 277/480 | 800 volts |
| 346, or 346/600 | 1200 volts |
| 480 | 1500 volts |
| 600 | 2000 volts |

Response Time:
Typical response time of all suppression components shall be <0.5 ns.

Noise Attenuation
The filter shall provide insertion loss with a maximum of 40dB to 50dB from 10 kHz to 100 MHz with data obtained utilizing the 50 ohm Insertion Loss Methodology from MIL-STD-220A.

Environmental Requirements
Operating Temperature :- $40^0$ C to $+85^0$ C ($-40^0$ to $+187^0$ F)
Relative humidity : - 0% to 95%

Audible Noise:- The unit shall not generate any appreciable noise. 40 DB for RFI and EMI noise attenuation

Operating Altitude: 0 to 14,000 feet above sea level.

Magnetic Fields: The unit shall not generate any appreciable magnetic fields and shall suitable for use directly inside computer rooms.

Connection type- Parallel

Protection lvl in kV – based on level of protection

Status indication – LED type dry contacts

## 11.6 LIGHTNING PROTECTION SYSTEM

Conventional Type

1. General

Supply & installation of Lightning Protection System shall be strictly in accordance with IS2309/IEC: 62305-2010.

Zone of Protection

The zone of protection of a lightning conductor defines the space within which a lightning conductor provides protection against a direct lightning stroke by diverting the stroke to itself. For a single vertical conductor, this zone is described as a cone with its apex at the highest point of the conductor and with an angle called as protective angle. For the purpose of providing an acceptable degree of protection the protective angle of termination network shall be considered as 4°. Between two or more vertical conductors of equal height spaced at a distance not exceeding twice their height, the protective angle within the space bounded the air termination shall be taken as 60° to the vertical, while the protective angle away from the conductor will be taken as 45° to the verticals.

2. Material and Dimensions

The materials of lightning conductor, down conductors, earth termination etc. shall be copper / GI as per schedule of quantities and shall be protected against corrosion.

All air terminations and down conductors shall be of copper / GI as per schedule of quantities and shall conform to IS/IEC: 62305-2010.

3. Joints and Bonds

The lightning protective system shall have as few joints as far as possible. Wherever joints in the conductor are necessary they shall be mechanically and electrically effective, and shall be riveted and brazed in case of copper and by welding / bolting in case of GI in an approved manner.

4. Earth Terminations

Each down conductor shall have an independent earth termination. All the earth termination shall be inter-connected and shall be capable of isolation for testing.

5. Earth Electrode

Earth pits shall be of GEL type.

The resistance of earthing system shall not exceed 1 ohm.

6. Air Terminations Mesh (On the Terrace)

As an alternative to vertical air termination, grid of horizontal air termination may also be provided as per IS2309/IEC:62305-2010. Often combination of both may be provided when structure to be protected for high ratio of length to height. Air termination mesh shall be provided not greater than 10mx20m. Down conductor shall be not more than 10 m apart where the building height in more than 20 m.

The design shall be made according to IS:2309/IEC 62305-3 using any or combination of three method -

Rolling sphere,Angle of protection and Mesh method as per defined lightning protection level.

- ✓ Rolling sphere method
- ✓ Mesh method
- ✓ Protective angle method

The designing is based on level of protection of individual building / structure determined by Risk assessment. It differentiates between four classes of lightning protection system. A Class I lightning protection system provides the maximum protection and a Class IV, by comparison, the least.

| Lightning protection level LPL | Probabilities for the limit values of the lightning current parameters | | Radius of the rolling sphere (final striking distance $h_B$) r in m | Min. peak value of current I in kA |
|---|---|---|---|---|
| | < Max. values acc. to Table 5 IEC 62305-1 (EN 62305-1) | > Min. values acc. to Table 6 IEC 62305-1 (EN 62305-1) | | |
| IV | 0.84 | 0.97 | 60 | 16 |
| III | 0.91 | 0.97 | 45 | 10 |
| II | 0.97 | 0.98 | 30 | 5 |
| I | 0.99 | 0.99 | 20 | 3 |

Relations between lightning protection levels.
The rolling sphere method is the universal method of design particularly recommended for all types of buildings / structure especially to geometrically complicated applications.

Separation distance shall be considered while designing the ELP as per IEC 62305-3which is essential to avoid creepage flashover. It can be achieved either by maintaining physical separation distance or by use of High voltage insulated (HVI) cable, as a down conductor to compensate the need of the separation distance.

Lightning Protection components shall be tested for natural weathering and exposure to corrosion i.e. Salt Mist Treatment test according to EN 60068-2-52 and Humid Sulphurous atmosphere treatment test according to BS EN ISO 6988.

Metal compatibility shall be ensured to avoid corrosion and contact resistance at connection point.

External Lightning Protection comprises of below listed items: All components shall meet the requirement of IEC 62305 standard.

7. Down conductor
In order to reduce probability of damage it is often necessary to have several parallel current paths. As recommended by IS/IEC:62305-2010 equal spacing of down conductors , 8 mm Copper \ AL \ GI external strip, around the building perimeter

The down conductor must be kept in constant physical contact with the structure via conductive mounting clamps.

Each down conductor shall be directly connected at the dedicated earthing pit and the dedicated earth pit shall be connected to the other earth pits in the earthing grid.

Alternatively, steel reinforcement can be used as down conductor in line with IS/IEC:62305-2010. Steelwork within reinforced concrete structures is considered to be electrically continuous, provided that major part of interconnections of vertical & horizontal bars are welded, clamped or overlapped a minimum of 20 times their diameter and bound or otherwise securely connected.

While using structural reinforcement as down conductor,
- Preferably outer columns which are straight from terrace up to the ground floor shall be used as down conductor. Steel bars in this column should be welded \ bolted with proper overlapping at every floor to ensure, proper continuity throughout.
- At ground level steel bars shall be taken out & welded \ bolted to the GI tape, and the tape will be carried out till the earthing pit at ground
- Also at terrace level steel bars will be taken out & to the connected to the Air terminal

This method is allowed by IS \ IEC , however requires close coordination with structural agency & monitoring during construction work to ensure proper bonding of steel bars at every level.

In this case responsibility matrix, may be worked out as under –

| Sr. No. | Description | Responsibility |
|---|---|---|
| | Design stage | |
| 1 | System proposal with details like, identification of column, recommended overlapping to ensure continuity, typical details for taking out reinforcement at various levels, bonding details etc, | MEP consultant |
| 2 | Integration of all above details in the arch & GFC structural design to be followed for construction. | Arch & structural consultant |
| | Construction Stage | |
| 3 | Direct Supervision on site to ensure proper overlapping, workman ship to ensure continuity. Proper log of continuity at every floor level before & after pouring of concrete | Engineer In-charge \ Electrical Contractor |
| 4 | Ensure proper method to take out reinforcement at various levels for connection with AT & EP network & bonding with structure of curtain wall. | Engineer In-charge \ Electrical Contractor |

For buildings utilizing steel reinforcement as down conductor, the electrical continuity if reinforcing bars shall be determined by electrical testing between uppermost part &ground level. The overall electrical resistance should not be greater than 0.2 ohms measured using test equipment suitable for this purpose.

8. Fasteners

Conductors shall be securely fixed to the building to be protected by fasteners which shall be not more than 1.20 meter apart for horizontal run and 1.0 meters for vertical run.

| | | |
|---|---|---|
| 1 | Air terminal | It shall be made of Aluminum/ GI or it's alloy, as far as possible drilling shall be avoided on roof top, The terminal shall withstand wind velocity of 145 KM/hour. |
| 2 | Down conductor | Preferably round conductor (long length, minimum joints) shall be made of Aluminum / GI or it's alloy, min dia 8 mm. |
| 3 | Clamp for support to conductor | The conductor shall be supported with the structure at every 1 mtr, as far as drilling shall be avoided on roof top. |
| 4 | Expansion piece | It shall be used at every 20 -25 mtr to compensate the expansion and contraction of metal due temperature variation. |
| 5 | Cross connectors | In case of conductors are crossing one over another/ T joints “cross connector clamp” (universal clamps) shall be used. |
| 6 | Test clamps | It shall be used for every down conductor at 1(approx) meter above to ground level (connection /disconnection purpose). |
| 7 | Equi-potential bond | All metal (natural conductor) components shall be bonded together with roof/down conductor for equi-potential bonding. |

## 11.7 1.1 KV GRADE CABLES AND CABLE TRAYS

a. Standards Of Codes

This chapter covers the specifications for supply and laying of Medium Voltage XLPE insulated PVC sheathed FRLS cables for 1100 volts.

All equipments, components, materials and entire work shall be carried out in conformity with applicable and relevant Bureau of Indian Standards and Codes of Practice, as amended upto date. In addition, relevant clauses of the Indian Electricity Act 1910 and Indian Electricity Rules 1956 as amended upto date shall also apply. Wherever appropriate Indian Standards are not available, relevant British and /or IEC Standards shall be applicable.

b. Cables

Medium voltage cables shall be aluminium/copper ( as specified in BOQ) conductor XLPE insulated, FRLS PVC sheathed, armoured conforming to latest IS. Cables shall be rated for 1100 Volts.

Conductors shall be insulated with high quality XLPE base compound. A common covering (bedding) shall be applied over the laid up cores by extruded sheath of un-vulcanised compound. Armoring shall be applied below outer sheath of PVC sheathing. The outer sheath shall bear the manufacturer's name and trade mark at every meter length. Cores shall be provided with following color scheme of PVC insulation.

| | | |
|---|---|---|
| 1 Core | : | Red/Black/Yellow/Blue |
| 2 Core | : | Red and Black |
| 3 Core | : | Red, Yellow and Blue |
| 3 ½ /4 Core | : | Red, Yellow, Blue and Black |

c. LAYING

Cables shall be laid as per the specifications given below :

1.1 Duct system

Wherever specified such as road crossing, entry to building or in paved area etc. cables shall be laid in underground ducts. The duct system shall consists of a required number of stone ware pipes, GI, CI or spun reinforced concrete pipe with simplex joints and all the jointing work shall be done according to the CPWD building specifications or as per the instructions of the Engineer-In-Charge as the case may be. The size of the pipe shall not be less than 100mm in diameter for a single cable and shall not be less than 150mm for more than one cable and so on. The pipe shall be laid directly in ground without making any special bed but wherever asbestos cement pipes are used, the pipes shall be encased in concrete of 75mm thick. The ducts shall be properly anchored to prevent any movement. The top surface of the cable ducts shall not be less than 60 cm. below the ground level. The ducts shall be laid a gradient of at least 1:300. The duct shall be provided manholes of adequate size at regular intervals for drawing the cables. The manhole cover and frame shall be of cast iron and machine finished to ensure a perfect joint. The manhole covers shall be installed flush with the ground or paved surfaces. The duct entry to the manholes shall be made leak proof with lead-wool joints. The ducts shall be properly plugged at the ends to prevent entry of water, rodents, etc. Suitable duct markers shall be placed along the run of the cable ducts. The duct markers shall at least be 15 cm. square embedded in concrete, indicating duct. Suitable cable supports made of angle iron shall be provided in the manholes for supporting the cables. Proper identification tags shall be provided for each cable in the manholes.

1.2 Cables in outdoor trenches

Cable shall be laid in outdoor trenches wherever called for. The depth of the trenches shall not be less than 75cm from the final ground level. The width of the trenches shall not be less than 45 cm. However, where more than one cable is laid, an axial distance of not less than 15 cm. shall be

allowed between the cables. The trenches shall be excavated in reasonably straight line with vertical side walls and with uniform depth. Wherever there is a change in direction suitable curvature shall be provided complying with the requirements. Suitable shoring and propping may be done to avoid caving in of trench walls. The bottom of the trench shall be level and free from stone brick bats etc. The trench shall then be provided with a layer of clean, dry sand cushion of not less than 8 cm. in depth.

The cable shall be pulled over rollers in the trench steadily and uniformly without jerks and strains. The entire cable length shall as far as possible be paved of in one stretch. However where this is not possible the remainder of the cable may be removed by "Flaking" i.e. by making one long loop in the reverse direction. After the cable has been uncoiled and laid into the trench over the rollers, the cable shall be lifted slightly over the rollers beginning from one end by helpers standing about 10 mtrs. apart and drawn straight. The cable should then be taken off the rollers by additional helpers lifting the cable and then laid in a reasonably straight line.

For short cut runs and sizes upto 50 sq.mm of cables upto 1.1 KV grade any other suitable method of direct handling and laying can be adopted with the prior approval of the Engineer-in-charge.

When the cable has been properly straightened, the cores are tested for continuity and insulation resistance and the cable length then measured. The ends of all cables shall be sealed immediately. In case of PVC cables suitable moisture seal tape shall be used for this purpose.

Cable laid in trenches in a single tier formation shall have a covering of clean, dry sand of not less 17 cms above the base cushion of sand before the protective cover is laid. In the case of vertical multi-tier formation after the first cable has been laid, a sand cushion of 30 cms shall be provided over the initial bed before the second tier is laid. If additional tiers are formed, each of the subsequent tiers also shall have a sand cushion of 30 cms as stated above. The top most cable shall have final sand covering not less than 17 cms before the protective cover is laid.

Unless otherwise specified, the cables shall be protected by the second class bricks of not less 20 cms x 10 cms x 10 cms (nominal size) protection covers placed on top of the sand (bricks to be laid breadth wise) for the full length of the cable. Where more than one cable is to be laid in the same trench, this protective covering shall cover all the cables and project at 5 cm. over the sides of the end cables. The trenches shall be taken back filled with excavated earth free from stones or other sharp edge debris and shall be rammed and watered, if necessary, in successive layers not exceeding 30 cm, unless otherwise specified.

1.3 Route Marker & Painting

Cable route marker marked "Cable" shall be provided alongwith the route of the cable and location of loops. The route markers shall be of tapered concrete slab of 60 x 60cm at bottom and 50 x 50cm at top having a thickness of 10cm. Cable marker shall be mounted parallel to and 50cm away from the edge of the trench.

All exposed part of cables (Horizontal run) in all manholes & all vertical cables running through shafts shall be painted with a fire resistant paint.

1.4 Cables in indoor trenches

Cables shall be laid in indoor trenches wherever specified. The trench shall be made of concrete with smooth cement mortar finish with suitable removable covers (i.e. precasted slabs or chequred plates). The dimensions of the trenches shall be determined depending upon the maximum number of cables that is expected to be accommodated and can be conveniently laid. Cables shall be arranged in tier formation in trenches and if necessary, cables may be fixed with clamps. Suitable clamps, hooks and saddles shall be used for securing the cables in position. Spacing between the

cables shall not be less than 15 cm centre to centre. Wherever specified, trenches shall be filled with fine sand and covered with RCC or steel chequred trench covers.

1.5 Cable on Trays / Racks

Cable shall be laid on cable trays/racks wherever specified. Cable racks/trays shall be of ladder/ perforated, trough or channel design suitable for the purpose. The nominal depth of the trays/racks shall be 50 mm. The width of the trays shall be shall be as per cable quantities laid. The trays/racks shall be completed with end plates, tees, elbows, risers, and all necessary hardware, entire steel trays/ racks shall be hot dip galvanized including widths & accessories. Cable trays shall be erected properly to present a neat and clean appearance. Suitable cleats or saddles made of aluminium strips with PVC covering shall be used for securing the cables to the cable trays. The cable trays shall comply with the following requirements :

The tray shall have suitable strength and rigidity to provide adequate support for all contained cables.

- It shall not present sharp edges, burrs or projections injurious to the insulation of wiring/cables.
- If made of metal, it shall be adequately protected against corrosion or shall be made of corrosion-resistant material.
- It shall have side rails or equivalent structural members.
- It shall include fittings or other suitable means for changes in direction and elevation of runs.

1.6 Installation

Cable trays shall be installed as a complete system. Trays shall be supported properly from the building structure. The entire cable tray system shall be rigid.
Each run of the cable tray shall be completed before the installation of cables.

In portions where additional protection is required, non combustible covers/enclosures shall be used.

Cable trays shall be exposed and accessible.

Where cables of different system are installed on the same cable tray, non combustible, solid barriers shall be used for segregating the cables.

Cable trays shall be grounded by two nos, earth continuity wires. Cable trays shall not be used as equipment grounding conductors.

At no place the cable tray / rack / ladder running horizontally should rest on any building partition like Brick wall, RCC beams etc. but instead proper hangers to be provided at minimum of 1500 mm intervals and at every Turning Angles.

1.7 Hangers & Supports

Wire Hangers shall be used to suspend all static Electrical services. Wire Hangers should consist of a pre-formed wire rope sling with a range of end fixings to fit various substrates and service fixings, these include a ferruled loop, permanently fixed threaded M6 (or M8, M10) stud, permanently fixed nipple end with toggle, at one end or hook or eyelet, cladding hook, barrel, wedge anchor, eyebolt anchor or any other end fixture type or size as per Manufacturers recommendation and design. The end fixings and the wire must be of the same Manufacturer with several options available. The system should be secured and tensioned with a Hanger self-locking grip at the other end. Once the grip is locked for safety purpose unlocking should only be done by using a separate setting key and should not be an integral part of the self-locking grip. Only wire and/or supports supplied and/or approved, shall be used with the system.

**a.** Wire Hangers should have been independently tested by Lloyds Register. APAVE, TUV, NEBS, CSA, Chiltern International fire, ADCAS, Intertek, ECA, and SMACNA, approved by ULC and CSA and comply with the requirements of DW/144 and BSRIA – wire Rope Suspension systems. Wire

rope should be manufactured to BSEN 12385: 2002

**b.** The Contractor shall select the correct specification of wire hanger to use for supporting each particular service from table 1 below. Each size is designated with a maximum safe working load limit (which incorporates a 5:1 safety factor).

The correct specification of wire Hanger required is determined using the following formula.

Weight per meter of object suspended (kg) X distance between suspension points (m) = weight loading per Hanger suspension point (kg).

Where the installed wire rope is not vertical then the working load limit shall be reduced in accordance with the recommendations give in the Manufacturer's handbook.

The Contractor shall select the correct length of wire rope required to support the service. Lengths from 1-10m lengths. Specials can be made, check with Manufacturer. No in–line joints should be made in the rope.

| Wire (Gripple) Hanger Safe Working Loads | | |
|---|---|---|
| **size** | **minimum breaking load of Wire Rope** | **working load limit (kg/lbs)** |
| No. 1 | 80kg/176 lbs | 0-10 kg / 0-22 lbs |
| No. 2 | 260kg/572 lbs | 10-45 kg / 23-100 lbs |
| No. 3 | 580kg/1276 lbs | 45-90 kg / 101-200 lbs |
| No. 4 | 1500kg/3300 lbs | 90-225 kg / 210-495 lbs |
| No. 5 | 2160kg/4752 lbs | 225-325 kg / 496-715 lbs |
| No. 6 | 2500kg/5500 lbs | 325-500 kg / 715-1100 lbs |

The standard range of Hanger Kits should contain galvanized high tensile steel wire rope or stainless steel wire rope as per the application; the minimum specification is as above and should be manufactured to BS 302 (1987), BSEN12385. Comply with Manufacturer's load ratings and recommended installation procedures. Note the testing is done to the minimum breaking load of the wire thus giving a minimum safety factor of 5: 1.

**a.** Supports can be provided for: Bus bar, Cable Ladder, Cable Tray, Cable Basket, Channel, Trunking, Light Rafts, Luminaires, Secondary Supports, Safety Lines, High Bay/Low Bay Lights, Electrical Cables, CCTV and Catenary Supports: Y-Fit solution shall be used to a maximum width of 500mm Cable Tray. For Tray over 500mm cradle support method or independent supports must be taken as appropriate based on load. Any other solution can be used based on Manufacturer's recommendation on site conditions after prior approval.

1.8 Jointing and Termination's

Cable jointing shall be done as per the recommendations of the cable manufacturer. All jointing work shall be done only by qualified/licensed cable jointer.

All jointing pits shall be of sufficient dimensions as to allow easy and comfortable working.

Jointing materials and accessories like conductor, ferrules, solder, flex, insulating and protective tapes, filling compound, jointing box etc. of right quality and correct sizes, confirming to relevant Indian Standards.

Each termination's shall be carried out using brass double compression glands and cable sockets. Hydraulic crimping tool hall be used for making the end termination's. Cable gland shall be bonded to the earth by using suitable size copper wire/tape.

1.9 Specific Requirements - Power Cables

The cables shall be 1100V grade, single / multi-core, stranded XLPE insulated aluminium/copper conductor and FRLS PVC sheathed. The cables for emergency services shall be with additional FRLS properties. The cables shall conform to IS. IS 7098-Part-I for multicore cables, fillers used to fill in the space between the phases shall be non-hygroscopic, chemically inert and non-putrescent.

Cables laid outside the building, either buried or in trench shall be of armored type. All power cables shall be armored type.

1.10 Specific Requirements - Control Cables

1100V grade multicore, 1.5 / 2.5 sq.mm stranded copper conductor, PVC insulated and extruded PVC inner sheathed and extruded FRLS PVC outer sheathed of PVC. FRLS cables, which have outer sheath of specially formulated FRLS PVC cable, shall be used for cables connected to Emergency services. The cables shall conform to IS 1554 Part- I (1985) / IEC 502 (1983) in all other respects.

Cables laid outside the building, either buried or in trench shall be of armoured type.

1.11 Design Criteria for Cable Sizing

Power cables shall be selected on the following basis:

a) Power cable shall carry the full load current of the circuit continuously under site conditions considering the various derating factors like ambient air temperature (50 deg C), grouping, laying methods etc.

b) Power cable shall be sized to restrict the voltage drop in cables between LT panels to motor terminal for full load current shall be limited to 3%. The total voltage drop transformer secondary to motor terminal shall be limited to 5%. Under motor starting conditions the corresponding voltage drop shall not exceed 10%.

c) Cable shall have less than 1% loss as per the GRIHA norms

d) Power cable shall withstand the fault current of the circuit for the duration not less than the maximum time taken by the primary protective system to isolate the fault.

1.12 Testing of Cables

Cables shall be tested at works for all routine tests as per IS including the following tests before being dispatched to site by the project team.

Insulation Resistance Test.

Continuity resistance test.

Earth test.(in armoured cables)

Hi Pot Test.

Test shall also be conducted at site for insulation between phases and between phase and earth for each length of cable, before and after jointing. On completion of cable laying work, the following tests shall be conducted in the presence of the Owner's site representative.

Insulation Resistance Test (Sectional and overall)

Continuity resistance test.

Earth test.

All tests shall be carried out in accordance with relevant Standard Code of Practice and Electricity Rules. The Contractor shall provide necessary instruments, equipment and labour for conducting the above tests and shall bear all expenses in connection with such tests. All tests shall be carried out in the presence of the Engineer In charge/ his representative, results will be noted and signed by all present and record be maintained. All the test certificate shall be submitted by contractor.

d. CABLE TRAYS

Cable Trays shall be Hot dip Galvanized and factory fabricated out of G.I. channels, angle iron, tee, bends, sections, flats and perforated sheet for different loads and number and size of cables as given below :

Cable trays shall be galvanized as per Specification given elsewhere.

Ladder Type (Hot dip galvanized)

1000 mm wide

Runners 25 x 100 x 25 x 3 mm
Rungs 2# 20 x 40 x 20 x 3 mm 250 mm C/C
Suspenders 2 Nos. 40 x 40 x 5 mm GI angle 1500 mm C/C with base support of 40x 40 x 5mm GI angle.

750 mm wide
Runners 20 x 75 x 20 x 2.5 mm
Rungs 20 x 30 x 20 x 2.5 mm 250 mm C/C
Suspenders 2 Nos. 32 x 32 x 5 mm GI angle 1800 mm C/C with base support of 40x 40 x 5mm GI angle.

600 mm wide
Runners 20 x 75 x 20 x 2.5 mm
Rungs 20 x 30 x 20 x 2.5 mm 250 mm C/C
Suspenders 2 Nos. 32 x 32 x 5 mm GI angle 1800 mm C/C with base Support of 40x 40 x 5mm GI angle.

450 mm wide
Runners 20 x 75 x 20 x 2.5 mm
Rungs 20 x 30 x 20 x 2.5 mm 250 mm C/C
Suspenders 2 Nos. 25 x 25 x 4 mm GI angle 1800 mm C/C with base support of 40x 40 x 5mm GI angle.

Supply and fixing of perforated type cable trays of the following sizes of pre-galvanized iron.

a) 900 mm width X 62.5 mm depth X 2.0 mm thickness
b) 750 mm width X 62.5 mm depth X 2.0 mm thickness
c) 600 mm width X 62.5 mm depth X 2.0 mm thickness
d) 450 mm width X 50 mm depth X 2.0 mm thickness
e) 300 mm width X 50 mm depth X 1.6 mm thickness
f) 150 mm width X 50 mm depth X 1.6 mm thickness

Note: Suitable length of 10 mm dia GI rod suspenders at 1800 mm interval shall be included in the item for perforated type cable tray.

Specification for Hot Dip Galvanizing Process for Mild Steel Used For Earthing, Cable Trays or Junction Boxes for Electrical Installation.

1.1 General Requirements

Quality of Zinc

Zinc to be used shall conform to minimum Zn 98 grade as per requirement of IS:209-1992.

Coating Requirement

Minimum weight of zinc coating for mild steel flats with thickness upto 6 mm in accordance with IS:6745-1972 shall be 400 g/sqm.

The weight of coating expressed in grams per square metre shall be calculated by dividing the total weight of Zinc by total area (both sides) of the coated surface.

The Zinc coating shall be uniform, smooth and free from imperfections as flux, ash and dross inclusions, bare patches black spots, pimples, lumpiness, runs, rust stains bulky white deposits, blisters.

Mild steel flats / wires shall undergo a process of degreasing pickling in acid, cold rinsing and then galvanizing.

The thickness of galvanizing shall be 610 gm / Sq. mtr. (87 Microns) in line with IS: 4759

All finished cable trays and accessories shall be free from sharp tees, corners, burrs and unevenness.

1.2 Cable Trays - Installation Notes

Cable trays shall be installed generally at the elevations shown in respective cable tray layout drawings. If any major modifications in the drawings are envisaged in the field, these should be carried out after getting approval from design office.

Before laying the trays, contractor shall submit the shop drawing & take the approval from client/consultant.

It shall be the responsibility of the electrical contractor to mark up all the field modifications on the latest issues of the drawings and return two copies of all such " as constructed " drawings to client/consultant's design office.

The type and size of tray to be used shall be as mentioned in the individual layout drawings.

Cable trays shall be welded to the mounting/carrier structures. Trays shall be supported with suitable angle/hitech rod supports.

Each continuous laid out length of cable tray shall be earthed at minimum two places by GI flats of minimum size 25x6 mm (unless otherwise noted) to the purchaser's earthing system. The distance between earthing points shall not exceed 10 meters.

The following shall be checked before laying the cables on trays.

a) Check for proper identification nos. of the trays.
b) Check for continuity of cable trays over the entire route.
c) Check that all sharp corners, burrs and waste materials have been removed from the tray.
d) Obtain clearances from piping contractor / engineer that no piping will be taken in the way of cable trays.
e) Check for earth continuity & earth connection of cable trays.
f) Cable tray installation work shall comply with all currently applicable statutes, regulations and safety codes in the locality/country where the installation is to be carried out.

## 11.8 ELEVATOR WORKS

1. General

The following elevator standards and design criteria are for the guidance of the elevator system contractor in understanding features and facilities, and the quality of after sales services required for the Projects.

The elevator contractor shall regard these standards and specifications describing a complete, functioning system with necessary intelligence, flexibility and riding comfort provided herein. Nothing in these specifications shall be taken to state or imply "work by others" except where specifically so mentioned. The contractor shall, at the time of tender, clearly indicate features and facilities which he is unable to provide or modifications or any alternate system he wants to offer. Such features & facilities shall be clearly identified at the time of submitting his offer. The cost of such items of materials, equipment, and labour shall also be identified separately.

2. GOVERNING CODES AND PERMITS

2.1 Code (Imported Equipment)

Elevator equipment shall be furnished and installed in accordance with A.N.S.I. / A.S.M.E. A17.1/ CENEN 81-1 Japanese Codes including latest supplement. The Elevator Contractor shall inform the owning Company of any intended or required departures from the code requirements described above.

No degradation of ANSI/ASME/CENEN 81-1 requirements is acceptable simply on the basis of the local code requirement. It is acceptable only when the ANSI/ASME/CENEN 81-1 code is in direct conflict with local code requirements and where the latter is more stringent than the former.

2.2 Site Conditions

Location : Delhi

Notes: All equipment shall give required output under the above conditions.

3. PROJECT EXECUTION AND MANAGEMENT

The Contractor shall ensure that senior planning and erection personnel from his organization are assigned exclusively for this project. They shall have minimum 8 to 10 years experience in this type of installation. The Contractor shall appoint one erection engineer and one senior supervisor posted at site on full time basis.

For quality control and monitoring of workmanship, contractor shall assign at least one full time engineer who would be exclusively responsible for ensuring strict quality control, adherence to specifications and ensuring top class workmanship for the installation.

The contractor shall arrange to have mechanized and modern facilities of transporting material to place of installation for speedy execution of work.

4. GUARANTEE, MAINTENANCE

4.1 Guarantee

The elevator contractor shall guarantee all equipment parts, materials and workmanship furnished for the installation. The elevator contractor warrants for a period of 24 months from the date of acceptance to replace all failed part or parts exhibiting unusual wear and tear during guarantee period and shall be replaced without any cost to the Owner, such replacement shall be factory approved new, equal or better than original. All labour, tools, materials, transportation, insurance, etc. required in performance of guarantee shall be at the elevator contractor's expense.

4.2 Maintenance

The elevator contractor shall maintain the elevator system in a first class and safe manner during guarantee period. Such maintenance shall be for the entire elevator system except when failure occurs due to work performed by others. Responsibility entails daily inspection by the supervisor / technician and unlimited call back service including nights, weekends and holidays.

Apart from the above this maintenance shall include 1 visit by Engineer per week for the first 6 months from the date of acceptance of the elevator system. Call back service shall be provided for emergencies, and responded within 2 Hrs.

Engineer's Visits for the next six months shall be not less than 1 per fortnight with visit timings adjusted so as not to coincide with the busiest usage period. Call back service shall be responded within 2 Hours and service involving more than one stalled or erratic elevator shall be immediately provided regardless of the time of day or night. Emergency call back service for trapped passengers shall be responded to within 10 minutes. There shall be no compensation for call back service regardless of the hour/ day, etc.

The elevator contractor shall maintain the elevator system in a professional, first class manner and keep and maintain elevator machines with other equipment in a neat workman like order.

The contractor shall anticipate demand on supplies and parts and keep an inventory of a reasonable number of spare parts, at his own cost, on site in a self provided lockable metal cabinet.

The elevator contractor shall maintain the lift for a period of 5 years after the DLP .

5. PAINTING

All exposed metal work furnished under these specifications, unless otherwise specified, shall be shop primed and properly painted. Shop coats of paint that have become marred during shipment or erection, shall be cleaned off with mineral sprits, wire brushed and spot painted over the affected areas, then coated with enamel paint to match the finish over the adjoining shop painted surface.

6. IMPORT LICENSE

Should any import license be required for import of any component, the contractor shall make his own arrangement for the same. The Owners shall not undertake any responsibility for import of components and all payments shall be made in Indian rupees only.

7. DEVIATIONS

Contractor shall stipulate the deviations, if any, from these Technical Specifications, and reason thereof

8. STRUCTURAL REQUIREMENTS

Contractor shall clearly indicate the structural and electrical requirements for the installation of elevators. Shaft and pit shall be provided by the Owners through other agency. Other preparation work and all items of supply and installation in the hoistway shall be the responsibility of the contractor.

9. EXCLUSIONS

Any items excluded from the offer, but functionally required, shall be clearly defined and listed by the tenderers, giving description of the items, quantity and estimated cost and the reason for excluding the items.

10. TOOLS AND TACKLES

All tools, tackles, supports, scaffolding and staging etc. required for erection and assembly of the equipment and installation covered by the contract shall be provided by the Contractor himself. In addition, all other materials such as foundation bolts, nuts etc. required for the installation of the equipment shall also be provided by the contractor at his cost.

11. TESTING AND HANDING OVER AND STATUTORY APPROVALS :

a. The Contractor shall carry out test run of the installation in the presence of representatives of the Owner, to establish satisfactory functioning of the installation.
b. The Installations shall be handed over to the Owner's site representative after satisfactory testing along with six sets of completion documents each consisting of :
   - Detailed equipments data and catalogues.
   - Manufacturer's maintenance chart including check chart and Lubrication chart.
   - Set of "AS INSTALLED DRAWINGS" showing layouts, equipments details, electrical power & control wiring diagrams etc.
   - Test Certificates for major equipments.

- Certificates of approval from Statutory and/or Local Authorities for the operating and maintenance of the installation and equipment, wherever such approval or certification is required. (Lift inspector's certificate/ license).
- Certificate from the Engineer that the contractor has cleared the site of all debris and litter caused by him during the Construction.

c. Submission of the above documents shall form a precondition for the final acceptance of the installation and final payment.
d. Upon handing over, the Owner's site representative shall issue to the contractor the necessary certificate of acceptance.
e. The contractor shall be responsible for all the approvals to be taken from the statutatory authority before starting of work and after commissioning of the lifts .
f. The necessary approval shall be taken by the contractor from the electrical inspector after the installation of the elevators .

12. UPTIME GUARANTEE

The contractor shall guarantee for the installed system an uptime of 98%. In case of shortfall in any month during the defects liability period, the defects liability period shall get extended by a month for every month having shortfall.

13. WORK BY OTHER AGENCIES

The following associated civil and electrical work is being carried out by Owners through other Agencies:

a. Hoist Way : Hoist way shall be made properly framed and enclosed, including a pit of proper depth with drainage provision and water proofing. The hoist way and pit walls shall be duly treated and painted.
   Smooth, vertical & painted/whitewash hoistway shall be provided by the civil contractor.
b. Hoist way Guard : Provision shall be made during construction for proper guarding and protection of hoist way and temporary barricading of hoist way entrances.
c. Power and Light : Power /light shall be provided :-
   i. Power to the lift machine with one isolating switch including common earth for entire system.
   ii. Lighting of the lift shaft (Bulk head at every floor level, power point (16 A) at every floor and in the lift pit.
d. If required, Interior decoration of cabins shall be done by others.
   Except for items of exclusion mentioned above, all items/materials/equipments required for completion and functioning of the installation in all respect are deemed to be included in the scope of this work whether specifically mentioned or not.

14. MISCELLANEOUS

The following shall be in the scope of the successful elevator contractor and it shall be his responsibility to arrange the items in order to complete the installation.

i) Scaffolding
ii) All minor builder works such as chipping of surfaces, cutting and finishing of walls/floors/partitions & foundation for machine etc shall be responsibility of elevator contractor.
iii) All steel items included.
iv) Stainless Steel Jamb Panel & sill Angles.

15. QUALITY ASSURANCE PROGRAM & TEST PROCEDURE FOR ACCEPTANCE

Following test procedures shall be carried out prior to acceptance of elevator system.

a. Test to determine that the insulation resistance between power and control lines and earth is as per specified IS codes.
b. Test to determine that the earthing of all conduit, switch, casings and similar metal works is continuous and of low resistance.
c. Test to determine that the motor, brake, control equipment and door locking devices and limit switches function correctly.
d. Brake to be tested to check whether it can sustained a car at rest with 25% of contract load.
e. Test to determine that the lift car raises and lowers smoothly at the rated load.
f. Test to determine that the lift car achieves the specified speed.
g. Test to determine that the safety gear stops the car with the rated load.

h. Test for rated power against actual power consumption under full load.
i. Check for current drawn by each elevator during starting and full load operation.
j. Sound level check for motors.
k. Visual inspection for all components.
l. The contractor shall guarantee the smooth and noiseless performance of the elevators System as per IS-1860 -–1980 & IS-6620-1972 (Reaffirmed 1991).

Besides the above, contractor shall submit his standard quality assurance programme and test acceptance procedures for reference of Owner's site representative / Consultant.

16. ALL INCLUSIVE MAINTENANCE CONTRACT

a. Routine Preventive Maintenance Schedule to be submitted
   i. Schedule to cover manufacturer's recommendation and/or common engineering practice (for all plant and machinery under contract).
   ii. Plant and machinery history card giving full details of equipment and frequency of checks and overhaul.
   iii. Monthly status report.
b. Uptime during maintenance contract
   i. 98% uptime of all systems under contract.
   ii. Up time shall be assessed every month and in case of shortfall during any month the contract shall be extended by a month.
   iii. There shall be no reimbursement for the extended period.
   iv. Break-downs shall be attended to within two hours of reporting.
c. Manpower
   i. Adequate number of persons to the satisfaction of the Owner's site representative shall be provided including relievers.
   ii. Statutory requirements of EPF, ESIC and other applicable labour legislations to be complied with; and monthly certification to that effect to be submitted.
   iii. Duty allocation and Roaster control shall be contractor's responsibility.
   iv. No overtime shall be payable by Owner for any reason whatsoever.
d. Shut Downs
   i. Routine shut downs shall be permitted only with prior permission.
   ii. Contractor shall be at liberty to carry out routine maintenance as and when required but with prior permission of the Owner.
e. Payment Terms
   i. Quarterly payment at the beginning of each quarter on pro-rata basis.

B. SPECIFICATIONS

1 PASSENGER & SERVICE ELEVATORS

Elevators shall include all elements conforming to specifications or as amended herein. Elevators covered by this specification shall be provided, installed, tested, commissioned, certified and approved as per statutory requirements by Lift Inspectorate.

Notes:

a. One Fireman's switch for each set of elevator shall be provided.
b. Elevator shall be provided with short duration emergency lighting in each cab which shall be through local dry cell rechargeable battery with necessary changeover relays. Light output shall be minimum 50 LUX at floor level.
c. Provision of 150 Kg weight for interior finishes shall be kept for passenger elevator. In case interior finishing materials in cab exceeds this provision, then the elevator contractor shall clearly identify the loss of carrying capacity, if any. Recess in platform of 25 - 30 mm shall be provided in floor for receiving stone flooring in the passenger elevator.

2. HOIST GEAR

Hoisting machines for passenger elevators shall be of geared type operating at m/sec as per Annexure.

3a). EMERGENCY CRANKING

The hoisting machines shall be provided with a set of special tools including a hand crank to allow release of hoist brake and provide for manual movement of the car in case of emergency. These tools shall be hung up on a tool board fitted to a wall in overhead area, with instructions for their use

clearly written on the board both in English and the local language. The elevator system supplier shall qualify his bid with respect to manual cranking. An automatic switch shall be provided to interrupt power to the elevator mains. Upon withdrawal of crank and manual resetting of power monitor switch, power shall be restored.

b). AUTOMATIC RESCUE DEVICE

All hoisting machines shall be provided with automatic rescue device (ARD) which shall comprise an UPS of required capacity and number of maintenance free batteries. The system should be capable to drive the motor to bring down the car at floor level, in case of failing of electric supply in between the floors. A switch to put the machine on ARD system shall be provided inside the car.

4 BRAKE

Brakes with non asbestos lining shall be spring loaded and shall close and open electrically. Brake shall be applied using variable input frequency to insure smooth stopping.

5. AUTOMATIC SELF-LEVELING

The elevator shall be provided with automatic self-leveling feature that shall bring the elevator car level to within ±3 mm for passenger & service elevators and + 5 mm for freight elevator of the landing floor regardless of load or direction of travel. The automatic self-leveling feature shall compensate for over travel and rope stretch.

6. HOISTWAY MATERIALS

Hoistway materials shall be non flammable except travelling cable which shall be flame resistant. All other electrical cables shall also be flame resistant and housed in metal conduit or other metal enclosures.

7. HOISTWAY ENTRANCES & CAR DOOR

All landing hoistway entrance door shall have center opening horizontal sliding type doors suitable for a clear opening as indicated in Technical Data for each type of elevator and shall include flush doors of hollow metal construction, extruded aluminium sill with anti slip grooving and hanger supports and hanger cover shall be provided. Exposed surfaces of doors and frames shall be finished as directed by the Interior Designer.

Sheave type two point suspension ball bearing door hangers and tracks shall be furnished for each hoistway opening. Sheaves shall not be less than 58 mm diameter and adjustable ball bearing rollers shall take the up thrust of the doors.

Each car and hoistway door leaf shall be fitted with minimum two nos. teflon or nylon gibes as bottom door stabilizers.

8. CAR AND HOISTWAY DOOR OPERATOR

For each elevator door, an electric VVVF door operator or PWM DC door operator shall be furnished to simultaneously open the car and hoistway doors when the car is at a landing. The doors shall be closed simultaneously by motor power. Emergency key provision shall be made to open doors at all landing from outside of the hoistway.

In the event of interruption of electric power or failure of the door operator, it shall not be possible to open the car door manually from within the car.

An electric contact for the car door shall be provided which shall prevent elevator movement away from the landing unless the door is in the closed position. Each hoistwaydoor shall be equipped with a positive electromechanical interlock and auxiliary door closing device so that the elevator can be operated only after the interlock circuit is established.

The doors shall open automatically while the car is levelling at the respective landing. The doors shall automatically close after a predetermined time interval has elapsed, but the momentary pressure of the “door open” button provided in the car shall reverse the motion and reopen the doors and reset the time interval unless overridden by the electronic door monitor.

9. PHOTO ELECTRIC MONITORS

An Electronic Door Monitor device shall be installed on each passenger elevator. This device shall monitor traffic across the threshold of the door and shall initiate door closing 2 seconds

after interruption, thus overriding door open period. There shall be no dead zone in the entire opening which is not monitored by the device.

10. DOORS

Doors, threshold and door hangers shall be, as a system, fire rated for not less than 1.5 hours.

11. DOOR OPEN CLEARANCE

Clear door opening on passenger service/freight elevators shall be as indicated in technical data. Any other dimension requires Owners approval. Finishes shall be as specified under finishes.

12. CAR TOP STATION

A car top operating station shall comprise of key operated switch and constant pressure up/down buttons which shall be provided on each elevator. Car shall respond to up/down command at inspection speed. The elevator contractor shall provide LED electrical fixture switched from car top station to maintain 50LUX level.

13. SHEAVES

Sheaves shall be machined, balanced and shall maintain cable/sheave ratio well within requirements. Lubrication points shall be extended to a location that is easily accessible.

14. CARFRAME AND SAFETY

A car-frame fabricated from formed or structural steel members shall be provided with adequate bracing to support the platform and car enclosures. The car safety shall be integral with car-frame, or shall be mounted on the bottom members of the car-frame, and shall be of the flexible guide clamp type designed to stop and hold a fully loaded car which exceeds descending speed. Safeties shall conform to ANSI/ASME/CENEN-81 or local codes if more stringent.

15. SPEED GOVERNOR

The car safety shall be operated by a mechanical centrifugal speed governor located in the overhead & at the top of the hoistway. The governor shall actuate a switch when excessive descending speed occurs, disconnecting power to the hoist motor and applying the brake prior to deployment of the safeties. Governor sheave in elevator pit shall be enclosed in a wire cage to a height of 2.40 m.

16. WIRING

All wiring and electrical interconnections shall comply with governing codes. Wiring shall be PVC insulated 1100 volt grade flame retardant and shall run in metal conduit, tubing or approved electrical raceways. Travelling cables shall be flexible and suspended to relieve strain on individual conductors. A minimum of 10% spare conductors shall be provided in travelling cable.

17. VOLTAGE FLUCTUATIONS

All electrical equipments supplied by the lift contractor shall withstand an incoming supply voltage fluctuations of +5% - 5%

18. HOISTWAY OPERATING DEVICES

Redundant series wired terminal stopping devices shall be provided to slow down and stop the car automatically at the terminal landings. Resetting a tripped device shall be done manually only.

19. PIT SWITCH

An emergency stop switch shall be located in the pit which when operated shall stop the car regardless of position in the hoistway.

20. BUFFERS

Buffers shall be provided in the pit in compliance with ANSI/ASME/CENEN-81 or local code if more stringent. Clearance from underside of car resting on a fully compressed buffer shall be not less than 1.20m. Buffer shall be designed for design speed + 15%. Oil buffers shall be provided for the passenger elevators for speeds of more than 1.7 mps and spring buffers for lower speeds or in case of specifically asked for in technical data. The oil buffers shall be self resetting type and shall be provided with means for determining the oil level.

21. GUIDE RAILS
Steel guide rails shall be installed to guide the car and counterweight, erected plumb and securely fastened to the building structure, fitted to ensure smooth joints. The guide rail shall be minimum 16 mm, tongued and grooved type.

22. GUIDES
Rubber encased coil spring tension adjusted roller guides shall be provided for passenger elevators with speed of 1.7 mps or greater, mounted on top and bottom of the car frame, and on top and bottom of the counterweight frame to engage their respective guide rails. Service elevators and low speed elevators can have sliding guides on car and counterweights.

23. CABLE ANCHOR
Cable shall conform to ANSI/ASME/CENEN-81 and shall anchor to the frame by means of an equalizing device to insure uniform cable loading. Cable safety shall conform to ANSI/ASME/CENEN-81 or governing code if available.

24. TRAVELLING CABLE
Travelling cable shall be secured to the cars underside. Cable shall be clear of all obstructions while car is in motion. Cable jacket shall be suitable for immersion in water, salt water and oil. Jacket shall minimize strain on conductor.

25. INTERLOCKS
Hoistway openings shall be provided with electro-mechanical locks.

26. COMPENSATING ROPE
Compensating ropes shall be furnished and installed for all elevators with speed over 2.0 m/sec, and travel in excess of 30 m, to compensate for the shifting weight of the hoist ropes. A device shall be provided to tie the car and counterweight together to limit the jump of the car or counterweight. Compensating chain where provided shall be enclosed in a plastic flame resistant jacket to minimize noise.

27. COUNTERWEIGHT
A structural steel frame with cast iron or steel plate filler weights shall be furnished to provide proper counterbalance for smooth operation.

28. COUNTERWEIGHT GUARD
A metal counterweight guard shall be furnished and installed at the bottom of the hoistway, and shall wrap around counterweight rails for a height of no less than 1.80 m in order to protect accidental contact.

29. ROPES
Hoist ropes shall be traction steel of size, construction and number to insure proper operation of the elevator and give satisfactory and safety assurance. Governor ropes shall be steel. All ropes shall consist of at least eight strands wound about a hemp core center. All ropes shall conform to ANSI/ASME/CENEN-81 or more governing codes or regulations. The minimum factor of safety for ropes shall be 10.

30 PLATFORM
The car platform shall be of Aluminium/ Stainless steel plate as asked for in the BOQ. The entire platform shall rest on rubber pads, so designed to form an isolating cushion between the car and car frame. Platform deflection shall be limited to maximum 3 mm under maximum normal operating conditions. Platform shall conform to ANSI/ASME/CENEN-81 or more stringent local codes.

31. HEAVY LOADING PLATFORM (SERVICE ELEVATOR & FREIGHT ELEVATOR)
The platform shall be provided with slip resistant Aluminium/Stainless Steel chequered plate flooring. The platform shall be arranged to accommodate one piece load lf mechanical / electrical equipment, etc.

32. OVER-LOAD FEATURE

Elevators shall be fitted with the load weighing feature to illuminate “Over-Load” and defeat the car’s operating circuits when car load reaches 110% or more of rated load. Car platform may require stiffening to minimize margin of error resulting from excessive deflection. Overload feature and / or circuit defeat for elevators shall conform to governing code.

33. CAR SPEED

Car speed shall be based on the travel distance and number of floors. This has been specified in Schedule of Quantities.

34. SYSTEM PERFORMANCE

The bidder shall do the traffic analysis and submit the same with his tender. The study shall confirm that under normal operating conditions, maximum waiting time at any landing shall not exceeds 35 seconds, if not possible contractor shall propose most economical modification to achieve that.

35. ACCELERATION / DECELERATION

Acceleration / Deceleration shall be linear and smooth. Stops shall be without cable oscillations. Acceleration & Declaration shall be site adjustable.

36. NOISE LEVELS (PASSENGER ELEVATOR)

Noise from moving equipment including door operation, car motion, fan, etc. shall not intrude into adjoining spaces by more than 20 dB and adjoining occupied areas by not more than 10 dB. (All octave bands).

Noise level inside the car shall not exceed 50 dB.without car cabin fan running.

Noise level inside the car shall not exceed 55 dB.in case of door opening / closing. The noise level shall be measured at ‘Zero Activity’.

37. LATERAL QUAKING & VERTIVCAL VIBRATIONS

Lateral quaking and vertical vibrations should not exceed 20 gal and 85 dB respectively. Contractor to demonstrate these parameters at site with performance analyzer.

38. EMERGENCY CAR LIGHTING & INTERCOM

Provision shall be made in the car for lighting, low speed and low noise fan, status indication and communication. Wiring cabling for the above facilities shall be provided along with travelling cable. Elevator contractor shall provide and install hand free communication unit above the car operation panel. Fan shall be four speed and low noise and shall be approved by the Architect / Consultant. Speaker shall be provided for emergency announcement and background music.

39. CAR POSITION INDICATOR (PASSENGER CARS)

Scrolling alpha numeric car position indicator shall be installed above each operating panel. The position of the car in thehoistway shall be shown by illuminating the corresponding landing at which the car is stopped or passing.

40. LIGHTING

The cab manufacturer shall make all provisions for installation of lighting fixtures specified by interior designer, including integration of emergency lighting fixtures.

41. HALL BUTTONS (ALL CARS)

For elevators hall buttons shall be provided at each terminal landing. A single micro movement push button shall be provided at top most and the lowest floor landing, two micro movement buttons on a single plate shall be provided at each intermediate floor. When a hall call is registered by momentary pressure on a landing button, that button shall become illuminated and remain illuminated until the call is answered.

42. CALL BUTTON

Selection for call button for passenger car shall be as per Architect selection . Freight elevator call buttons shall be as per manufacturer’s standard product. The catalogues of the buttons offered shall be submitted along with the tenders.

43. FIXTURE FINISHES

The metal faceplates of the signal and operating fixtures in the cars and at the landings, along with the metal accessories in the cars, shall be hair line stainless steel or as selected by the Architect. Push button fixtures at the landings shall be of design approved by the Architect. All fixtures, form and finishes, etc. shall be subject to the Architect's and interior designer's approval.

44. CAB CLADDING AND FINISHES

a. Service Elevator

Flooring shall be of 5 mm thick Aluminiumchequered plate with all seams for liquid tightness. Walls shall be of stainless steel sheet. Interior finishes shall be brushed stainless steel to full height.

b. Passenger Elevator

Flooring shall be stainless steel chequered plate with all welded seams for liquid tightness. Flooring shall have 20 mm drop for flooring. Walls and the interior of the car shall as per technical data sheet.

45. AUTOMATIC ELEVATOR RETRIEVAL SYSTEM (FIRE PHASE- I)

All elevators shall be equipped with automatic elevator retrieval system which shall, upon signal from the central fire alarm system or manually operated key switch, cause all elevators to be dispatched automatically to the ground floor. Elevators shall, open their doors and remain at the ground floor. All floor and car buttons shall be rendered ineffective until the system is manually reset. A smoke detector shall be placed in close proximity to each elevator bank on the ground floor. If this device senses smoke, system shall land elevators at a pre-selected, alternate, landing floor. A key operated switch shall be provided at the ground floor to activate and reset the retrieval system manually.

a. Emergency operation shall return the elevator/s to a designated floor, most commonly, the Lobby, by means of a signal from the automatic fire alarm system.
b. On initiation from the fire alarm system, all elevators travelling away from the lobby floors shall stop and reverse without opening their doors indicating fire mode-operation to passengers, ignoring all car and hall calls and express to the lobby or assigned floor.
c. Cars travelling toward lobby shall express to lobby ignoring all car and hall calls. Cars parked on intermediate floors shall close their doors and express to lobby. Cars parked at lobby shall open their doors ignoring car and hall calls. All hall and car buttons shall extinguish and shall accept no further hall or car registration.
d. All elevators shall, in addition and where allowed by code, be provided with a key operated switch where designated by the Architect, for use by in-house fire brigade.
e. The elevator contractor shall coordinate and cooperate with the fire detection & alarm system supplier / installer for his system interfacing responsibilities.

Fireman Emergency – Phase - II

Actuation of fire mode shall put all car functions as described here under fireman control by means of a key switch.

a. Hall button giving car call indication shall cause the doors to close.
b. Applying constant pressure to the door open button shall cause door to begin to open. Releasing the button before door is fully open shall cause the door to close.
c. Hall buttons shall be rendered inoperative.
d. Car position indicator shall indicate floor when car is within door operating range, and if in motion it shall indicate nearest floor by flashing. When a car is within operating zone, the position indicator shall light uninterrupted.
e. All electrical door safety locks shall remain effective.
f. Car position, direction of travel and floor conditions shall be displayed on the car position monitor in the lobby, and at elevator system monitor in engineering room.
g. Returning the car to the designated landing floor, deactivating the lobby switch shall render the car to original pre fire mode condition.
h. Resetting the Fire Alarm contacts in the car monitoring panel shall restore the system to normal condition.

46. INSPECTION OPERATION - ALL ELEVATORS

A switch shall be provided in the car to permit operation of the elevator from top of the car for inspection purposes, with car and hall buttons inoperative. Car shall travel at inspection speed not exceeding 0.5 m/sec. Motion of car shall require constant pressure to directional button.

47. INDEPENDENT SERVICE (ALL CARS)

A key operated switch shall be provided in the car operating station which, when actuated, shall disconnect the elevator from the hall buttons and permit operation from the car buttons only.

48. HOIST GEAR

The hoisting machine shall be gearless type or lower with motor, brake and traction drive sheave compactly mounted on a continuous bed-plate and set on steel beams for the speeds as specified in BOQ. Sound isolating pads shall be installed beneath the machine bed-plate to reduce vibration or air borne noise.

The hoisting machine shall be single worm geared traction type with motor, brake, gearing and driving sheave assembled on a steel base plate. The motor shall be reversible type particularly designed for elevator service with high starting torque and low starting current. Sound reducing material shall be installed under machine.

The machine shall be located directly above the hoist way. Foundation bolts shall be provided by the elevator contractor for building into the foundation furnished by others. Suitable beams shall be furnished for mounting deflector pulleys, if required by the elevator contractor.

Requirements for permanent lifting hooks hoisting beams and access hatches shall be indicated on the drawings by the elevator system, supplier / installer.

49. PASSENGER ELEVATORS

Passenger elevators shall conform to all details in these standards stipulated, unless otherwise differently arranged hereunder.

49.1 Elevator Cab

Cab dimensions shall be as detailed under technical data of this tender .

The car sill shall be flush with finished floor. Sill to sill space shall be as per manufacturer's standard and not exceeding 25 mm. Cab height shall be as per technical data indicated in the tender.

49.2 Car Platform

Shall conform to ANSI/ASME/CENEN-81 specifications. To suppress the noise and drumming effects, the floor must be stiffened and preferably lined with fire retarded plywood or other material which will suit the proposed finish. All finishing materials shall be fireproof or fire resistant conforming to applicable codes.

The platform shall be mounted on rubber pads supported on an auxiliary steel frame fastened to the car frame. This arrangement shall form an isolating cushion between the car and frame for vibration and load weighing transducers.

49.3 Car Doors

Car doors shall, unless specifically stated, be center parting, automatic power operated, variable frequency door operator or PWM DC door operator and electronic door detector. An infrared light source shall be provided to monitor the door closing and function as a safety edge infra red light system shall initiate door closure about 2 seconds after last light beam interruption. Light sensor shall override designated "door open period" on top and intermediate floors and shall on the lower level be inactive until the car has been designated as "next up" and given signal to close its doors.

Car doors shall be hung plumb and even, to within 1 mm. with minimum number of 4 gibbs per leaf. Floor gibbs shall be well fitted so as to prevent popping noise as a car passes structural members, or car in motion in a shared shaft, etc. Hoistway doors shall be hung plumb and show a maximum of 6 mm joint at sides, top and bottom and 2 mm at centre joint. Narrow

door frame or jamb panel shall be supplied by elevator contractor. A soft chime shall ring prior to doors closing and opening.

49.4 Door Operation

Upon the car reaching landing in response to a hall or car call, a soft chime in the car shall sound. Door opening shall commence when the car is 25 mm from the levelling . Door open period shall be adjustable to within a range of + 1 second. Doors shall open at a nominal speed of 1.20 m/sec. Closing speed shall be adjustable from 1.5 to 2.5 seconds or as demanded by particular circumstances. Door-open-period on all floors except lobby floor shall be shortened to the extent that door closure will commence 2 seconds (field adjustable) following the sensor beam interruption by the last boarding or disembarking passenger. This period shall be adjustable to 1.5 seconds ± 1.0 seconds. Normal door-open-period at lobby floor shall be monitored by the car's CPU. Door closure shall override "door-open-period" where car loading has reached by pass limit, or when another car approaches the lobby floor.

a. Doors shall be arranged to remain open for a time period sufficient to meet handicapped requirements. (Optional).
b. The time interval for which the elevator doors remain open when a car stops at a landing shall be independently adjustable for response to car calls and response to hall calls.
c. An approved positive interlock shall be provided for each hoistway entrance which shall prevent operation of the elevator unless all doors for that elevator are secured and shall maintain the doors in their closed position while the elevator is away from the landing. Emergency access to the hoistway as required by governing codes shall be provided.

49.5 Monitor Door Operation

Stopping in response to hall or car call, doors shall be normally kept open for a predetermined period of time. With Monitor operation, the door closing period is automatically shortened to approximately 1.0 seconds. Time open period feature must be field adjustable. Door open period shall be increased when the light ray senses a passenger leaving or entering the car.

50. CAR OPERATING PANEL

The car operating panel shall contain a bank of micro movement illuminated buttons marked to correspond to the landings serviced. It shall include a series of push buttons corresponding to the floors served, along with an emergency stop and switches required. Operating panel shall incorporate the following : floor buttons, door open/close, emergency stop/alarm, up/down in manual mode, man/auto key switch and seismic operation.

The emergency alarm button shall be connected to the 12 volt rechargeable battery circuit. A locked compartment integral with operating panel shall contain :

a. Auto/manual/inspection key operated switch.
b. Up/down button.
c. Fan switches
d. Synthesized voice announcements

On sounding of general fire alarm, the elevator shall if in motion, express to the ground floor. If stopped, the elevator shall open its doors and remain there until reset. Emergency talk-back system shall be provided, installed in integral cabinet and connected to the EPABX by the low tension contractor.

All Elevators of 13 passenger capacity and above shall be provided with 2 Nos. Car operating panels and freight elevator with 1 No. Car Operating Panel.

51. AUTOMATIC LOAD BYPASS

Transducers in the car platform shall monitor passenger load which shall override "pre-programmed door open period" and despatch the loaded car from the low terminal. The load weighing device shall also function in the same manner on all intermediate and top floors and in addition shall express to the next car call and ignore all hall calls. Hall calls which are bypassed shall not be canceled. The automatic load bypass device shall be field adjusted for 50% - 75% of rated load.

51.1. Operation – One Car Simplex (Passenger or Service)

a. Operation shall be automatic by means of the car and landing buttons. Stops registered by the momentary actuation of the car or landing buttons shall be made in order in which the landings are reached in each direction of travel after the buttons have been actuated. All stops shall be subject to the respective car or landing button being actuated sufficiently in advance of the arrival of the car at that landing to enable the stop to be made. The direction of travel for an idle car shall be established by the first car or hall button actuated.

b. "UP" landing calls shall be answered while the car is travelling in the up direction and "DOWN" landing calls shall be answered while the car is travelling down. The car shall reverse after the uppermost or lowermost car or landing call has been answered, and proceed to answer calls and landing calls registered in the opposite direction

c. If a car without registered car calls arrive at a floor where both up and down hall calls have registered, it shall initially respond to the hall call in the direction that the car was travelling. If no car call or hall call is registered for further travel in that direction, the car shall close its doors and immediately reopen them in response to the hall call in the opposite direction . Direction lanterns shall indicate the changed direction and initiate gong when the doors reopen.

51.2. Operation

Group Control for Passenger Elevators

a. The building shall be divided into three (3) zones with one car assigned to the "Lower" zone and the other car assigned to the top zone. Each car shall park in its assigned zone when there are no unanswered calls.

b. The lower zone shall include the lobby, lower levels, and adjacent floors immediately above the lobby. The remainder of the floors shall be divided between the top zone and the middle zone. Either car may answer calls in the middle zone, but neither car shall park in that zone.

c. The first car entering a parking zone without hall or car calls shall be assigned to that zone. The car in the lobby zone shall park at the lobby or other pre-designated floor. The car entering the top zone with no calls registered shall stop at the lowest floor in that zone.

d. Optimized response to hall calls shall be achieved by computing a relative system response (RSR) time for each registered hall call. The computation of each car's RSR time to a call shall be based on, but not limited to, such relevant factors as distance, service to previously assigned car and hall calls, car load, direction, door and car motion status, and coincidence of car and hall calls. The car with the least RSR shall have such a call assigned to it.

e. RSR computations for each hall call shall be repeated several times a second and the hall call assignment might be changed if a more suitable car is found available.

f. A car arriving at a floor to park shall not open its doors. Cars shall open their doors only when stopping in response to a car or hall call.

g. If for any reason the doors are prevented from closing and the car is unable to respond to a call, it shall lose its zone assignment and the call shall be transferred to the other car.

h. When a car is filled to a predetermined load setting, it shall no longer stop for hall calls. Any registered hall call shall remain registered for the next elevator to respond.

i. When the independent service switch in the car operation station is actuated, that elevator shall be disconnected from the hall button riser/s and operate independently from car buttons only.

52. EXPANDED LOBBY ZONE ARRANGEMENT FOR HEAVY DOWN PERIOD

The group supervisory control system shall be arranged to include a number of consecutive floors above the main floor as part of the lowest zone. Upon completion of travel within the expanded lobby zone, the car assigned to that zone shall return to a pre-designated floor.

52.1 Car to Lobby Operation

Provide a key operated switch for each elevator at the main floor which, when actuated, shall cause the corresponding elevator to make a trip to the lobby as soon as the car is available for response to the special call.

52.2 Next Car Up

"Next Car Up" shall be indicated by flashing of lantern for the car so designated at the lobby. Other cars shall remain parked with doors closed until each car, in turn, is assigned as "Next Car Up".

52.3 Express Feature

Express feature shall be extended to hall call of 30 seconds or longer due to bypassed floors.

52.4 Express Priority Service (Optional)

a. A key switch and signal light shall be provided at each selected landing for the purpose of providing an express priority service to each such landing. The control system shall compute the relative response times (RST) of all available designated elevators to service the call, based on the position and direction of the elevator relative to the priority floor, and also based on its door status, and select the car which has the shortest predictable response time (SPRT).Each car may be assigned to only one priority call at a time, and all cars which are designated to provide express priority service which are in service, and which have not already been selected and assigned to a call, may be selected simultaneously. The cars which are to provide express priority service shall be designated by contract.

b. Should the selected car fail to respond to its assigned priority call within an allowable time interval (due to unpredictable circumstances, such as the failure of its doors to close), selection shall automatically be passed on to another car, based on the aforementioned computations.

c. Each selected car shall cancel all registered car calls and bypass all hall call on its way to its assigned priority landing. When the car arrives at the priority landing, it shall remain with doors open for a predetermined period of time. If not placed in service the doors shall close, and the car shall automatically return to normal operation.

d. The signal lights shall be illuminated while a car is responding to a priority call, and shall be extinguished when the car has opened its doors at its assigned priority landing.

53. DESPATCH SYSTEM

The dispatch system shall be microprocessor based. The system's main computer shall communicate with each car's computer. Microprocessor shall be intelligent in that it learns traffic patterns and applies best solution to each traffic condition, as determined by shortest predictable response. The CPU shall monitor demand on the system and shall execute the most economical assignment of cars.

54. ELEVATOR CAB

Car shall be detailed by the Architect or Interior Designer.

The cab manufacturer shall make provisions for ventilation inlets at the bottom of the cab (concealed from Passenger's view) and exhaust fan (concealed ) at ceiling.

The car sill shall be flushed with finished floor. Sill to sill space shall not exceed 25 mm. Cab height, conditions permitting, shall be as per specification. The elevator contractor shall coordinate with electrical contractor to provide normal and emergency power and lighting to each elevator.

55. ADDITIONAL INFORMATION

Tenderer shall enclose with their offer the following additional information:

a. List of installation of 2.5 mps& above installation completed by the tenderer during the last 5 years.
b. Details of "In-House" facilities for testing and inspection of elevator materials.
c. Details of service facilities in India.
d. Confirm that elevator may be operated on DG sets and provide power characteristic to design the generator capacity.

Tenderers shall submit details / samples / photographs / catalogues for following. These shall be relevant to the project and the contractor shall indicate which of these are being offered in the bid.

a. Hall Lantern
b. Car Operating Panel.
c. Hall Buttons
d. Group Indication panel.
e. Option for stainless steel finishes

56. Battery operated alarm bell & emergency light, blower fan, PA system, ARD, 2hr. fire rated doors and BMS potential free contacts shall be provided.

57. All elevators to have Braille encrypted controls with audio assistance.

## 11.8.1. ANNEXURE I - GUARANTEE PROFORMA FOR ELEVATOR INSTALLATION

We hereby guarantee the two year round Elevator System which we have installed in the Complex described below :

Building SAU

Location Delhi

For a period of 24 months from the date of acceptance of the total installation, WE AGREE TO repair or replace to the satisfaction of the Owner, any or all such work that may prove defective in workmanship, equipment or materials within that period, ordinary wear and tear and unusual abuse or neglect excluded, together with any other work, which may be damaged or displaced in so doing. In the event of our failure to comply with the above mentioned conditions within a reasonable time, after being notified in writing, we collectively and separately, do hereby authorize the Owner to proceed to have the defects repaired and made good at our expense, and we shall pay the cost and charges thereof, immediately upon demand.

WE ALSO HEREBY UNDERTAKE to test the entire installation upon completion and ensure that all units are functioning satisfactorily.

SIGNATURE OF CONTRACTOR
For ELEVATOR INSTALLATION

DATE : SEAL

## 11.8.2. ANNEXURE II – TECHNICAL DATA FOR ELEVATORS

### ADMINISTRATION BUILDING (AD1)

| | ELEVATOR NO. | Elevator No. 1 & 2 | Elevator No. 3 |
|---|---|---|---|
| 1 | TYPE OF ELEVATOR | Passenger Elevators MRL | Passenger Elevators MRL |
| | | | |
| 2 | QUANTITY | 2 Nos. | 1 No. |
| | | | |
| 3 | CONTROL | VVVF | VVVF |
| | | | |
| 4 | OPERATION W/WO ATTENDANT | Duplex Collective | Simplex |
| | | | |
| 5 | CAPACITY | | |
| a. | Weight in Kgs. | 884 KG | 680 KG |
| b. | Weight for interior material of the car | 150 | 150 |
| c. | No. of persons | 13 Persons | 10 Persons |
| | | | |
| 6 | MACHINE | Gearless | Gearless |
| | | | |
| 7 | SPEED (MPS) rated | 1.5 | 1.5 |
| | | | |
| 8 | TRAVEL | B+G to 5th | G+1st to 3rd floor |
| | | | |
| 9 | RISE IN METERS | 22925 mm | 22925 mm |
| | | | |
| 10 | STOPS AND OPENINGS | 7 | 7 |
| | | | |
| a. | No. of Stops | 7 | 7 |
| | | | |
| b. | No. of openings | 7 (All openings on same side. | 7 (All openings on same side. |
| | | | |
| *11 | CAR SIZE IN (MM) (Inside Dimensions) | 1100 W x 2000 D | 1300 W x 1350 D |
| | | | |
| 12 | AVAILABLE HOIST WAY SIZE (MM) (Inside Dimensions) | 1975 W x 2500 D | 2000 D x 2000 W |
| | | | |
| 13 | CAR AND HOISTWAY ENTRANCE (MM) | 900, 2 C | 900, 2 C |
| | | | |
| 14 | DOOR OPERATION | Automatic with electronic door detector | Automatic with electronic door detector |
| | | | |
| 15 | HEIGHT OF LIFT CAR | 2400mm | 2400mm |
| 16 | HEIGHT OF HOISTWAY ENTRANCE | 2100 | 2100 |
| | | | |
| 17 | PIT DEPTH REQUIRED | 2150mm + 100mm | 1500mm + 100mm |

| | | | |
|---|---|---|---|
| | | | |
| 18 | OVERHEAD REQUIRED (MM) | 4800 | 4800 |
| | | | |
| 19 | NOISE LEVEL IN CABIN (RUNNING CAR) | As per Specs | As per Specs |
| 20 | INTERIOR (CAR ENCLOSURE) With SS hand rail | Walls – Stainless steel in dot matrix (Scratch less)<br><br>Floor – 19mm thick granite stone.<br><br>Ceiling – False ceiling with Aluminum cladding, LED lamps and ceiling fan | Walls – Stainless steel in dot matrix (Scratch less)<br><br>Floor – 19mm thick granite stone.<br><br>Ceiling – False ceiling with Aluminum cladding, LED lamps and ceiling fan |

* The car size mentioned in the above table is indicative only and may vary as per the different manufacturer's products.

**LIBRARY (L1)**

| | | | |
|---|---|---|---|
| | ELEVATOR NO. | Lift No. – 1 & 2 | Lift No. – 3 |
| 1 | TYPE OF ELEVATOR | Passenger Elevators MRL | Passenger Elevators MRL |
| | | | |
| 2 | QUANTITY | 2 Nos. | 1 No. |
| | | | |
| 3 | CONTROL | VVVF | VVVF |
| | | | |
| 4 | OPERATION W/WO ATTENDANT | Duplex, Full Collective | Simplex |
| | | | |
| 5 | CAPACITY | | |
| a. | Weight in Kgs. | 680 KG | 1632 KG |
| b. | Weight for interior material of the car | 150 | 200 |
| c. | No. of persons | 10 Persons | 24 Persons |
| | | | |
| 6 | MACHINE | Gearless | Gearless |
| | | | |
| 7 | SPEED (MPS) rated | 1.5 | 1.5 |
| | | | |
| 8 | TRAVEL | B + G + 1 to 5th Floor | B + G + 1 to 5th Floor |
| | | | |
| 9 | RISE IN METERS | 22925 mm | 22925 mm |
| | | | |
| 10 | STOPS AND OPENINGS | 7 | 7 |
| | | | |
| a. | No. of Stops | 7 | 7 |
| | | | |
| b. | No. of openings | 7 (All openings on same side. | 7 (All openings on same side. |
| | | | |
| *11 | CAR SIZE IN (MM) (Inside Dimensions) | 1300W x 1350D | 1500W x 2400D |
| | | | |
| 12 | AVAILABLE HOIST WAY SIZE (MM) (Inside Dimensions) | 2175 D x 2100 W | 2900 D x 2900 W |
| | | | |
| 13 | CAR AND HOISTWAY ENTRANCE (MM) | 1100, 2 C | 1100, 2 C |
| | | | |
| 14 | DOOR OPERATION | Automatic with electronic door detector | Automatic with electronic door detector |
| | | | |
| 15 | HEIGHT OF LIFT CAR | 2400 | 2400 |
| 16 | HEIGHT OF HOISTWAY ENTRANCE | 2100 | 2100 |
| | | | |
| 17 | PIT DEPTH AVAILABLE | 2150mm + 100mm | 2150mm + 100mm |
| 18 | OVERHEAD AVAILABE (mm) | 4800 mm | 4800 mm |

| | | | |
|---|---|---|---|
| | | | |
| 19 | NOISE LEVEL IN CABIN (RUNNING CAR) | As per Specs | As per Specs |
| 20 | INTERIOR (CAR ENCLOSURE) With SS hand Rail | Walls – Stainless steel in dot matrix (Scratch less)<br><br>Floor – 19mm thick granite stone.<br><br>Ceiling – False ceiling with Aluminum cladding, LED lamps and ceiling fan | Walls – Stainless steel in dot matrix (Scratch less)<br><br>Floor – 19mm thick granite stone.<br><br>Ceiling – False ceiling with Aluminum cladding, LED lamps and ceiling fan |

* The car size mentioned in the above table is indicative only and may vary as per the different manufacturer's products.

**SAARC STUDIES (AC9)**

| | | |
|---|---|---|
| | ELEVATOR NO. | Elevator No. 1 & 2 |
| 1 | TYPE OF ELEVATOR | Passenger Elevators<br>MRL |
| | | |
| 2 | QUANTITY | 2 NoS. |
| | | |
| 3 | CONTROL | VVVF |
| | | |
| 4 | OPERATION W/WO ATTENDANT | Duplex, full collective |
| | | |
| 5 | CAPACITY | |
| a. | Weight in Kgs. | 884 kg |
| b. | Weight for interior material of the car | 150 |
| c. | No. of persons | 13 Persons |
| | | |
| 6 | MACHINE | Gearless |
| | | |
| 7 | SPEED (MPS) rated | 1.5 |
| | | |
| 8 | TRAVEL | B + G + 1 to 7th Floor |
| | | |
| 9 | RISE IN METERS | 31800 mm |
| | | |
| 10 | STOPS AND OPENINGS | 9 |
| | | |
| a. | No. of Stops | 9 |
| | | |
| b. | No. of openings | 9 (All openings on same side. |
| | | |
| *11 | CAR SIZE IN (MM)<br>(Inside Dimensions) | 1100W x 2000D |
| | | |
| 12 | AVAILABLE HOIST WAY SIZE (MM)<br>(Inside Dimensions) | 1975 D x 2500 W |
| | | |
| 13 | CAR AND HOISTWAY ENTRANCE (MM) | 1000, 2 C |
| | | |
| 14 | DOOR OPERATION | Automatic with electronic door detector |
| | | |
| 15 | HEIGHT OF LIFT CAR | 2400mm |
| 16 | HEIGHT OF HOISTWAY ENTRANCE | 2100 |
| | | |
| 17 | PIT DEPTH REQUIRED | 2150mm + 100mm |
| | | |
| 18 | OVERHEAD REQUIRED (MM) | 4800 |
| | | |

| | | |
|---|---|---|
| 19 | NOISE LEVEL IN CABIN (RUNNING CAR) | As per Specs |
| 20 | INTERIOR (CAR ENCLOSURE) With SS handrail | Walls – Stainless steel in dot matrix (Scratch less)<br><br>Floor – 19mm thick granite stone.<br><br>Ceiling – False ceiling with Aluminum cladding, LED lamps and ceiling fan |

* The car size mentioned in the above table is indicative only and may vary as per the different manufacturer's products.

**LAW & HUMANITIES BUILDING (AC4)**

| | | |
|---|---|---|
| | ELEVATOR NO. | Elevator No. 1 & 2 |
| 1 | TYPE OF ELEVATOR | Passenger Elevators MRL |
| | | |
| 2 | QUANTITY | 2 Nos. |
| | | |
| 3 | CONTROL | VVVF |
| | | |
| 4 | OPERATION W/WO ATTENDANT | Duplex, full collective |
| | | |
| 5 | CAPACITY | |
| a. | Weight in Kgs. | 1088 kg |
| b. | Weight for interior material of the car | 150 |
| c. | No. of persons | 16 Persons |
| | | |
| 6 | MACHINE | Gearless |
| | | |
| 7 | SPEED (MPS) rated | 1.5 |
| | | |
| 8 | TRAVEL | B + G + 1 to 3rd Floor |
| | | |
| 9 | RISE IN METERS | 17100 mm |
| | | |
| 10 | STOPS AND OPENINGS | 5 |
| | | |
| a. | No. of Stops | 5 |
| | | |
| b. | No. of openings | 5 (All openings on same side. |
| | | |
| *11 | CAR SIZE IN (MM)<br>(Inside Dimensions) | 1600W x 1600D |
| | | |
| 12 | AVAILABLE HOIST WAY SIZE (MM)<br>(Inside Dimensions) | 2300 D x 2475W |
| | | |
| 13 | CAR AND HOISTWAY ENTRANCE (MM) | 1000 , 2 C |
| | | |
| 14 | DOOR OPERATION | Automatic with electronic door detector |
| | | |
| 15 | HEIGHT OF LIFT CAR | 2300 |
| 16 | HEIGHT OF HOISTWAY ENTRANCE | 2100 |
| | | |
| 17 | PIT DEPTH REQUIRED | 2150mm + 100mm |
| | | |
| 18 | OVERHEAD REQUIRED (MM) | 4800 |
| | | |

| | | |
|---|---|---|
| 19 | NOISE LEVEL IN CABIN (RUNNING CAR) | As per Specs |
| 20 | INTERIOR (CAR ENCLOSURE) With SS Hand Rail | Walls – Stainless steel in dot matrix (Scratch less)<br><br>Floor – 19mm thick granite stone.<br><br>Ceiling – False ceiling with Aluminum cladding, LED lamps and ceiling fan. |

* The car size mentioned in the above table is indicative only and may vary as per the different manufacturer's products.

**LAW & HUMANITIES BUILDING (AC4)**

| | | |
|---|---|---|
| | ELEVATOR NO. | Lift No. – 3 & 4 |
| 1 | TYPE OF ELEVATOR | Passenger Elevators<br>MRL |
| | | |
| 2 | QUANTITY | 2 Nos. |
| | | |
| 3 | CONTROL | VVVF |
| | | |
| 4 | OPERATION W/WO ATTENDANT | Duplex, Full collectve |
| | | |
| 5 | CAPACITY | |
| a. | Weight in Kgs. | 1088 KG |
| b. | Weight for interior material of the car | 150 |
| c. | No. of persons | 16 Persons |
| | | |
| 6 | MACHINE | Gearless |
| | | |
| 7 | SPEED (MPS) rated | 1.5 |
| | | |
| 8 | TRAVEL | B + G + 1 to 3rd Floor |
| | | |
| 9 | RISE IN METERS | 17100 mm |
| | | |
| 10 | STOPS AND OPENINGS | 5 |
| | | |
| a. | No. of Stops | 5 |
| | | |
| b. | No. of openings | 5 (All openings on same side. |
| | | |
| *11 | CAR SIZE IN (MM)<br>(Inside Dimensions) | 1600W x 1600D |
| | | |
| 12 | AVAILABLE HOIST WAY SIZE (MM)<br>(Inside Dimensions) | 2300 D x 2475 W |
| | | |
| 13 | CAR AND HOISTWAY ENTRANCE (MM) | 1000, 2 C |
| | | |
| 14 | DOOR OPERATION | Automatic with electronic door detector |
| | | |
| 15 | HEIGHT OF LIFT CAR | 2300mm |
| 16 | HEIGHT OF HOISTWAY ENTRANCE | 2100 |
| | | |
| 17 | PIT DEPTH AVAILABLE | 2150 mm + 100mm |
| 18 | OVERHEAD AVAILABE (mm) | 4800 |
| | | |

| | | |
|---|---|---|
| 19 | NOISE LEVEL IN CABIN (RUNNING CAR) | As per Specs |
| 20 | INTERIOR (CAR ENCLOSURE) With SS hand Rail | Walls – Stainless steel in dot matrix (Scratch less)<br><br>Floor – 19mm thick granite stone.<br><br>Ceiling – False ceiling with Aluminum cladding, LED lamps and ceiling fan. |

* The car size mentioned in the above table is indicative only and may vary as per the different manufacturer's products.

**MATHS, CHEMISTRY, PHYSICS & IT BUILDING (AC3)**

| | | | |
|---|---|---|---|
| | ELEVATOR NO. | Lift No. – 1 & 2 | Lift No. – 3 & 4 |
| 1 | TYPE OF ELEVATOR | Passenger Elevators MRL | Passenger Elevators MRL |
| | | | |
| 2 | QUANTITY | 2 Nos. | 2 Nos. |
| | | | |
| 3 | CONTROL | VVVF | VVVF |
| | | | |
| 4 | OPERATION W/WO ATTENDANT | Duplex Full Collective | Duplex Full Collective |
| | | | |
| 5 | CAPACITY | | |
| a. | Weight in Kgs. | 1088 KG | 1088 KG |
| b. | Weight for interior material of the car | 150 | 150 |
| c. | No. of persons | 16 Persons | 16 Persons |
| | | | |
| 6 | MACHINE | Gearless | Gearless |
| | | | |
| 7 | SPEED (MPS) rated | 1.5 | 1.5 |
| | | | |
| 8 | TRAVEL | B + G + 1 to 4th Floor | B + G + 1 to 3rd Floor |
| | | | |
| 9 | RISE IN METERS | 2130 mm | 17100 mm |
| | | | |
| 10 | STOPS AND OPENINGS | 6 | 5 |
| | | | |
| a. | No. of Stops | 6 | 5 |
| | | | |
| b. | No. of openings | 6 (All openings on same side. | 5 (All openings on same side. |
| | | | |
| *11 | CAR SIZE IN (MM) (Inside Dimensions) | 1600W x 1600D | 1600W x 1600D |
| | | | |
| 12 | AVAILABLE HOIST WAY SIZE (MM) (Inside Dimensions) | 2300 D x 2475 W | 2300 D x 2475 W |
| | | | |
| 13 | CAR AND HOISTWAY ENTRANCE (MM) | 1000, 2 C | 1000, 2 C |
| | | | |
| 14 | DOOR OPERATION | Automatic with electronic door detector | Automatic with electronic door detector |
| | | | |
| 15 | HEIGHT OF LIFT CAR | 2300mm | 2300mm |
| 16 | HEIGHT OF HOISTWAY ENTRANCE | 2100 | 2100 |
| | | | |
| 17 | PIT DEPTH AVAILABLE | 2150mm + 100mm | 2150mm + 100mm |
| 18 | OVERHEAD AVAILABE (mm) | 4800 | 4800 |

| | | | |
|---|---|---|---|
| 19 | NOISE LEVEL IN CABIN (RUNNING CAR) | As per Specs | As per Specs |
| 20 | INTERIOR (CAR ENCLOSURE) With SS hand Rail | Walls – Stainless steel in dot matrix (Scratch less)<br><br>Floor – 19mm thick granite stone.<br><br>Ceiling – False ceiling with Aluminum cladding, LED lamps and fan in ceiling. | Walls – Stainless steel in dot matrix (Scratch less)<br><br>Floor – 19mm thick granite stone.<br><br>Ceiling – False ceiling with Aluminum cladding, LED lamps and fan in ceiling. |

* The car size mentioned in the above table is indicative only and may vary as per the different manufacturer's products.

**ARTS DESIGN (AC1)**

| | ELEVATOR NO. | Lift No. – 1 & 2 | Lift No. – 3 |
|---|---|---|---|
| 1 | TYPE OF ELEVATOR | Passenger Elevators MRL | Service Elevator MRL |
| | | | |
| 2 | QUANTITY | 2 Nos. | 1 No. |
| | | | |
| 3 | CONTROL | VVVF | VVVF |
| | | | |
| 4 | OPERATION W/WO ATTENDANT | Duplex full collective | Simplex |
| | | | |
| 5 | CAPACITY | | |
| a. | Weight in Kgs. | 1088 KG | 1632 KG |
| b. | Weight for interior material of the car | 150 | 200 |
| c. | No. of persons | 16 Persons | 24 Persons |
| | | | |
| 6 | MACHINE | Gearless | Gearless |
| | | | |
| 7 | SPEED (MPS) rated | 1.5 | 1.5 |
| | | | |
| 8 | TRAVEL | B2 + B1 + G + 1 to 4th Floor | B2 + B1 + G + 1 to 4th Floor |
| | | | |
| 9 | RISE IN METERS | 25000 mm | 25000 mm |
| | | | |
| 10 | STOPS AND OPENINGS | 7 | 7 |
| | | | |
| a. | No. of Stops | 7 | 7 |
| | | | |
| b. | No. of openings | 7 (All openings on same side) | 7 (All openings on same side) |
| | | | |
| *11 | CAR SIZE IN (MM) (Inside Dimensions) | 1600W x 1600D | 1500W x 2400D |
| | | | |
| 12 | AVAILABLE HOIST WAY SIZE (MM) (Inside Dimensions) | 2300 D x 2335 W | 2700 D x 2600 W |
| | | | |
| 13 | CAR AND HOISTWAY ENTRANCE (MM) | 1000, 2 C | 1100, 2 C |
| | | | |
| 14 | DOOR OPERATION | Automatic with electronic door detector | Automatic with electronic door detector |
| | | | |
| 15 | HEIGHT OF LIFT CAR | 2300mm | 2300mm |
| 16 | HEIGHT OF HOISTWAY ENTRANCE | 2100 | 2150 |
| | | | |
| 17 | PIT DEPTH AVAILABLE | 2150mm + 100mm | 2150mm + 100mm |
| 18 | OVERHEAD AVAILABE (mm) | 4800 | 4800 |

| | | | |
|---|---|---|---|
| 19 | NOISE LEVEL IN CABIN (RUNNING CAR) | As per Specs | As per Specs |
| 20 | INTERIOR (CAR ENCLOSURE) With SS hand Rail | Walls – Stainless steel in dot matrix (Scratch less)<br><br>Floor – 19mm thick granite stone.<br><br>Ceiling – False ceiling with Aluminum cladding, LED lamps and ceiling fan. | Walls – Stainless steel in dot matrix (Scratch less)<br><br>Floor – 19mm thick granite stone.<br><br>Ceiling – False ceiling with Aluminum cladding, LED lamps and ceiling fan. |

* The car size mentioned in the above table is indicative only and may vary as per the different manufacturer's products.

**CONVENTION CENTRE (C1)**

| | ELEVATOR NO. | Lift No.–1, 2, 3, 4, 5 & 6 | Lift No. – 7 | Lift No. – 8 |
|---|---|---|---|---|
| 1 | TYPE OF ELEVATOR | Passenger Elevator MRL | Service Elevator MRL | Service Elevator MRL |
| | | | | |
| 2 | QUANTITY | 6 Nos. | 1 No. | 1 No. |
| | | | | |
| 3 | CONTROL | VVVF | VVVF | VVVF |
| | | | | |
| 4 | OPERATION W/WO ATTENDANT | Simplex | Simplex | Simplex |
| | | | | |
| 5 | CAPACITY | | | |
| a. | Weight in Kgs. | 1632 KG | 1088 KG | 1088 KG |
| b. | Weight for interior material of the car | 200 | 150 | 150 |
| c. | Persons | 24 Persons | 16 Persons | 16 Persons |
| | | | | |
| 6 | MACHINE | Gearless | Gearless | Gearless |
| | | | | |
| 7 | SPEED (MPS) rated | 1.5 | 1.5 | 1.5 |
| | | | | |
| 8 | TRAVEL | B2 + B1 + G + 1 to 3rd Floor | B2 + B1 + G + 1 to 3rd Floor | B2 + B1 + G + 1 to 3rd Floor |
| | | | | |
| 9 | RISE IN METERS | 25000 mm | 25500 mm | 25500 mm |
| | | | | |
| 10 | STOPS AND OPENINGS | 6 | 6 | 6 |
| | | | | |
| a. | No. of Stops | 6 | 6 | 6 |
| | | | | |
| b. | No. of openings | 6 (All openings on same side. | 6 (All openings on same side. | 6 (All openings on same side. |
| | | | | |
| *11 | CAR SIZE IN (MM) (Inside Dimensions) | 1500W x 2400D | 1600W x 1600D | 1600W x 1600D |
| | | | | |
| 12 | AVAILABLE HOIST WAY SIZE (MM) (Inside Dimensions) | 2600 D x 2465 W | 2450 D x 2250 W | 3000 D x 2500 W |
| | | | | |
| 13 | CAR AND HOISTWAY ENTRANCE (MM) | 1100, 2 C | 1000, 2 C | 1000, 2 C |
| | | | | |
| 14 | DOOR OPERATION | Automatic with electronic door detector | Automatic with electronic door detector | Automatic with electronic door detector |
| | | | | |
| 15 | HEIGHT OF LIFT CAR | 2300mm | 2300mm | 2300mm |
| 16 | HEIGHT OF HOISTWAY ENTRANCE | 2100 | 2100 | 2100 |
| | | | | |

| | | | | |
|---|---|---|---|---|
| | | | | |
| 17 | PIT DEPTH AVAILABLE | 2150mm + 100mm | 2150mm + 100mm | 2150mm + 100mm |
| 18 | OVERHEAD AVAILABE (mm) | 4800 | 4800 | 4800 |
| | | | | |
| 19 | NOISE LEVEL IN CABIN (RUNNING CAR) | As per Specs | As per Specs | As per Specs |
| 20 | INTERIOR (CAR ENCLOSURE) With SS hand Rail | Walls – Stainless steel in dot matrix (Scratch less)<br><br>Floor – 19mm thick granite stone.<br><br>Ceiling – False ceiling with Aluminum cladding, LED lamps and ceiling fan. | Walls – Stainless steel in dot matrix (Scratch less)<br><br>Floor – 19mm thick granite stone.<br><br>Ceiling – False ceiling with Aluminum cladding, LED lamps and ceiling fan. | Walls – Stainless steel in dot matrix (Scratch less)<br><br>Floor – 19mm thick granite stone.<br><br>Ceiling – False ceiling with Aluminum cladding, LED lamps and ceiling fan. |

* The car size mentioned in the above table is indicative only and may vary as per the different manufacturer's products.

**UTILITY BUILDING (U1)**

| | | |
|---|---|---|
| | ELEVATOR NO. | Lift No.– 1 |
| 1 | TYPE OF ELEVATOR | Service Elevator MRL |
| | | |
| 2 | QUANTITY | 1 Nos. |
| | | |
| 3 | CONTROL | VVVF |
| | | |
| 4 | OPERATION W/WO ATTENDANT | Simplex |
| | | |
| 5 | CAPACITY | |
| a. | Weight in Kgs. | 1768 KG |
| b. | Weight for interior material of the car | 200 |
| | | |
| 6 | MACHINE | Gearless |
| | | |
| 7 | SPEED (MPS) rated | 1.0 |
| | | |
| 8 | TRAVEL | B to G |
| | | |
| 9 | RISE IN METERS | 6000 mm |
| | | |
| 10 | STOPS AND OPENINGS | 2 |
| | | |
| a. | No. of Stops | 2 |
| | | |
| b. | No. of openings | 2 (All openings on same side) |
| | | |
| *11 | CAR SIZE IN (MM)<br>(Inside Dimensions) | -- |
| | | |
| 12 | AVAILABLE HOIST WAY SIZE (MM)<br>(Inside Dimensions) | 3000 D x 3000 W |
| | | |
| 13 | CAR AND HOISTWAY ENTRANCE (MM) | 1100, 2 C |
| | | |
| 14 | DOOR OPERATION | Automatic with electronic door detector |
| | | |
| 15 | HEIGHT OF LIFT CAR | 2300mm |
| 16 | HEIGHT OF HOISTWAY ENTRANCE | 2100 |
| | | |
| 17 | PIT DEPTH AVAILABLE | 2150mm + 100mm |
| 18 | OVERHEAD AVAILABE (mm) | 4800 |
| | | |
| 19 | NOISE LEVEL IN CABIN (RUNNING CAR) | As per Specs |

| | | |
|---|---|---|
| 20 | INTERIOR (CAR ENCLOSURE) With SS hand Rail | Walls – Stainless steel in dot matrix (Scratch less)<br><br>Floor – 19mm thick granite stone.<br><br>Ceiling – False ceiling with Aluminum cladding, LED lamps and ceiling fan. |

* The car size mentioned in the above table is indicative only and may vary as per the different manufacturer's products.

## 11.8.3. ANNEXURE III - LIST OF INDIAN STANDARDS FOR ELEVATORS

| | | |
|---|---|---|
| 1. | Safety Rules Section-1 Passenger and Good Fits. | IS-14665 (Part 3) Sec-1 : 2000 |
| 2. | Code of practice for installation, operation and maintenance of electric service lift. | IS-14665 (Part 2) Sec-2 : 2000 |
| 3. | Code of Practice for installation, operation and maintenance of electric passenger & goods lifts. | IS-14665 (Part 2) Sec-1: 2000 |
| 4. | Safety Rules Section-2 – Service Lifts | IS-14665 (Part 3) Sec-2 : 2000 |
| 5. | Outline dimension for electric lifts. | IS-14665 (Part-1) : 2000 |
| 6. | Inspection Manual for Electric Lifts | IS-14665 (Part 5) : 1999 |
| 7. | Electric Traction Lifts – Components | IS-14665 (Part 4) Sec-1 to 9 : 2001 |
| 8. | Method of loading rating of worm gear. | IS-7443-1974<br>Reaffirmed 1991 |
| 9. | Specification for lifts cables. | IS-4289 (Par-1) : 1984<br>Reaffirmed 1991 |
| 10. | Specification for hot rolled and slit steel tee bars. | IS-1173-1978<br>Reaffirmed 1987 |
| | | |
| 11. | Code of practice for selection of standard worn and helical gear box. | IS-7403-1974<br>Reaffirmed 1991 |
| 12. | Isometrics screw threads. | IS-4218-(Part-II)1976<br>Reaffirmed 1996 |
| 13. | PVC insulated electric cable for working voltage upto and including 1100 volts. | IS-694-1990 |
| 14. | Conductors for insulated electric cables and flexible codes | IS-8130-1984 |
| 15. | Classification of insulating materials for electrical machinery and apparatus in relation to their thermal stability in service. | IS-1271-1985<br>Reaffirmed 1990 |
| 16. | Code of practice for earthing. | IS-3043-1987 |
| 17. | Degree of protection provided by enclosure for low voltage switchgear and control gear. | IS-2147-1962 |
| 18. | PVC insulated (Heavy Duty) electric cables for working voltage upto and including 1100 volts. | IS-1554-1988 (Part-1) |
| 19. | Code of practice for electrical wiring and installation | IS-732-1989 |
| 20. | Flexible steel conduits for electrical wiring | IS-3480-1966 |
| 21. | Accessories for rigid steel conduit for electrical wiring | IS-3837-1976 |
| 22. | Guide for safety procedures and practices in electrical work. | IS-5216-1982 (Part-1) |
| 23. | Marking and arrangement of bus bars | IS-5578 & 11353-1985 |
| 24. | Factory built assemblies of switchgear and control | IS-8623-1977 (Part-1) |

| | | |
|---|---|---|
| | gear for voltages upto and including 1000 V AC and 1200 VDC | |
| 25. | Miniature Circuit Breakers | IS-8828-1996 |
| 26. | Electrical installation Fire Safety of Building. | IS-1646-1997 |
| 27. | Methods of test for cables | IS-10810-1998 |
| 28. | Earth Leakage Circuit Breakers. | IS-12640-1988 |
| 29. | Rigid steel conduits for electrical wiring (Second revisions) | IS-9537-1981 |

## 11.8.4. ANNEXURE IV - LIST OF ACT / BYE LAWS FOR ELEVATORS

The lift installations shall also be governed by the following Acts/Bye-laws/Codes as amended upto date in addition to the an codes specified in the tender:

1. Local Fire Prevention and Fire Safety Rule
2. Local Lift Act
3. Building Bye-Laws
4. National Building Code of India – 2005
5. Indian Electricity Act – 1910
6. Indian Electricity Rule - 1956

## 11.8.5. ANNEXURE V - SAFETY ASPECTS & PROCEDURES

1. Since lift installation consists of a number of electrical and mechanical components having linear / rotary motions, utmost caution should be exercised while working and all safety precautions shall be rigorously followed.

2. Only authorized persons shall be allowed to work on lift installations and officer (s) empowered for such authorization shall keep proper record thereof during the tests; inspection and maintenance except where necessary.

3. If during erection any safety or protection device is inoperative, special care must be taken to avoid accidents on this account

4. Supply at main incoming circuit breaker shall be switched off before examining any part of the equipment. Whether during periodical inspection, or while carrying out any work on the equipments (including using the winding handle at times of mains failures) unless power is particularly required for particular operation or tests on the lifts, the breaker shall be locked in OFF position.

5. Whenever the car needs to be moved by use of winding handle in the lift machine;

   a. Power at incoming shall be switched off before applying the handle.

   b. Power shall be restored only after this handle is removed from winding shaft and brakes are applied.

6. The landing and car buttons shall be kept out of circuit by switching on the 'Maintenance Switch' located on the top of the lift car during maintenance operators. Whenever maintenance switch is not provided emergency stop switch inside car and or attendant control switch should be used.

7. Before carrying out any repair work it shall be ensured that none of the electro-mechanical door locks are short circuited either from the controller or at the landings.

8. As a general precaution, facia plate between the door header and the corresponding upper landing sill on each floor must be provided.

## 11.9 EXTERNAL LIGHTING POLES & HIGH MASTS

1) M.S. Tubular Poles

Meter High Pole with Ladder Bars

7 meter high (5.75 meters above and 1.25 meters below ground shall be M.S.step tubular pole in 3 steps (bottom part shall be 4 meters high, 114.3 mm outer dia and 3.65 mm walll thickness, middle part shall be 1.5 meter high, 88.9 mm outer dia and 3.25 mm wall thickness, top part shall be 1.5 meters high, 76.1 mm outer dia and 3.25 mm wall thickness) with 300 mm x 300 mm x 6 mm thick base plate. Foundation for the pole shall be of cement concrete in 1:2:4 ratio. (1 part cement, 2 parts, coarse sand and 4 parts stone aggregate) IP-55 weather proof junction box shall also be provided to accommodate 1 No. 3 phase and neutral terminal block and 1 No. 6 amps SP MCB including 2.5 sq.mm PVC insulated copper conductor wire from the terminals block to the fixture and 2 Nos. 32 mm dia GI sleeves of suitable length shall be provided to the junction box.

Meter High Pole

4.5 meter high (3.6 meter above and 0.9 meter below ground) shall be 75 mm dia, 3.25 mm wall thickness MS tubular straight pole with a cast aluminium adaptor for post top mounting. Pole shall be provided with 300 mm x 300 mm x 6 mm thick MS base plate. Foundation for the pole shall be of cement concrete in 1:2:4 rates (1 part cement, 2 parts coarse sand and 4 parts stone aggregate) IP-55 weather proof junction box shall also be provided to accommodate 1 No. 3 phase and neutral terminal block and 1 No. 6 amps SP MCB including 2.5 sq.mm PVC insulated copper conductor wires from the terminal block to the fixture and 2 Nos. 32 mm dia GI sleeves of suitable length shall be provided to the junction box.

2) Cast Aluminium Poles

Design & Construction

Ornamental cast aluminum pole shall be made out of cast aluminum as per requirements of IS:202 (1993). Casting of all pole Sections shall be accurately done from permanent moulds and cores of the design submitted to Achieve uniformity in all design aspects in internal and external shape of the unit. All sections shall be free from defects like blow holes, porosity, hard spots, cracks, Hot tears, cold shuts, distortion, sand and slag inclusion and other harmful defects. All the casted sections used in the pole shall be free from welding of any kind used to repair it. The casted sections shall be machined from all the locations used to insert the pieces into one another using either threading or socket method. Accuracy of all machined parts shall be maintained through out a lot for random replacements of sections if and when required. All the threaded joints shall be mechanically tightened and sealed using industrial tools to make the entire unit vandal resistant.

Aesthetic appearance

All the grooves and carvings of the pole unit shall be free from any kind of distortion for a pleasing aesthetic appearance.

Material

Cast aluminum material used for casting pole unit shall be Grade FG-220 type, as described in IS:202 and shall have minimum tensile strength of the order of 200 N/mmsq.

Pre-treatment

Each and every casted piece shall be subject to Sand blasting at a pressure of 10-15 kgf to remove all its external dirt and sand remains etc..

Painting and Finishing

Entire unit shall be given an extensive three stage treatment with PU based two packZn-Ph primer and paint prescribed for CI surfaces to make it absolutely rust and corrosion proof, as well as giving it a pleasing appearance. PU based paint shall be MRF make or equivalent.

Thickness of the coating

A minimum of 80 microns of coating thickness shall be achieved on the final piece.

Mounting arrangement

Pole unit shall be grouted using 4 nos. anchor bolts of size M-16x450 mm confirming to 6.8 Gr. as per IS 2062. Pole unit shall be grouted on a foundation made out of 1:3:6 concrete cement after excavating the earth with proper cable sleeves etc..laid in the foundation itself.

Dimensions of the unit

| | | |
|---|---|---|
| Total height | = | 3000 mm |
| Dia of base plate | = | 380 mm |
| Pitch Circle Dia | = | 335 mm |

Description of top bracket / arms

Single double decorative arm shall be provided on the pole (as asked for in B.O.Q.), secured with the help of two nos. bolts outreach not less than 400 mm.

Service window

A service window of the size 150 mm x 100 mm shall be provided in the base of the pole to allow access to electrical connections and terminations. It shall be covered with MS plate and proper rubber gaskets shall be provided to prevent any ingress of water etc..

Electrical connections

Four way connectors shall be provided along with Slide lock and 1 no. 6 amps Sp MCB including 2.5 sqmm PVC insulated copper conducter wires from the terminal block to the fixture and 2 nos. 32 mm dia GI sleeves of suitable length shall be provided upto the service window. An earth boss is provided on the control plate along with connectors and interrupters.

3) Galvanized Octagonal Poles

Design

The Octagonal poles shall be designed to withstand the maximum wind speed of 169 KM / Hr. as per IS 875. The top loading i.e. area and the weight of fixtures are to be considered to calculate maximum deflection of the pole and the same shall meet the requirement of BS : 5649 Part VI 1982.

Pole Shaft

The pole shaft shall have octagonal cross section and shall be continuously tapered with single longitudinal welding. There shall not be any circumferential welding. The welding of pole shaft shall be done by submerged Arc Welding (SAW) process.

All octagonal pole shafts shall be provided with the rigid flange plate of suitable thickness with provision for fixing 4 foundation bolts. This base plate shall be fillet welded to the pole shaft at two locations i.e. from inside and outside. The welding shall be done as per qualified MMAW process approved by Third Party Inspection agency.

Door opening

The octagonal poles shall have door of approximate 500 mm length at the elevation of 500 mm from the Base plate. The door shall be vandal resistance and shall be weather proof to ensure safety of inside connections. The door shall be flush with the exterior surface and shall have suitable locking arrangement. There shall also be suitable arrangement for the purpose of earthing.

The pole shall be adequately strengthened at the location of the door to compensate for the loss in section.

Material

| | |
|---|---|
| Octagonal Poles | HT Steel Conforming to grade S355JO |
| Base Plate | Fe 410 conforming to IS 226 / IS 2062 |
| Foundation Bolts | EN.8 grade |

Welding

The welding shall be carried out confirming to approved procedures duly qualified by third party inspection agency. The welders shall also be qualified for welding the octagonal shafts.

Pole sections

The Octagonal Poles shall be in single section (upto 11 mtr). There shall not be any circumferential weld joint.

Galvanization

The poles shall be hot dip galvanized as per IS 2629 / IS 2633 / IS 4759 standards with average coating thickness of 70 micron. The galvanizing shall be done in single dipping.

Xing type

The Octagonal Poles shall be bolted on a pre-cast foundation with a set of four foundation bolts for greater rigidity.

Top Mountings

The galvanized mounting bracket shall be supplied along with the Octagonal Poles for Installation of the luminaries.

Manufacturing

The pole manufacturing & galvanizing unit shall be ISO 9001 : 2000 & ISO 14001 certified to ensure consistent quality & environmental protection.

Service window

A service window of the size 150 mm x 100 mm shall be provided in the base of the pole to allow access to electrical connections and terminations. It shall be covered with MS plate and proper rubber gaskets shall be provided to prevent any ingress of water etc..

Electrical connections

Four way connectors shall be provided along with Slide lock and 1 no. 6 amps Sp MCB including 2.5 sqmm PVC insulated copper conductor wires from the terminal block to the fixture and 2 nos. 32 mm dia GI sleeves of suitable length shall be provided upto the service window. An earth boss is provided on the control plate along with connectors and interrupters.

Galvanized Octagonal Poles Dimensions

| HEIGHT | TOP DIA (A/F) | BOTTOM DIA (A/F) | SHEET THICK NESS | BASE PLATE DIMENSIONS (LxBxT) | FOUNDATION BOLT | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | BOLT SIZE (NO. x DIA) | PITCH CIRCLE DIA (PCD) | BOLT LENGTH (MM) | PROJECTED BOLT LENGTH |
| (mtr) | (mm) | (mm) | (mm) | (mm) | (mm) | (mm) | (mm) | (mm) |
| 3 | 70 | 130 | 3 | 200 x 200 x 12 | 4 x 16 Dia | 200 | 450 | 80 |
| 4 | 70 | 130 | 3 | 200 x 200 x 12 | 4 x 16 Dia | 200 | 450 | 80 |
| 5 | 70 | 130 | 3 | 200 x 200 x 12 | 4 x 16 Dia | 200 | 600 | 80 |
| 6 | 70 | 130 | 3 | 220 x 220 x 12 | 4 x 20 Dia | 205 | 600 | 100 |
| 7 | 70 | 130 | 3 | 220 x 220 x 12 | 4 x 20 Dia | 205 | 700 | 100 |
| 8 | 70 | 135 | 3 | 225 x 225 x 16 | 4 x 20 Dia | 210 | 750 | 100 |
| 9 | 70 | 155 | 3 | 260 x 260 x 16 | 4 x 24 Dia | 250 | 750 | 125 |
| 10 | 70 | 175 | 3 | 275 x 275 x 16 | 4 x 24 Dia | 270 | 750 | 125 |
| 11 | 90 | 210 | 3 | 300 x 300 x 20 | 4 x 24 Dia | 300 | 750 | 125 |
| 12 | 90 | 240 | 3 | 320 x 320 x 20 | 4 x 24 Dia | 325 | 850 | 125 |

6 M HIGH MAST (16 mtr)

| | |
|---|---|
| Height of mast | 16 Meter |
| No. of sections | Two |
| Material construction | S 355 Grade as per BS-EN 10 025 |
| Base dia. and top diameter (A/F) | Top: 150 mm<br>Bottom: 360 mm |
| Plate thickness & section Length | Top: 3 mm<br>Bottom: 3 mm |
| Cross section of Mast Standard | 20 Side Polygon |
| for of galvanisation | As per BS EN ISO 1461 |
| Size of opening and door at base | 1050 x 225 mm |
| Diameter of base plate Thickness of | 520 mm |
| base plate Lightning protection finial | 25 mm |
| Max.wind speed | G.I Single Spike<br>50/47/44/39 m/s |
| Number of foundation bolts | 6 Nos. |
| PCD of foundation bolts | 445 mm |
| Type / diameter / length of foundation bolts | TS 600 / 24 mm dia / 750 mm long |

LUMINAIRES CARRIAGE

| | |
|---|---|
| Material of construction | 40 NB ERW Class A – M.S. Tube |
| Diameter of carriage ring (mm) | 450 mm (ID) |
| Construction | 8 Arm, Welded, 2 Sections |
| Load carrying capacity | 8 Luminare |

TRAILING CABLE

| | |
|---|---|
| Conductor | Copper, 5 Core, 2.5 Sq.mm |
| Insulation | PVC Insulated PVC Scheathed |
| No. of circuits per mast | One |

WINCH / POWER TOOL

| | |
|---|---|
| Type / SWL of winch | Double Drum (SGDD MINI PB) / 500 Kg |
| Method of operation | Inegral Motor |
| Motor capacity | 0.75 HP |
| No of speeds | 6 Pole, Single Speed |

STAINLESS STEEL WIRE ROPE

| | |
|---|---|
| Grade / construction | AISI 304, 7/19 |
| Number of ropes | Two |
| Diameter (mm) Braking | 5 mm |
| Load capacity | 1450 kg x 2 |

HIGH MAST (20 mtr)

| | |
|---|---|
| Height of mast | 20 meter |
| No. of sections | Two |
| Material construction | S 355 grade as per BS-EN10 025 |
| Base dia. and top diameter (A/F) | Top: 150 mm<br>Bottom: 360 mm |
| Plate thickness & section Length | Top: 3 mm<br>Bottom: 3 mm |

| | |
|---|---|
| Cross section of Mast Standard | 20 side polygon |
| for of galvanisation | As per BS EN ISO 1461 |
| Size of opening and door at base | 1050 x 225 mm |
| Diameter of base plate Thickness of | 520 mm |
| base plate Lightning protection finial | 25 mm |
| Max.wind speed | G.I Single Spike |
| | 39 m/s |
| Number of foundation bolts | 6 Nos. |
| PCD of foundation bolts | 445 mm |
| Type / diameter / length of foundation bolts | TS 600 / 30 mm dia / 850 long |

LUMINAIRES CARRIAGE

| | |
|---|---|
| Material of construction | 40 NB ERW Class A – M.S. Tube |
| Diameter of carriage ring (mm) | 535 mm (ID) |
| Construction | 9 Arm, Welded, 2 Sections |
| Load carrying capacity | 9 Luminaire |

TRAILING CABLE

| | |
|---|---|
| Conductor | Copper, 5 Core, 2.5 Sq mm |
| Insulation | PVC insulated PVC scheathed |
| No. of circuits per mast | One |

WINCH / POWER TOOL

| | |
|---|---|
| Type / SWL of winch | SGDD MINI PB / 500 Kg |
| Method of operation | Integrsl Motor |
| Motor capacity | 0.75 HP |
| No of speeds | 6 Pole, Single Speed |

STAINLESS STEEL WIRE ROPE

| | |
|---|---|
| Grade / construction | AISI 304, 7/19 Construction |
| Number of ropes | Two |
| Diameter (mm) Braking | 5 mm |
| load capacity | 1450 kg x 2 |

**11.10 UPS**

1. GENERAL REQUIREMENTS

1.1 The scope of work for supply and installation of UPS system shall include design manufacture, supply, installation, testing and commissioning of all related equipments together with all accessories and auxiliaries as per specifications.

The system shall be fully operational and shall comply to the specified codes and standards.

The contractor shall be responsible for providing all materials, equipments and engineering services specified or which are required to fulfill the intent of ensuring reliability of the total work covered under these specifications within his quoted price.

1.2 Supply and installation of the UPS system covered under this specification shall conform to the latest editions of codes and standards mentioned below and all other applicable Standards.

| | | | |
|---|---|---|---|
| a) | IEEE Standard 446-1987 | : | Emergency and standby power systems. |
| b) | IEEE Standard 450-1975 | : | |
| c) | IEEE Paper 4-177 | : | Some discharge characteristics of lead acid batteries. |
| d) | IEC 60140-3 | : | UPS Performance |
| e) | IEC 60140-2 | : | Electro Magnetic Compatibility |
| f) | IEC 60140-1 | : | Safety |
| e) | ANSI C 37.90a, IEEE Standard 472 | : | Surge withstand capability test. |
| f) | ANSI C 34.2 | : | Practices and requirements for semiconductor power rectifiers. |
| g) | ANSI C 37.90 | : | Relays and relay system associated with electrical power apparatus. |
| h) | NEMA PE-1-1983 | : | Uninterrupted Power System Standard |
| i) | IS 2208 & IS 9224 (Part 1 & Part 2) (I.E.C. 269) | : | Cartridge fuses for voltages upto and including 650 V |
| j) | IS 9224 (Part - 4) | : | Fuses for protection of semiconductors. |
| k) | BS 2709 (I.E.C 119) | : | The Electrical Performance of Semiconductor Rectifiers. (Metal Rectifiers) |
| l) | BS 4417 (I.E.C 146) | : | Semi-conductor Rectifier Equipments. |
| m) | IS 13947 : 1993 | : | Specification for Low voltage Switchgear & Control gear |
| n) | IS 3961(Part 2) :1967 | : | Recommended current rating for PVC insulated Cables |
| o) | IS 1652 & IS 1652 | : | Lead-acid stationary cells and batteries. |
| p) | BD 9720 | : | Custom-built transformers and inductors of assessed quality. |
| q) | IP20 | : | Degree of protection. |
| r) | IEC | : | Semi Conductor Convertor Standards. |
| s) | JEC | : | Standard of the Japanese Electro technical committee |
| t) | JIS | : | Japanese Industrial Standard. |
| u) | JEM | : | The standard of the Japan Electrical Manufactures Association. |
| v) | ISO 9001 approved | | |

1.3 The contractor shall submit his offer for UPS systems as indicated in the tender document.

1.4 All components of the UPS equipment shall have Surge Withstand Capability (SWC) to meet the requirements of ANSI C62.41-1980. ANSI C 37.90a, IEEE Standard 472-1974.

1.5 All components of UPS system shall withstand short circuit current without any damage.

1.6 The UPS design shall ensure that a single component/ device failure shall not result in failure of the entire UPS system. The design of UPS System shall be modular to permit easy maintenance.

1.7 The various overload capacities of inverters , static switch as specified herein are the minimum requirements. However, if the Contractor's offered system has better overload capacities for the above devices, the same shall be highlighted by the Bidder in his bid .

1.8 The UPS system offered by the contractor shall be suitable for operating continuously at the rated capacity indicated in tender with in ambient temperature 0-40 deg.C and relative humidity of 0 to 95%. Also the UPS system shall be suitable for operation as per full rating up to 1000 meters above sea level without de-rating. The Contractor shall furnish a certificate towards compliance on ambient conditions permissible.

1.9 The UPS system to be supplied by the contractor shall have maximum humming noise level of 65 DB one meter away from the UPS cabinets and shall not exceed 69 dBA measured 5 feet from surface of the UPS.

1.10 Suppression of Radio Interference shall be provided to meet statutory requirements.

1.11 Detailed literature should be provided showing Quality Assurance Procedure adhered to.

1.12 The contractor shall submit detailed item by item compliance statement along with the tender.

2. FUNCTIONAL REQUIREMENTS

2.1 Contractor shall furnish On-Line Uninterruptible Power Supply (UPS) system of continuous duty of the ratings mentioned in Bill of Quantities. Each UPS shall give regulated filtered & uninterruptible power supply as described in the specifications.

2.2 Contractor shall note that the KVA ratings of the UPS systems shall be guaranteed at 40 deg.C ambient temperature. In case contractor's standard UPS KVA rating are based at a lower temperature, the contractor must consider a derating factor of at least 1.5% per deg.C for arriving at the specified UPS capacity at 40 deg.C ambient temperature.

2.3 In case the calculated /specified UPS capacity is not the same as one of the standard KVA ratings of the UPS manufacturer, the next higher standard KVA rating shall be selected. UPS of non standard rating shall not be acceptable.

2.4 UPS system supplied by the contractor shall be the latest state of the art technology system fully digitalized using microprocessor controlled IGBT rectifier and IGBT inverter.

2.5 Batteries shall be valve regulated lead acid specially meant for UPS application.

2.6 Monitoring and control system shall also be state of the art technology LCD touch panel type providing all relevant data described in this document.

2.7 The monitoring and control system shall be capable of RS485 with MODBUS protocol input software for connecting to customer's computer system for data display and monitoring.

2.8 All necessary components required for protecting UPS equipment and connected inputs and outputs shall be furnished by the Contractor as an integral part of the UPS system.

2.9 The control logic power supply shall have redundant power supply AC input and the system battery as power sources.

2.10 The UPS systems shall include but not be limited to the following equipment :

a. UPS system including 100% capacity float-cum-boost charger with 100% sealed valve regulated lead acid battteries with guaranteed battery life of 5 years.

b. Suitable factory built battery cabinet for housing the batteries, including terminal isolator / breaker and power disconnect device. The enclosure shall conform to IP 20 as minimum.

c. All cables, connectors, accessories like trunkng, cable trays, conduits etc. required for connection between battery and the UPS unit.

2.11 UPS shall be with parallel redundant operation compatible.

3. STATIC CONVERTER

3.1 General

MODES OF OPERATION

UPS shall be designed to operate as a double conversion, on-line reverse transfer system in the following modes.

1. Normal: The UPS system shall continuously supply power to the critical load.
2. Battery: Upon failure of the utility AC power source, the critical load shall be supplied by the inverter, which, without any interruption, shall obtain its power from the battery.
3. Recharge: Upon restoration of the utility AC power source (prior to complete battery discharge), the PFC rectifier shall power the inverter and simultaneously recharge the battery.

4. Static bypass: The static bypass switch shall be used to transfer the load to the bypass without interruption to the critical power load. This shall be accomplished by turning the inverter off. Automatic re-transfer or forward transfer of the load shall be accomplished by turning the inverter on.
5. Maintenance bypass: In maintenance bypass the load is supplied with unconditioned power from the bypass input included in the UPS.
6. ECO mode: The UPS system is configured to use static bypass operation as the preferred mode under predefined. Transfers to battery operation upon utility failure. Efficiency up to 99%.

The static converter (rectifier) shall be a multi-functional converter providing functions of power conversion, battery charging and shall have the additional functions of input power factor improvement and current harmonics reduction. The converter equipment shall include all necessary control circuitry and device to conform requirements like voltage regulation, current limiting, wave shaping, transient recovery, automatic synchronization etc. as given below.

The converter shall be a solid state static PWM converter utilizing utilize Insulated Gate Bipolar Transistors (IGBT) or Intelligent Power Module (IPM) transistors and shall include intelligent features like the drive circuitry, over current protection, over temperature protection, control power failure protection and short circuit protection.

The IGBT / IPM transistors shall enable high speed switching at 6 KHz thus reducing the heat dissipation in the UPS and thereby providing high efficiency.

The PWM converter shall utilize the above and achieve unity power factor and reduce input current harmonics as given earlier and thus improve the overall power factor of the converter achieving input KVA savings.

During any step inverter load change (0-100%) the converter shall only supply 100% current to the inverter. The battery shall not be cycled at any time during this step load changes.

3.2 Input Current Limit

The converter logic shall provide input current limiting by limiting the DC output current. Two (2) line-side current transformers shall be employed as a means of sensing the current amplitude. The converter logic shall also be capable of providing auxiliary current limited when the logic is signaled to do so via an external dry contact closure (e.g. UPS fed from generator). The converter shall be capable of supplying overload current in excess to the full load rating. It shall also have sufficient capacity to provide power to a fully loaded inverter while simultaneously recharging the system battery to 95% of full capacity within 10 times the discharge time. The DC output current limit values shall be as follows:

- Rectifier output current (maximum) 100%.
- Rectifier output Current (aux.) 25% - 100% variable.

Note : 100% current shall be under the battery recharging mode.

3.3 Battery Charge Current Limited

The converter logic shall provide current limiting function of battery charging to prevent the battery from damage. The following battery current limit and protection shall be provided.

- Battery charge current limit 10% of battery Ah rate.
- Over-current protection at 120% of above item.

3.4 Voltage Regulation

The rectifier / charger output voltage including variation effects of input voltage does not deviate by more than +/- 1% of the nominal output voltage, due to the following conditions:

- Form 0 to 100% loading.
- Rectifier input variations of voltage and frequency within the limitations set in Section 3.10.
- Environmental condition variations within the limitations set in Section 3.10.

3.5 Automatic Input Current Walk-in

The converter logic shall employ circuitry to allow a delayed and timed ramping of input current. Subsequent to energizing the converter input, the ramping of current shall be delayed by a

maximum of 3 seconds. Upon starting the walk-in process, the ramping of current is timed to assume the load gradually within 1 through 60 seconds (every 1 second selectable).

3.6 Input Overload Protection

The inverter shall be protected by the following features that shall be independently adjustable for maximum system flexibility.

1) DC Over-voltage Trip.
2) DC Under-voltage Shutdown.
3) DC Under-voltage Disconnect annunciated by an internal visual alarm and relay contact closure.

**3.7** Output Protection

- The inverter shall be electronically turned off to protect against overloads and abnormal load conditions which exceed the units rating.
- UPS systems shall sense an overload condition and automatically transfer to the bypass input source which shall be used to provide the necessary current required.

**3.8** Over-current Protection

The inverter shall be protected from excessive overloads, including reverse currents, by fast acting fuses to prevent damage to power semiconductors. All fuses shall be provided with a blown fuse indicator with alarm indication on the control panel.

3.9 Equalizing Charge Timer

The UPS logic shall provide an electronic automatic equalize charge timer which shall be selectable 24 hours for Lead Acid type or 8 hour for Alkaline type batteries. The timer circuit, once activated shall provide a high rate equalizing charge voltage to the system battery for the selected time. The circuit shall also be capable of manual activation via the LCD touch panel mounted on the front door. The level of equalizing voltage shall be equal to that stated by the battery manufacturer. Upon completion of the timer count, the converter output voltage shall automatically return to the specified float voltage.

3.10 Step Load Change

During any step inverter load change (0-100%), only the converter shall supply 100% current to the inverter. The batteries SHALL NOT be cycled at any time during these step load changes.

3.11 Input Voltage

The converter shall be fed from the Normal Power Supply source.

3.12. The converter shall meet the following specifications in addition to other requirements stated herein:

| | | |
|---|---|---|
| Nominal Voltage | : | 415V, 3 Phase, 3 Wire |
| Voltage Range. | : | +/- 10% AC |
| Normal Frequency | : | 50Hz |
| Frequency Range | : | ± 10% (± 5 Hz) |
| Input Power Factor | : | 0.9 lagging or more at full load<br>(PF improvement) |
| AC – AC Efficiency | | >92.5% from 50% load to 100% load |
| | | |
| Input Harmonic Current THD | : | 3% typical at 100% load<br>6% maximum at 50% load |
| Duty | : | Continuous at 40 deg.C |
| Cooling | : | Forced cooling using fans with thermal relays using a latched cut out for re-setting as protection for cooling fans. Each individual fan shall have its own thermal relay. |
| Ambient operating temperature range | : | Operating - 0 to 40 deg.C maximum.<br><br>Storage & Transport -25°C to +45°C dry heat |
| Operating Relative Humidity | : | 0-95% non-condensing. |

| | | |
|---|---|---|
| Operating Altitude | : | Altitude Operating: to 3,000 ft. (1,000 meters) above Mean Sea Level. De-rated for higher altitude applications.<br><br>Storage/Transport: to 32,000 ft. (10000 meters) above Mean Sea Level |
| Magnetized sub-cycle in rush current | : | Typically 8 times normal full load current |
| Converter Walk-in time | : | 1 through 60 seconds (every 1 second selectable, (0 to 100% rated load) |
| Input | : | Suitable terminals shall be provided for termination of cables from the AC distribution board. |

4. STATIC INVERTER

4.1 General

The static inverter shall be of solid state type using proven Pulse Width Modulation (PWM) technique. The inverter equipment shall include all necessary control circuitry and devices to conform requirements like voltage regulation, current limiting, wave shaping, transient recovery, automatic synchronization etc. as given below.

The inverter shall utilize Insulated Gate Bipolar Transistors (IGBT) or Intelligent Power Module (IPM) Transistors which shall provide intelligent features like the drive circuitry, over-current protection, over temperature protection, control power failure protection and short circuit protection.

The IGBT / IPM transistors shall enable high speed switching of 6 Khz thus reducing the heat dissipation in the UPS and thereby providing high efficiency.

The UPS shall utilize both Voltage and Current feedback control circuits so that the inverter shall act not only as a constant voltage source but also as a load required current source. This shall enable the inverter to quickly adapt to the changing load current value and wave shape.

4.2 Voltage Regulation

The inverter output voltage shall not deviate by more than + 1% RMS due to the following steady state conditions :

Form 0 to 100% loading
Inverter DC input voltage varies from maximum to minimum.
Environmental conditions variations within the limitations set in the section 4.8.

4.3 Frequency Control

The inverter output frequency shall be controlled by an oscillator internal to the UPS module logic. It shall be capable of synchronizing to an external reference (e.g. the bypass source or another UPS module) or operating asynchronously. The oscillator shall maintain synchronization with the external reference within the limitations set hereunder. The inverter shall operate on self run mode without synchronism if the bypass frequency exceeds the set value. The oscillator, while running asynchronously, shall maintain the frequency as 50 Hz + 0.01% (or + 0.005 Hz). Automatic adjustment of phase relationship between inverter output and standby bypass source shall be gradual at a controlled slew rate which shall be adjustable at the rate of 0.5, 1.0, 2.0, 3.0 Hz / second. (default 2.0 Hz / second).

The inverter output frequency shall not vary during steady state or transient operation due to the following conditions:

a. From 0 to 100% loading.
b. Inverter DC input varies from maximum to minimum.
c. Environmental condition variations within the limitations set in section 4.8.

4.4 Output Voltage Harmonic Distortion

The inverter output shall limit the amount of harmonic content to the values stated in section 4.9. The use of excessive or additional filtering shall not be required to limit the harmonic content thus maintaining a high level of efficiency, reliability and original equipment footprint.

4.5 Output Overload Capability

The inverter output shall be capable of providing an overload current while maintaining rated output voltage to the values stated in section 4.8. An LED indicator shall be located on the control panel to identify this condition. If the time limit associated with the overload condition expires or the overload is in excess of the set current amplitude, the load shall be transferred to the bypass source without interruption.

4.6 Inverter Current Limit

The inverter output shall be limited to 150% of rated load current. The two sensing locations shall operate separately and independently thus providing redundancy and, in the event of a failure, preventing unnecessary damage to power transistor components / fuses. Load current above 150% shall cause an immediate transfer of the load to the bypass source for fault clearing.

4.7 Inverter Overload Protection

The AC output from the inverter shall utilize fuses for overload protection. The inverter shall utilize a contactor to isolate the inverter output from the critical bus.
The inverter fuses shall be the fast acting semiconductor type.

The inverter output isolation contactor shall be located in the UPS module and shall be controlled by the internal UPS module system logic.

4.8 The inverter shall meet the following specifications in addition to other requirements stated herein:

| | | |
|---|---|---|
| Voltage Input | : | Three Phase UPS :<br>380 V/ 400 V / 415 V |
| Nominal Voltage Output | : | 415 V + 1% AC 3 Phase, 4 Wire |
| Inverter Capacity | : | |
| Voltage Regulation | : | |
| a. For 0 to 100% loading | : | < + 1% |
| b. Inverter DC input voltage vary from maximum to minimum | : | < + 1% |
| c. Environmental conditions given below | : | < + 1% |
| Transient Voltage Regulation | : | |
| a. AT 100% step load change | : | < + 3% |
| b. At loss or return of AC input | : | < + 1% |
| c. At load transfer from bypass to inverter | : | < + 3% |
| | | |
| Time to recover from transient to normal voltage | : | The output voltage returns to within ±1% of the steady state value within 50ms. |
| | | |
| Wave form | | |
| | | |
| a. Normal frequency | : | 50 Hz |
| b. Frequency regulation for all conditions of input supplies, loads and temperature occurring simultaneously or in any combination (automatically | : | + 0.01% |

| | | |
|---|---|---|
| controlled) | | |
| c. Synchronization limits for synchronism between the inverter and standby AC source. | : | 49 Hz to 51 Hz. |
| d. Field adjustment range for above | : | 50 + 0.25 Hz to 50 + 1.5 Hz |
| | | |
| Total voltage harmonic distortion | : | < 2% THD for 100% linear load<br>< 4% THD for 100% non-linear load |
| | | |
| Duty | : | Continuous |
| Cooling | : | Forced cooling using fans. |
| Ambient operating temperature range | : | 0 to 40 deg.C maximum continuous. |
| Operating relative humidity | : | 0-95% non-condensing. |
| Operating altitude. | : | Sea level to 1000 meters. |
| Overload Capacity | | 10 minutes at a load representing 125% of the rated load;<br>1 minutes at a load representing 150% of the rated load |
| Output | : | Suitable terminals are provided for termination of cables for connecting inverter output to AC distribution board. |

4.10 Isolation Transformer (After static switch)

An external isolation transformer (K13 Cu wound) after static switch i.e. At complete output of UPS system as per IEEE 1100 – 2005 shall be provided for achieving galvanic isolation. This shall provide neutral separation which shall mean that output neutral will be independent of incoming neutral during all the three cases i.e. Double Conversion Online Mode, Bypass Mode and Maintenance Bypass Mode. Hence critical load shall be isolated from the problems like incoming neutral open or, short or, variations in neutral to earth voltage due to sudden loading in neighboring installation.

4.11 Reverse Phase Sequence Protection

In the event of Phase sequence reversal at the input, UPS system shall continue to work on the main power supply, or UPS systems shall go into battery mode, and shall not trip the UPS system.

5. BYPASS AND STATIC TRANSFER SWITCH

5.1 A bypass circuit shall be provided as an alternate source of power other than the inverter. A high speed switch and wrap-around contactor shall be used for the critical load during automatic transfers to the bypass circuit. The static switch and wrap-around contactor shall drive power from an upstream bypass feed circuit breaker internal to the UPS module provided for overload protection. The wrap-around contactor shall be electrically connected in parallel to the static switch and shall at the same time as the static switch, energize and upon closure, maintain the bypass source. The static switch shall only be utilized for the time needed to energize the wrap-around contactor thus increasing reliability. The bypass circuit shall be capable of supplying the UPS rated load current and also provide fault clearing current. The UPS system logic shall employ sensing which shall cause the static switch to energize within 150 microseconds thus providing an uninterrupted transfer to the bypass source when any of the following limitations shall exceed :

Inverter output under voltage or over voltage.
Overload beyond the capability of the inverter
DC circuit under voltage or over voltage
Final end voltage of system battery is reached.
Bypass source present and available
System failure (eg.Logic fail, fuse blown, etc.)

5.2 Keeping the above requirements in view, the static switch shall have the following minimum rating.
Capacity continuous equal to 100% of continuous rating of the inverter.
Capacity overload equivalent to overload characteristics specified for UPS.

| | | |
|---|---|---|
| Nominal bypass input voltage | : | 415 V / 240 V, 3 phase, 4 wire |
| | | |
| Voltage Range | : | + 10% of nominal |
| Nominal Frequency | : | 50 Hz |
| Frequency range | : | + 2%<br>Please refer to selectable range of Inverter given in point 4.3 & 4.8 |
| Output Fault Clearing : | | |
| Current | : | 1000% |
| Duration | : | 20 milli seconds |
| | | |
| Ambient operating temperature | : | 0 to +40 degree C continuous |
| Operating relative humidity | : | 0-95% non-condensing |
| Operating altitude | : | Sea level to 1000 meters |
| Cooling | : | Natural Convection |
| Duty | : | Continuous |

5.4 Automatic Re-Transfer
In the event that the critical load must be transferred to the bypass source due to an overload, the UPS system logic monitors the overload condition and, upon the overload being cleared, perform an automatic re-transfer back to the inverter output. The UPS system logic shall only allow a re-transfer to occur three times within a ten minute period. Re-transfer shall be inhibited on the fourth transfer due to the likelihood of a recurring problem at the UPS load distribution. The re-transfer a load to the inverter shall also be inhibited due to the limitations set in section 5.3.

5.5 Manual Transfer
The UPS shall be capable of transferring the critical load to / from the bypass source via LCD touch panel. When performing manual transfer to inverter or automatic re-transfers, the UPS system logic shall force the inverter output voltage to match the bypass input voltage and then parallel the inverter and bypass source providing a make-before-break transition allowing a controlled walk-in of load current to the inverter.

5.6 Maintenance Bypass Switch (MBS)
The UPS shall include as standard equipment, a zero energy maintenance bypass switch. Full UPS wrap-around enables personnel to do work inside the UPS module or maintenance bypass switchboard without danger fro high voltage conditions.

6 UPS BATTERY SYSTEM

a. The UPS system shall, as an integral part, provide battery system for backup time as specified in the Schedule (Full Load) standby capacity.
b. The latest state of the art Valve Regulated Sealed Maintenance Free Lead Acid Batteries shall be used with a 20 hours discharge rating.
c. The battery system shall be sized to provide back-up time as specified in the schedule of quantity when the UPS is supplying 100% rated load at 0.8 load power factor.
d. An ageing factor of 15% shall be applied to the capacity arrived at, to allow for compensation against capacity loss during float operation.

e. The battery system design shall be provided with necessary devices to prevent deep discharge beyond recommended limits to prevent the batteries discharging beyond end cell voltage specified by the battery maker. The connections from battery to battery shall be by using copper bus bar strips and the entire battery system shall be used in IP20 steel cabinet enclosure and shall be similar to the UPS enclosure.

f. All batteries shall be clearly identified and identification numbers marked on the batteries and a schematic diagram along with the complete calculations, including manufacturers supporting curves, shall be submitted with the tender.

g. The UPS shall have a properly rated and sized circuit breaker to isolate it from the battery

7. OPERATION

a. Under normal operation, the UPS load will be fed from the Inverter with the bypass switch inhibited. The Converter, apart from providing DC power to the Inverter, also charges the battery under the float charge mode. The battery charge system shall have float charge, equalizing charge and recovery charge modes, to replenish the batteries self-discharging part while the battery is fully charged, equalizing the battery cell voltage to a constant value forcibly, and recharging the battery system to the required values when the batteries have been used, respectively.

b. The Inverter shall constantly monitor the AC source frequency and shall be in synchronization with the AC input source till the frequency of the AC input source is within synchronization limit and if the frequency of the standby source exceeds the synchronization limit the Inverter will work on its own internal oscillator maintaining an output frequency of 50 Hz +/- 0.01% under all conditions of load. When the Inverter operates on its internal oscillator, it shall continuously monitor the frequency of the input source and when the input source frequency returns to within synchronization limit, the Inverter shall automatically synchronization itself with the input A/C source frequency and use it as a signal for Inverter output frequency control.

c. Battery Operation:

i) When the A/C input voltage drops below specified limits or in case of a power failure the Inverter continues to supply AC power of constant voltage and constant frequency utilizing the battery system as a power source until the input voltage returns to normal requirement. When the power supply is resumed or the input voltage returns to limits, the Converter shall automatically start and the load fed for normal operation status.

ii) If the power failure continues beyond battery back-up time or the battery voltage drops to the final discharge voltage, the Inverter should automatically stop and at the same time transferring the load to the bypass circuit. On resumption of power supply, the Converter shall automatically re-start the operations and charge the batteries whereas the Inverter should inhibit automatic start and should be started manually.

d. Bypass Operation:

When power is supplied from the Inverter in synchronization with the bypass, it shall accomplish the following:

i) When the UPS output current reaches overload status it shall automatically transfer the load to bypass circuit with no interruption and when the overload status is cleared it automatically re-transfers the load to Inverter.

ii) When the battery final discharge condition is reached, the load shall automatically be transferred to the bypass circuit without interruption.

iii) In case of failure of the UPS, the load shall be automatically transferred to the bypass circuit with no interruption and when the failure is cleared, re-transfer the load to the Inverter shall be done manually.

iv) There should be provision made in the system to prevent, when necessary, asynchronous transfer.

v) When the UPS goes on bypass mode in any of the conditions described above and if at that time there is no bypass power supply available due to power failure, the UPS shall remain in standby mode and as soon as the bypass power supply is available will transfer the load to bypass.

v) A maintenance bypass transfer switch shall be provided with lock and key arrangement and should be manually done by authorized personnel only.

8. CABINET AND ENCLOSURES

8.1 The entire UPS system, including all components like inverter, static switch, maintenance bypass, shall be housed in free-standing steel type factory-finished enclosures complying with the protection standards of IP20. The enclosure shall be open-able using a special tool for internal access. The colour shall be light grey.

8.2 Ventilation

Forced air-cooling shall be provided to allow components to operate within their rated temperature specified. The cooling fans shall have thermal relays protection using a latched cut fire re-setting, as a protection for the cooling fans.

Similarly, the backup battery system shall also be housed as described earlier in an IP20 cabinet.

9. CONTROL AND MONITORING

a. The UPS shall utilise state of the art full DDC control software driven Control and Monitoring System.

b. It shall be provided with LED displays.

Metering should display the following parameters on the control panel

- Input AC voltage line-to-line and line-to-neutral for each phase
- Input AC current for each phase
- Input frequency
- Battery voltage
- Battery charge/discharge current
- Output AC voltage line-to-line and line-to-neutral for each phase
- Output AC current for each phase
- Output frequency
- Percent of rated load being supplied by the UPS
- Battery time left during battery operation.
- Bypass power available.

Following alarm messages to be displayed at the control panel:

- Input power out of tolerance
- Input phase rotation incorrect
- Incorrect input frequency
- Charger in reduced current mode
- Battery Charger Problem
- Battery failed test
- Low battery warning (adjustable 1 to 99 minutes)
- Low battery shutdown
- DC bus overvoltage
- Bypass frequency out of range
- Load transferred to bypass
- Excessive retransfers attempted
- Static switch failure
- UPS output not synchronized to input power
- Input power single phased
- Input voltage sensor failed
- Inverter leg over current in X-phase
- Output under voltage
- Output overvoltage
- Output over current
- System output overloaded
- Load transferred to bypass due to overload
- Overload shutdown
- Control Error

- Critical power supply failure
- Load transferred due to internal protection
- External shutdown (remote EPO activated)
- Fan failure
- Over temperature shutdown impending
- Over temperature shutdown.
- Lamp test.

c. The UPS logic should provide one set of normally open dry contact / relay output to allow interfacing of UPS operating status to an external system and should be capable of providing, as a minimum, 10 numbers status and, should the UPS manufacturer's standard product does not provide such software, the bidder must add additional equipment and cost for the same.

d. The UPS shall also have an RS485 port with MODBUS interface card if required for interfacing to BAS system or client's centralized computer network.

e. LCD touch panel (Optional)

   i. The UPS shall be provided with a operator friendly large scale LCD touch panel.

   ii. The LCD touch panel shall also include graphic measurement display, operational procedures of each activity, fault status display and also have capability to record at least 50 faults.

   iii. The touch screen panel shall clearly define specified areas for operational function, execution and message display.

   iv. It should be possible to operate the entire UPS system and its components and obtain all measurements and data through the touch screen operation. The measurement software should provide capability to measure phase voltage, current in each phase, frequency, power factor, available battery time etc.

   v. Under all operating conditions, the system software should have capability for displaying fault alarm automatically. The tenderer should describe in detail the faults that would be displayed under this mode.

10. UPS TESTING

- The Contractor shall perform the following tests, as a minimum, at site prior to handing over, to confirm the functional and the performance specification of the UPS as specified. All required test equipment like Digital Oscilloscope, Voltage Regulator, and Measurement Meters etc. shall be the responsibility of the Contractor without any additional cost.
- The Contractor shall demonstrate as a minimum the following features on site by providing all required test equipment, such as power factor improvement, input current THD, output voltage THD, output frequency and all other performance monitoring requirements detailed before as required by the Owner.

## 11.11 BUS DUCT (SANDWICHED TYPE)

1) Scope

The specification covers design, manufacturing, supply, installation, testing and commissioning of Sandwich type busbar trunking for use as feeder busbars for interconnection between separate electrical equipment / load centers, and for use as plug in busbar risers.

2) System details

The busbar shall be suitable for operation in a 600V system, with frequency of 50 Hz having 100% neutral and internal earth.
The bus duct shall conform to IEE/NEMA/BUI/JIS for seismic protection certification.

3) Design & Construction requirements – Sandwich bus bars

3.1 General

The busbars shall be of sandwich construction, non-ventilated design. It shall be possible to mount the busbar system in any orientation, without affecting the current rating.

The bus duct shall consist of three phases and neutral bus bar permanently positioned dust and vermin proof and the degree of enclosure protection shall be IP 52 for indoor installation and shall be IP-65 for outdoor installation as per schedule of quantities.

3.2 Busbars

The busbars shall of high conductivity Copper, or Aluminum, as specified in the tender.

Where an earth conductor is required, it shall be a separate, integral earth conductor, of the same high conductivity material as the phase conductors,

3.3 Insulation

The busbars shall be insulated throughout their length by epoxy coating / Mylar. The insulation material used shall be of Class F (150 deg. C). The insulation must comply to UL 94 V-O. It shall be Halogen Free.

Housing: The housing shall be made of extruded Aluminum case duly enameled/ electro-galvanized sheet steel, with an epoxy powder coated paint finish. The housing shall be profiled, to provide higher strength and efficient heat dissipation. The width of the housing shall preferably be the same for all ratings of busbars, in order to provide interchangeability of tap off boxes.

3.4 Joints

The joints between sections shall be made so as to provide flexibility during installation and expansion / contraction of busbar during operation. The joints shall be of the single bolt type

The joint construction must have the following features:-

a) Heat expansion of at least 3mm per joint.
b) The joint insulation must be of one piece molded design and not have any cut edges which can absorb moisture.
c) The joint construction must allow a +/- 14mm adjustment at the time of installation, for ease of adjusting to site measurement variations.
d) The joint bolt must be insulated with a bolt insulator. The bolt insulator must be of molded one piece.
e) The joint system must be designed in a way that the installer cannot insert the busduct length too far and damage the bolt insulator.
f) The busbar ends shall not have holes or slots at the joints – the electrical continuity shall be through pressure plates, achieving a high area of joint cross section and expansion capability.
g) It shall be possible to install and remove the joints without disturbing the busbar run.

3.5 End termination

At the termination either on the transformer side or on the panel side, bus duct shall be provided with flange ends, adopter box and copper flexible( preferably multi sheet types) to connect bus bar of bus duct to bus bar of panels or transformer terminals.

Accessories:
A full range of accessories like bends, end flanges, end feed units, and support brackets etc. shall be available.

4) Installation

Bus ducts running along the wall shall be supported at intervals not exceeding 1.5 m. In case of branching, there shall be support on all branches at a distance of 300 mm from the point of branching, Support shall not be less than 40 x 40 x 6 mm MS angle secured in an approved manner. Supports may also be provided in the form of brackets fixed to walls where the duct runs along the wall. In case of ceiling suspended bus ducts, supports made out of 40x40x6 mm MS angle iron shall be provided along with 12mm dia MS rod with threading and nut bolts. The horizontal distance between two such supports shall not be more than 1200 mm. The ducts supports shall be suspended from suitable approved suspension devices provided in the ceiling. Fire barrier shall be provided at each floor/wall crossing as per relevant IS code. Continuous earth bus of suitable size shall be provided along with throughout the length of Bus duct. Fire barrier of 2hrs rating shall be provided on each floor.

5) Testing

The busbars shall be type tested at a reputed international test laboratory (ASTA or CPRI) for short circuit withstand. The test shall be for a minimum duration of 1 second. Tests shall be performed over a range of current ratings, covering the different frame sizes of the manufacturer.

Degree of ingress protection (IP rating) shall also be tested at any reputed independent laboratory. This test shall be for IP54 for indoor application and IP65 for outdoor application for sandwiched busbars.

The following tests shall be carried out at site and test results to be recorded:-

a) Insulation resistance shall be tested with 1000 V megger and shall be not less than 100 mega ohms.

b) Earth continuity test

## 11.12 CABLING FOR VOICE SYSTEM

1. Scope

This document defines the cabling system and subsystem components to include cable, termination hardware, supporting hardware, and miscellany required to supply, and to install a complete cabling infrastructure supporting voice and video. The intent of this section is to provide pertinent information to allow the vendor to bid the labor, supervision, tooling, materials, and miscellaneous installation hardware and consumables to install a complete system. However, it is the responsibility of the vendor to propose any, and, all items required for a complete system whether or not it is identified in the specification, drawings and bill of materials attached to this specification.

2. Applicable Documents:

The cabling system described in this specification is derived in part from the recommendations made in industry standard documents. The list of documents below (or the latest revisions) has bearing on the desired cabling infrastructure are incorporated into this specification by reference:

This Technical Specification and Associated Drawings
ANSI/TIA/EIA 568-B Commercial Building Telecommunications Cabling Standard – March 2001
ANSI/EIA/TIA-569-A Commercial Building Standard for Telecommunications Pathways and Spaces - February, 1998
ANSI/EIA/TIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings - February, 1993
ANSI/TIA/EIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications - August, 1994

3. Backbone Wiring

The function of the backbone wiring shall be to provide interconnections between telecommunications closets, equipment rooms and entrance facilities in the telecommunications wiring system. The backbone wiring shall consist of the transmission media, intermediate and main cross connects, and mechanical terminations for interconnection of telecommunications closets, equipment rooms and entrance facilities. The backbone wiring shall include transmission media in the building.

The backbone wiring shall use the star topology wherein each telecommunications closet shall be wired to a main cross connect / patch panel or an intermediate cross connect then to a main cross-connects / patch panel. There shall be no more than two hierarchical levels of cross connects / patch panel in the backbone wiring. Interconnections between any two telecommunications closet shall pass through three or fewer cross-connects / patch panel.

Bridged taps shall not be permitted as part of the backbone wiring.

One of the following types of cables shall be used for backbone wiring as defined in schedule of quantities.

100-ohm UTP multiplier backbone cable.
62.5 / 12.5 um optical fiber cable.
The contractor has to assure that cross talk coupling between individual, unshielded twisted-pairs shall not affect the transmission performance of multi-pair cables.

4. Horizontal Wiring

The horizontal wiring shall be the portion of the tele communications wiring system that will extend from the work area telecommunications outlet to the telecommunications closet. The horizontal wiring shall include the telecommunications outlet in the work area, mechanical termination for the horizontal cables, and cross-connections located in the telecommunications closet.

The horizontal wiring shall be capable of handling the following minimum services.

Voice telecommunications.
Premises switching equipment.
The horizontal wiring shall be a star topology with each work area telecommunications outlet connected to a telecommunications closet. Horizontal wiring shall preferably contain no more than one transition point between different forms of the same cable type.

Bridged taps shall not be permitted as part of the horizontal wiring.

The maximum horizontal distance shall be limited to 90 meters (295 ft) independent of media type i.e. the cable length from the mechanical terminating of the media in the telecommunications closet to the telecommunications outlet in the work area shall be limited to this distance. This horizontal distance includes cabling required from the telecommunications outlet to the work station. Horizontal cable shall be limited to one of the following types as listed out in the schedule of quantities.

- Four-pair 100-ohm unshielded twisted pair (UP) cables.
- 62.5/125 um optical fiber cable.

5. Grounding Considerations

a) Grounding system shall be an integral part of the telecommunications wiring system. In addition to helping protect personnel and equipment from hazardous voltages, the grounding system shall reduce the effect of electromagnetic interference ((EMI) to and from the telecommunications wiring system.
b) Grounding shall meet the NEC requirements and practices or local authorities or codes whichever impose a more stringent requirement.
c) The following shall be considered for the grounding system.
d) Installation conforms with proper practices and requirements.
e) Each telecommunications closet shall have an appropriate grounding access.
f) Grounding shall be available for cross-connect frames, patch panel racks, telephone and data equipment and equipment required for maintenance and testing.

6. Backbone Wiring Distances

Telecommunications Closet to Main Cross-Connect

a) The maximum backbone distance between the main cross-connect patch panel and the mechanical termination in the telecommunications closet shall be as follows:
b) For 62.5 / 125 ohms optical Fiber cable the distance between Telecommunication closet and main cross connect / patch panel shall not exceed 2000 mts.
c) For 100 ohm UTP cable, maximum distance between telecommunication closet and main cross connect / panel shall be 800 mts.
d) Telecommunications equipment which connect directly to main or intermediate cross-connects / patch panel shall done via cables of 30 m or less.

7. Telecommunications Closet

A telecommunications closet shall be defined as an area within the building set aside for the exclusive purpose of housing equipment associated with the telecommunications wiring system. There shall be no upper limit on the number of telecommunications closets which may be provided within the building. The telecommunication closet shall have following three possible configurations.

a) Horizontal Backbone Connection: The telecommunications closet shall contain the mechanical terminations for a portion of the horizontal wiring system and a portion for the backbone wiring system. In such a case the telecom closet shall provide facilities (space, power, grounding etc.) for the passive (cross-connect) / patch panel or active devices or both used to interconnect the two system.

b) Backbone Wiring System Interconnection: The telecommunications closet may contain the intermediate cross-connect / patch panel or main cross connect / patch panel for different portions of the backbone wiring system. In this usage, the telecommunications closet shall provide facilities for the passive or active devices or both used to interconnect two or more portions or the backbone wiring system.

c) Entrance Facilities: A telecommunications closet may be used to contain the demarcation point or an interbuilding entrance facility. In this usage, the telecommunications closet shall provide facilities for the active and / or passive devised required to interconnect the demarcation point or interbuilding entrance facility or both to the telecommunication wiring system.

d) The design of the telecommunications closet shall be as per the requirements of EIA/TIA-569.

8. Equipment Room

The equipment room shall be defined as an area within the building where telecommunications systems shall be housed along with the mechanical termination of one or more portions of the telecommunications wiring system. Equipment room shall be considered to be distinct from telecommunications closets because of the nature or complexity of the equipment they contain. Any or all of the functions of a telecommunications closet shall be alternatively provided by an equipment room.

9. Cable Specifications

UTP Cabling System

a) Unshielded twisted pair cabling system, TIA / EIA 568-B.1 addendum Category 6 Cabling system

| | |
|---|---|
| a. Networks Supported | 10 / 100/1000 Ethernet, 155 Mbps ATM, 1000 Mbps IEEE 802.3ab Ethernet, and proposed Cat 6 Gigabit Ethernet |
| b. Warranty | 25-year systems warranty; Warranty to cover Bandwidth of the specified and installed cabling system, and the installation costs |
| c. Performance characteristics to be provided along with bid | Attenuation, Pair-to-pair and PS NEXT, ELFEXT and PSELFEXT, Return Loss, ACR and PS ACR for 4-connector channel |

b) Unshielded Twisted Pair, Category 6, TIA / EIA 568-B.2

| | |
|---|---|
| a. Material: | |
| b. Conductors | 23 AWG solid bare copper or better |
| c. Insulation | Polyethylene |
| d. Jacket | Flame Retardant PVC |
| e. Pair Separator | Cross-member fluted Spline. |
| f. Approvals | UL Listed |
| | ETL verified to TIA / EIA Cat 6 |
| g. Operating temperature | -20 Deg. C to +60 Deg. C |
| h. Frequency tested up to | Minimum 600 MHz |
| i. Packing | Box of 305 meters |
| j. Delay Skew | 45ns MAX. |
| k. Impedance | 100 Ohms + / - 15 ohms, 1 to 600 MHz. |
| l. Performance characteristics to be provided along with bid | Attenuation, Pair-to-pair and PS NEXT, ELFEXT and PSELFEXT, Return Loss, ACR and PS ACR |

10. IPDA

System components

Communication server

Central unit Communication server and call control for voice and non-voice services for envisaged configuration

System Management and remote administration

Configuration Management Application to configure the communication server; installed on the central unit.

Performance Management Application to measure the communication server; installed on the central unit

Fault Management application supporting the monitoring of the communication server; installed on the central unit

System interface for remote maintenance Via a secure LAN connectivity,

The service center of the supplier can perform maintenance operations. The system itself can send messages relating to safety and reliability via the automatically set up connection to the service center.

The access has to be password protected. The service center can now interrogate files, amend configurations to enhance quality of service, modify switching parameters etc.

Thanks to the messages from the dependability system, indicating, say, that the thresholds for quality counters have been exceeded, it should be possible to take service action before the faults become acute.

Distributed architecture via IPDA network

IP Access Point for the reception of hardware modules, interfaces and IP gateways via internal IP network infrastructure with the following features:-free standing-up to 16 slots -central control module to support up to 50 connections in the IP network-2 x 10/100 Base-T interface (redundant network connectivity)-local TDM switching matrix with a switching capacity up to. 256 B-channels-support IP -based network protocols -support of all features and applications of the central system-administration of all components via integrated management tool-QoS according to IEEE 802.1 d/q and IETF DiffServ-integrated echo compensation-Voice compression according to ITU-T G.711 and G.729 AB-transparent fax-modem support (FMoIP) according to G.711t-T.38 fax support

IP Access Point for the reception of hardware modules, interfaces and IP gateways via internal IP infrastructure.Such as 1.4.1 to support up to 100 B-channels in the IP network

IP Access Point (19 inch style)for the reception of hardware modules, interfaces and IP gateways via internal IP network infrastructures with the following features:-Up to 9 slots for peripheral modules per IP access point-central control module to support up to 50 B-channels to the IP network-2 x 10/100 Base-T interface (redundant network connectivity)-local TDM switching matrix with a switching capacity up to 256 B-channels-support of IP-based network protocols-support of all features and applications of the central system-administration of all components via integrated management tool-distributed voice switching -QoS according to IEEE 802.1 p/q and IETF DiffServ-integrated echo compensation -Voice compression according to ITU-T G.711 and G.729 AB-transparent fax-modem support (FMoIP) according to G.711t-T.38 fax support

IP Access Point (19 inch style)for the reception hardware modules, interfaces and IP gateways via internal IP infrastructures to support up to 100 B-channels to the IP networkService provider interfacesS0 basic accessfor the digital exchange lines with ISDN-channel structure B+B+D and DSS1 protocol
S2primary rate accessfor digital exchange lines with channel structure 30B+D and DSS1-protocol PCM30 accesswith CAS (channel-associated signaling),outgoing/incoming traffic with DID, Scootedsignaling and E&M-signaling

Interfaces for networking Connection element for digital dedicated connections$S_{0FV}$, basic dedicated connections, channel structure 2B+D (2 x 64 kbps + 1 x 16 kbps) according to ITU. 430 with manufacturer-specific networking protocol to support network-wide functions and to provide cross-network features.Alternatively configurable with DSS1-protocol-PSS1-(Q-Sig)-

protocol

Connection element for digital dedicated connections$S_{2MFV}$, primary rate access dedicated connection, channel structure 30B+D (30 x 64 kbps + 1 x 64 kbps) to ITU-T G. 703/704 with manufacturer-specific networking protocol to support network-wide functions and to provide cross-network features. Alternatively configurable with -DSS1-protocol-PSS1 (Q-Sig)-protocol
VoIP TruckingGateway interface to realize voice networks over the internal IP network infrastructure with manufacturer-specific networking protocol to support network-wide functions and to provide cross-network features.Such as 1.6.3 with IP interface to support up to 100 B-channels

VoIP Trucking Gateway SIPIP Interface for the realization of voice-networks using company internal IP infrastructureSuch as 1.6.5 with IP interface for support up to 100 B-channels

CF/E&M circuitsfor two-way call traffic with signaling via 2- or 4- wire lines with pulse signaling (CF method) or continuous signaling (E&M method).

Connection element digital interface unitwith CAS (channel-associated signalling) for PCM30 access with E&M-signaling

*Subscriber interfaces*
Connection element, analogue a/b- interfacefor connecting analogue telephones, payphones and card telephones with transfer of call charge pulses, modems and group 3 faxes, pulse dialling or DTMF dialing

Connection element, digital 2-channel $U_{P0}$–interfaceConnecting two-channel digital telephones and PNT adapters, channel structure B+B+D (2 x 64 + 16 kbps), 2-wire.

Connection element, digital 2-channel$S_0$ interface with DSS1-protocolConnecting 2-channel ISDN- telephones, ISDN-Router, ISDN-adapter, ISDN- group 4 faxes and adapters for conventional interfaces, operating mode point-to-point or point-to-bus. Channel structure B+B+D (2 x 64 + 16 kbps), 4-wire

Connection element for base stations to cover radio cells (cordless)with 4 voice channels per interface, 2-wire

IP Subscriber Gateway connection of IP telephone via internal IP based infrastructure with the following features:-2 x 10/100 BaseT interface-support of voice-based network protocols via IP-support of voice compression according to ITU-T G.711, G.723 and G.729 AB-QOS according to IEEE 802.1p and IETF DiffServ-administration of the IP users by the central management-IP interface to support up 60 B-channels-up to 240 IP terminals configurable per Gateway
alternatively configurable as -SIP-subscriber gateway -IP-trunking gateway-SIP- carrier/trunking gateway

Units for special systems and special equipment
Connection element for paging equipment Multi-wire interface for connecting a single or multiple paging device. Initiation of paging in prefix dialing, suffix dialing or by call diversion. Search modes, optical displays or cordless paging receiver with voice announcement as simple beeper or with display.Message procedure using message code number or, with display, by means of ”meet me”. Criteria exchange for paging with DTMF in accordance with the ESPA standard. In addition to the a/b wire, another wire is required to check readiness for operation.

Connection element for door release/intercom system Multi-wire interface for a/b connection of the amplifier for the door release/intercom system which is turned on by means of a dialed code number via a third wire. By suffix dialing a further code, the door opener can be activated via another wire.

Connection element for recorded announcement equipment Multi-wire interface for connection of a recorded announcement device to ensure that the announcement texts are played at the correct time. An additional signaling wire is required to indicate the start of the text. Another wire is used to monitor the operating state of the connected device.

## 11.13 CABLING FOR DATA SYSTEM

1 Scope

This document defines the cabling system and subsystem components to include cable, termination hardware, supporting hardware, and miscellany required to supply, and to install a complete cabling infrastructure supporting data and video. The intent of this section is to provide pertinent information to allow the vendor to bid the labor, supervision, tooling, materials, and miscellaneous mounting hardware and consumables to install a complete system. However, it is the responsibility of the vendor to propose any, and, all items required for a complete system whether or not it is identified in the specification, drawings and bill of materials attached to this specification.

2 Applicable Documents

The cabling system described in this specification is derived in part from the recommendations made in industry standard documents. The list of documents below (or the latest revisions) has bearing on the desired cabling infrastructure are incorporated into this specification by reference:

- This Technical Specification and Associated Drawings
- ANSI/TIA/EIA 568-B Commercial Building Telecommunications Cabling Standard – March 2001
- ANSI/EIA/TIA-569-A Commercial Building Standard for Telecommunications Pathways and Spaces - February, 1998
- ANSI/EIA/TIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings - February, 1993
- ANSI/TIA/EIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications - August, 1994

2.1 Cabling System and Component Specifications

2.1.1 UTP Cabling System

2.1.1.1 Unshielded twisted pair cabling system, TIA / EIA 568-B.1 addendum Category 6 Cabling system

| | |
|---|---|
| Networks Supported | 10 / 100 Ethernet, 155 Mbps ATM, 1000 Mbps IEEE 802.3ab Ethernet, and proposed Cat 6 Gigabit Ethernet |
| Warranty | 25-year systems warranty; Warranty to cover Bandwidth of the specified and installed cabling system, and the installation costs |
| Performance characteristics to be provided along with bid | Attenuation, Pair-to-pair and PS NEXT, ELFEXT and PSELFEXT, Return Loss, ACR and PS ACR for 4-connector channel |

2.1.1.2 Unshielded Twisted Pair, Category 6, TIA / EIA 568-B.2

| | |
|---|---|
| Material: | |
| Conductors | 23 AWG solid bare copper or better |
| Insulation | Polyethylene |
| Jacket | Flame Retardant PVC |
| Pair Separator | Cross-member fluted Spline. |
| Approvals | UL Listed ETL verified to TIA / EIA Cat 6 |
| Operating temperature | -20 Deg. C to +60 Deg. C |
| Frequency tested up to | Minimum 600 MHz |
| Packing | Box of 305 meters |
| Delay Skew | 45ns MAX. |
| Impedance | 100 Ohms + / - 15 ohms, 1 to 600 MHz. |
| Performance characteristics to be provided along with bid | Attenuation, Pair-to-pair and PS NEXT, ELFEXT and PSELFEXT, Return Loss, ACR and PS ACR |

2.1.1.3 UTP Jacks

| | |
|---|---|
| Type | PCB based, Unshielded Twisted Pair, Category 6, TIA / EIA 568-B.2 |

| | |
|---|---|
| Durability | |
| Modular Jack | 750 mating cycles |
| Wire terminal | 200 termination cycles |
| Accessories | Strain relief and bend-limiting boot for cable<br>Integrated hinged dust cover |
| Materials | |
| Housing | Polyphenylene oxide, 94V-0 rated |
| Wiring blocks | Polycarbonate, 94V-0 rated |
| Jack contacts | Phosphorous bronze, plated with 1.27micro-meter thick gold |
| Approvals | UL listed |
| Performance Characteristics to be provided with bid | Attenuation, NEXT, PS NEXT, FEXT and Return Loss |

2.1.1.4 UTP Jack Panels

| | |
|---|---|
| Type | 24-port, PCB based, Unshielded Twisted Pair, Category 6, TIA / EIA 568-B.2 |
| Ports | 24 |
| Port arrangement | Modules of 6-ports each, arranged 1port x 6. |
| Category | Category 6 |
| Circuit Identification Scheme | Icons on each of 24-ports |
| Port Identification | 9mm or 12mm Labels on each of 24-ports (to be included in supply) |
| Height | 1 U (1.75 inches) |
| Durability | |
| Modular Jack | 750 mating cycles |
| Wire terminal (110 block) | 200 termination cycles |
| Accessories | Strain relief and bend limiting boot for cable |
| Materials | |
| Housing | Polyphenylene oxide, 94V-0 rated |
| Wiring blocks | Polycarbonate, 94V-0 rated |
| Jack contacts | Phosphhorous bronze, plated with 1.27micro-meter thick gold |
| Panel | Black, powder coated steel |
| Approvals | UL listed |
| Termination Pattern | TIA / EIA 568 A and B; |
| Performance Characteristics to be provided along with bid | Attenuation, NEXT, PS NEXT, FEXT and Return Loss |

2.1.1.5 Faceplates

| | |
|---|---|
| Type | 1-port, White surface box |
| Material | ABS / UL 94 V-0 |
| No. of ports | One |

2.1.1.6 Workstation / Equipment Cords

| | |
|---|---|
| Type | Unshielded Twisted Pair, Category 6, TIA / EIA 568-B.2 |
| Conductor | 24 AWG 7 / 32, stranded copper |
| Length | 7-feet |
| Plug Protection | Matching colored snag-less, elastomer polyolefin boot |
| Warranty | 25-year component warranty |
| Category | Category 5 |
| Plug | |

| | |
|---|---|
| Housing | Clear polycarbonate |
| Terminals | Phosphor Bronze, 50 micron gold plating over selected area and gold flash over remainder, over 100 micron nickel underplate |
| Load bar | PBT polyester |
| Jacket | PVC |
| Insulation | Flame Retardant Polyethylene |

2.1.1.7Warranty

Owner seeks warranty for the installed cable plant from the OEM equipment supplier. Bidder shall ensure that the OEM norms for supply, installation, testing and documentation as specified by the OEM supplier shall be adhered to, provided those are in line with TIA / EIA standards and Owner requirement specifications. The warranty shall be provided by the OEM vendor to Owner and shall be administered in India. The duration of the warranty shall be for a minimum of 25 years and shall cover the system performance, application assurance and the costs of the supply of components and installation.

3. NETWORK SWITCHES

3.1 12 Port stackable 1G/ 10G SFP (including Multi-mode fiber module)

| S.No | Specifications | Compliance |
|---|---|---|
| - | - | |
| Access Switch (12-port gigabit switch)<br>12 Port 10/100/1000 Mbps (RJ45) Switch with Four 10G Slots | | |
| 1 | Architecture | |
| | Shall be 19" Rack Mountable. The switch shall be non-blocking in architecture and should be stackable | |
| | Switch should be equipped with internal field replaceable redundant power supplies and fan modules | |
| | 12 RJ-45 autosensing 10/100/1000 ports | |
| | The switch must have additional four 10-Gigabit ports (SFP+/XFP) | |
| | 1 RJ-45 serial console port | |
| | Shall have switching capacity of 200 Gbps for providing non-blocking performance on all Gigabit ports | |
| | Shall have up to 150 million pps switching throughput to achieve wire-speed forwarding on all Gigabit ports | |
| 2 | Resiliency | |
| | Shall support up to 84 Gbps stacking bandwidth (full duplex) per Switch in a resilient stacking configuration | |
| | Switch should have dedicated stacking ports | |
| | Shall support 802.3ad (LACP) with upto 8 ports supported in 32 groups | |
| | Switch should have L2 multipathing using TRILL/VPC/SPB to provide resiliency without STP | |
| | IEEE 802.1D Spanning Tree Protocol, IEEE 802.1w Rapid Spanning Tree Protocol and IEEE 802.1s Multiple Spanning Tree Protocol , IEEE 802.3ad Link Aggregation Control Protocol (LACP) | |
| | Switch should support auto switch replacement in an existing stack with the new switch without any configuration for joining the stack without stack restart/reboot | |
| 3 | Layer 2 Features and Layer 3 (any additional licenses required shall be included) | |
| | Shall support up to 1,024 port or IEEE 802.1Q-based VLANs | |

| | | |
|---|---|---|
| | Support for minimum 8k MAC addresses | |
| | Shall support marking, policing, and shaping with upto 8 queues / port | |
| | Static Routing, RIPv1/v2, OSPF, VRRP | |
| | Should support IGMP v1, v2 and v3; MLD and PIM Sparse Mode (PIM-SM) for multicast applications | |
| | Switch should also support IGMP v1/v2/v3 snooping & Proxy modes | |
| | Switch should support minimum 400 multicast groups | |
| | Should support for IPv6 features like Neighbor discovery, Syslog, Telnet, SSH, Web GUI, SNMP, NTP, DNS, RADIUS over IPv6, classification and marking and IPv6 routing | |
| | Should have mimimum 8 hardware based queues per port | |
| | Switch should support QoS configuration on per switch port basis. | |
| | Switch should support classification and marking based on IP Type of Service (TOS) and DSCP | |
| 4 | Security Features | |
| | Local proxy ARP, Static ARP, DHCP snooping, IP source guard | |
| | Should support AAA using RADIUS or TACACS+ | |
| | Unicast, multicast and broadcast storm control | |
| | Should support EAP MD5 and IEEE 802.1x based authentication | |
| 5 | Management Features | |
| | Configuration through the CLI, console, Telnet, SSH and Web Management | |
| | SNMPv1, v2, and v3 and Remote monitoring (RMON) support | |
| | Network Time Protocol (NTP) or equivalent support | |
| | Switch should support System & Event logging functions as well as forwarding of these logs to multiple syslog servers. | |
| | Switch should support on-line software reconfiguration to implement changes without rebooting. Any changes in the configuration of switches related to Layer-2 & 3 functions, VLAN, STP, Security, QoS should not require rebooting of the switch. | |
| | Switch should support Multiple privilege levels to provide different levels of access. | |
| 5 | Environmental Features | |
| | Operating temperature of 0°C to 50°C | |

3.2 16 Port stackable 1G/ 10G SFP (including Multi-mode fiber module)

| S.No | Specifications | Compliance |
|---|---|---|
| - | - | |
| Access Switch (16-port gigabit switch)<br>16 Port 10/100/1000 Mbps (RJ45) Switch with Four 10G Slots | | |
| 1 | Architecture | |
| | Shall be 19" Rack Mountable. The switch shall be non-blocking in architecture and should be stackable | |
| | Switch should be equipped with internal field replaceable redundant power supplies and fan modules | |
| | 16 RJ-45 autosensing 10/100/1000 ports | |
| | The switch must have additional four 10-Gigabit ports | |

| | | |
|---|---|---|
| | (SFP+/XFP) | |
| | 1 RJ-45 serial console port | |
| | Shall have switching capacity of 200 Gbps for providing non-blocking performance on all Gigabit ports | |
| | Shall have up to 150 million pps switching throughput to achieve wire-speed forwarding on all Gigabit ports | |
| 2 | Resiliency | |
| | Shall support up to 84 Gbps stacking bandwidth (full duplex) per Switch in a resilient stacking configuration | |
| | Switch should have dedicated stacking ports | |
| | Shall support 802.3ad (LACP) with upto 8 ports supported in 32 groups | |
| | Switch should have L2 multipathing using TRILL/VPC/SPB to provide resiliency without STP | |
| | IEEE 802.1D Spanning Tree Protocol, IEEE 802.1w Rapid Spanning Tree Protocol and IEEE 802.1s Multiple Spanning Tree Protocol , IEEE 802.3ad Link Aggregation Control Protocol (LACP) | |
| | Switch should support auto switch replacement in an existing stack with the new switch without any configuration for joining the stack without stack restart/reboot | |
| 3 | Layer 2 Features and Layer 3 (any additional licenses required shall be included) | |
| | Shall support up to 1,024 port or IEEE 802.1Q-based VLANs | |
| | Support for minimum 8k MAC addresses | |
| | Shall support marking, policing, and shaping with upto 8 queues / port | |
| | Static Routing, RIPv1/v2, OSPF, VRRP | |
| | Should support IGMP v1, v2 and v3; MLD and PIM Sparse Mode (PIM-SM) for multicast applications | |
| | Switch should also support IGMP v1/v2/v3 snooping & Proxy modes | |
| | Switch should support minimum 400 multicast groups | |
| | Should support for IPv6 features like Neighbor discovery, Syslog, Telnet, SSH, Web GUI, SNMP, NTP, DNS, RADIUS over IPv6, classification and marking and IPv6 routing | |
| | Should have mimimum 8 hardware based queues per port | |
| | Switch should support QoS configuration on per switch port basis. | |
| | Switch should support classification and marking based on IP Type of Service (TOS) and DSCP | |
| 4 | Security Features | |
| | Local proxy ARP, Static ARP, DHCP snooping, IP source guard | |
| | Should support AAA using RADIUS or TACACS+ | |
| | Unicast, multicast and broadcast storm control | |
| | Should support EAP MD5 and IEEE 802.1x based authentication | |
| 5 | Management Features | |
| | Configuration through the CLI, console, Telnet, SSH and Web Management | |
| | SNMPv1, v2, and v3 and Remote monitoring (RMON) support | |
| | Network Time Protocol (NTP) or equivalent support | |

| | | |
|---|---|---|
| | Switch should support System & Event logging functions as well as forwarding of these logs to multiple syslog servers. | |
| | Switch should support on-line software reconfiguration to implement changes without rebooting. Any changes in the configuration of switches related to Layer-2 & 3 functions, VLAN, STP, Security, QoS should not require rebooting of the switch. | |
| | Switch should support Multiple privilege levels to provide different levels of access. | |
| 5 | Environmental Features | |
| | Operating temperature of 0°C to 50°C | |

3.3 24 Port stackable 1G/ 10G SFP (including Multi-mode fiber module)

| S.No | Specifications | Compliance |
|---|---|---|
| - | - | |
| Access Switch (24-port gigabit switch) 24 Port 10/100/1000 Mbps (RJ45) Switch with Four 10G Slots | | |
| 1 | Architecture | |
| | Shall be 19" Rack Mountable. The switch shall be non-blocking in architecture and should be stackable | |
| | Switch should be equipped with internal field replaceable redundant power supplies and fan modules | |
| | 24 RJ-45 autosensing 10/100/1000 ports | |
| | The switch must have additional four 10-Gigabit ports (SFP+/XFP) | |
| | 1 RJ-45 serial console port | |
| | Shall have switching capacity of 200 Gbps for providing non-blocking performance on all Gigabit ports | |
| | Shall have up to 150 million pps switching throughput to achieve wire-speed forwarding on all Gigabit ports | |
| 2 | Resiliency | |
| | Shall support up to 84 Gbps stacking bandwidth (full duplex) per Switch in a resilient stacking configuration | |
| | Switch should have dedicated stacking ports | |
| | Shall support 802.3ad (LACP) with upto 8 ports supported in 32 groups | |
| | Switch should have L2 multipathing using TRILL/VPC/SPB to provide resiliency without STP | |
| | IEEE 802.1D Spanning Tree Protocol, IEEE 802.1w Rapid Spanning Tree Protocol and IEEE 802.1s Multiple Spanning Tree Protocol , IEEE 802.3ad Link Aggregation Control Protocol (LACP) | |
| | Switch should support auto switch replacement in an existing stack with the new switch without any configuration for joining the stack without stack restart/reboot | |
| 3 | Layer 2 Features and Layer 3 (any additional licenses required shall be included) | |
| | Shall support up to 1,024 port or IEEE 802.1Q-based VLANs | |
| | Support for minimum 8k MAC addresses | |
| | Shall support marking, policing, and shaping with upto 8 queues / port | |
| | Static Routing, RIPv1/v2, OSPF, VRRP | |
| | Should support IGMP v1, v2 and v3; MLD and PIM Sparse Mode (PIM-SM) for multicast applications | |

| | | |
|---|---|---|
| | Switch should also support IGMP v1/v2/v3 snooping & Proxy modes | |
| | Switch should support minimum 400 multicast groups | |
| | Should support for IPv6 features like Neighbor discovery, Syslog, Telnet, SSH, Web GUI, SNMP, NTP, DNS, RADIUS over IPv6, classification and marking and IPv6 routing | |
| | Should have mimimum 8 hardware based queues per port | |
| | Switch should support QoS configuration on per switch port basis. | |
| | Switch should support classification and marking based on IP Type of Service (TOS) and DSCP | |
| 4 | Security Features | |
| | Local proxy ARP, Static ARP, DHCP snooping, IP source guard | |
| | Should support AAA using RADIUS or TACACS+ | |
| | Unicast, multicast and broadcast storm control | |
| | Should support EAP MD5 and IEEE 802.1x based authentication | |
| 5 | Management Features | |
| | Configuration through the CLI, console, Telnet, SSH and Web Management | |
| | SNMPv1, v2, and v3 and Remote monitoring (RMON) support | |
| | Network Time Protocol (NTP) or equivalent support | |
| | Switch should support System & Event logging functions as well as forwarding of these logs to multiple syslog servers. | |
| | Switch should support on-line software reconfiguration to implement changes without rebooting. Any changes in the configuration of switches related to Layer-2 & 3 functions, VLAN, STP, Security, QoS should not require rebooting of the switch. | |
| | Switch should support Multiple privilege levels to provide different levels of access. | |
| 5 | Environmental Features | |
| | Operating temperature of 0°C to 50°C | |

3.4 48 Port stackable 1G/ 10G SFP (including Multi-mode fiber module)

| S.No | Specifications | Compliance |
|---|---|---|
| - | - | |
| Access Switch (48-port gigabit switch) 48 Port 10/100/1000 Mbps (RJ45) Switch with Four 10G Slots | | |
| 1 | Architecture | |
| | Shall be 19" Rack Mountable. The switch shall be non-blocking in architecture and should be stackable | |
| | Switch should be equipped with internal field replaceable redundant power supplies and fan modules | |
| | 48 RJ-45 autosensing 10/100/1000 ports | |
| | The switch must have additional four 10-Gigabit ports (SFP+/XFP) | |
| | 1 RJ-45 serial console port | |
| | Shall have switching capacity of 250 Gbps for providing non-blocking performance on all Gigabit ports | |
| | Shall have up to 184 million pps switching throughput to achieve wire-speed forwarding on all Gigabit ports | |

| | | |
|---|---|---|
| 2 | Resiliency | |
| | Shall support up to 84 Gbps stacking bandwidth (full duplex) per Switch in a resilient stacking configuration | |
| | Switch should have dedicated stacking ports | |
| | Shall support 802.3ad (LACP) with upto 8 ports supported in 32 groups | |
| | Switch should have L2 multipathing using TRILL/VPC/SPB to provide resiliency without STP | |
| | IEEE 802.1D Spanning Tree Protocol, IEEE 802.1w Rapid Spanning Tree Protocol and IEEE 802.1s Multiple Spanning Tree Protocol , IEEE 802.3ad Link Aggregation Control Protocol (LACP) | |
| | Switch should support auto switch replacement in an existing stack with the new switch without any configuration for joining the stack without stack restart/reboot | |
| 3 | Layer 2 Features and Layer 3 (any additional licenses required shall be included) | |
| | Shall support up to 1,024 port or IEEE 802.1Q-based VLANs | |
| | Support for minimum 8k MAC addresses | |
| | Shall support marking, policing, and shaping with upto 8 queues / port | |
| | Static Routing, RIPv1/v2, OSPF, VRRP | |
| | Should support IGMP v1, v2 and v3; MLD and PIM Sparse Mode (PIM-SM) for multicast applications | |
| | Switch should also support IGMP v1/v2/v3 snooping & Proxy modes | |
| | Switch should support minimum 400 multicast groups | |
| | Should support for IPv6 features like Neighbor discovery, Syslog, Telnet, SSH, Web GUI, SNMP, NTP, DNS, RADIUS over IPv6, classification and marking and IPv6 routing | |
| | Should have mimimum 8 hardware based queues per port | |
| | Switch should support QoS configuration on per switch port basis. | |
| | Switch should support classification and marking based on IP Type of Service (TOS) and DSCP | |
| 4 | Security Features | |
| | Local proxy ARP, Static ARP, DHCP snooping, IP source guard | |
| | Should support AAA using RADIUS or TACACS+ | |
| | Unicast, multicast and broadcast storm control | |
| | Should support EAP MD5 and IEEE 802.1x based authentication | |
| 5 | Management Features | |
| | Configuration through the CLI, console, Telnet, SSH and Web Management | |
| | SNMPv1, v2, and v3 and Remote monitoring (RMON) support | |
| | Network Time Protocol (NTP) or equivalent support | |
| | Switch should support System & Event logging functions as well as forwarding of these logs to multiple syslog servers. | |
| | Switch should support on-line software reconfiguration to implement changes without rebooting. Any changes in the configuration of switches related to Layer-2 & 3 functions, VLAN, STP, Security, QoS should not require rebooting of the switch. | |

| | | |
|---|---|---|
| | Switch should support Multiple privilege levels to provide different levels of access. | |
| 5 | Environmental Features | |
| | Operating temperature of 0°C to 50°C | |

## 11.14 FIRE DETECTION ALARM AND PA SYSTEM

1 GENERAL DESCRIPTION:

a. The bidder shall furnish all labor, materials and equipment, transportation, supply, installation, testing and commissioning of the complete Fire Detection and Alarm System (FDAS) & PA system in accordance with NFPA 72 (Latest edition)/EN 54 and requirements of the Contract Documents. Provide a complete operable and intelligent analog addressable Fire Detection & Alarm System (FDAS) with associated communication and notification systems. The system shall include interfaces for foreign systems, as described herein and in accordance with the Contract
b. Documents, and all applicable Codes, Standards and local Regulations, and be approved by Fire Services.
c. All Plant furnished shall be new and the latest state-of-the-art, products of a single Manufacturer engaged in the manufacturing of analog fire detection devices for at least 5 years.
d. All software licenses shall be supplied as part of the contract. Renewable & subscription license are not acceptable.
e. The system shall be supplied, installed, tested, and approved by the local Authority Having Jurisdiction, and turned over to the Contractor in an operational condition.
f. The subcontractor shall contract with a single supplier for the fire alarm Plant, engineering, programming, inspection and tests, and shall provide a “UL /LPCB Listing Certificate” for the complete system.
g. Drawings: The Drawings shall serve to indicate the general arrangement of the various Plant and their generic functional interconnections. However, layout of Plant, accessories, specialties, conduit system and wiring, are diagrammatic and do not necessarily indicate every required device, fitting, etc., required for the complete installation.

2 SCOPE:

A new intelligent reporting, microprocessor controlled fire detection system shall be installed in accordance to the project specifications and drawings.

Basic Performance:
Alarm, trouble and supervisory signals from all intelligent reporting devices shall be encoded on NFPA Style 6 (Class A) Signaling Line Circuits (SLC)/EN.

Initiation Device Circuits (IDC) shall be wired Class A (NFPA Style D)//EN as part of an addressable device connected by the SLC Circuit.

Notification Appliance Circuits (NAC) shall be wired Class A (NFPA Style Z)/EN as part of an addressable device connected by the SLC Circuit.
On Style 6 or 7 (Class A) configurations a single ground fault or open circuit on the system Signaling Line Circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.

Alarm signals arriving at the FACP shall not be lost following a primary power failure (or outage) until the alarm signal is processed and recorded.

NAC speaker circuits shall be arranged such that there is a minimum of one speaker circuit per floor of the building or smoke zone which ever is greater.
Audio amplifiers and tone generating equipment shall be electrically supervised for normal and abnormal conditions.

NAC speaker circuits and control equipment shall be arranged such that loss of any one (1) speaker circuit will not cause the loss of any other speaker circuit in the system.
Two-way telephone communication circuits shall be supervised for open and short circuit conditions.
Equivalent system as per EN/LPCB standard is also acceptable.

3. DRAWINGS & TECHNICAL SUBMITTALS

I. General:

Two copies of all submittals shall be submitted to the Architect/Engineer for review.

All references to manufacturer's model numbers and other pertinent information herein is intended to establish minimum standards of performance, function and quality. Equivalent compatible UL-

listed equipment from other manufacturers may be substituted for the specified equipment as long as the minimum standards are met.

For equipment other than that specified, the contractor shall supply proof that such substitute equipment equals or exceeds the features, functions, performance, and quality of the specified equipment.

The vendor shall also submit following documents:-
- Document Register
- Compliance Matrix
- Five year operation spare part list
- Recommendation for storage/ long term storage
- Recommendation for protection during transport
- All equipment and software data sheets
- Site Acceptance Test (SAT)

II. Shop Drawings:
Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.

Include manufacturer's name(s), model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to-point diagrams, and conduit layouts.
Show annunciator layout, configurations, and terminations.

The bidder shall produce all drawings using latest edition of Computer Aided Design (CAD) and drafting package.

The bidder shall produce schematic and graphic pages for all systems controlled by or monitored on the FDAS. Allowance shall be made for any necessary site modifications to graphics to incorporate any revised locations, presentation of dynamic information and Architect / Consultants / Owner's site representatives comments

The bidder shall produce Equipment installation and mounting details, Power schematic diagram, and Equipment list with power consumption, voltage supply, heat dissipation, required circuit breaker rating, physical size, weight, Manufacturer and origin, Cabinet arrangement, cable entries, cables specification

III. Manuals:
Submit simultaneously with the shop drawings, complete operating and maintenance manuals listing the manufacturer's name(s), including technical data sheets, Technical description & installation procedure.

The data sheet shall be approved prior to procurement of material.

Wiring diagrams shall indicate internal wiring for each device and the interconnections between the items of equipment.

Provide a clear and concise description of operation that gives, in detail, the information required to properly operate the equipment and system.

Software Modifications
Provide the services of a factory trained and authorized technician to perform all system software modifications, upgrades or changes. Response time of the technician to the site shall not exceed 4 hours.

Provide all hardware, software, programming tools and documentation necessary to modify the fire alarm system on site. Modification includes addition and deletion of devices, circuits, zones and changes to system operation and custom label changes for devices or zones. The system structure and software shall place no limit on the type or extent of software modifications on-site.

Certifications:

Together with the shop drawing submittal, submit a certification from the major equipment manufacturer indicating that the proposed supervisor of the installation and the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer. Include names and addresses in the certification.

4. POST CONTRACT MAINTENANCE:

Complete maintenance and repair service for the fire alarm system shall be available from a factory trained authorized representative of the manufacturer of the major equipment for a period of three (3) years after expiration of the DLP.

As part of the bid/proposal, include a quote for a maintenance contract to provide all maintenance, tests, and repairs described below. Include also a quote for unscheduled maintenance/repairs, including hourly rates for technicians trained on this equipment, and response travel costs for each year of the maintenance period. Rates and costs shall be valid for the period of three (3) years after expiration of the guaranty.

Maintenance and testing shall be on a semiannual basis. A preventive maintenance schedule shall be provided by the contractor describing the protocol for preventive maintenance. The schedule shall include:

Systematic examination, adjustment and cleaning of all detectors, manual fire alarm stations, control panels, power supplies, relays, waterflow switches and all accessories of the fire alarm system.

Each circuit in the fire alarm system shall be tested semiannually.

Each smoke detector shall be tested in accordance with the requirements of NFPA 72 Chapter 7/ EN standard.

5. APPLICABLE STANDARDS AND SPECIFICATIONS:

The specifications and standards listed below form a part of this specification. The system shall fully comply with the latest issue of these standards, if applicable.

A. National Fire Protection Association (NFPA) - USA:

| | |
|---|---|
| NFPA 13 | Sprinkler Systems |
| NFPA 16 | Foam/Water Deluge and Spray Systems |
| NFPA 17 | Dry Chemical Extinguishing Systems |
| NFPA 17A | Wet Chemical Extinguishing Systems |
| NFPA 2001 | Clean Agent Extinguishing Systems |
| NFPA 72 | National Fire Alarm Code |
| NFPA 76 | Telecommunication Facilities |
| NFPA 318 | Clean Room Applications |
| NFPA 101 | Life Safety Code |
| NFPA 90A | Air conditioning & ventilation system |

B. Underwriters Laboratories Inc. (UL) - USA:

| | |
|---|---|
| UL 268 | Smoke Detectors for Fire Protective Signaling Systems |
| UL 864 | Control Units for Fire Protective Signaling Systems 9th Edition Listed |
| UL 268 | A Smoke Detectors for Duct Applications |
| UL 521 | Heat Detectors for Fire Protective Signaling Systems |
| UL 464 | Audible Signaling Appliances |
| UL 38 | Manually Actuated Signaling Boxes |
| UL 346 | Waterflow Indicators for Fire Protective Signaling Systems |
| UL 1971 | Visual Notification Appliances |
| UL 228 | Door Holders |

6. NATIONAL BUILDING CODES

IS 2189

EN standard of Europe

LPCB : Loss Prevention certification board of United Kingdom

The Video Display Terminal (VDT) shall comply with Swedish magnetic emission and X-radiation guidelines MPR 1990:10.
APPROVALS:
The system shall have proper listing and/or approval from the following nationally recognized agencies:
UL Underwriters Laboratories Inc(9th Edition)
LPCB Loss Prevention Certification Board

The fire alarm control panel shall meet UL Standard 864 9th Edition/LPCB (Control Units).
The system shall be listed by the national agencies as suitable for extinguishing release applications. The system shall support release of high and low pressure CO2.

7. PRODUCTS
EQUIPMENT AND MATERIAL, GENERAL:
All equipment and components shall be new, and the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protective signaling system, meeting the National Fire Alarm Code.

All equipment and components shall be installed in strict compliance with manufacturers' recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation.

All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

8. CONDUIT AND WIRE:
Conduit:
Conduit shall be in accordance with The National Electrical Code (NEC), local and state requirements.
Where required, all wiring shall be installed in conduit or raceway. Conduit fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.

Cable must be separated from any open conductors of power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, per NEC Article 760-29.

Wiring for 24 volt DC control, alarm notification, emergency communication and similar power-limited auxiliary functions may be run in the same conduit as initiating and signaling line circuits. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.

Conduit shall not enter the fire alarm control panel, or any other remotely mounted control panel equipment or backboxes, except where conduit entry is specified by the FACP manufacturer.
Conduit shall be 3/4-inch (19.1 mm) minimum.

Wire:
All fire alarm system wiring shall be FRLSZH type.
Wiring shall be in accordance with local, state and national codes (e.g., NEC Article 760) and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 18 AWG (1.02 mm) for Initiating Device Circuits and Signaling Line Circuits, and 14 AWG (1.63 mm) for Notification Appliance Circuits.

All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system.

9. MAIN FIRE ALARM CONTROL PANEL OR NETWORK NODE:

The main FACP Central Console shall contain a microprocessor based Central Processing Unit (CPU). The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent addressable smoke and thermal (heat) detectors, addressable modules, panel modules including initiating circuits, control circuits, and notification appliance circuits, local and remote operator terminals, printers, annunciators, and other system controlled devices.

1. In conjunction with intelligent Loop Control Modules and Loop Expander Modules, the main FACP shall perform the following functions:-

- Supervise and monitor all intelligent addressable detectors and monitor modules connected to the system for normal, trouble and alarm conditions.
- Supervise all initiating signaling and notification circuits throughout the facility by way of connection to monitor and control modules.
- Detect the activation of any initiating device and the location of the alarm condition. Operate all notification appliances and auxiliary devices as programmed. In the event of CPU failure, all SLC loop modules shall fallback to degrade mode. Such degrade mode shall treat the corresponding SLC loop control modules and associated detection devices as conventional two-wire operation. Any activation of a detector in this mode shall automatically activate associated Notification Appliance Circuits.
- Visually and audibly annunciate any trouble, supervisory, security or alarm condition on operator's terminals, panel display, and annunciators.

2. When a fire alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:-

- The system alarm LED shall flash.
- A local piezo-electric audible device in the control panel shall sound a distinctive signal.
- The minimum 80-character backlit LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
- Printing and history storage equipment shall log and print the event information along with a time and date stamp.
- All system outputs assigned via preprogrammed equations for a particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.

3. When a trouble condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

- The system trouble LED shall flash.
- A local piezo-electric audible device in the control panel shall sound a distinctive signal.
- The minimum 80-character backlit LCD display shall indicate all information associated with the trouble condition, including the type of trouble point and its location within the protected premises.
- Printing and history storage equipment shall log and print the event information along with a time and date stamp.
- All system outputs assigned via preprogrammed equations for a particular point in trouble shall be executed, and the associated system outputs (trouble notification appliances and/or relays) shall be activated.

4. When a supervisory condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

- The system trouble LED shall flash.
- A local piezo-electric audible device in the control panel shall sound a distinctive signal.
- The minimum 80-character backlit LCD display shall indicate all information associated with the supervisory condition, including the type of trouble point and its location within the protected premises.
- Printing and history storage equipment shall log and print the event information along with a time and date stamp.
- All system outputs assigned via preprogrammed equations for a particular point in trouble shall be executed, and the associated system outputs (notification appliances and/or relays) shall be activated.

5. When a security alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

- The system security LED shall flash.
- A local piezo-electric audible device in the control panel shall sound a distinctive signal.
- The minimum 80-character backlit LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
- Printing and history storage equipment shall log and print the event information along with a time and date stamp.
- All system outputs assigned via preprogrammed equations for a particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.

6. When a pre-alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

- The system pre-alarm LED shall flash.
- A local piezo-electric audible device in the control panel shall sound a distinctive signal.
- The minimum 80-character backlit LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
- Printing and history storage equipment shall log and print the event information along with a time and date stamp.
- All system outputs assigned via preprogrammed equations for a particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.

Operator Control

1. Acknowledge Switch:

- Activation of the control panel acknowledge switch in response to new alarms and/or troubles shall silence the local panel piezo electric signal and change the alarm and trouble LEDs from flashing mode to steady-ON mode. If multiple alarm or trouble conditions exist, depression of this switch shall advance the LCD display to the next alarm or trouble condition. In addition, the FACP shall support Block Acknowledge to allow multiple trouble conditions to be acknowledged with a single depression of this switch.
- Depression of the Acknowledge switch shall also silence all remote annunciator piezo sounders.

Signal Silence Switch:
Depression of the Signal Silence switch shall cause all programmed alarm notification appliances and relays to return to the normal condition. The selection of notification circuits and relays that are silence able by this switch shall be fully field programmable within the confines of all applicable standards. The FACP software shall include silence inhibit and auto-silence timers.

1. Drill Switch:
Depression of the Drill switch shall activate all programmed notification appliance circuits. The drill function shall latch until the panel is silenced or reset.

2. System Reset Switch:
Depression of the System Reset switch shall cause all electronically latched initiating devices to return to their normal condition. Initiating devices shall re-report if active. Active notification appliance circuits shall not silence upon Reset. Systems that de-activate and subsequently re-activate notification appliance circuits shall not be considered equal. All programmed Control-By-Event equations shall be re-evaluated after the reset sequence is complete if the initiating condition has cleared. Non-latching trouble conditions shall not clear and re-report upon reset.

3. Lamp Test:
The Lamp Test switch shall activate all local system LEDs, light each segment of the liquid crystal display and display the panel software revision for service personal.

4. Scroll Display Keys:

There shall be Scroll Display keys for FIRE ALARM, SECURITY, SUPERVISORY, TROUBLE, and OTHER EVENTS. Depression of the Scroll Display key shall display the next event in the selected queue allowing the operator to view events by type.

5. Print Screen:
   Depression of the PRINT SCREEN switch shall send the information currently displayed on the 80-character display to the printer.

System Capacity and General Operation

- The control panel shall be capable of expansion via up to 10 SLC modules. Each module shall support a minimum of 198 analog/addressable devices for a maximum system capacity of 1980 points.
- The Fire Alarm Control Panel shall include a full featured operator interface control and annunciation panel that shall include a backlit minimum 80/640-character liquid crystal display, individual, color coded system status LEDs, and an alphanumeric keypad for the field programming and control of the fire alarm system. Said LCD shall also support graphic bit maps capable of displaying the company name and logo of either the owner or installing company.
- All programming or editing of the existing program in the system shall be achieved without special equipment and without interrupting the alarm monitoring functions of the fire alarm control panel.

The FACP shall be able to provide the following software and hardware features:

a. Pre-signal and Positive Alarm Sequence: The system shall provide means to cause alarm signals to only sound in specific areas with a delay of the alarm from 60 to up to 180 seconds after start of alarm processing. In addition, a Positive Alarm Sequence selection shall be available that allows a 15-second time period for acknowledging an alarm signal from a fire detection/initiating device. If the alarm is not acknowledged within 15 seconds, all local and remote outputs shall automatically activate immediately.
b. Smoke Detector Pre-alarm Indication at Control Panel: To obtain early warning of incipient or potential fire conditions, the system shall support a programmable option to determine system response to real-time detector sensing values above the programmed setting. Two levels of Pre-alarm indication shall be available at the control panel: alert and action.
c. Alert: It shall be possible to set individual smoke detectors for pre-programmed pre-alarm thresholds. If the individual threshold is reached, the pre-alarm condition shall be activated.
d. Action: If programmed for action, and the detector reaches a level exceeding the pre-programmed level, the control panel shall indicate an action condition. Sounders installed will automatically activate with general evacuation on alarm level
e. The system shall support a detector response time to meet world annunciation requirements of less than 3 seconds.
f. Device Blink Control: Means shall be provided to turn off detector/module LED strobes for special areas.
g. NFPA 72 /EN Smoke Detector Sensitivity Test: The system shall provide an automatic smoke detector test function that meet the requirements of NFPA 72/ EN standard.
h. Programmable Trouble Reminder: The system shall provide means to automatically initiate a reminder that troubles exist in the system. The reminder will appear on the system display and (if enabled) will sound a piezo alarm.
i. On-line or Off-line programming: The system shall provide means to allow panel programming either through an off-line software utility program away from the panel or while connected and on-line. The system shall also support upload and download of programmed database and panel executive system program to a Personal Computer/laptop.
j. History Events: The panel shall maintain a history file of the last 1000 events, each with a time and date stamp. History events shall include all alarms, troubles, operator actions, and programming entries. The control panels shall also maintain a 1000 event Alarm History buffer, which consists of the 1000 most recent alarm events.
k. Smoke Control Modes: The system shall provide means to perform FSCS mode Smoke Control to meet NFPA-92A /EN standard and 90B and HVAC mode to meet NFPA 90A/EN standard.
l. The system shall provide means for all SLC devices on any SLC loop to be auto programmed into the system by specific address. The system shall recognize specific device type ID's and associate that ID with the corresponding address of the device.

m. Drill: The system shall support means to activate all silenceable fire output circuits in the event of a practice evacuation or "drill". If enabled for local control, the front panel switch shall be held for a minimum of 2 seconds prior to activating the drill function
n. Passwords and Users: The system shall support two password levels, master and user. Up to 9 user passwords shall be available, each of which may be assigned access to the programming change menus, the alter status menus, or both. Only the master password shall allow access to password change screens.
o. Block Acknowledge: The system shall support a block Acknowledge for Trouble Conditions
p. Sensitivity Adjust: The system shall provide Automatic Detector Sensitivity Adjust based on Occupancy schedules including a Holiday list of up to 15 days.
q. Environmental Drift Control: The system shall provide means for setting Environmental Drift Compensation by device. When a detector accumulates dust in the chamber and reaches an unacceptable level but yet still below the allowed limit, the control panel shall indicate a maintenance alert warning. When the detector accumulates dust in the chamber above the allowed limit, the control panel shall indicate a maintenance urgent warning.
r. Custom Action Messages: The system shall provide means to enter up to 100 custom action messages of up to 160 characters each. It shall be possible to assign any of the 100 messages to any point.
s. Print Functions: The system shall provide means to obtain a variety of reports listing all event, alarm, trouble, supervisory, or security history. Additional reports shall be available for point activation for the last Walk Test performed, detector maintenance report containing the detector maintenance status of each installed addressable detector, all network parameters, all panel settings including broad cast time, event ordering, and block acknowledge, panel timer values for Auto Silence, Silence Inhibit, AC Fail Delay time and if enabled, Proprietary Reminder, and Remote Reminder timers, supervision settings for power supply and printers, all programmed logic equations, all custom action messages, all non-fire and output activations (if pre-programmed for logging) all active points filtered by alarms only, troubles only, supervisory alarms, prealarms, disabled points and activated points, all installed points filtered by SLC points, panel circuits, logic zones, annunicators, releasing zones, spal zones, and trouble zones.
t. Local Mode: If communication is lost to the central processor the system shall provide added survivability through the intelligent loop control modules. Inputs from devices connected to the SLC and loop control modules shall activate outputs on the same loop when the inputs and outputs have been set with point programming to participate in local mode or when the type codes are of the same type: that is, an input with a fire alarm type code shall activate an output with a fire alarm type code.
u. Resound based on type for security or supervisory: The system shall indicate a Security alarm when a monitor module point programmed with a security Type Code activates. If silenced alarms exist, a Security alarm will resound the panel sounder. The system shall indicate a Supervisory alarm when a monitor module point programmed with a supervisory Type Code activates. If there are silenced alarms, a Supervisory alarm will resound the panel sounder.
v. Read status preview - enabled and disabled points: Prior to re-enabling points, the system shall inform the user that a disabled device is in the alarm state. This shall provide notice that the device must be reset before the device is enabled thereby avoiding activation of the notification circuits.
w. Custom Graphics: When fitted with an LCD display, the panel shall permit uploading of a custom bit-mapped graphic to the display screen. Graphic shall display when all systems are normal.
x. Multi-Detector and Cooperating Detectors: The system shall provide means to link one detector to up to two detectors at other addresses on the same loop in cooperative multi-detector sensing. There shall be no requirement for sequential addresses on the detectors and the alarm event shall be a result or product of all cooperating detectors chamber readings.
y. Tracking/Latching Duct : The system shall support both tracking and latching duct detectors.
   - ACTIVE EVENT: The system shall provide a Type ID called FIRE CONTROL for purposes of air-handling shutdown, which shall be intended to override normal operating automatic functions. Activation of a FIRE CONTROL point shall cause the control panel to (1) initiate the monitor module Control-by-Event, (2) send a message to the panel display, history buffer, installed printer and annunciators, (3) shall not light an indicator at the control panel, (4) Shall display ACTIVE on the LCD as well a display a FIRE CONTROL Type Code and other information specific to the device.
   - NON-FIRE Alarm Module Reporting: A point with a type ID of NON-FIRE shall be available for use for energy management or other non-fire situations. NON-FIRE point operation shall not affect control panel operation nor shall it display a message at the panel LDC. Activation of a

NON-FIRE point shall activate control by event logic but shall not cause any indication on the control panel.

- Security Monitor Points: The system shall provide means to monitor any point as a type security.
- One-Man Walk Test: The system shall provide both a basic and advanced walk test for testing the entire fire alarm system. The basic walk test shall allow a single operator to run audible tests on the panel. All logic equation automation shall be suspended during the test and while annunciators can be enabled for the test, all shall default to the disabled state. During an advanced walk test, field-supplied output point programming will react to input stimuli such as CBE and logic equations. When points are activated in advanced test mode, each initiating event shall latch the input. The advanced test shall be audible and shall be used for pull station verification, magnet activated tests on input devices, input and output device and wiring operation/verification.
- Control By Event Functions: CBE software functions shall provide means to program a variety of output responses based on various initiating events. The control panel shall operate CBE through lists of zones. A zone shall become listed when it is added to a point's zone map through point programming. Each input point such as detector, monitor module or panel circuit module shall support listing of up to 10 zones into its programmed zone map.
- Permitted zone types shall be general zone, releasing zone and special zone. Each output point (control module, panel circuit module) can support a list of up to 10 zones including general zone, logic zone, releasing zone and trouble zone. It shall be possible for output points to be assigned to list general alarm. Non-Alarm or Supervisory points shall not activate the general alarm zone.
- 128 General Zones: The system shall support up to 128 general purpose software zones for linking inputs to outputs. When an input device activates, any general zone programmed into that device's zone map will be active and any output device that has an active general zone in its map will be active. It shall also be possible to use general zone as arguments in logic equations.
- Logic Equations: The system shall support for AND, OR, NOT, ONLY1, ANYX, XZONE or RANGE operators that allow conditional I/O linking. When any logic equation becomes true, all output points mapped to the logic zone shall activate.
- Trouble equations per device: The system shall provide support for equations for each device, which shall permit programming parameters to be altered, based on specific fault conditions. If the trouble equation becomes true, all output points mapped to the trouble zone shall activate.
- Control-By-Time: A time based logic function shall be available to delay an action for a specific period of time based upon a logic input with tracking feature. A latched version shall also be available. Another version of this shall permit activation on specific days of the week or year with ability to set and restore based on a 24 hour time schedule on any day of the week or year.
- Multiple agent releasing zones: The system shall support up to 10 releasing zones to protect against 10 independent hazards. Releasing zones shall provide up to three cross-zone with four abort options to satisfy any local jurisdiction requirements. In case of a third party release panel, integration shall be provided with the main fire alarm system.
- Alarm Verification, by device, with timer and tally: The system shall provide a user-defined global software timer function that can be set for a specific detector or indicating panel module input. The timer function shall delay an alarm signal for a user-specified time period and the control panel shall ignore the alarm verification timer if another alarm is detected during the verification period. It shall also be possible to set a maximum verification count between 0 and 20 with the "0" setting producing no alarm verification. When the counter exceeds the threshold value entered, a trouble shall be generated to the panel.

Central Processing Unit

a. The Central Processing Unit shall communicate with, monitor, and control all other modules within the control panel. Removal, disconnection or failure of any control panel module shall be detected and reported to the system display by the Central Processing Unit.
b. The Central Processing Unit shall contain and execute all control-by-event (including Boolean functions including but not limited to AND, OR, NOT, ANYx, and CROSSZONE) programs for specific action to be taken if an alarm condition is detected by the system. Such control-by-event

programs shall be held in non-volatile programmable memory, and shall not be lost with system primary and secondary power failure.

c. The Central Processing Unit shall also provide a real-time clock for time annotation, to the second, of all system events. The time-of-day and date shall not be lost if system primary and secondary power supplies fail.
d. The CPU shall be capable of being programmed on site without requiring the use of any external programming equipment. Systems that require the use of external programmers or change of EPROMs are not acceptable.
e. Consistent with UL864/equivalent EN standards, the CPU and associated equipment are to be protected so that voltage surges or line transients will not affect them.
f. Each peripheral device connected to the CPU shall be continuously scanned for proper operation. Data transmissions between the CPU and peripheral devices shall be reliable and error free. The transmission scheme used shall employ dual transmission or other equivalent error checking techniques.
g. The CPU shall provide an RS/EIA-232 interface between the fire alarm control panel and the UL Listed Electronic Data Processing (EDP) peripherals.
h. The CPU shall provide two RS/EIA-485 ports for the serial connection to annunciation and control subsystem components.
i. The RS/EIA-232 serial output circuit shall be optically isolated to assure protection from earth ground.
j. The CPU shall provide one high-speed serial connection for support of network communication modules.
k. The CPU shall provide double pole relays for FIRE ALARM, SYSTEM TROUBLE, SUPERVISORY, and SECURITY. The SUPERVISORY and SECURITY relays shall provide selection for additional FIRE ALARM contacts.

Display

a. The system display shall provide all the controls and indicators used by the system operator and may also be used to program all system operational parameters.
b. The display assembly shall contain, and display as required, custom alphanumeric labels for all intelligent detectors, addressable modules, and software zones.
c. The system display shall provide a 6 inch or 80-character backlit alphanumeric Liquid Crystal Display (LCD). It shall also provide ten Light-Emitting-Diodes (LEDs), that indicate the status of the following system parameters: AC POWER, FIRE ALARM, PREALARM, SECURITY, SUPERVISORY, SYSTEM TROUBLE, OTHER EVENT, SIGNALS SILENCED, POINT DISABLED, and CPU FAILURE.
d. The system display shall provide a keypad with control capability to command all system functions, entry of any alphabetic or numeric information, and field programming. Two different password levels with up to ten (one Master and nine User) passwords shall be accessible through the display interface assembly to prevent unauthorized system control or programming.
e. The system display shall include the following operator control switches: ACKNOWLEDGE, SIGNAL SILENCE, RESET, DRILL, and LAMP TEST. Additionally, the display interface shall allow scrolling of events by event type including, FIRE ALARM, SECURITY, SUPERVISORY, TROUBLE, and OTHER EVENTS. A PRINT SCREEN button shall be provided for printing the event currently displayed on the 640-character LCD.

Loop (Signaling Line Circuit) Control Module:

a. The Loop Control Module shall monitor and control a minimum of 198 intelligent addressable devices and additional capacity for Loop Cable Isolators. This includes 99 intelligent detectors, 99 monitor or control modules
b. The Loop Control Module shall contain its own microprocessor and shall be capable of operating in a local/degrade mode (any addressable device input shall be capable of activating any or all addressable device outputs) in the unlikely event of a failure in the main CPU.
c. The Loop Control Module shall provide power and communicate with all intelligent addressable detectors and modules on a single pair of wires. This SLC Loop shall be capable of operating as a NFPA Style 6 (Class A) circuit
d. The SLC interface board shall be able to drive an NFPA Style 6 twisted shielded circuit up to 12,500 feet in length. The SLC Interface shall also be capable of driving an NFPA Style 6, no twist, no shield circuit up to 3,000 feet in length. In addition, SLC wiring shall meet the listing requirements for it to exit the building or structure.

e. The SLC interface board shall receive analog or digital information from all intelligent detectors and shall process this information to determine whether normal, alarm, or trouble conditions exist for that particular device. Each SLC Loop shall be isolated and equipped to annunciate an Earth Fault condition. The SLC interface board software shall include software to automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analog information may also be used for automatic detector testing and the automatic determination of detector maintenance requirements.
f. An equivalent cabling as per EN standard is also acceptable.

Enclosures:

a. The control panel shall be housed in a UL/EN-listed cabinet suitable for surface or semi-flush mounting. The cabinet and front shall be corrosion protected, given a rust-resistant prime coat, and manufacturer's standard finish.
b. The back box and door shall be constructed of 0.060 steel with provisions for electrical conduit connections into the sides and top.
c. The door shall provide a key lock and shall include a glass or other transparent opening for viewing of all indicators. For convenience, the door may be site configured for either right or left hand hinging.
d. The control unit shall be modular in structure for ease of installation, maintenance, and future expansion.

Power Supply:

a. The Addressable Main Power Supply shall operate on 240 VAC, 50 Hz, and shall provide all necessary power for the FACP.
b. The Addressable Main Power Supply shall provide sufficient power to the CPU, using a switching 24 VDC regulator and shall incorporate a battery charger for 24 hours of standby power using dual-rate charging techniques for fast battery recharge.
c. The Addressable Main Power Supply shall provide a battery charger for 24 hours of standby using dual-rate charging techniques for fast battery recharge. The supply shall be capable of charging batteries ranging in capacity from 25-200 amp-hours within a 48-hour period.
d. The Addressable Main Power Supply shall provide a very low frequency sweep earth detect circuit, capable of detecting earth faults.
e. The Addressable Main Power Supply shall be power-limited per 1995 UL864/EN requirements.

Digital Voice Command Center

a. The Digital Voice Command Center located with the FACP, shall contain all equipment required for all audio control, emergency telephone system control, signaling and supervisory functions. This shall include speaker zone indication and control, telephone circuit indication and control, digital voice units, microphone and main telephone handset.
b. Function: The Voice Command Center equipment shall perform the following functions:

- Operate as a supervised multi-channel emergency voice communication system.
- Operate as a two-way emergency telephone system control center.
- Audibly and visually annunciate the active or trouble condition of every speaker circuit and emergency telephone circuit.
- Audibly and visually annunciate any trouble condition for digital tone and voice units required for normal operation of the system.
- Provide all-call Emergency Paging activities through activation of a single control switch.
- As required, provide vectored paging control to specific audio zones via dedicated control switches.
- Provide a factory recorded “library” of voice messages and tones in standard WAV. File format, which may be edited and saved on a PC running a current Windows® operating system.
- Provide a software utility capable of off-line programming for the VCC operation and the audio message files. This utility shall support the creation of new programs as well as editing and saving existing program files. Uploading or downloading the VCC shall not inhibit the emergency operation of other nodes on the fire alarm network.
- Support an optional mode of operation with four analog audio outputs capable of being used with UL 864 fire-listed analog audio amplifiers and SCL controlled switching.
- The Digital Voice Command shall be modular in construction, and shall be capable of being field programmable without requiring the return of any components to the manufacturer and without requiring use of any external computers or other programming equipment.

- The Digital Voice Command and associated equipment shall be protected against unusually high voltage surges or line transients.
- The inbuilt PA system shall share internal seamless integration with FDAS to achieve the same functionality. Integrated PA system integration to FDAS shall be on zonal basis hardwired using dry contacts of addressable control module.
- The hardwired integration of FDAS to Access control system shall be through on/off dry contacts of addressable control module. The BMS system shall communicate to FDAS via Modbus/ Bacnet protocol.

Addressable Digital Audio Amplifiers

a. The Digital Audio Amplifiers will provide Audio Power for distribution to speaker circuits.
b. Multiple audio amplifiers may be mounted in a single enclosure, either to supply incremental audio power, or to function as an automatically switched backup amplifier(s).
c. The audio amplifier shall include an integral power supply, and shall provide built-in LED indicators for the following conditions:
d. The audio amplifier shall provide the following built-in controls:
   - Amplifier Address Selection Switches
   - Signal Silence of communication loss annunciation Reset
   - Level adjustment for background music
   - Enable/Disable for Earth Fault detection
   - Enable/Disable for Earth Fault detection
   - Switch for 2-wire/4-wire FFT riser
e. Adjustment of the correct audio level for the amplifier shall not require any special tools or test equipment.
f. Includes audio input and amplified output supervision, back up input, and automatic switch over function, (if primary amplifier should fail).
g. System shall be capable of backing up digital amplifiers.

Audio Message Generator (Prerecorded Voice)/Speaker Control:

a. Each initiating zone or intelligent device shall interface with an emergency voice communication system capable of transmitting a prerecorded voice message to all speakers in the building.
b. Actuation of any alarm initiating device shall cause a prerecorded message to sound over the speakers. The message shall be repeated four (4) times. Pre- and post-message tones shall be supported.
c. A built-in microphone shall be provided to allow paging through speaker circuits.
d. System paging from emergency telephone circuits shall be supported.
e. The audio message generator shall have the following indicators and controls to allow for proper operator understanding and control:

Controls with associated LED Indicators:

a. Speaker Switches/Indicators

- The speaker circuit control switches/indicators shall include visual indication of active and trouble status for each speaker circuit in the system.
- The speaker circuit control panel shall include switches to manually activate or deactivate each speaker circuit in the system.

b. Emergency Two-Way Telephone Control Switches/Indicators

- The emergency telephone circuit control panel shall include visual indication of active and trouble status for each telephone circuit in the system.
- The telephone circuit control panel shall include switches to manually activate or deactivate each telephone circuit in the system.
- In case of standalone VAC, an equivalent digital voice evacuation shall be proposed and the same will be integrated zone wise with the fire alarm system. Cost of integration shall be included in the price of the system.

Remote Transmissions:

a. Provide local energy or polarity reversal or trip circuits as required.
b. The system shall be capable of operating a polarity reversal or local energy or fire alarm transmitter for automatically transmitting fire information to the fire department.

c. Provide capability and equipment for transmission of zone alarm and trouble signals to remote operator's terminals, system printers and annunciators.
d. Transmitters shall be compatible with the systems and equipment they are connected to such as timing, operation and other required features.

Field Charging Power Supply:
The FCPS is a device designed for use as either a remote 24 volt power supply or to power Notification Appliances and provide synchronization signals to visual strobe devices through UPS.

a. The FCPS shall be available in two models offering either up to 6.0 amps (4.0 amps continuous) or 8.0 amps (6.0 amps continuous) of regulated 24-volt power. It shall include an integral charger designed to charge 7.0 amp hour batteries and to support 60-hour standby.
b. The Field Charging Power Supply shall have two input triggers. The input trigger shall be a Notification Appliance Circuit (from the fire alarm control panel) or a relay. Four outputs (two Style Y or Z and two style Y) shall be available for connection to the Notification devices.
c. The FCPS shall include an attractive surface mount back box.
d. The Field Charging Power Supply shall include the ability to delay the AC fail delay per NFPA requirements.
e. The FCPS include power limited circuitry, per 1995 UL standards.

System Circuit Supervision:

a. The FACP shall supervise all circuits to intelligent devices, annunciators and conventional peripherals and annunciate loss of communications with these devices. The CPU shall continuously scan above devices for proper system operation and upon loss of response from a device shall sound an audible trouble, indicate that device or devices are not responding and print the information in the history buffer and on a printer.
b. Sprinkler system valves, standpipe control valves, PIV and main gate valves shall be supervised for off-normal position.

Field Wiring Terminal Blocks:

a. All wiring terminal blocks shall be the plug-in/removable type and shall be capable of terminating up to 12 AWG wire. Terminal blocks that are permanently fixed to the PC board are not acceptable.

Field Programming

a. The system shall be programmable, configurable and expandable in the field without the need for special tools, laptop computers, or other electronic interface equipment. There shall be no firmware changes required to field modify the system time, point information, equations, or annunciator programming/information.
b. It shall be possible to program through the standard FACP keyboard all system functions.
c. All field defined programs shall be stored in non-volatile memory.
d. Two levels of password protection shall be provided in addition to a key-lock cabinet. One level shall be used for status level changes such as point/zone disable or manual on/off commands (Building Manager). A second (higher-level) shall be used for actual change of the life safety program (installer). These passwords shall be five (5) digits at a minimum. Upon entry of an invalid password for the third time within a one minute time period an encrypted number shall be displayed. This number can be used as a reference for determining a forgotten password.
e. The system programming shall be "backed" up on a 3.5" floppy diskette utilizing an upload/download program. This system back-up disk shall be completed and given in duplicate to the building owner and/or operator upon completion of the final inspection. The program that performs this function shall be "non-proprietary", in that, it shall be possible to forward it to the building owner/operator upon his or her request.

The installer's field programming and hardware shall be functionally tested on a computer against known parameters/norms which are established by the FACP manufacturer. A software program shall test Input-to-Output correlations, device Type ID associations, point associations, time equations, etc. This test shall be performed on an IBM-compatible PC with a verification software package. A report shall be generated of the test results and two copies turned in to the engineer(s) on record.

It shall be the responsibility of the equipment supplier /installer to ensure that all equipment supplied will fit in locations designated on plans and in the specifications.

Specific System Operations

a. Smoke Detector Sensitivity Adjust: Means shall be provided for adjusting the sensitivity of any or all analog intelligent smoke detectors in the system from the system keypad or from the keyboard of the video terminal. Sensitivity range shall be within the allowed UL/EN window.
b. Alarm Verification: Each of the Intelligent Addressable Smoke Detectors in the system may be independently selected and enabled to be an alarm verified detector. The alarm verification function shall be programmable from 5 to 50 seconds and each detector shall be able to be selected for verification during the field programming of the system or anytime after system turn-on. Alarm verification shall not require any additional hardware to be added to the control panel. The FACP shall keep a count of the number of times that each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.

c. System Point Operations:
   - Any addressable device in the system shall have the capability to be enabled or disabled through the system keypad or video terminal.
   - System output points shall be capable of being turned on or off from the system keypad or the video terminal.

d. Point Read: The system shall be able to display the following point status diagnostic functions without the need for peripheral equipment. Each point shall be annunciated for the parameters listed:
   - Device Status.
   - Device Type.
   - Custom Device Label.
   - Software Zone Label.
   - Device Zone Assignments.
   - Analog Detector Sensitivity.
   - All Program Parameters.

e. System Status Reports: Upon command from an operator of the system, a status report will be generated and printed, listing all system statuses:
f. System History Recording and Reporting: The fire alarm control panel shall contain a history buffer that will be capable of storing up to 1000 system events. Each of these events will be stored, with time and date stamp, until an operator requests that the contents be either displayed or printed. The contents of the history buffer may be manually reviewed, one event at a time, and the actual number of activations may also be displayed and or printed.
g. The history buffer shall use non-volatile memory. Systems that use volatile memory for history storage are not acceptable.
h. Automatic Detector Maintenance Alert: The fire alarm control panel shall automatically interrogate each intelligent system detector and shall analyze the detector responses over a period of time.
i. If any intelligent detector in the system responds with a reading that is below or above normal limits, then the system will enter the trouble mode, and the particular Intelligent Detector will be annunciated on the system display, and printed on the optional system printer. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.
j. The system shall include the ability (programmable) to indicate a "pre-alarm" condition. This will be used to alert maintenance personal when a detector is at 80% of its alarm threshold in a 60 second period.

Network Repeater Panel

A NRP shall be provided to display all system intelligent points. The NRP shall be capable of displaying all information for points on the network. Network display devices, which are only capable of displaying a subset of network points, shall not be suitable substitutes.

The NRP shall include a minimum of 6 inch or 80 characters, backlit by a long life, solid state LCD display. It shall also include a full keypad with tactile feel. Additionally, the network display shall include ten soft-keys for screen navigation and the ability to scroll events by type. i.e. Fire Alarm, Supervisory Alarm, Trouble, etc.

The network control annunciator shall have the ability to display up to eight events in order of priority and time of occurrence. Counters shall be provided to indicate the total number of events by type.

The NRP shall mount in any of the network node fire alarm control panels. Optionally, the network display may mount in a backbox designed for this use. The network shall support a minimum of 103 network control annunciators (not to exceed total node capacity) and shall connect to the network over either a wire or fiber interface.

The network control annunciator shall have an event history buffer capable of storing a minimum of 1000 events in non-volatile memory. Additionally, the NRP shall have a fire alarm history buffer capable of storing a minimum of 200 events in non-volatile memory. Systems that do not protect fire alarm events from being overwritten by other events are not suitable substitutes.

The NRP shall include two optically isolated, 9600 baud, industry standard RS/EIA-232 ports for UL864/EN listed printers and CRT's. These peripheral devices shall print or display network activity.

The network control annunciator shall include control switches for system wide control of Acknowledge, Signal Silence, System Reset, Drill, and local Lamp Test. A mechanical means by which the controls switches are "locked out", such as a key, shall be available.

The NRP shall include long life LEDs to display Power, Fire Alarm, Pre-Alarm, Security Alarm, System Trouble, Supervisory, Signals Silenced, Disabled Points, Other (non-fire) Events, and CPU Failure.

The network control annunciator shall include a Master password and up to nine User passwords. Each password shall be up to eight alpha-numeric characters in length. The Master password shall be authorized to access the programming and alter status menus. Each User password may have different levels of authorization assigned by the Master password.

The NRP shall allow editing of labels for all points within the network; control on/off of outputs; enable/disable of all network points; alter detector sensitivity; clear detector verification counters for any analog addressable detector within the network; clear any history log within the network; change the Time/Date settings; initiate a Walk Test.

The network control annunciator shall support an optional WindowsTM based program utility. This utility shall allow the user create an NRP database, upload/download an NRP database, and download an upgrade to the NRP executive. To ensure program validity, this utility shall check stored databases for errors. A compare function shall be included to identify differences between databases.
For time keeping purposes the NRP shall include a time of day clock.

Each NCA shall support up to 32 additional 80 character remote display annunciators for displaying network activity. These "Terminal Mode" displays will mimic the activity appearing on the corresponding NRP.

Network Control Station

1.1 SCOPE

A. A PC based graphical facilities monitoring system shall be installed in accordance to the project specifications and drawings.

B. The PC based graphical facilities monitoring system shall include, but not be limited to, one or more PC based graphical workstations, all input/output devices, network communications media, control equipment, auxiliary control devices, power supplies, and wire / fiber optic media as shown on the drawings and specified herein.

C. A supervised interface to fire alarm control panels shall be made available.

D. The system shall employ an advanced technology network to monitor and control various fire, security, and CCTV and other facility information over a LonWorks network or any other equivalent interface.

E. The system shall include an interface to digital alarm communicator receivers for wide area network monitoring.

F. The system shall allow a mixture of different technologies and manufacturers' equipment to operate on the same network and provide the operator with a consistent look and operation for all monitored equipment.

G. The system shall support a variety of topologies and media and shall provide an industry standard open architecture transport layer protocol.

H. Using standard RS 232 ports on existing and future monitoring and control systems used by the facility, the system shall connect to and interpret status change data transmitted from the ports and provide graphic annunciation, control, history logging and reporting as specified herein.

I. Proprietary network systems that cannot interface to existing addressable fire alarm systems at the facility or systems requiring the use of a "dry contact" or "voltage monitoring" interface shall not be accepted.

J. The system shall be electrically supervised and monitor the integrity of all conductors.

10 WORKSTATION PERFORMANCE

A. The network will interface and report the individually monitored system's status via a user-friendly Graphical User Interface (GUI) based software workstation.

B. The software shall operate under Microsoft® Windows® XP Professional as manufactured by Microsoft Corporation.

C. The GUI based software must be capable of graphically representing each facility being monitored with floor plans and icons depicting the actual locations of the various systems; and / or sensors' locations.

D. The software shall use a 1024 X 768 GUI display capable of showing a large primary floor plan display, a key map representative of a larger view of the primary display and its relationship to the facility being monitored, the current operator, number of fire, supervisory, pre-alarms, troubles, and security events within the network as well as outstanding events and acknowledged events.

E. The workstation shall have the ability to support graphic printing of all data including graphical floor plans, system activity, history, and guidance text. A Windows compatible printer shall be supported for the graphics and report printer options.

F. The workstation software shall permit automatic navigation to the screen containing an icon that represents the system or sensor in the event of an off-normal condition.

G. The system/sensor icon shall indicate the type of off-normal condition and shall flash and change to the color associated with the off-normal condition (e.g., RED for ALARM and YELLOW for TROUBLE).

H. The software shall allow the attachment of text (TXT) files, sound (WAV) files, image (BMP) files and video (AVI) files to each system or sensor icon allowing additional information to be provided to the system operator for responding to the off-normal condition.

I. The software shall allow the importation of externally developed floor plans in Windows Metafile (WMF), JPEG (JPG), Graphics Interchange Format (GIF) and Bitmap (BMP) format.

J. The software shall provide auto-navigation to the screen containing the icon of any system or sensor when an event is initially annunciated. In addition, operator navigation to screens containing outstanding events shall be accomplished by "clicking on" the event from either the acknowledged or unacknowledged event.

K. History Manager. The software shall contain a History Manager, which shall record all system events with a time and date stamp as well as the current system operator's name.

1. The system shall provide for the ability to store all off-normal events experienced by the various sub-systems that are monitored by the system.
2. All events shall be recorded with a time and date stamp and the system operator shall be provided with the ability to log a pre-defined response or a custom comment for each off-normal event and have that comment stored in the history file with the time, date and operator name.
3. Provide for the ability to conduct searches and generate subsequent reports, based on all events for a single system / device address, a specific node, a specific type of off-normal condition and date range (mm/dd/yy to mm/dd/yy) or combinations of these search parameters. The number of entries in the history file that match the determined search criteria will be displayed.
4. The History Manager shall signal a need to back-up the history file at 100,000 events and then remind the operator at intervals of 100 events thereafter.

5. It shall be possible to pre-select data fields for reporting and then saving the report as a template with a file name. It shall also be possible to schedule the pre-defined report to print at a designated time.

L. Alarm Monitoring. The system shall provide for continuous monitoring of all off-normal conditions regardless of the current activity displayed on the screen.
   1. If an operator is viewing the history of a sub-system and an alarm condition should occur, the system shall automatically navigate to the graphic screen showing the area where the off-normal event is occurring.
   2. The system shall prioritize all off-normal events as defined by Underwriter's Laboratories into the following categories: fire alarms, troubles, supervisory alarms, pre-alarms and security alarms.
   3. The system shall display a running count of all events by type in an alarm event counter window. The event counter window shall include five counters, defaulted to Alarm, Trouble, Security, and Supervisory events.
   4. The system shall show a running list of all unacknowledged events and acknowledged events and allow the system operator to acknowledge an event by "double-clicking" on that event in the Unacknowledged Events box. The Unacknowledged and Acknowledged Events boxes shall contain an abbreviated description of the off-normal condition.
   5. The details of the condition may be viewed by selecting event in the unacknowledged events box.
   6. The system shall allow the attachment of user-definable text files, image files and sound files, to each device / system monitored in order to facilitate the operators and response personnel's response to the off-normal condition.
   7. The system shall record all events to the system's hard drive

M. Reports & Logs:
   1. The system shall provide for the ability to generate reports based on system history.
   2. The system shall allow the system operator to enter custom comments up to 255 characters for each event and have those comments recorded in the system's history file.

N. Boolean Logic
   1. An automated event response application shall be provided to automatically perform actions across the entire system based on network activity.
   2. The event response application shall allow event responses (actions) based on predefined user conditions using simplified Boolean logic.
   3. Actions shall be configured to be executed immediately or timed as required.

O. Control Aspects of System Software
   1. The system shall provide for the direct control of all outputs associated with Input / Output dry contact relay points on Network Input/Output Nodes (NIONs). In addition, the system shall have the ability to control and program a sub-system Fire Alarm Panel through a terminal mode window (ASCII terminal type connection) interface to microprocessor-based sub-systems via an RS 232 serial NION if available as an ancillary feature.
   2. The system shall have the ability to monitor and control Fire Alarm Panels:
   3. Discrete I/O NION interfaces allow the system operator to initiate a change of state for the associated dry contacts.
   4. A scheduling utility shall be included with the workstation to configure the I/O points on these NIONs for automated activate/deactivate, and Arm/Disarm (depending on device type) status.
   5. The workstation shall provide configuration utilities for monitoring and control profiles. These profiles shall be user definable for distribution of monitoring and control allowances for operators per workstation.
   6. Terminal mode interfaces using serial NIONs (if available for the specific system) shall be available to allow full programming and control of the system being monitored and shall provide the operator with the ability to take advantage of all features supported by a CRT attached to the associated individual sub-system.
   7. Under no condition shall any sub-system be required to rely on the network for any data processing required to perform its particular function. Each individual sub-system shall be in effect "stand-alone" as to insure it's continued operation should a disruption in communication with the system be experienced.

P. The software shall be password protected and provide for the definition of security profiles for operator access control.

Q. The software shall contain provision for defining monitoring profiles of pre-selected NIONs for monitoring. This shall include provision for status types within the selected NODES.

R. The software shall contain provision for defining control profiles of pre-selected NIONs for control.
   1. The system administrator shall be provided means to select which signals can be controlled by selected Workstation.

S. The software shall support live voice paging for mass notification to voice evacuation system over Internet Protocol (IP).

11 WORKSTATION

A. The system shall be a Facilities Monitoring System.

B. The system shall operate on an Intel Pentium III processor operating at no less than 800 MHz on the Microsoft® Windows® XP Professional platform.

C. The workstation shall have: no less than 256 megabytes of RAM, a hard drive with no less than 20 Gigabytes of storage space, a minimum of 8 megabytes of video RAM, a CD-R/W for system backup, internal supervisory CPU watchdog board with audible annunciator, 100 Base-T Ethernet NIC card, a 104 key keyboard, and a mouse type pointing device.

D. The workstation shall come equipped with all necessary gateway modules to allow connection to the network it monitors as standard equipment. All workstations shall support Ethernet communications when multiple workstations are required.

E. The workstation shall support an SVGA monitor and be supplied with a 17” flat screen LCD monitor.

F. The computer shall be capable of networking to additional computers and these computers shall be capable of operating as workstations and/or gateways for local area or wide area networks.

G. Alarm annunciation shall appear on all workstations and may be silenced at each local workstation.
   1. Only one workstation and operator shall be in command of the system for global alarm acknowledgement at any time.

12 MONITORING NETWORK

A. The network shall have the ability to use fiber optic cable (single-mode and multi-mode), wire (twisted pair copper media in a style 4 or style 7 configuration), or combination wire/fiber communications with support of up to 103 nodes.
   1. Wire networks shall support 12 AWG, 1 Pair Shielded to 24 AWG, 4 Pair Unshielded following the manufacturer’s guidelines.
   2. Fiber optic networks shall support 62.5/125µm cable 8dB limit (50/125µm cable 4.2dB limit).
   3. Wire to fiber conversions using repeaters.

B. MONITORINGNETWORK point Data speed to 12 Mbps on wire and 100 Mbps on fiber.

C. True peer-to-peer communications.

13 INTEGRATION NETWORK

A. The integration network shall be capable of monitoring a minimum of 100 nodes (NIONs and routers) on an integration gateway consisting of, but not limited to:
   1. Intelligent or conventional fire alarm control panels.
   2. Competitor’s intelligent or conventional fire alarm control panels.

B. Up to 99 gateways shall be connected via Ethernet for a total local area combination of up to 12672 (99x128) nodes.

C. Local area networks shall consist of a free topology network using twisted pair copper media in a bus, star, T-tap, or ring style 7 configurations at 78 Kilo baud.
   Transmit/receive twin fiber (multi-mode 62.5/125 µm) strand FT-10 point-to-point topology and bi-directional FO-10 networks shall also be available. Wide area networks shall be supported by the use of network expansion routers.
   1. Free topology (FT-10 style) wire network run allows multiple T-taps within a 1,500-foot (457.2 m) radius; 8,000 foot (2438.4 m) point-to-point using twisted pair; or 6,000-foot (1828.8 m) bus topology.
   2. Free topology (FT-10 style) fiber network can also use fiber-optic cabling. Operates at 78.5 Kbaud.

3. Fiber optic (FO-10 style) network allows bus or ring topology using only fiber-optic cabling; node-to-node distance of over 10,000 feet (3048 m) with message regeneration. FO-10 style operates at 1250 Kbaud and utilizes multi-mode bi-directional fiber media (single fiber strand) in a bus or loop configuration.

D. Provide routers, repeaters or bridges where required to increase distance, alter network configuration or change media or to extend to remote facilities over alternate communications media including UL listed dial-up PSTN telephone, leased line, multimode fiber or Ethernet connectivity.
   1. Dial-up units shall dial a local number and stay connected. Upon loss of carrier, a supervisory alarm shall be indicated at the workstation and the units shall automatically redial to connect.
   2. Network expansion routers shall support public switched telephone circuits, two-wire or four-wire leased lines, and CAT5 Ethernet networks.

E. Network interface software shall be by the same manufacturer as the hardware portion of this specification.

F. The integration network shall utilize Network Input / Output Nodes (NIONs) to interface between the individual buildings' systems to be monitored by the integration network. The NIONs shall act as a translator from the building system's specific panel communications protocol to the integration network protocol as well as serve as a transceiver from the building system panel to the integration network.
   1. NIONs shall be available in configurations that will allow transparent communications via RS 232 serial data ports with intelligent fire alarm control panels, security systems, and CCTV systems.
   2. NIONs shall be available in configurations that will allow monitoring of dry contacts, switched voltages, conventional security devices, access control panels and conventional fire alarm control panels using scheduled, automated and manual control.
   3. NIONs shall be UL listed to Standard 864 and 1076 and be provided with their own enclosure or be available in chassis mount configurations.
   4. NIONs shall operate at 24 VDC and obtain their power from the monitored control panel or a UL listed battery backed auxiliary power supply. All terminals shall be transient protected to 2400V and LEDs shall be provided for status, service and diagnostics.

G. Digital Alarm Communicator Receiver Network
   1. The system shall provide a digital alarm communicator receiver (DACR) gateway with a RS 232 interface to the following digital alarm communicator receivers for wide area event reporting: Ademco 685, Silent Knight 9500 and 9800, Radionics 6600.
   2. Each gateway shall support up to 10 digital alarm communicator receivers for alarm and trouble information from reporting devices.

H. Workstation Network:
   1. Computers shall be networked using Ethernet supporting the use of TCP/IP protocol for local area systems.
   2. The network shall be capable of supporting multiple clients (e.g., workstations, configuration applications, automated response applications) and up to ninety-nine (99) gateways.
   3. A UL listed Ethernet Hub shall be provided for connection of multiple workstations, gateways, clients, and/or network printers.
   4. System shall be UL listed to communicate between clients and gateways over a business computer network (shared IP).

I. System Expansion. Additional software and hardware modules shall be currently available by the system manufacturer to provide for:

   1. CCTV with on-screen Pan/Tilt/Zoom and live video on-screen.
   2. Supported systems shall include the following CCTV switch manufacturers, Pelco, Burle/Phillips and Vicon. The ability to support all listed CCTV switch units simultaneously on the same system shall be supported.

Signaling Line Circuits (SLC)

Each FACP or FACP network node shall support up to two SLCs. Each SLC interface shall provide power to and communicate with up to 99 intelligent detectors, 99 intelligent modules (monitor or control) of 198 devices. The addition of the optional second loop shall double the device capacity, supporting a total of 400 devices. Each SLC shall be capable of NFPA 72 Style 4, Style 6, or Style 7 (Class A or B) wiring.

CPU shall receive analog information from all intelligent detectors to be processed to determine whether normal, alarm, prealarm, or trouble conditions exist for each detector. The software shall automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analog information shall also be used for automatic detector testing and for the automatic determination of detector maintenance requirements.

Serial Interfaces

The system shall include two serial EIA-232 interfaces. Each interface shall be a means of connecting UL Listed Information Technology Equipment (ITE) peripherals.

One EIA-232 interface shall be used to connect a 40 or 80 column printer.

One EIA-232 interface shall be used to connect a CRT terminal. This interface shall include special protocol methods that allow off-site monitoring of the FACP over standard dial-up phone lines. This ancillary capability shall allow remote readout of all status information, including analog values, and shall not interfere with or degrade FACP operations when used. It shall allow remote FACP Acknowledge, Reset, or Signal Silence in this mode. It shall also allow adjustment of detector sensitivity and readout of the history file.

The system shall include an EIA-485 port for the serial connection of optional annunciators and remote LCD displays.

The EIA-485 interface may be used for network connection to a proprietary-receiving unit.

Notification Appliance Circuit (NAC) Module

The Notification Appliance Circuit module shall provide four fully supervised Class A or B (NFPA Style Z or Y) notification circuits. An expansion circuit board shall allow expansion to eight circuits per module.

The notification circuit capacity shall be 3.0 amperes maximum per circuit and 6.0 amperes maximum per module.

The module shall not affect other module circuits in any way during a short circuit condition.

The module shall provide eight green ON/OFF LEDs and eight yellow trouble LEDs.

The module shall also provide a momentary switch per circuit that may be used to manually turn the particular circuit on or off or to disable the circuit.

Each notification circuit shall include a custom label inserted to identify each circuit's location. Labels shall be created using a standard typewriter or word processor.

The notification circuit module shall be provided with removable wiring terminal blocks for ease of installation and service. The terminal strips shall be UL listed for use with up to 12 AWG wire.

Each circuit shall be capable of, through system programming, deactivating upon depression of the signal silence switch.

Equivalent EN standard is also acceptable.

14. INTERACTIVE FIREFIGHTERS' TOUCH SCREEN DISPLAY Panel (wall Mounted)

The network will interface and report the individually monitored system's alarm status via a user-friendly Touch Screen Graphical User Interface (GUI) based software.

The Touch Screen software shall operate under Microsoft® Windows® XP Embedded platform as manufactured by Microsoft Corporation.

The Touch Screen GUI based software must be capable of graphically representing the facility being monitored with floor plans and icons depicting the actual locations of the fire alarm device locations.

The Touch Screen software shall use a 1280 pixel x 1024 pixel GUI 17 inch display capable of showing a large primary floor plan display, a site plan representative of an aerial view of the facility, the first active fire alarm on the system.

The Touch Screen software shall permit automatic navigation to the screen containing an icon that represents the first fire alarm device in alarm in the event of an off-normal condition.

The fire alarm device icon shall be visible only when it is in an alarm (or active) condition.

The Touch Screen software shall display the activated smoke detectors in a time sequence to track smoke progression.

The Touch Screen software shall allow the importation of externally developed floor plans in Windows Metafile (WMF), JPEG (JPG), Graphics Interchange Format (GIF) and Bitmap (BMP) format.

The Touch Screen software shall provide a intuitive and easy way to navigate to different screens representing floors and areas within a facility.

The system shall provide for continuous monitoring of all fire alarm conditions regardless of the current activity displayed on the screen.

The software shall display "YOU ARE HERE" along with icons representing standard building objects (stairs, elevators, etc) to be shown on the floor plan.

The Touch Screen software shall allow icons that represent hazardous materials stored in a facility.

The Touch Screen software shall provide a screen that displays preprogrammed building contact information.

The Touch Screen software shall provide a screen the displays building occupancy and other general building information.

The Touch Screen software shall allow a site plan to be imported that shows an aerial view of the facility.

The Touch Screen software shall display all active fire, supervisory, and security events within an event list.

Waterflow Operation

An alarm from a waterflow detection device shall activate the appropriate alarm message on the main panel display, turn on all programmed notification appliance circuits and shall not be affected by the signal silence switch.

Supervisory Operation

An alarm from a supervisory device shall cause the appropriate indication on the system display, light a common supervisory LED, but will not cause the system to enter the trouble mode.

Signal Silence Operation

The FACP shall have the ability to program each output circuit (notification, relay, speaker etc) to deactivate upon depression of the signal silence switch.

Sprinkler and Standpipe Valve Supervisory Switches:
Each sprinkler system water supply control valve riser, zone control valve, and standpipe system riser control valve shall be equipped with a supervisory switch. Standpipe hose valves, and test and drain valves shall not be equipped with supervisory switches.
PIV (post indicator valve) or main gate valves shall be equipped with a supervisory switch.

The switch shall be mounted so as not to interfere with the normal operation of the valve and adjusted to operate within two revolutions toward the closed position of the valve control, or when the stem has moved no more than one-fifth of the distance from its normal position.

The supervisory switch shall be contained in a weatherproof aluminum housing, which shall provide a 3/4 inch (19 mm) conduit entrance and incorporate the necessary facilities for attachment to the valves.

The switch housing shall be finished in red baked enamel.

The entire installed assembly shall be tamper proof and arranged to cause a switch operation if the housing cover is removed, or if the unit is removed from its mounting.

Valve supervisory switches shall be provided and connected under this section and installed by mechanical contractor.
Non-Alarm Input Operation
Any addressable initiating device in the system may be used as a non-alarm input to monitor normally open contact type devices. Non-alarm functions are a lower priority than fire alarm initiating devices.

Combo Zone

A special type code shall be available to allow waterflow and supervisory devices to share a common addressable module. Waterflow devices shall be wired in parallel, supervisory devices in series.

15 SYSTEM COMPONENTS - ADDRESSABLE DEVICES
Addressable Devices - General
Addressable devices shall use simple to install and maintain decade, decimal address switches. Devices shall be capable of being set to an address in a range of 01 to 99. How ever electronic addressing will be accepted only if all the devices can be fully programmed for sensitivity settings, pre alarm level etc from the panel with no extra programming tools and computer shall be used.

Detectors shall be intelligent (analog) and addressable, and shall connect with two wires to the fire alarm control panel Signaling Line Circuits.

Addressable smoke and thermal detectors shall provide dual alarm and power/polling LEDs. Both LEDs shall flash green under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady red illumination by the control panel, indicating that an alarm condition has been detected. If required, the LED flash shall have the ability to be removed from the system program. An output connection shall also be provided in the base to connect an external remote alarm LED.

The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system. The panel on a time-of-day basis shall automatically adjust sensitivity.

Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72, Chapter 7/EN standard.

The detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature. Bases shall include a sounder base with a built-in (local) sounder rated at 85 DBA minimum, a relay base and an isolator base designed for Style 7 applications.

The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.

Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device .

Detectors will operate in an analog fashion, where the detector simply measures its designed environment variable and transmits an analog value to the FACP based on real-time measured values. The FACP software, not the detector, shall make the alarm/normal decision, thereby allowing the sensitivity of each detector to be set in the FACP program and allowing the system operator to view the current analog value of each detector.

Addressable devices shall store an internal identifying code that the control panel shall use to identify the type of device.

A magnetic test switch shall be provided to test detectors and modules. Detectors shall report an indication of an analog value reaching 100% of the alarm threshold.

Addressable modules shall mount in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box. An optional surface mount Lexan enclosure shall be available.

Detector shall be with fault isolator either built-in the detector or in the form of separate isolator modules/isolator bases.

Programmable Electronic Exit Point Directional Sounders:

Shall follow NFPA 72 2007 edition recommendation.

Electronic sounders shall operate on 24 VDC nominal.

Electronic sounders shall be field programmable without the use of special tools, at a sound level of at least 90 dBA measured at 10 feet from the device.

Shall be flush or surface mounted as shown on plans.

Shall produce broad band directional sound with 20 Hz to 20 Khz frequency band to guide occupants to safe exists even in complete darkness.

Strobe lights shall meet the requirements of the ADA, UL Standard 1971, be fully synchronized, and shall meet the following criteria:

The maximum pulse duration shall be 2/10 of one second.

Strobe intensity shall meet the requirements of UL 1971.

The flash rate shall meet the requirements of UL 1971.
Field Wiring Terminal Blocks

For ease of service all panel I/O wiring terminal blocks shall be removable, plug-in types and have sufficient capacity for #18 to #12 AWG wire. Terminal blocks that are permanently fixed are not acceptable.
Equivalent exit of EN standard is also acceptable.

Addressable Manual Fire Alarm Box (manual station)

Addressable manual fire alarm boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.

All operated stations shall have a positive, visual indication of operation and utilize a key type reset.

Manual fire alarm boxes shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inches (44 mm) or larger. The manual station shall be single action break glass unit type.

Intelligent Multi-Co-Operative Sensing type Photoelectric Smoke Detector
The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall be in position to work in advance multi Co-Operative Sensing, on command from the control panel, send data to the panel representing the analog level of smoke density.

Intelligent Thermal Detectors
Thermal detectors shall be intelligent addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a rate-of-rise element rated at 15 degrees F (9.4 degrees C) per minute. It shall connect via two wires to the fire alarm control panel signaling line circuit.

Intelligent Laser Photo Smoke Detector

- The intelligent laser photo smoke detector shall be a spot type detector that incorporates an extremely bright laser diode and an integral lens that focuses the light beam to a very small volume near a receiving photo sensor. The scattering of smoke particles shall activate the photo sensor.
- The laser detector shall have conductive plastic so that dust accumulation is reduced significantly.
- The intelligent laser photo detector shall have nine sensitivity levels and be sensitive to a minimum obscuration of 0.03 percent per foot.
- The laser detector shall not require expensive conduit, special fittings or PVC pipe.
- The intelligent laser photo detector shall support standard, relay, isolator and sounder detector bases.
- The laser photo detector shall not require other cleaning requirements than those listed in NFPA 72. Replacement, refurbishment or specialized cleaning of the detector head shall not be required.
- The laser photo detector shall include two bicolor LEDs that flash green in normal operation and turn on steady red in alarm.

<u>Intelligent Multi Criteria Acclimating Detector</u>

- The intelligent multi criteria Acclimate detector shall be an addressable device that is designed to monitor a minimum of photoelectric and thermal technologies in a single sensing device. The design shall include the ability to adapt to its environment by utilizing a built-in microprocessor to determine it's environment and choose the appropriate sensing settings. The detector design shall allow a wide sensitivity window, no less than 1 to 4% per foot obscuration. This detector shall utilize advanced electronics that react to slow smoldering fires and thermal properties all within a single sensing device.
- The microprocessor design shall be capable of selecting the appropriate sensitivity levels based on the environment type it is in (office, manufacturing, kitchen etc.) and then have the ability to automatically change the setting as the environment changes (as walls are moved or as the occupancy changes).
- The intelligent multi criteria detection device shall include the ability to combine the signal of the thermal sensor with the signal of the photoelectric signal in an effort to react hastily in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a false alarm condition by examining the characteristics of the thermal and smoke sensing chambers and comparing them to a database of actual fire and deceptive phenomena.

Intelligent Duct Smoke Detector

- The smoke detector housing shall accommodate either an intelligent ionization detector or an intelligent photoelectric detector, of that provides continuous analog monitoring and alarm verification from the panel.

- When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system.

Devices as per equivalent LPCB approval/EN standard is also acceptable

Two Wire Zone Monitor Module for Conventional Devices, Flow switches etc.

- Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional 2-wire smoke detectors or alarm initiating devices (any N.O. dry contact device).
- The IDC zone may be wired for Class A or B (Style D or Style B) operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.

Addressable Control Module

- Addressable control modules shall be provided to supervise and control the operation of one conventional NACs of compatible, 24 VDC powered, polarized audio/visual notification appliances.
- The control module NAC may be wired for Style Z or Style Y (Class A/B) with up to 1 amp of inductive A/V signal, or 2 amps of resistive A/V signal operation.
- Audio/visual power shall be provided by a separate supervised power circuit from the main fire alarm control panel or from a supervised UL listed remote power supply.
- The control module shall be suitable for pilot duty applications and rated for a minimum of 0.6 amps at 30 VDC.

Addressable Relay Module

- Addressable Relay Modules shall be available for HVAC control and other building functions. The relay shall be form C and rated for a minimum of 2.0 Amps resistive or 1.0 Amps inductive. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.

Isolator Module

- Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC Class A or Class B branch. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC loop segment or branch. At least one isolator module shall be provided for each detector in the building.
- If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the SLC. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.
- The isolator module shall not require address-setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.
- The isolator module shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.
- The isolator module shall not consume any detector or device address from the loop capacity.

Aspiration Smoke detection

The detector shall be configured to operate either as a stand alone unit, providing volt free relay contacts to signal fire alarm and fault or as a loop controlled device, communicating with a compatible analogue addressable control panel. In the loop controlled mode the fire alarm relay is controlled by panel command. Number of Sensors: 1/2 Laser Sensors (System Filtration: Cartridge dust particle filter Flow Monitoring: Thermal device, high and low thresholds. 10 element bar graph indication. Loop fault reporting.
IP rating: IP50 / IP65 optional
Operating Temperature: -10°C to 60°C
Operating Humidity: 10 to 95% RH (non-condensing)
Aspirating smoke detectors shall be equipped with two detection pipe channels and laser sensor for each channel. A high performance aspirator and flow monitoring circuits shall ensure a constant, monitored flow level which can be displayed on a 10 element bar graph with adjustments for high and low flow thresholds. Three alarm levels give warnings at their pre-set levels. The Aspiration units incorporate in-line air filters to remove dust particles from the air samples. These are housed in removable transparent cartridges enabling rapid inspection and maintenance. A USB port shall be located of the unit may be used to download all the data that is logged within the unit. This can then be used to look at events or trends over a period of time. The Detector shall provides closed loop sampling whereby the exhausted air can be completely returned to the sampled area making it particularly suitable for prison cells.

Pipe Sections
Smoke tests should be performed before planning and installing the pipe network.
Material ABS or UPVC, copper or stainless steel may also be used if required.

Integration with Fire Panel
The Laser based aspiration system shall be of same make of panel and shall be integrated without any software or protocol converter.

In case contractor proposes different make of aspiration system, then contractor has to ensure the 100% integration of aspiration system with his fire alarm system

16. BATTERIES:
The battery shall have sufficient capacity to power the fire alarm system for not less than twenty-four hours plus two hour of alarm upon a normal AC power failure.

The batteries are to be completely maintenance free. No liquids are required. Fluid level checks for refilling, spills, and leakage shall not be required.
If necessary to meet standby requirements, external battery and charger systems may be used.
The Unit shall be UL / FM / VDS/IS approved.

17. EXECUTION
INSTALLATION:
Installation shall be in accordance with the NEC, NFPA 72, local and state codes, as shown on the drawings, and as recommended by the major equipment manufacturer.

All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.

All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.

Manual fire alarm boxes shall be suitable for surface mounting or semi-flush mounting as shown on the plans, and shall be installed not less than 42 inches (1067 mm), nor more than 48 inches (122 mm) above the finished floor.
TEST:

The service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment shall be provided to technically supervise and participate during all of the adjustments and tests for the system. All testing shall be in accordance with NFPA 72, Chapter 7/EN.

Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.

Close each sprinkler system flow valve and verify proper supervisory alarm at the FACP.
Verify activation of all waterflow switches.
Open initiating device circuits and verify that the trouble signal actuates.
Open and short signaling line circuits and verify that the trouble signal actuates.
Open and short notification appliance circuits and verify that trouble signal actuates.
Ground all circuits and verify response of trouble signals.
Check presence and audibility of tone at all alarm notification devices.
Check installation, supervision, and operation of all intelligent smoke detectors using the walk test.

Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.
When the system is equipped with optional features, the manufacturer's manual shall be consulted to determine the proper testing procedures. This is intended to address such items as verifying controls performed by individually addressed or grouped devices, sensitivity monitoring, verification functionality and similar.

FINAL INSPECTION:
At the final inspection, a factory-trained representative of the manufacturer of the major equipment shall demonstrate that the system functions properly in every respect.

INSTRUCTION:
Instruction shall be provided as required for operating the system. Hands-on demonstrations of the operation of all system components and the entire system including program changes and functions shall be provided.

The contractor and/or the systems manufacturer's representatives shall provide a typewritten "Sequence of Operation."

The entire Fire alarm System components shall be of same make and Listed. The data sheets of each equipment shall be submitted along with offer.

Fire Resistant / Fire Survival Cable (Specs) (Fire survival Low Smoke Zero Halogen)

- Armoured cable shall be of 600/1000V rated with 2 core 1.5 sqmm armoured Copper conductor as per BS EN 60228 with glass mica fire barrier tape covered by an extruded layer of Cross-linkable Fire survival Low smoke Zero halogen (FRLSZH) insulation as per EI-5 of BS EN 50363 having LSZH inner & outer sheath. Should comply with the requirements of British Standard BS 7846 (Latest edition) & Clause 26.2e of BS 5839-1(Latest edition).

- Un-armoured cable shall be of 300/500V rated with Copper conductor as Per BS EN 60228 with glass mica fire barrier tape covered by an extruded layer of Cross- linkable Fire Survival Low smoke Zero halogen (FRLSZH) insulation as per EI-5 of BS EN 50363, ATC drain wire, aluminium tape screening having (FRLSZH) outer sheath. Should comply with the requirements of British Standard BS 7629-1 (Latest edition) & Clause 26.2e of BS 5839-1(Latest edition).
  - Armored & unarmored cables should maintain circuit integrity under fire conditions as per Clause 26.2e of BS 5839-1 when tested in accordance to BS 8434-2 (Latest edition)i.e Simultaneous action of Fire with mechanical shock plus fire with mechanical shock with water on single sample @ 930 degree C.
  - The cables should not emit toxic gases in case of fire. The toxicity index should be less than 3 (refer NES 713).

- The cables shall comply with the requirements of IEC-61034 Part 1&2 (Measurement of Smoke density of cables burning under defined conditions).
- The cables shall comply with the requirements of BS EN 50267-2-1 (Determination for amount of halogen acid gas content which shall not be greater than 0.5%).
- The cable manufacturer should provide factory production control certificate related to the manufacturing of fire resistant wires & cables from LPCB / BRE Global/ **NABL accredited laboratory.**

18 DOCUMENTS:

The following documents shall be required from Vendor:-

1) Document register
2) Compliance sheet
3) BOQ (including commissioning spares)
4) 5 years operation spare part list
5) Maintenance tools list
6) All equipment and software data sheets
7) Quality control plan
8) Equipment installation and mounting details
9) Power schematic diagram
10) Equipment list with power consumption, voltage supply, heat dissipation, required circuit breaker rating, physical size, weight, Manufacturer and origin.
11) Cabinet arrangement, cable entries
12) Required interconnection cables specification
13) Cabinet cable wiring and termination schedules
14) Installation procedure
15) Recommendations for storage, including long term storage
16) Recommendations for protection during transportation
17) Recommendations for handling
18) O & M manuals
19) Commissioning procedure

## Annexure-I

| S. No. | 8 Port PoE Gigabit Switch | |
|---|---|---|
| | **Technical Specifications** | |
| 1 | No of ports | 8 PoE 10/100/1000 Mbps |
| | | 2 combo 10/100/1000BASE-T/SFP |
| 2 | Network cabes | UTP Cat.5, Cat.5e (100m max) |
| | | EIA/TIA-568 100-ohm STP (100m max) |
| 3 | Full/ Half Duplex | Full/half duplex for 10/100Mbps speeds |
| | | Full duplex for Gigabit speed |
| 4 | Media interface Exchange | Auto MDI/MDI-X adjustment for all twisted-pair ports |
| 5 | Port Standards and functions | IEEE 802.3 10BASE-T Ethernet (twisted-pair copper) |
| | | IEEE 802.3u 100BASE-TX Fast Ethernet (twisted-pair copper) |
| | | IEEE 802.3ab 1000BASE-T Gigabit Ethernet (twisted-pair copper) |
| | | Auto-negotiation |
| | | IEEE 802.3x Flow Control |
| | **Performance** | |
| 1 | Switching capacity | 20Gbps |
| 2 | Maximum 64 byte package forwarding rate | 14.88Mpps |
| 3 | RAM Buffer | 512KB per device |
| 4 | Transmission method | Store-and-forward |
| 5 | MAC address table | 8K entries per device |
| 6 | MAC address update | Up to 256 static MAC entries addresses |
| | Physical and Environmental | |
| 1 | Maximum Power consumption | 109.6 W (PoE on) 14.45 W (PoE off) |
| 2 | Standby power Consumption | 7W/110 V, 7.8W/240V |
| 3 | Fan quantity | Not Required |
| 4 | Accoustic | 0dBA |
| 5 | Heat dissipation | 373.96 BTU/hr |
| 6 | AC Input | 100 to 240 VAC 50/60Hz internal universal power supply |
| 7 | Operating temperature | 32deg to 104deg F (0deg to 40degC) |
| 8 | Storage temperature | 14deg to 158degF (-10deg to 70deg C) |
| 9 | Emmissions | FCC Class A, CE Class A, IC Class A, VCCI Class A, C-Tick |
| 10 | Diagnostic LEDs | Power (per device) |
| | | Link/Activity/Speed (per 10/100/1000Mbps port, per SFP port) |

| | | |
|---|---|---|
| | **Safety** | **cUL, LVD** |
| **1** | **PoE** | |
| **2** | **PoE Standards** | **802.3af** |
| **3** | **PoE capable ports** | **Port 1 to 8: 15.4w or 30w** |
| | | **Max. 15.4w on 4 10/100/1000Mbps ports** |
| **4** | **PoE Power Budget** | **Maximum: 78W** |
| | **Software Feature** | |
| | **L2 Features** | |
| **1** | **MAC address table** | **8K** |
| **2** | **Flow Control** | **802.3x Flow Control** |
| **3** | **Spanning tree protocol** | **802.1D STP** |
| **4** | **IGMP Snooping** | **IGMP v1/v2 Snooping** |
| | | **Supports IGMP Snooping Querier** |
| | | **IGMP per VLAN** |
| | **VLAN** | |
| **1** | **802.1Q** | **2003 Edition** |
| **2** | **VLAN** | **Max 256 static VLAN groups, max 4094 VIDs** |
| **3** | **Management VLAN** | **Max 256 static VLAN groups, max 4094 VIDs** |
| **4** | **Asymmetric VLAN** | **Yes** |
| **5** | **Auto Voice VLAN** | **Max. 10 user defined OUI, Max. 8 default OUI** |
| **6** | **Auto Surveillance** | **Yes** |
| | **Security** | |
| **1** | **802.1XPort based access control** | **Default 802.1X forwarding** |
| **2** | **Port Security** | **Supports up to 64 MAC address per port** |
| **3** | **Traffic control** | **Broadcast/ multicast/ unitcast storm control** |
| **4** | **Static MAC** | **Supports 256 static MAC entries** |
| **5** | **Safeguard engine** | **Yes** |
| **6** | **DHCP server screening** | **Yes** |
| **7** | **ARP Spoofing prevention** | **Max 64 entries** |
| **8** | **SSL** | **Supports V1/V2/V3** |
| | **Management** | |
| **1** | **Web-based GUI** | **Supports IPv4** |
| **2** | **Compact CLI throughTelnet** | **Yes** |
| **3** | **Telnet server** | **Maximum Connection is 4, Supports IPv4** |
| **4** | **TFTP Client** | **Supports IPv4** |
| **5** | **SNMP** | **v1/v2/v3** |

## 11.15 IP BASED CCTV SYSTEM

IP based CCTV system is proposed to record the events at basement & ground floor Lift lobby and all floors passage/public areas.

The system shall comprise of CCD Cameras, TV Monitor, Multiplexer, and Time Lapse Recorder. All the cameras shall be connected through 10/16-channel multiplexer. The unit shall record all the cameras as paid succession of full scale images. The multiplexer shall receive the alarm signal, select the camera covering the forced entry area and record exclusively the camera to tape. The time lapse recorder shall be provided which shall be connected to the multiplexer unit to tape events seen by all cameras simultaneously.

1. HIGH RESOLUTION FIXED DOME CAMERA WITH WIDE DYNAMIC RANGE:

The fixed dome camera should have the following features:

- 1/3" CCD/ CMOS sensor.
- Minimum illumination 0.01lx (DSS).
- Enhanced features such as Back Light Compensation, Wide Dynamic Range, Digital Noise Reduction, BMB (Black Masking BLC), PIP (picture in picture), Quad View, Mirror, Digital Zoom, Motion detection and Privacy masking

The camera should meet the minimum following specifications:-

| HD VANDAL PROOF NETWORK D/N DOME CAMERA | |
|---|---|
| Video standards | Triple streaming H.264/MPEG4/MJPEG selectable |
| Sensor | 1/2.8 inchHD resolution CMOS or better |
| Scanning | Progressive Scan system |
| Sensor matrix | PAL : 1920 x 1080/1280 x 960 or better |
| Recording Frame Rate | 25fps/18fps/12fps/8fps selectable @ 1280x 960 Resolution |
| Signal | PAL |
| Connectors | RJ-45, 10BaseT/ 100BaseTX |
| Video S/N | ≥ 50 dB |
| Minimum Illumination @f/1.2 | 0.01 lux or better<br>0 Lux (IR On) |
| Night vision distance | Upto20m or more |
| Wide Dynamic Range | Yes |
| Shutter Speed | 1s ~ 1/100,000s sec or equivalent/better |
| Lens | 2.8 to 12mm |
| Iris control | Automatic |
| Audio Codec | G.711/G.726 |
| Audio Input | 1-ch audio interface |
| Audio Output | 1-ch interface |
| Day & Night | Automatically Removable IR-cut filter |
| 3D Noise Reduction | Yes |
| Firmware | Remote update |
| BLC & HLC | ON/OFF, Selectable |
| Anti-haze | Yes, Function should improve the whole image's visibility and clarity even in very foggy weather to capture the vehicle image clearly |
| User Defined codec | Camera shall have feature to configure areas of interest with better image quality under the same bit rate and streaming conditions compared to unimportant region in the image. |
| Electronic Image Stabilization | yes |
| Security | User authentication (username and password), IP address filtering, anonymous access |
| Settings | Features configurable through client software or |

| | |
|---|---|
| | web browser |
| Protocols | TCP/IP, ICMP, HTTP, HTTPS, FTP, DHCP, DNS, DDNS, RTP, RTSP, RTCP, PPPoE, NTP, UPnP,<br>SMTP, SNMP, IGMP, 802.1X, QoS, IPv6, Bonjour SIP, SRTP |
| Support NAS storage | Yes |
| Local Storage | Micro SD Card or USB slot, upto 64 GB |
| Alarm | Camera should trigger alarm in case of tampering, defocus, network disconnect, IP address conflict, storage exceptions. |
| Ethernet | (10Base / 100Base), PoE, RJ45 |
| RS 485 | Yes |
| PoE | IEEE 802.3af compliant |
| System Compatibility | ONVIF |
| Input voltage | 24 V AC, 12 VDC or PoE, IEEE 802.3 af |
| Operating Temp. | -10 °C ~ 60 °C or better |
| Environmental Housing | IP66 and Vandal Proof,IK10 standard |
| Certification | CE / FCC and UL |

2. NETWORK VEDIO RECORDER:

- 2 port HDMI/VGA output at up to 1220×960P resolution
- 64IP Channel Video Inputs with incoming bandwidth of minimum 256mbps.
- Support live view, storage and playback of video at 5.0 Megapixel resolutions.
- Realize instant playback for assigned channel during multi-channel display mode.
- Digital zoom in live view and playback mode.
- Up to 16-ch synchronous playback.
- Searching record files and captured pictures by events (alarm input/motion detection), searching and playing back by tags.
- HDD quota management; different capacity can be assigned to different channel.
- 2 port self-adaptive 10M/100M/1000M network interface。
- IPv6 is supported.
- TCP/IP protocol, PPPoE, DHCP, DNS, DDNS, NTP, SADP, SMTP, SNMP, NFS, and iSCSI are supported.
- H.264 video compression with high reliability and superior definition.
- Independent configuration for each channel, including resolution, frame rate, bit rate, image quality, etc.
- The video input/output quality is configurable.
- Each channel supports two kinds of compression parameters, the normal continuous and event, which can be configured locally.
- Encoding for both audio/video composite stream and video stream; audio and video synchronization during composite stream encoding.
- 1/4/6/8/9/16 screen live view is supported, and the display sequence of screens is adjustable.
- Live view screen can be switched in group, and manual switch and automatic cycle review is also provided, the interval of automatic cycle can be adjusted.
- Quick setting menu is provided for live view.
- The selected live view channel can be shielded.
- Motion detection, tamper-proof, video exception alert and video loss alert functions.
- 16 SATA hard disks interface and each disk is with a maximum of 4TB storage capacity with RAID supported
- 2 eSATA interfaces
- HDD group management with support HDD standby function.
- Cycle and non-cycle recording mode.

- Normal and event video encoding parameters.
- Multiple recording types: manual, continuous, alarm, motion, motion alarm, motion & alarm.
- 8 recording time periods with separated recording types.
- Pre-record and post-record for alarm, motion detection for recording or capture, and pre-record time for schedule and manual recording.
- Searching record files and captured pictures by events (alarm input/motion detection).
- Customization of tags, searching and playing back by tags.
- Searching and playing back record files by channel number, recording type, start time, end time, etc.
- Zooming in for any area when playback.
- Supports pause, play reversely, speed up, speed down, skip forward, and skip backward when playback, locating by dragging the mouse.
- Capture, continuous capture and picture playback.
- Export data by USB device
- Export video clips when playback.
- Management and maintenance of exporting devices.
- Configurable arming time of alarm input/output.
- Alarm for video loss, motion detection, tampering, abnormal signal, different input and output video standard, illegal login, network disconnected, IP confliction, abnormal record/capture, HDD error, and HDD full, etc.
- Alarm triggers full screen monitoring, audio alarm, notifying surveillance center, sending email and alarm output.
- Automatic restore when system is abnormal.
- Users can operate by front panel, mouse, and the remote control.
- Three-level user management; admin user can create many operating account and define their limits of authority, which includes the limit to access any channel.
- Completeness of operation, alarm, exceptions and log writing and searching.
- Manual Triggering and clearing alarms.
- 2 RJ-45 10 / 100 / 1000 Mbps self-adaptive Ethernet interfaces
- 3 x USB2.0
- 16 Alarm in, Alarm out 4
- Dual gigabit network interfaces and IPv6 is supported.
- Remote search, playback, download, locking and unlocking the record files, and downloading files broken transfer resume.
- Remote parameters setup; remote import/export of device parameters.
- Remote viewing of the device status, system logs and alarm status.
- Remote HDD formatting and program upgrading.
- Remote system restart and shutdown.
- RS-232, RS-485 transparent channel transmission.
- Alarm and exception information can be sent to the remote host
- Remotely start/stop recording.
- Remotely start/stop alarm output and Remote JPEG capture.
- Two-way voice talk and voice broadcasting.
- Embedded WEB server.

3. CENTRAL MONITORING SOFTWARE:

Client Software is video management software. It uses distributed structure to manage all devices. It includes monitoring, alarm, and record and device management. With different modules and their collocation, it can provide many solutions for different supervisory places, medium or small scale. It is a steady and reliable system with functions like real-time monitoring, video record and search, file backup, video wall. Etc.

It should have features of:

- Multiple window-division display modes, and multi-screen in full-screen display;
- Picture capture and real-time recording in preview mode;
- Digital Zoom;
- Manage by group;
- Multiple cycling preview;
- Dynamic adjustment of brightness, contrast, saturation and hue parameter;
- Manage files that are captured or recorded;
- Switch between preview and playback;
- Voice talk;
- Display status of supervisory place;
- Switch interfaces from preview to parameters configuration;
- Full-functional remote PTZ and lens control;
- 3D position;
- Set the position of preset and call preset;
- Flexible patrol and pattern;
- Graphically recording schedule configuration;
- Variety of recording type;
- Recording schedule template setting;
- Distributed PC NVR deployment and management;
- Pre-allocate hard disk for recording;
- Event record;
- Search files by channel, time and event;
- Fast forward play and single frame play;
- Locate with time line exactly;
- Multi-screen playback simultaneously(Only for event playback);
- Capture pictures when playback
- Download data when playback;
- Edit playback data when playback;
- Volume control during playback;
- Add, remove, modify device and parameters configuration;
- Add, remove, modify and configure servers;
- Support DVR/DVS/IPC/IP Dome/Decoder/NVR;
- Management detail to each channel;
- Search and display on-line device;
- Add device by domain name and USER management.

4. CABLE SPECIFICATIONS FOR CCTV SYSTEM

| | |
|---|---|
| Unshielded twisted pair cabling system, TIA / EIA 568-B.1 addendum Category 6 Cabling system | |
| Networks Supported | 10 / 100 Ethernet, 155 Mbps ATM, 1000 Mbps IEEE 802.3ab Ethernet, and proposed Cat 6 Gigabit Ethernet |
| Warranty | 25-year systems warranty; Warranty to cover Bandwidth of the specified and installed cabling system, and the installation costs |
| Performance characteristics to be provided along with bid | Attenuation, Pair-to-pair and PS NEXT, ELFEXT and PSELFEXT, Return Loss, ACR and PS ACR for 4-connector channel |

| Unshielded Twisted Pair, Category 6, TIA / EIA 568-B.2 | |
|---|---|
| Material: | |
| Conductors | 23 AWG solid bare copper or better |
| Insulation | Polyethylene |
| Jacket | Flame Retardant PVC |
| Pair Separator | Cross-member fluted Spline. |
| Approvals | UL Listed |
| | ETL verified to TIA / EIA Cat 6 |
| Operating temperature | -20 Deg. C to +60 Deg. C |
| Frequency tested up to | Minimum 600 MHz |
| Packing | Box of 305 meters |
| Delay Skew | 45ns MAX. |
| Impedance | 100 Ohms + / - 15 ohms, 1 to 600 MHz. |
| Performance characteristics to be provided along with bid | Attenuation, Pair-to-pair and PS NEXT, ELFEXT and PSELFEXT, Return Loss, ACR and PS ACR |

5. NETWORK SWITCH SPECIFICATIONS:

12 port POE+ switch

| S.No | Specifications | Compliance |
|---|---|---|
| - | - | |
| Access Switch (12-port POE+ gigabit switch) 12 Port 10/100/1000 Mbps (RJ45) POE+ Switch with Four 10G Slots | | |
| 1 | Architecture | |
| | Shall be 19" Rack Mountable. The switch shall be non-blocking in architecture and should be stackable | |
| | Switch should support internal field replaceable redundant power supplies and fan modules | |
| | 12 RJ-45 autosensing 10/100/1000 POE+ ports | |
| | The switch must have additional four 10-Gigabit ports (SFP+/XFP) | |
| | 1 RJ-45 serial console port | |
| | All Ports should work on POE+ simultaneously from day 1 | |
| | Shall have switching capacity of 200 Gbps for providing non-blocking performance on all Gigabit ports | |
| | Shall have up to 150 million pps switching throughput to achieve wire-speed forwarding on all Gigabit ports | |
| 2 | Resiliency | |
| | Shall support up to 84 Gbps stacking bandwidth (full duplex) per Switch in a resilient stacking configuration | |
| | Switch should have dedicated stacking ports | |
| | Shall support 802.3ad (LACP) with upto 8 ports supported in 32 groups | |

| | | |
|---|---|---|
| | Switch should have L2 multipathing using TRILL/VPC/SPB to provide resiliency without STP | |
| | IEEE 802.1D Spanning Tree Protocol, IEEE 802.1w Rapid Spanning Tree Protocol and IEEE 802.1s Multiple Spanning Tree Protocol , IEEE 802.3ad Link Aggregation Control Protocol (LACP) | |
| | Switch should support auto switch replacement in an existing stack with the new switch without any configuration for joining the stack without stack restart/reboot | |
| 3 | Layer 2 Features and Layer 3 (any additional licenses required shall be included) | |
| | Shall support up to 1,024 port or IEEE 802.1Q-based VLANs | |
| | Support for minimum 8k MAC addresses | |
| | Shall support marking, policing, and shaping with upto 8 queues / port | |
| | Static Routing, RIPv1/v2, OSPF, VRRP | |
| | Should support IGMP v1, v2 and v3; MLD and PIM Sparse Mode (PIM-SM) for multicast applications | |
| | Switch should also support IGMP v1/v2/v3 snooping & Proxy modes | |
| | Switch should support minimum 400 multicast groups | |
| | Should support for IPv6 features like Neighbor discovery, Syslog, Telnet, SSH, Web GUI, SNMP, NTP, DNS, RADIUS over IPv6, classification and marking and IPv6 routing | |
| | Should have mimimum 8 hardware based queues per port | |
| | Switch should support QoS configuration on per switch port basis. | |
| | Switch should support classification and marking based on IP Type of Service (TOS) and DSCP | |
| 4 | Security Features | |
| | Local proxy ARP, Static ARP, DHCP snooping, IP source guard | |
| | Should support AAA using RADIUS or TACACS+ | |
| | Unicast, multicast and broadcast storm control | |
| | Should support EAP MD5 and IEEE 802.1x based authentication | |
| 5 | Management Features | |
| | Configuration through the CLI, console, Telnet, SSH and Web Management | |
| | SNMPv1, v2, and v3 and Remote monitoring (RMON) support | |
| | Network Time Protocol (NTP) or equivalent support | |
| | Switch should support System & Event logging functions as well as forwarding of these logs to multiple syslog servers. | |

| | | |
|---|---|---|
| | Switch should support on-line software reconfiguration to implement changes without rebooting. Any changes in the configuration of switches related to Layer-2 & 3 functions, VLAN, STP, Security, QoS should not require rebooting of the switch. | |
| | Switch should support Multiple privilege levels to provide different levels of access. | |
| 5 | Environmental Features | |
| | Operating temperature of 0°C to 50°C | |

24 port POE+ switch

| S.No | Specifications | Compliance |
|---|---|---|
| - | - | |
| Access Switch (24-port POE+ gigabit switch) 24 Port 10/100/1000 Mbps (RJ45) POE+ Switch with Four 10G Slots | | |
| 1 | Architecture | |
| | Shall be 19" Rack Mountable. The switch shall be non-blocking in architecture and should be stackable | |
| | Switch should support internal field replaceable redundant power supplies and fan modules | |
| | 24 RJ-45 autosensing 10/100/1000 POE+ ports | |
| | The switch must have additional four 10-Gigabit ports (SFP+/XFP) | |
| | 1 RJ-45 serial console port | |
| | All Ports should work on POE+ simultaneously from day 1 | |
| | Shall have switching capacity of 200 Gbps for providing non-blocking performance on all Gigabit ports | |
| | Shall have up to 150 million pps switching throughput to achieve wire-speed forwarding on all Gigabit ports | |
| 2 | Resiliency | |
| | Shall support up to 84 Gbps stacking bandwidth (full duplex) per Switch in a resilient stacking configuration | |
| | Switch should have dedicated stacking ports | |
| | Shall support 802.3ad (LACP) with upto 8 ports supported in 32 groups | |
| | Switch should have L2 multipathing using TRILL/VPC/SPB to provide resiliency without STP | |
| | IEEE 802.1D Spanning Tree Protocol, IEEE 802.1w Rapid Spanning Tree Protocol and IEEE 802.1s Multiple Spanning Tree Protocol , IEEE 802.3ad Link Aggregation Control Protocol (LACP) | |
| | Switch should support auto switch replacement in an existing stack with the new switch without any configuration for joining the stack without stack restart/reboot | |

| | | |
|---|---|---|
| 3 | Layer 2 Features and Layer 3 (any additional licenses required shall be included) | |
| | Shall support up to 1,024 port or IEEE 802.1Q-based VLANs | |
| | Support for minimum 8k MAC addresses | |
| | Shall support marking, policing, and shaping with upto 8 queues / port | |
| | Static Routing, RIPv1/v2, OSPF, VRRP | |
| | Should support IGMP v1, v2 and v3; MLD and PIM Sparse Mode (PIM-SM) for multicast applications | |
| | Switch should also support IGMP v1/v2/v3 snooping & Proxy modes | |
| | Switch should support minimum 400 multicast groups | |
| | Should support for IPv6 features like Neighbor discovery, Syslog, Telnet, SSH, Web GUI, SNMP, NTP, DNS, RADIUS over IPv6, classification and marking and IPv6 routing | |
| | Should have mimimum 8 hardware based queues per port | |
| | Switch should support QoS configuration on per switch port basis. | |
| | Switch should support classification and marking based on IP Type of Service (TOS) and DSCP | |
| 4 | Security Features | |
| | Local proxy ARP, Static ARP, DHCP snooping, IP source guard | |
| | Should support AAA using RADIUS or TACACS+ | |
| | Unicast, multicast and broadcast storm control | |
| | Should support EAP MD5 and IEEE 802.1x based authentication | |
| 5 | Management Features | |
| | Configuration through the CLI, console, Telnet, SSH and Web Management | |
| | SNMPv1, v2, and v3 and Remote monitoring (RMON) support | |
| | Network Time Protocol (NTP) or equivalent support | |
| | Switch should support System & Event logging functions as well as forwarding of these logs to multiple syslog servers. | |
| | Switch should support on-line software reconfiguration to implement changes without rebooting. Any changes in the configuration of switches related to Layer-2 & 3 functions, VLAN, STP, Security, QoS should not require rebooting of the switch. | |
| | Switch should support Multiple privilege levels to provide different levels of access. | |
| 5 | Environmental Features | |
| | Operating temperature of 0°C to 50°C | |

48 port POE+ switch

| S.No | Specifications | Compliance |
|---|---|---|
| - | - | |
| Access Switch (48-port gigabit switch) 48 Port 10/100/1000 Mbps (RJ45) Switch with Four 10G Slots | | |
| 1 | Architecture | |
| | Shall be 19" Rack Mountable . The switch shall be non-blocking in architecture and should be stackable | |
| | Switch should support internal field replaceable redundant power supplies and fan modules | |
| | 48 RJ-45 autosensing 10/100/1000 POE+ ports | |
| | The switch must have additional four 10-Gigabit ports (SFP+/XFP) | |
| | 1 RJ-45 serial console port | |
| | All Ports should work on POE+ simultaneously from day 1 | |
| | Shall have switching capacity of 250 Gbps for providing non-blocking performance on all Gigabit ports | |
| | Shall have up to 184 million pps switching throughput to achieve wire-speed forwarding on all Gigabit ports | |
| 2 | Resiliency | |
| | Shall support up to 84 Gbps stacking bandwidth (full duplex) per Switch in a resilient stacking configuration | |
| | Switch should have dedicated stacking ports | |
| | Shall support 802.3ad (LACP) with upto 8 ports supported in 32 groups | |
| | Switch should have L2 multipathing using TRILL/VPC/SPB to provide resiliency without STP | |
| | IEEE 802.1D Spanning Tree Protocol, IEEE 802.1w Rapid Spanning Tree Protocol and IEEE 802.1s Multiple Spanning Tree Protocol , IEEE 802.3ad Link Aggregation Control Protocol (LACP) | |
| | Switch should support auto switch replacement in an existing stack with the new switch without any configuration for joining the stack without stack restart/reboot | |
| 3 | Layer 2 Features and Layer 3 (any additional licenses required shall be included) | |
| | Shall support up to 1,024 port or IEEE 802.1Q-based VLANs | |
| | Support for minimum 8k MAC addresses | |
| | Shall support marking, policing, and shaping with upto 8 queues / port | |
| | Static Routing, RIPv1/v2, OSPF, VRRP | |
| | Should support IGMP v1, v2 and v3; MLD and PIM Sparse Mode (PIM-SM) for multicast applications | |
| | Switch should also support IGMP v1/v2/v3 snooping & Proxy modes | |
| | Switch should support minimum 400 multicast groups | |

| | | |
|---|---|---|
| | Should support for IPv6 features like Neighbor discovery, Syslog, Telnet, SSH, Web GUI, SNMP, NTP, DNS, RADIUS over IPv6, classification and marking and IPv6 routing | |
| | Should have mimimum 8 hardware based queues per port | |
| | Switch should support QoS configuration on per switch port basis. | |
| | Switch should support classification and marking based on IP Type of Service (TOS) and DSCP | |
| 4 | Security Features | |
| | Local proxy ARP, Static ARP, DHCP snooping, IP source guard | |
| | Should support AAA using RADIUS or TACACS+ | |
| | Unicast, multicast and broadcast storm control | |
| | Should support EAP MD5 and IEEE 802.1x based authentication | |
| 5 | Management Features | |
| | Configuration through the CLI, console, Telnet, SSH and Web Management | |
| | SNMPv1, v2, and v3 and Remote monitoring (RMON) support | |
| | Network Time Protocol (NTP) or equivalent support | |
| | Switch should support System & Event logging functions as well as forwarding of these logs to multiple syslog servers. | |
| | Switch should support on-line software reconfiguration to implement changes without rebooting. Any changes in the configuration of switches related to Layer-2 & 3 functions, VLAN, STP, Security, QoS should not require rebooting of the switch. | |
| | Switch should support Multiple privilege levels to provide different levels of access. | |
| 5 | Environmental Features | |
| | Operating temperature of 0°C to 50°C | |

6. Training
   - Train the clients to know the system structure and principles.
   - Train the clients to know and master the installation methods of the CCTV systems.
   - Train the clients to master the configuration methods of the CCTV systems.
   - Train the clients to use CCTV systems software.
   - Train the clients to know basic troubleshooting and maintenance methods of the CCTV systems.

## 11.16 ACCESS CONTROL SYSTEM

Specification for Access Control System

1 GENERAL

1.1 Scope of Work

The following scope of work is to be included in this contract and does not necessarily include every item of work. The Contractor shall supply and install items that meet the specified requirements of the final order. The Access Control System (ACS) Workstations shall be furnished complete, installed, tested, and operational. The ACS is designed to secure the designated CLIENT corporate office.

1.2 Scope of System

A. Basic System Characteristics

Any alternate system shall comply with all of the capabilities of the specified system and be pre-approved by the specifying engineer. Contractors who propose alternative systems without prior approval may be required to provide a solution that meets these capabilities at no additional costs to the owner.

The intent for the ACS system is to provide the CLIENT with a GUI that provides a single seat of control for multiple 3rd party low voltage systems.

Though it is possible for the above systems to be integrated through the use of relay logic it is the intent of this project and specification to provide a software level integration between these systems. The software integration shall provide the client the ability to not only share alarmed information with the ACS GUI but also provide a means of controlling and configuring the 3rd party applications from the ACS GUI.

- The ACS shall provide an integrated solution through the use of a PC workstation-based software for Access Control and Security/Intrusion Detection. The ACS shall include the ability of providing an integrated solution through the same PC workstation-based software for those items listed above in section “1.2 - A.” Independent systems are not acceptable.
- This ACS shall provide a true multi-tasking, multi-workstation client-server architecture based on PC-based client platforms running Microsoft’s Windows 7 Pro Workstation operating system and PC-based server(s) running Microsoft Windows 2014 SQL Server and relational database management system. The same SQL database that is used to store card information shall be used to store biometric information about the card holder.
- The ACS client-server architecture shall communicate with native TCP/IP Security Access Controllers (SAC) over Ethernet TCP/IP enterprise network.
- Card information shall be stored in the Security Access Controller (SAC) and shall not depend on a Server to perform the card access functions. Each SAC shall be capable of storing 40,000 card holders.
- The ACS shall be capable of controlling a up to100,000 doors, 5000 expandable up to 2,50,000 card holders
- The ACS system shall be a modular system which facilitates software upgrades to increase overall system capacity when and as required.

1.3 Referenced and System Certifications

A. Design and operation of the ACS shall conform to the following referenced codes, regulations, and standards as applicable:
   1. UL/ CE
   2. ROHS

1.4 Systems Description & Capabilities

A. Primary Function

The ACS’s primary functions shall be to regulate access through specific doors and/or gates to secured areas of the CLIENT’s site and facility and to provide digital DVMS recording capability to view live and recorded video that is associated with alarm events. The ACS shall utilize a single server for its access control. Integration shall be provided using one operating environment.

The software architecture shall be object-oriented in design, a true 32-bit application suite utilizing Microsoft's ActiveX, COM, DCOM and .NET technologies.

The alarm monitoring and display workstation shall be able to monitor field hardware devices, such as card readers, controllers, and I/O modules. Administrative tasks, such as assigning security areas, schedules, report generation, displaying color graphic maps, etc., shall be provided from any ACS workstation on the network.

The ACS shall utilize a commercially available, Open Database

Connectivity-compliant (ODBC), SQL open architecture relational database with flexible design allowing the integration into other data structures. This database shall handle the storage and retrieval of all card holder records information, biometric information, images, system maps, reports, and screen designs. The database shall operate in a truly multitasking environment without degradation of system operation and be of a design that will handle the transaction loading placed on the system. The relational database shall support online backup, database redundancy, stored procedures with control logic, and server-based referential integrity.
The ACS shall allow for SNMP trap and port monitoring by IT software.
The ACS shall have Muster reporting and alarm tracking capability.

B. System Design

The ACS shall be designed to perform a wide variety of features and functions. These system functions should be categorized into four primary "system components" which shall include:

I. Access Control -

The ACS's primary purpose shall be to provide access control. The system shall be able to make access granted or denied decisions, define access privileges, and to set schedules and holiday groups. And through the use of application programming these inputs and outputs shall be capable of being linked at all field controllers for purposes of implementing system-wide control strategies. The system shall support features such as area control, anti-pass back, threat level conditioning, dial-up field hardware communications, extended shunt time, and multiple-man rule. The SAC shall be capable of executing all these functions in a stand alone condition, not connected to the network or PC workstations.

II. Alarm Management

The ACS shall be used for alarm monitoring. A color graphic application shall allow a user to create or import customized color graphic maps of their facility and to attach alarm icons to those maps. Alarms are to be prioritized. A status window shall provide information about the specific alarm including date and time and location of the alarm. The ACS shall allow unique emergency instructions to be specified for each type of alarm. Output control operations shall be available to lock, unlock, or pulse control points or groups of points as a standard feature. A user shall be able to log comments associated with the alarm and this shall be stored in the database for future review. An image comparison feature shall be provided for use in conjunction with a DVMS technology interface. The ACS shall allow up to four DVMS cameras connected to the digital video recorder workstation(s) to be associated with any alarm device, physical or virtual. Upon activation of an alarm the ACS shall automatically permit an authorized user to query the pre- and post-video that was recorded and associated with the alarm from any of the associated camera(s).

III. Card Holder Management and Enrollment

The ACS shall include an employee management system integrated with the access control system. This employee management functionality shall allow the enrollment of card holders into the database, capturing of images, and import/export employee data. The importing function shall support .csv interface to facilitate integration with Windows Active Directory. This functionality shall also allow the user to assign or modify access privileges of a cardholder, assign elevator access, capture ID Badging information, and capture Biometric information.

The ACS shall include a state-of-the-art credential creation and production system integrated with the cardholder management system. This shall allow the creation of different badge types based on database fields and the use of security colors to allow security officers to quickly identify personnel access authority by the badge design.

IV. System Administration

System Administrative tasks such as defining workstation and user permissions, area access, schedules; generation of reports; displaying and interacting with facility/site maps; etc. shall be available at any ACS workstation on the network. System backup and remote diagnostics shall occur at the designated file server that provides the required hardware.

Additionally the ACS System Administrative functions shall allow an operator to monitor, control, and configure those items listed in section 1.2.A from the ACS GUI.

2.0 PRODUCT

2.1 Operational Requirements

A. The design of the ACS shall include devices and equipment used to monitor and control access to restricted areas, detect and deny unauthorized entries within specific buildings or areas, annunciate alarms and generate reports. The ACS shall also provide Video Management System integration and allow easy retrieval of recorded video and viewing of live video along with other 3rd party low voltage system integrations. Once incorporated with the day-to-day operations of the designated facility, the ACS shall detect and deter unauthorized entry into restricted areas and permit integrated VMS survClientlance to permit viewing of recorded video associated with alarm events. The ACS is to be designed and configured to provide operational flexibility and reliable performance.

B. Functional Responsibilities

CLIENT shall have the responsibility for managing and operating the system. It shall be the responsibility of the CLIENT to enroll all personnel and capture the associated images.

It shall be the responsibility of the ACS contractor to install, configure, program, and train the CLIENT on the ACS system, day-to-day operation of the ACS System to the Client's satisfaction.

C. Operational Concept

The ACS shall consist of equipment and devices placed at predetermined locations as depicted on the drawings to ensure that only cardholders who are authorized to enter secured areas through certain doors or gates can do so. This shall be accomplished by means of a computer and electronic devices used in conjunction with door locks, gate systems, card readers.

2.2 ACS Features

A. All ACS applications shall be easy, quick and efficient to use. The system shall combine keyboard and mouse operations with graphical presentations of onscreen information. The Workstation GUI shall have Icon based menus. These Icon based menus shall be based on job function of operator (Guard, Administrator, Data Administrator). Each application is to provide consistent user interfaces across all operations of the system. Standard terminology, practical methods of generating help options, and menus are also required. All routine information displayed and requiring input shall be in English language prose. No operation shall require the interpretation of machine code or the use of mnemonics.

B. Access Control

1. Access Privileges

All cardholders shall have facility access based on privileges assigned by controlled area, time and date. For example, some badges shall only allow access to the facility on weekdays between 8:00 a.m. and 5:00 p.m., while others allow access on weekends between 1 p.m. to 5 p.m. and so on. These time zones for each day are to be pre-defined by CLIENT and shall be able to be modified quickly by authorized employees without vendor intervention. There shall be an unlimited number of user-definable access privileges. Access privileges for Biometric Enrollment and Elevator Access/Floor Access shall be accomplished through the same GUI.

2. Holidays

The Holidays application shall allow the System Administrator to create holiday schedules that designate individual days as holidays, or special days to cover vacations, maintenance shutdowns, or other events, indefinitely into the future. Holidays or special days can signal that the

system shall operate on a schedule different from the normal. Holiday schedules shall be capable of overriding normal schedules. Software should be able to define at least 180 holidays or configurable as per user requirements.

3. Time/Date

The time and date of the system shall be set by the operating system of the client workstation. Dates for Daylight Savings Time shall automatically take effect.

4. Global Data Exchange and Operating Strategies

The ACS shall provide global data exchange and operating strategies. The system shall allow any input point configured in the system (i.e., door, tamper, duress, etc.) to permit activation of any control output point such as a relay(s) that opens a door and/or sounds an alarm. The logic shall be developed using an application programming language that shall be capable of incorporating other parameters such as date and time; it shall not be limited by a fixed numbers of rules, or the simple linking of inputs to outputs. The global operating strategies feature shall provide the ability to drive any system output or outputs from single or multiple inputs, access events, alarms, etc.

Each output point shall be controllable by the system and be configurable individually for the following responses:

A. Output relays (and groups) shall be capable of responding to:

- Input alarms from any I/O module or card reader point in the system, or any combination thereof .
- Access events.
- Date and time parameters.
- Commands from a user.

B. Output relays (and groups) shall be capable of:

- Pulsing for a predetermined duration; duration shall be programmable for each relay individually.
- “Following” any input point from any I/O module, or card reader input in the system (on with alarm, off when clear, or as required).
- Locking On with alarm, requiring user intervention to reset the output relay.
- The system shall permit output relays to be ordered on, off, pulsed or reset back to a default setting.

C. Shunt Time

A Shunt Time feature shall be provided to allow users to program, at the door level, a length of time to hold a door open without creating an alarm condition at the monitoring workstation. The shunt time feature shall be usable by any cardholder with an active badge and appropriate access rights. Valid open times shall range from 0-255 seconds. If the door fails to close prior to the expiration of the shunt period, a “door held open” alarm shall occur at the system’s monitoring workstation. If the door is closed prior to the expiration of the shunt period, the door position switch shall become active immediately, allowing a “door forced open” alarm to be annunciated in the event of an intrusion.

D. Area Control

The ACS shall provide seven area control features: hard anti-passback, soft anti-passback, timed anti-passback, multiple-man rule, occupancy limit, Area Lockdown and Condition level access, executive privileges, and threat level conditioning. Area control shall be a security method of preventing a person from passing their badge to another person for dual entry into a location utilizing one card.

1. Hard Anti-passback

The hard Anti-passback feature shall require that a badge always be used to enter and exit an area. The controlled areas shall have both entry and exit readers at all portals. Areas shall be logically defined under the ACS, and area control shall not be required at all areas of CLIENT facility to be utilized. The system shall allow supervisors whose cards are configured “VIP” to be exempt from this feature as configured by the System Administrator.

2. Soft Anti-pass back

The soft anti-pass back feature shall require that a badge be used to enter and exit an area, but access shall not be denied if the badge was not presented in the correct order. The system shall automatically generate an anti-pass back violation event and can be trigger an alarm to be generated. The controlled areas shall have both entry and exit readers at all portals. When a card holder uses a card reader for entrance, and has not swiped out, an anti-pass back alarm shall notify the user. Areas shall be logically defined under the ACS, and area control shall not be required at all areas of CLIENT facility to be utilized. The system shall allow supervisors whose cards are configured "VIP" to be exempt from this feature as configured by the System Administrator.

3. Timed Anti-pass back
   This anti-passback feature shall allow the System Administrator to decide how long after a card holder has swiped will they have to wait before the same card will be accepted again at the same reader or globally at any other reader defined in the Area.

4. Multiple-man Rule
   Multiple-man rule shall be provided through application programming to restrict access to certain areas unless there is more than one card holder present. Individual exit shall be permitted until the required number of people to originally gain access is reached, at which point the Multiple-Man Rule applies for exiting.

5. Occupancy Limit
   Occupancy limit shall restrict the number of card holders that will be present in an area at any given time. The occupancy limit shall be able to be defined by the System Administrator for each controlled area. Each area for which occupancy limit is enabled shall be definable at all controlled areas equipped with entry and exit card readers.

6. Area Lockdown
   Area Lockdown shall allow securing of an Area based on any of the following: User entry via a graphic, automatically triggered based on an alarm or based on a status change of any input to the system. A card holder can be given a special privilege that will allow access during a lockdown condition

   Threat Level Conditioning

   Threat Level Conditioning shall be available to the CLIENT that allows an operator to manually increase or decrease the security of a site or system based upon their own internal parameters similar to the Threat Level Conditioning used by the Dept. of Homeland Security. An operator shall be able to increase or decrease the security level form one place and have the information broadcasted across the entire system. The changing of security parameters shall provide the ability to require additional access credentials such as PIN and/or Biometric information in addition to traditional access card information.

E. Manual Control

A user shall have the ability to easily dictate manual control of all output points connected to the system via color graphic maps. Control points are defined as any door strike or any other relay output point of an I/O module. The System Administrator shall have the option to group these outputs to simplify common output command procedures. All system outputs shall be displayed upon command in a list window or graphic map. The list and commands shall be operational without interfering with alarm monitoring operations. If an output is ordered to a setting, and is also on time zone control, the last command shall always override. All manual control commands shall record into the activity log for viewing by any user given proper privileges to do so. Manual control for doors, or any relay output, shall allow the user to disable the door/output (to not accept any cards), unlock the door/output (leaving the door strike unlocked), pulse the door/output open, or reset the door/output to a pre-defined default setting.

F. Arm/Disarm

The user shall have the ability to determine the current status (armed or disarmed) as well as the current state (alarm/normal/fault) of an input point from an input list view at any time. The user shall have a "Status" item in the list view. Both the current status and state shall be reflected by the color of the respective columns in the list view. Arm-Disarm shall be accomplished by a user through a

simple click of the mouse on the individual point, a key switch input or automatically via a schedule. Once a user arms an input point, events from the respective area permit the display of alarms at an alarm monitoring workstation from that point forward. All input points shall be grouped for ease of operation into arm-disarm groups.

The arm/disarm functionality shall exist if the I/O points are connected to the Access Control System or the IDS system. If connected to the IDS system each I/O point shall be also configured into the ACS system GUI.

G. Alarm Management

1. General

The software shall be capable of accepting alarms directly from controllers, or generating alarms based on polling of data in controllers and comparing to limits or conditional equations configured through the software. Any alarm (regardless of its origination) shall be integrated into the overall alarm management system and shall appear in all standard alarm reports, be available for user acknowledgment, and have the option for displaying graphics, or reports. Alarm management features shall include:

- Minimum of 255-alarm notification levels. Each notification level shall establish a unique set of parameters for controlling alarm display, acknowledgment, keyboard annunciation, alarm printout, and record keeping.
- Automatic logging in the database of the alarm message, point name, point value, connected controller, timestamp, username, time of acknowledgement, and time of alarm silence (soft acknowledgement).
- Automatic printing of the alarm information or alarm report to an alarm printer or report printer.
- Sounding of an audible beep or playing an audio (.wav) file on alarm initiation or return to normal.
- Sending an e-mail and/or alphanumeric page to anyone listed in a workstation's e-mail account address list on either the initial occurrence of an alarm and/or if the alarm is repeated because a user has not acknowledged the alarm within a user-configurable timeframe. The ability to utilize e-mail and alphanumeric paging of alarms shall be a standard feature of the software integrated with the operating system's mail application interface (MAPI). No special software interfaces shall be required.
- Sending a text message to an alphanumeric pager compliant with the TAPI protocol.
- Individual alarms shall be able to be re-routed to a workstation or workstations at user-specified times and dates. For example, an invalid card read alarm can be configured to be routed to a system administrator workstation during normal working hours (7 a.m.-6 p.m., Mon-Fri) and to a Central Alarming workstation at all other times.
- An active alarm viewer shall be included which can be customized for each user or user type to hide or display any alarm attributes. As a minimum, the alarm viewer shall display:

    1. Date and time of alarm
    2. Name of alarm
    3. Priority of alarm
    4. Type of alarm
    5. Alarm message
    6. User text input
    7. User action drop-down list
    8. Acknowledged by
    9. Date and time of acknowledge
    10. Silenced by
    11. Date and time of silence

- The font type and color, and background color for each alarm notification level as seen in the active alarm viewer shall be customizable to allow easy identification of certain alarm types or alarm states.

- The active alarm viewer shall be configured for critical alarms such that a user is required to type in text in an alarm entry field and/or pick from the user action drop-down list. This ensures accountability (audit trail) for the response to critical alarms.
- The user shall have the ability to Soft Acknowledge (i.e., Silence) or Acknowledge the alarm. Each of these actions shall be logged and date/time stamped.
- Each alarm shall be configured to be acknowledged under the following:
    1. Acknowledge all of the same alarm type.
    2. Acknowledge all of the same alarm types until a specified time.
    3. Acknowledge only highlighted alarm.

- The user shall have the ability to configure how alarms are removed from the active alarm view based on:

    1. Acknowledged
    2. Returned to normal
    3. Acknowledged or returned to normal
    4. Acknowledged and returned to normal
    5. Acknowledged after returned to normal

- The user shall have the ability to highlight a specific alarm and select a button to display an associated graphic map, or select a button to display an associated report.
- Each alarm event shall be configured as either Single Entry or Multi-entry. Alarm events that occur for the same point going into and out of the active alarm state may be designated as Single Entry and displayed in the active alarm view once only. Each time the alarm occurs, the time/date stamp of the single entry shall update in the active alarm view. In addition, each individual alarm event shall be logged into history with all respective times of occurrence. Alarm events designated as Multi-entry shall be shown in the active alarm view and in the alarm history log for each occurrence.

p. When an alarm is acknowledged, the system shall request a User Name, Password and Operator text description to be entered.

q. Other alarms shall be displayed by the system while any alarm is being addressed. If another alarm occurs, the alarm pending counter shall increase by one, the new alarm shall enter into the alarm list box prioritized in an order as defined by the System Administrator.

r. The ACS shall allow journals to be retrieved, viewed, and edited on screen. Journals shall be saved to tape during tape backups for a permanent record as required by CLIENT regulations.

2. Current Status Indication

The active alarm view shall provide a status indicator that displays the current status of alarms and field controllers. Selecting the graphic icon shall provide the user with a detailed list of the groups of devices offering a dynamic list view of the current status of the respective points.

3. Card Holder Record Call-up

The user shall be able to initiate the call-up of a cardholder record. This feature shall be provided at all Alarm and Display Monitoring Workstations to assist the user in determining access rights for an employee who may have forgotten their badge. Utilizing a database search via the input of the cardholder's name, or other key search fields, the ACS shall access the employee's personnel file, containing pertinent information and the employee's image for identification by the user. This operation shall not restrict the operation of monitoring alarms.

4. VMS Video Integration

Activation of an alarm point, physical or virtual, shall automatically spawn the alarm video window to allow an authorized user to view the live video associated with the alarm area, as well as the pre- and post-video that had been recorded and associated with the alarm. Up to

four cameras may be associated with each alarm point. A user shall also be able to query past video using date/time parameters and alarm device names.

6. Automatic User Logoff

The system shall automatically log the user out of the application after a specified period of inactivity. The user shall have to log back into the system to handle an alarm. This feature shall be configurable on a user by user basis by the system administrator.

7. Scheduling

Time of day schedules shall be in a calendar style and shall be programmable up to 10 years in advance. Each standard day of the week and user-defined day types shall be able to be associated with a color so that when the schedule is viewed it is very easy, at-a-glance, to determine the schedule for a particular day even from the yearly view. To change the schedule for a particular day, a user shall simply click on the day and then click on the day type. Each schedule shall appear on the screen viewable as an entire year, month, week, and day. A simple mouse click shall allow switching between views. It shall also be possible to scroll from one month to the next and view or alter any of the schedule times. Schedules shall be assigned to specific controllers and stored in their local RAM memory. Any changes made at a workstation shall be automatically updated to the corresponding schedule in the controller. Schedules shall be downloaded to the respective controller on a weekly basis.

H. Card Holder Management and Enrollment

The ACS shall incorporate into a single, integrated system the latest in imaging technology and identification management. The ACS shall generate and store up to four million personnel records, and monitor badge/credential use throughout the facility. These credentials shall be based on data and images that are input and captured at the time of enrollment and fabricated at any of the ACS photo imaging workstations. Credential images are to be digitized using industry standard JPEG image compression, and printed using a dye-sublimation/resin thermal transfer printing process that is high quality and environmentally safe. Additionally the ACS system shall capture and store individual card holder biometric information within a single SQL database along with the individual card holder information. The biometric information shall be associated with an individual card holder even if the CLIENT elects to deploy standard Proximity Card readers and cards.

I. Create and Maintain Personnel Database

The user shall be able to create personnel records either through the use of templates (as described in System Administration section), or direct input into the personnel record. Each personnel record shall allow for easy navigation through the fields using either the “tab” key or a mouse. The user shall have the ability from the personnel record to easily:

- Enable or disable the cards.
- Define expiration date.
- Define the acceptable card type.
- Define the card number, site code and PIN.
- Mark the card as lost.
- Issue temporary or restore permanent card.
- Display the employee photo image and/or signature.
- Capture individual card holder biometric information
- Have the ability create or edit the image.
- Create, edit, or delete the cardholder’s access privileges and additional personnel attributes.

J. The selection of card type shall be chosen from a drop-down list

that shall include ABA formats, Wigand formats, and custom Wigand format to allow use of a CLIENT’s existing cards that may be of a format not standard within the ACS. The expiration date shall be determined by date and time of day carried out to the nearest second. The user shall be able to mark the card as lost by selecting that control button. This shall disable the card and create a stored record with the associated card number and cardholder. A new record shall automatically be created allowing the user to only have to add the new card number. In the event an attempted use of the card occurs, an invalid card event shall be logged and an associated alarm can be

generated to an operator workstation. The user shall be able to issue a temporary card by selecting that control button. This action shall temporarily store the existing card number and allow the user to then simply enter into the record the temporary card number. Upon return of the temporary card, the user shall select the reissue permanent card control button, which shall automatically restore the original card number.

K. Assigning Access Privileges

After a badge is created it shall be possible to assign access privileges to the personnel record. For convenience, the System Administrator shall be able to define default templates for given personnel types. If a user has proper authorization, access privileges can be overwritten. When an individual's access privileges are modified, that change shall automatically be propagated to all required controllers immediately upon completion of the change. Record changes of access privileges shall affect only the modified record, and shall not require a download of the entire cardholder database. Using personnel record configuration templates, the ACS System Administrator shall be capable of attaching previously defined privileges attached to the templates to new personnel requiring similar privileges. It shall be possible for the System Administrator to individually access the newly created personnel record to modify the privileges in the event the person does not exactly comply with the template.

L. Badge Creation

a. Image Capture

Each ACS photo imaging workstation shall include all equipment required to capture a high quality portrait image, with flash lighting and a high quality RGB digital video camera. The photo imaging workstation shall allow the camera user to view a live video image of the subject on the screen. The user shall view the subject in an upright position as they are captured. While capturing subjects, the user shall have the option of capturing a new image of any subject without affecting the subject's record. The photo imaging workstation shall provide a digitizer color control window in order to adjust the contrast and brightness of images. For convenience, default settings shall be provided. The system shall provide the ability to move via mouse a "capture window" over any portion of the live image displayed on the monitor and store only the image information within the outline of the window. The ACS shall include the ability, upon command, to preview, online and in full color, the badge as it will appear when printed. This preview mode shall require less than 10 seconds to create a complete example of the badge online. ACS image capture, storage, and hardware compression techniques shall be in compliance with the ANSI X3L2.8 standard or JPEG.

b. Pre-defined Badge Formats

The badge format, including background color, layout, location of photo image, applicable graphics or company logos, text, etc., shall be completely and automatically determined by the system based on employee record information. Where choices are available to the user, choices are to be made via pre-defined list boxes to avoid user errors in spelling and badge assignment errors.

c. Multiple Badge Formats/Badge Layout Services

The successful vendor shall provide services for creating badge layouts based on this specification. A single badge layout shall be provided with the system. Additional badge layouts and logos shall be available through the vendor if required. The screen design and database configuration shall be done in conjunction with the badge layout design.

d. Security Color Levels

The ACS shall be able to print badges with varying, user-defined security color levels created from the entire RGB spectrum. For example, a blue background badge may designate SECURITY, an orange background badge may designate EMPLOYEE, a red background badge may designate VENDOR, and a green background badge may designate ESCORT REQUIRED.

e. Search Records

The ACS shall allow the user to search for records and images using search criteria on any field(s) in the database. The user shall be able to enter the search criteria for one or a combination of fields

2.3 System Administration

A. General

The workstation software shall use a familiar Windows Explorer-style interface for a user or programmer to view and/or edit any object (controller, point, alarm, report, schedule, etc.) in the entire system. In addition, this interface shall present a "network map" of all controllers and their associated points, programs, graphics, alarms, and reports in an easy-to-understand structure. The configuration interface shall also include support for template objects. These template objects shall be used as building blocks for the creation of the ACS database. The types of template objects supported shall include all data point types (input, output, string variables, etc.), personnel records, doors, alarm algorithms, alarm notification objects, reports, graphics displays, schedules, and programs. Groups of template object types shall be able to be set up as template subsystems and systems. The template system shall prompt for data entry if necessary. The template system shall maintain a link to all "child" objects created by each template. If a user wishes to make a change to a template object, the software shall ask the user if he/she wants to update all of child objects with the change. This template system shall facilitate configuration and programming consistency and afford the user a fast and simple method to make global changes to the ACS. All object names shall be alphanumeric and use Windows-type long filename conventions. The ACS shall allow all objects (door, personnel record, alarm, etc.) to be created with a unique 64-character name to provide the user with a fully descriptive object identifier. The system shall automatically create up to a 16-character alias from the object name to simplify the object's use in reports, applications programs, and alarms, for example.

B. Workstation and Password Privileges

The software shall be designed so that each user of the software can have a unique username and password. This username/password combination shall be linked to a set of capabilities within the software, set by, and only editable by, a system administrator. These sets of capabilities shall range from view only, acknowledge alarms, enable/disable, change values, program, and administrate. The system shall allow the above capabilities to be applied independently to each class of object. The system shall allow an unlimited number of users to be configured per workstation. The ACS shall allow the system administrator to configure each workstation with those functions that may be performed at that workstation. Individual user passwords shall also further restrict user functions and shall be specific to each user. Specific user restrictions shall include:

- Access to screens or functions (e.g., alarm monitoring, badge issue)
- Specific tasks allowed (e.g., modify data, view only)
- Alarm monitoring functions (e.g., clear alarms, output control,traces, reports, arm-disarm)

If a user is denied access to specific functions, those functions shall dimmed on the user's workstations or the status bar shall indicate "access denied" while that user password is logged in. A User shall be able to change their own password at any time. Passwords shall automatically expire after a user defined period as set by the System Administrator. A minimum password length shall be settable by the administrator to be between 1 and 16 characters. The ACS shall support individual password restrictions for each user. The ACS shall offer the option of using a Windows user account to access the system.

C. Create and Maintain Reader/Door Objects

Reader/Door objects shall be created either through the use of templates (as described in section 2.2.4.1) or by direct input by the user. The Reader/door object editor shall be organized with tabs for easy navigation through the attribute fields. From the Reader/Door record the user shall be able to:

Document a description of the door

1. View and/or change the door's current state from unlocked to locked and vice-versa
2. View the state of the door switch
3. Enable or disable the door state
4. Specify up to four acceptable site codes
5. Designate a general PIN
6. Choose between Wiegand or ABA card type and select the appropriate bit format
7. Associate door hardware wiring to the appropriate input/output channels
8. Attach specific door unlock and door lock schedules
9. Define anti-pass back rules
10. Define readers and attach associated controlled areas
11. View a list of the last 25 events associated with the door

D. User Activity Logging

The ACS shall provide full user activity tracking. The activity log shall be comprehensive, recording the date and time of the activity, the workstation where the activity was performed, and the user that performed the activity. The ACS shall record changes to the database made by any user. Users shall be prompted to enter a user name, password, and explanatory text before any change or command is made to the system. Changes shall include point control changes, point edits, commands from a graphic panel, schedule changes, etc. This additional information is saved in the activity log for future reporting. Users shall be able to maintain their own passwords and the system shall automatically prompt the user to change their password on periodic basis. ACS shall log over 200 separate functions, including:

1. User log-in and user log-out.
2. Additions, changes, and deletions to cardholder management.
3. Temporary pass add and delete.
4. Other critical database functions.

ACS shall log changes made to the access control configurations:

1. Changes to access privileges.
2. Holidays.
3. Time zone changes.
4. Other critical items.

ACS shall log all activity including alarms, alarms acknowledged, cleared, output control activity, trace, and other functions. The ACS shall log a minimum of 1,000,000 events before the system history overwrites the oldest data. The ACS shall provide a user activity report to query this information available in the ACS activity log. The report shall be sorted by workstation, user, date and time, or other selection criteria. On those occasions when historical data shall be needed, the user activity report shall be generated from an archived log as well as from the active ACS database.

E. Screen Format Design

The ACS shall allow a System Administrator to customize the employee record containing employee data. Additional data fields shall be definable in the database. Eighty user-defined data fields shall be available.

F. Integrated Development Environment

Each Alarm, Display, and Integrated workstation shall be equipped with an integrated development environment (IDE) to allow users the ability to write, edit, and de-bug the application programs resident in the Intelligent Door Access Controller (SAC). The IDE shall allow the display of multiple windows of application programs so users can quickly and easily “copy and paste” programming code using simple mouse clicks from one to another. The IDE shall also provide a tool set to allow users to quickly access libraries of commonly used object names, functions, values, and application programming keywords. Use of an IDE wizard shall permit use of pre-written application programs and creation of new programs that prompt for key values and create the program code automatically.

G. Reports

The ACS shall have the capability to provide as a minimum, the following standard reports:

1. User Activity Log
2. Alarm History Log
3. Muster Reports
4. Door Status Report
5. Alarm Point Status Report
6. Controller Status Report
7. Workstation Status Report
8. Event History Log
9. Invalid Attempt Log
10. Valid Access Log
11. All Personnel Report
12. Disabled Personnel Report
13. Personnel by Department Report

14. Personnel by Area Privileges Report
15. Lost Card Report
16. Input/Output Status Report
17. Schedules Report
18. Company Listing Report
19. Termination Report
20. Badge Pending Expiration Report
21. Cards Not Used in x days (Deadbeat Report)
22. All Doors Report
23. All Events Sorted by Door
24. All Events Sorted by Person

Note: Each report shall print the date and time that the report was run. Reports shall be viewed on the screen when the report is run and the data has been compiled.

H. Custom Report Generation

The software shall contain a built-in custom report generator, featuring word processing tools for the creation of custom reports. These custom reports shall be able to be set up to automatically run or be generated on demand. Reports can be of any length and contain any point attributes from any controller on the network. The report generator shall have access to the user programming language in order to perform mathematical calculations inside the body of the report, control the display output of the report, or prompt the user for additional information needed by the report. It shall be possible to run other executable programs whenever a report is initiated. Report Generator activity can be tied to the alarm management system, so that any of the configured reports can be displayed in response to an alarm condition. The software shall allow the simple configuration of row/column (spreadsheet-style) reports on any class of object in the system. These reports shall be user-configurable and shall be able to extract live (controller) data and/or data from the database. The user shall be able to setup each report to display in any text font, color, and background color. In addition the report shall be able to be configured to filter data, sort data, and highlight data which meets user-defined criteria

I. System Backup

A mandatory requirement, the ACS shall provide backup and restore programs utilizing the multi-tasking capabilities of the ACS which run concurrent with any other application of the system and in no way inhibit other use of the terminal. Database backup shall occur dynamically while other alarm monitoring, photo imaging, and/or access control applications remain active. The number of active events to be stored shall be user-definable. If the event log is filled to capacity before an archive backup is done, the system shall start to overwrite the oldest events to make room for the newer events (FIFO). The following functions are required for the database backup procedure of the system application:

1. Archive Information

This function shall indicate how many days' worth of event history is maintained on the system.

2. Warnings

The ACS shall provide a configurable warning to allow a System Administrator to enable and define automatic system warnings. These warnings are to be sent to all currently active alarm monitoring workstations to notify the users when the event log is starting to get full.

3. Capacity

The event queue storage capacity shall be displayed as a number up to eight digits long that shall specify the number of event records that can be stored on the system. This number shall be determined by the size of the fixed disk drive installed and is to be generated by the system's database.

J. Color Graphic Map Configuration

The system shall have the ability to draw, edit, and copy site color graphic maps using any third-party system software. At a minimum the map configuration software shall import map drawings from the following formats:

1. JPEG (.jpg)

2. Windows Bitmap (.bmp)

These architectural-type maps shall allow the detailed layout of an entire structure, part of a structure, a floor or department within a building, or layout the periphery of a facility. Overview maps of an entire facility or campus shall be viewable as requested, or a specific entry point of a facility can be accessed via graphic panel objects that shall be able to be configured with multiple “tabbed” pages allowing a user to quickly view individual graphics of equipment, which make up a subsystem or system. Once a map has been drawn, the user shall have the ability to place system level icons of card readers and input points in the appropriate area to indicate their respective location on the map. This is to be accomplished by simply dragging the icon with the mouse to the appropriate location on the map. The ACS shall permit use a full library of these controls including knobs, dials, gauges, switches, peripheral devices such as lights, motion detectors, doors, etc., shall be provided as part of the ACS software. The system shall allow various maps to be associated with each area to provide for the creation of a hierarchy of maps. The ACS shall support graphic maps having a minimum resolution of 1024 X 768 pixels.

2.4 ACS Server/Workstation Requirements

A. The ACS shall be a fully integrated solution operating on a primary database fileserver with capability to have complete redundancy being performed by a hot redundant secondary fileserver. The ACS system shall allow the centralized database to operate either on a single workstation or remotely through a separate database engine server. If desired by the client the ACS system shall be deployed to operate in a virtual environment with certain system functions being performed in existing virtual operating environments.

The client software on a multi-workstation system shall access the file server database via an Ethernet TCP/IP network running at either 100 Mbps or 1000 Mbps. Workstation(s) and file server shall be capable of residing directly on the CLIENT’s Ethernet TCP/IP LAN/WAN with no required gateways.

Workstation(s) and file server shall be capable of using standard, commercially available, off-the-shelf Ethernet infrastructure components such as routers and hubs. With this design the CLIENT may utilize the investment of an existing or new enterprise network or structured cabling system. This also allows the option of the maintenance of the LAN/WAN to be performed by the CLIENT’s Information Systems Department as all devices utilize standard TCP/IP components.

The system shall allow future expansion to include additional defined workstations without losing functionality. For multi-workstation systems, a minimum of 1,000 workstations shall be allowed on the Ethernet network along with the central file server. In this client/server configuration, any changes or additions made from one workstation shall automatically appear on all other workstations without the requirement for manual copying of files.

Multi-workstation systems with no central database will not be acceptable.

In addition to the above LAN/WAN architecture support, the same workstation software (front-end) shall be capable of managing remote systems via standard dial-up phone lines as a standard component of the software. Front-end “add-on” software modules to perform remote site communication will not be allowed. System administration operations shall be available from any workstation on the system. System Administrator functions include the creation of CLIENT-specific facility map configurations, alarm response instructions, access privileges, schedules, holidays, field hardware groups, arm-disarm groups, area control, output groups, application programs, and all required system configurations. The ACS shall include a network file server with integrated database.

B. In addition to the computer equipment listed above, the following minimum hardware requirements:

For ACCESS CONTROL APPLICATION & Database Server(s):-

| |
|---|
| SITC of Server Hardware Common for Application &Data Base Management.<br>- 19" rack mount with a minimum of two Quad Core Xeon Processor at 2.00GHz and 6MB Cache,<br>- 1333MHz FSB<br>- with 16GB of RAM,<br>-160 GB SAS HDDs for Application Server, 2TB for for Database Server<br>- Dual Embedded Gigabit CONTROLLERSs. , DVD Combo Drive, Monitor and Keyboard |
| - Latest Windows Server Standard OS with License. |
| - Microsoft SQL Server 2008 or Higher, standard edition License |

The Client workstation requirement shall be as follows:

| |
|---|
| Intel Dual core 2GHz Processor with minimum 2GB RAM, 80 GB HDD, Graphics Card, DVD Combo Drive, 19" Monitor and Keyboard. Complete with Windows 7 premium license. |

License agreement for all applicable software
ACS Server/Workstation shall be IBM/Dell/HP

C. Alarm Monitoring and Display Workstation

The alarm monitoring workstation shall be provided with full imaging display capability and shall be configured to perform alarm monitoring operations. The following major alarm Monitoring tasks shall be included: graphical alarm monitoring, acknowledging alarms, performing traces, output control functions, and badge record lookup. In addition, the alarm monitoring workstation shall also be utilized as an administration workstation as required. The alarm monitoring and display workstation shall be the main workstation for providing the alarm monitoring and access control features described in this specification.

D. Workstation Peripherals

2.5 ACS Field Hardware Devices

A. Overview

The ACS shall be equipped with the field hardware required to receive alarms, administer all access granted/denied decisions, provide interface capability to third-party systems, and implement global operation strategies. Depending upon the configuration, the ACS field hardware shall be able to include any or all of the following features:

1. Real-time Clock (RTC)
   A battery-backed RTC shall provide the following information: time, day, month, year, and day-of-week. In normal operation the system clock will be based on the frequency of the AC power. The system shall automatically correct for daylight-saving time and leap years. The system shall provide means to synchronize the time between all controllers and workstations on the network.
2. Automatic Restart after Power Failure Upon restoration of power, all controllers shall automatically and without human intervention: update all monitored functions; resume operation based on current, synchronized time and status, and implement special start-up strategies as required.
3. Indicator Lamps
   As a minimum, all controllers shall have LED indication of Power Status, CPU/Activity status, Comm status, and Error status.
4. Packaging

The Door Access Controller (SAC) and I/O modules shall be cased in a sleek, lightweight plastic housing. The mechanical design will incorporate built-in cable management troughs for wiring runs.

5. Card Readers Inputs - The card reader inputs shall have a dedicated processor to support current and future devices for advanced applications. Each input can be connected to a card reader, dedicated keypad or reader/keypad combination. The SAC shall accept standard formats (such as Weigand, ABA, HID Corporate 1000, CardKey) as well as custom formats (such as Custom Weigand, Custom ABA). The SAC shall be capable of supporting 260 bit encrypted data messages from the reader.

6. Inputs/Outputs

A. Inputs

The input section of the access I/O modules shall provide a minimum of one card reader channel and one keypad channel. It shall be possible to expand the number of card readers by simply adding I/O modules to the communications network. In addition, there shall be three supervised inputs on the base controller for request-to-exit devices, door status devices, and general supervised input monitoring. The card reader inputs shall accept Wiegand or Magnetic Stripe style readers. Up to 64 bits per card formats shall be supported for Wiegand applications and up to 255 bits per card formats shall be supported in ABA applications. Each supervised input shall be able to distinguish among normal operation, a short, open circuit, or a fault. Inputs shall be able to use double resistor-based supervised circuits. A normally open momentary switch shall be used for external tamper detection. This switch shall detect whenever the cabinet of the access control module has been opened. The access control module shall support Wiegand output or ABA output keypads. The keypad data shall be superimposed onto the Wiegand or ABA data lines.

B. Outputs

Output types shall be digital for control of doors. In addition to the door output, the control module shall contain one auxiliary output for ON/OFF control of annunciators, lights, etc. Outputs shall be available with built-in override switches. The digital outputs shall be rated for 24 VAC/DC operations at 5 amps minimum. Each output shall have a corresponding LED for visual indication of its state. A board-mounted three-position switch shall be provided for each output allowing local overrides. The position of the switch shall be detectable in software and available for alarm annunciation. If override switches are not provided on board, external switches shall be provided and wired to include feedback and alarming of the switch position, and shall be mounted in a locked enclosure.

C. Smart Card Readers

CLIENT requires the ACS to use Smart Card Readers the ACS contractor shall deploy these readers for all reader locations. This product line offers a variety of readers to match CLIENT needs. Each reader shall offer a low profile, rugged, weatherized polycarbonate sealed enclosure with multi-color LEDs and a sounder for access granted and denied indications. Each shall be mountable indoor or outdoor.

Reader Details
Reader Type Support

I/DISC
ABA Mag-Stripe
115 & 85-bit (9 to 16 digit)
Wiegand, user configurable (26 to 64 bit)
Watermark Magnetics

Reader Ports
4 per controller TTL Level signals,
Provides Reader Power of 5VDC @
50ma & 12VDC @ 100ma

2.6 Credentials

A. General

The ACS shall utilize card products designed specifically for security applications. Unless specified differently the ACS system shall utilize RF technology for the credentials. Credentials shall be managed from a single and integrated card management module included in the base ACS system. The credential management system shall also include the ability to manage elevator control access on a per card/cab/floor basis and the ability to capture, enroll individual card holder biometric information from within the ACS system. No 3rd party or separate software applications will be allowed to manage any of the credential functions.

2.7 Communication Ports

A. Security Access Controller (SAC)

Each SAC shall provide a powerful multi-user solution for network communications and information management across a high speed Ethernet with data transfer rates up to 100 MB. The data transfer shall be secure with IPsec/IKE encryption and authentication. Encryption (up to 125-bit) and authentication shall be available for communication between the workstations and the SAC. ACS shall utilize Internet Key Exchange (IKE) and Internet Protocol Security (IPSec) to assure tamper-proof communications over the Ethernet.

B. Networking

Each SAC shall be able to exchange information with other SACs over the high speed LAN. The network structure shall be transparent such that each controller may store and reference all global variables available in the network for use in the SAC's calculations or programs. Each SAC shall also have access to any of the readers, card records, inputs, outputs, and calculated variables contained in I/O modules that are connected to it.

C. Power Supply

SACs shall operate on a 24 VAC 50/60 Hz power or a 12-28 VDC auto-sensing power supply.

D. Battery Backup

Each SAC shall have long term memory battery backup providing at least 7 days of memory retention and Flash memory for unlimited application retention. In the event of a flash restoration after 7 days of power outage, the SAC shall automatically request a download of card holder privileges from the workstation.

2.8 ACS Integration

A. It is the intent of this specification to describe and define a fully integrated ACS system to be deployed as a part of this project.
B. For the purpose of this specification a fully integrated ACS system shall be defined as a system that:
   a. Allows a single seat of control from the ACS system of multiple related platforms including:
      1. CCTV Systems
      2. Intercom Systems
      3. Biometric Identification Systems
      4. Intrusion Detection Systems
      5. Emergency Power Systems
      6. Visitor Management Systems
      7. HR Database Integration

   b. From the ACS system operators shall have the ability to perform multiple functions without the need to launch 3rd party applications. These functions shall include:
      1. Device and System programming
      2. Device and System commissioning

   c. The interface to the DVMS system shall be configured so that DVMS images displayed on monitors and ACS workstations can be manipulated in the following ways:
      1. Switch displayed images of each camera on the workstations.
      2. Pan, tilt, and zoom of individual cameras

3. Change recording type and speed (FPS) based on an alarm.
4. ACS shall support and monitor loss of video, loss of DVR (offline), and motion alarms.

d. The ACS Interface to the Biometric reader shall directly integrate across the IP backbone and shall include the following features:
1. Launched from the Access Control Personnel Manager
2. Easy local enrollment or across the IP backbone
3. Distribution of fingerprint templates to the reader via the Andover Continuum access area assignments allowing proximity cards to be utilized for fingerprint authentication
4. Option for storing fingerprint image into smart card
5. Automatic fingerprint templates redistribution after connection loss
6. Easily configurable authentication options that range from proximity card or smart card only to the addition of a fingerprint, PIN or any combination for multi-factor authentication
7. Dynamic authentication requirements for changing condition or threat levels
8. Full-sized color LCD display on the reader to keep employees and visitors informed with dynamic messaging
9. Automatic date time synchronization between Access Control System and all readers.
10. Multithreading architecture to improve performance on distributions and commissioning
11. Manage reader, wallpaper and slide show
12. Automatic update of smart card security keys when compromised
13. Data fields integrated into the Access Control System database
14. Take full advantage of IP connectivity for remote device management.
15. Commissioning tool for reader configuration and firmware update
16. Standard Wiegand output to the Access Control System access panel for validation
17. Wiegand 26, Infinity 37, HID Corporate 1000 35 Bits, Wiegand Pass Through and Custom Wiegand formats are supported.
18. Ensure employees gain fast access for quick throughput.
19. Accommodate enterprise installations with storage of 100,000 templates for 1:1 verification at the reader
20. Error logs management
21. Duress Finger for “silent alarm”

e. The Interface to the IP Intercom System shall provide a simple, yet powerful interface and shall allow for the following:
1. Pop-up graphics with live video
2. Execute command / control sequences
3. Capture and route intercom call requests to a work queue
4. Initiate, answer or disconnect calls between remote and master stations

f. The Interface to the Visitor Management System (VMS) shall allow the Owner to grant temporary card access (or barcode access) to certain visitors or contractors directly from the SVM visitor form on the ACS Workstation at the time of check-in. The ACS operator shall either loan the person a proximity card, or have our barcoded badge open a turnstile or door, or activate an elevator within 2 seconds of issuing credential.

The VMS shall also have the ability to compare entered persons to various watch lists before granting credentials. The VMS shall support an Enterprise System and allow operators to assign specific access on a building by building basis.

The VMS shall pull the list of current cardholders from the ACS database on hourly intervals to have the most current active lists at all times and pull that list on a building by building basis

g. The ACS **shall Interface to Tender Package – II Elevator Compass** Controls and have the ability to interface to other IP based dispatching **Tender Package – III elevator** products.

h. The ACS shall provide for true seamless Green Integration to the BACnet HVAC and Lighting Control Systems as well as Power Monitoring. The Networked ACS Workstations shall be able to discover BACnet devices, view/edit BACnet objects (digital and analog), receive alarms, edit

schedules and create graphics.The following BACnet objects shall be able to be directly accessed from the ACS Workstation without any 3rd party integrators:

1. Analog
2. Binary
3. Multi-State
4. Program
5. Schedule
6. Event Notification
7. Event Alarm
8. Event Enrollment

The ACS/SAC shall provide for Native Modbus/Bacnet Integration over RS485 or IP.

## 11.17 BOOM BARRIER SYSTEM

1.1 GENERAL

This specification lays down the general, functional and technical specifications of Automatic Boom Barriers.

1.2 CONSTRUCTION & FUNCTION

The construction shall include electromechanical barrier with opening and losing end stroke micro switches. Spring balance, aluminum housing and structure. Internal housing for control panel. Intensive service, electric unlocking device. Dual speed and electronic braking provide optimum time for opening and closing with soft landing. Auto close mode is selected in designed for intensive use and minimum maintenance. Fully automated movement e.g. via push button, key switch, remote control system, magnetic/ digital code card reader. The barriers are used at entrances / exits to control and review traffic in and out of the premises. The operation of Boom Barriers can also be linked to access control systems with safety systems.

1.3 SYSTEM CONFIGURATION

The system shall consist of a fixed housing and a movable arm. The housing shall contain the motor, spring and control unit.

1.4 FEATURES

1) Electromechanical barriers.
2) Housing finish : Powder Coated Orange
3) The Housing base frame is of stainless steel so as to protect the housing from rusting from the bottom
4) Boom arm: Aluminum and Powder Coated White with red reflective tape every 250mm. The plinth of the boom shall be cast in to the concrete to allow all cables to terminate from the bottom.
5) Boom Length
6) Protection: All housing and internal parts have rust & corrosion free metals / alloys of high strength with suitable epoxy coating as applicable.
7) Easy to use external manual unlock device.
8) Amperometric anti-crushing control.
9) Slowing down setup thanks to two adjustable limit switches.
10) Soft start and slowing down functions adjustable in opening and closing.
11) Reflector tape on the arm ensures barrier visibility especially at night.
12) Auto close with timer (1s to 90s)
13) Painted fixed support for bars.
14) Including the road barrier, mechanical selector switch, all pole circuit breaker, magnetic detector, stand boom, articulated boom , fixed support fork, mobile support fork, rubber profile & electronic programmer.

1.5 ELECTRICAL

All electrical equipment shall be installed in IP 54 enclosures. Full electrical isolation and overload protection shall be provided. In case of power or mechanical failure it shall be possible to manually override the spike boom barrier. An isolator shall be provided in the control room from where the system shall be operated / monitored. All cabinets shall be powder coated in red and white. Electric motor/s shall be of standard 220V AC, 100% duty cycle, and instant reverse torque drive. Sleeves shall be installed for all data and electrical cabling. Data and electrical cabling shall be installed in separate sleeves.

1.6 ACCESSIBILITY

The equipment shall be easily accessible for maintenance and repair purposes as well as for manual operation. The access panel shall be lockable.

1.7. EXCAVATIONS AND DRAINING

The design shall allow for the minimum excavations and simplify the installation. If necessary drainage have to be provided to allow water seepage and prevent water to accumulate in and around the barrier.

1.8. INSTALLATION

The installation shall be done in such a way that it will prevent vehicles from driving in or out of the premises unauthorized. Correct directions must be determined on site with the user before commencing with the installation.

1.9. Manufacturers Details

The manufacturer's details and contact numbers as well as serial number, model and make of the equipment shall be displayed on the equipment cabinet and all parts. No equipment without identification shall be accepted.

1.10. Standards

All equipment shall be of the latest technology and conform to the latest national and international standards applicable to this type of security equipment. SANS, ISO, BS and UL.

1.11. TECHNICAL DATA

| TECHNICAL DATA | BOOM BARRIER UP TO 6.0M |
|---|---|
| Power supply | 230 Vac |
| Motor supply | 24 Vdc |
| Power input | 90W to 200W |
| Max. absorbed current | 8 A |
| Torque | 300Nm to 400N, |
| Opening speed | 4-6 sec |
| Operation cycle | |
| Protection level | IP 54 |
| Operating temp. | - 20 C/+70 C |
| Lubrication | Grease |
| Thermal protection | Integrated |

The following documents to be required from Vendor:-

1) Document register
2) Compliance
3) BOQ (including commissioning spares)
4) 5 years operation spare part list
5) Maintenance tools list
6) All equipment and software data sheets
7) Quality control plan
8) Equipment installation and mounting details
9) Power schematic diagram
10) Equipment list with power consumption, voltage supply, heat dissipation, required circuit breaker rating, physical size, weight, Manufacturer and origin.
11) Required interconnection cables specification
12) Installation procedure
13) Recommendations for storage, including long term storage
14) Recommendations for protection during transportation
15) Recommendations for handling
16) O & M manuals
17) Commissioning procedure

LIST OF ACT / BYE LAWS

The installations shall also be governed by the following Acts/Bye-laws/Codes as amended upto date in addition to the codes specified in the tender:

a) ANSI/ASME/CENEN 81 CODE

b) National Building Code of India - 2005

c) Indian Electricity Act - 1910

d) Central electricity authority regulation, 2010.

e) Local Lift Act/Bombay Lift Act(if local lift act is not available)

f) Building Bye-Laws

g) Local Fire Prevention and Fire Safety Rules

h) GRIHA

i) ECBC

NOTE:

1. Equipment, accessories, component parts, raw materials and tests shall in general conform to IS AND IEC.
2. Latest edition of above mentioned codes / Bye Laws / Act shall be referred

## 11.18 (A) POWER TRANSFORMER 66 KV/11 KV - OIL TYPE

1. Scope

Design, manufacture, testing, supply, Installation, testing and commissioning of outdoor type 66 KV /11 KV transformers with ONAN cooling complete with all the accessories and fittings for efficient and trouble free operation. The details are given in the data sheet. All other specifications shall be followed as per CPWD. First filling of oil shall be at site by contractor.

2. Standards:

The equipment and accessories covered by this specification shall be designed, manufactured and tested in compliance with the latest relevant standards published by the Indian Standards institution wherever available in order that specific aspects under Indian conditions are taken care of.

The equipment and accessories for which Indian Standards are not available shall be designed, manufactured and tested in accordance with the latest standards published by any other recognized national standards institution.

The equipment shall also conform to the latest Indian Electricity Rules as regards safety, earthing and other essential provisions specified therein for installation and operation of electrical plants.

3. General Design And Constructional Features:

All materials used shall be of best quality and of the class most suitable for working under the site conditions and shall withstand the variations of temperature and atmospheric conditions, overloads, over-excitation, short circuits as per applicable standards, without distortion or deterioration or the setting up of undue stresses in any part, and also without affecting the strength and suitability of the various parts for the work which they have to perform.

The design shall be such that the risks of accidental short-circuit due to birds or vermin's are obviated. All apparatus, including bushing insulators and fittings shall be so designed that water cannot collect at any point. Marshaling kiosks, boxes etc. shall be adequately ventilated to prevent condensation of moisture and so treated internally as to prevent growth of fungi on any coils, wires and insulating materials used.

The transformers shall operate with minimum noise and vibration. The cores, tank and other structural parts shall be properly constructed so that the mechanical vibrations are kept to the minimum, thus reducing the noise.

The design of the transformer shall be such that changes in transformer connection can be made by a simple change of link connection inside the tank. The transformers shall be designed to suppress harmonic voltages, specially the third and fifth, so as to eliminate distortion in wave form, and the possibility of circulating currents between the neutrals at different transformer stations.

All transformers shall be of the latest design, oil filled as called for in the main specification. All transformers shall be suitable for outdoor installation. The type of cooling and the corresponding ratings for each transformer shall be as indicated in the BOQ.

The magnetic circuit of each transformer shall be so designed as to minimize eddy- current and hysteresis losses in the core.

All electrical connections and contacts shall be of ample section for carrying the rated current without excessive heating.

All mechanisms shall be of stainless steel, brass, gunmetal, or other suitable material to prevent

sticking due to rust or corrosion.

4. Tank:

The transformer tank shall be made of steel plate, shaped in such a way that minimum of welding is required. The tank shall be electrically welded and all welding stresses shall be properly relieved. Tank walls shall be reinforced by adequate stiffeners to ensure mechanical rigidity permitting hoisting of complete transformers filled with oil and also to damp transformer noise. The tank shall be sufficiently strong to withstand shocks likely to be encountered during transport of the transformer without any deformation or weakening of joints. The joints shall be oil tight. Guides shall be welded on the inner side of the tank to facilitate tanking and untanking of the transformer core and coil assembly.

Tank cover shall be bolted on to the flanged rim of the tank with a suitable weather-proof, hot-oil-resistant gasket in between for oil tightness. The bolted tank cover shall be so arranged that it can be removed and the core inspected without removal of the radiators. All requisite access and inspection holes shall be provided with bolted oil tight, gasket seated cover plates. Bushing turrets, covers of access holes, covers of pockets to prevent leakage of water into the tank shall be provided.

The exterior of tank and other steel surface exposed to the weather shall be thoroughly cleaned and have a priming coat of zinc chromate applied. The second coat shall be of an oil and weather resistant nature preferably of distinct colour from the prime and finish coats. The final coat shall be of a glossy, oil and weather resisting non-fading paint of specified shade. The interior of the tank shall be cleaned by shot blasting and painted with two coats of heat resistant and oil insoluble paint.

Steel bolts and nuts exposed to atmosphere shall be galvanized however; surfaces of the transformer or other parts of the transformer or auxiliary equipment which are in contact with oil shall not be galvanized.

The transformer tank, auxiliary equipment and fittings shall be provided with necessary devices for lifting and haulage facilities. The tank shall be mounted on a substantial under-carriage.

Unless otherwise stated the tank together with radiators, conservator, bushings and other fittings shall be designed to withstand without permanent distortion the following conditions.

- Full vacuum of 760mm of Hg for filling oil by vacuum.
- Internal gas pressure of 0.35 Kg/Sq.cm. with oil at operating level.
- Valves shall not leak nor any welded joints sweat under above conditions.

Adequate space shall be provided at the bottom of the tank for collection of sediments.

5. Core:

The magnetic circuit shall be built of transformer grade cold rolled grain oriented low loss steel stampings having high permeability and conforming to adopted standards. Stampings shall be insulated from each other with material having high inter-lamination insulation resistance and rust inhibiting property and also capable of withstanding pressure, mechanical vibration and action of heat and oil, thus reducing the possibility of sludge formation to a minimum.

The framework, clamping arrangement and general structure of the cores of each transformer shall be of robust construction and shall be capable of withstanding any shock to which they may be subjected during transport, installation and service. The assembled core shall be securely clamped, on the limbs and the yoke, to build up a rigid structure. The clamping pressure shall be uniform over the whole of the core and so adjusted as to minimize noise and vibration in the core when the transformer is in service. The framework and the core bolts shall be efficiently insulated from the

core so as to reduce the circulating currents to a minimum.

The core clamping frame shall be provided with lifting eyes for the purpose of tanking and untanking the core with winding mounted thereon and shall have ample strength to take the full weight of the core and winding assembly.

An approved type of core grounding system shall be used; the grounding connections being located at the top of the core for easy access from the inspection hole.

6. Winding:

The coils used for transformer winding shall be flat in shape, made of paper insulated, continuous and smooth, tinned or enameled electrolytic copper conductors of high conductivity.

The transformer winding shall be designed for basic impulse insulation level not lower than that specified in the main specification.

Liberal ducts shall be provided to prevent any hot spot temperature in the winding that may adversely affect the life of the transformer. Adequate supports, wedges and spacers of hard insulating material shall be so fitted that they will neither move nor permit relative movement of any part of winding during transit of normal service or under terminal short circuit, nor damage the winding insulation in any way. All leads and connections shall be robust, adequately insulated, protected and clamped. The winding assembly shall be dried in vacuum with tested insulating oil of approved standard. The windings shall be subjected to a thorough shrinking and seasoning process so that no further shrinkage of windings occur during service at site. However adjustable devices shall be provided for taking up any possible shrinkage of coils in service. The assembly shall be held in position under adequate axial compression to withstand the axial thrust likely to occur under terminal short circuit.

The end turns on the high voltage winding shall have reinforced insulation to take care of the voltage surges likely to occur during switching or any other abnormal system condition.

The transformers shall be suitable for operation at full rated power on all tappings without exceeding the specified temperature rise as indicated in the applicable standards.

7. Insulating Materials:

The insulating oil shall conform to IS-335 and shall be suitable in all respects for operating the transformer at the rating and under conditions specified in the main equipment specification. Sufficient oil shall be supplied for the first filling of transformer, the oil circulating equipment and the tank containing tap-changing mechanism and an extra 10% shall be supplied in non-returnable drums. The tender shall contain information about the grades of oil recommended by the transformer manufacturer for use in the transformer. Test certificates for the oil shall be furnished before dispatch of transformer and acceptance by owner.

8. Transformer Tappings:

66/11 KV, delta / star wound, Transformers shall be with on load tap changer.

Transformer shall be provided with ‘ON’ load tap changing on 66 KV side. The tapings to be provided for variation on HV side from +5% to – 15% in steps of 1.25% each. Provision of bushing shall be made for neutral and neutral CTs shall also be provided.

Transformer shall be provided with an “In-Tank” or “Flange Mounted” type on-load tap –changer connected to the high voltage winding. The on-load tap-changer shall be capable of withstanding the voltage in comply with the requirements of IEC-60214, latest revision.

On Load Tap Changer shall be sourced from reputed manufacturer as approved and it should be type tested as per relevant IEC 60214:-

| S. No. | IEC Reference | Test description |
|---|---|---|
| 1 | Cl. 5.2.1 | Temperature rise of contacts |
| 2 | Cl. 5.2.2 | Switching Tests |
| 3 | Cl. 5.2.3 | Short-circuit current test |
| 4 | Cl. 5.2.4 | Short-circuit current test |
| 5 | Cl. 5.2.5 | Mechanical test |
| 6 | Cl. 5.2.6 | Di-electric test |

On Load Tap Changer shall be sourced from reputed manufacturer as approved and it should be routine tested as per relevant IEC 60214:-

| S. No. | IEC Reference | Test description |
|---|---|---|
| 1 | Cl. 5.3.1 | Mechanical test |
| 2 | Cl. 5.3.2 | Sequence test |
| 3 | Cl. 5.3.3 | Auxiliary circuits Insulation tests |
| 4 | Cl. 5.3.4 | Pressure test |
| 5 | Cl. 5.3.5 | Vacuum test |

It shall not be possible for oil in the diverter switch compartment to come in contact with oil in the main transformer tank.

9. Cooling Equipment:

Natural cooling by means of banks of detachable type radiators made from pressed/round tubes around transformer tank shall be provided. The radiators shall be of seamless mild steel sheet with clean bright internal surface and shall be suitably braced to protect them from shock.

10. Terminal Arrangement

- High Voltage Side (66 KV or 11kV)

  Cable box shall be provided suitable for terminating one no. 3C x 300/240 sq.mm XLPE insulated armoured 66 KV cable complete with disconnecting chamber, compression glands, tinned copper lugs, Armour earth clamp and body earth terminal.

  Cable box shall be fitted with bushing insulators for H.T. cable termination side.
- Low Voltage Side (11 KV )

  5/6.3 MVA, 66 KV / 11 KV delta / star Transformers – 11 KV Cable, outdoor connections shall be made

- Disconnecting Chamber

  The disconnecting chamber shall be air insulated and complete with seal off bushing, removable flexible connectors / links and removable covers. It shall be possible to trail out the transformer without having disconnecting the bus duct / cables.

  Phase to phase and phase to ground clearances within the chamber shall be such as to enable either the transformer or cable to be subjected separately to H.V. test.

- Bushing:

  Bushings shall confirm to IS: 2099 and other relevant standards.

  Bushings shall be supplied with terminal connector clamp suitable for connecting the bushing terminal to the owner's conductor.

Creepage distance of bushing shall be (31mm/kv phase ground) adequately,

11. Marshalling Box

Whenever optional fittings, temperature indicators, with auxiliary contacts, Buchholtz Relay and Bushing CT's are specified then the bidder shall provide a Marshalling box and Marshall to it all the contact terminals of electrical devices mounted on the transformer. It shall be in the contractor's scope to provide:

- The interconnection cabling between the Marshalling box and the accessory devices either by PVC insulated copper wire in G.I. conduits or PVC insulated copper conductor armoured cables.
- Necessary compression type brass cable glands at the Marshalling box for above cables.

The Marshalling box shall be tank mounted, water/dust tight sheet steel (2mm thick) enclosed with hinged door having padlocking facility. All doors, covers and plates shall be fitted with neoprene gaskets. Top surface shall be sloped and bottom shall be atleast 600mm from floor and provided with gland plate and cable glands as required.

Control terminals shall be clip on type rated for 10A. All contacts for alarm/trip indication shall be potential free, wired up to the terminal block. Wiring shall be done with stranded copper conductor wires of sizes not less than 1.5 sq.mm for control and 2.5 sq.mm for CT circuits. C.T. terminals shall be provided with shorting facility.

12. Electrical & Performance Requirement:

Transformer shall operate without injurious heating at the rated KVA at any voltage within +/- 10% of the rated voltage of that particular tap.

Transformer shall be designed for 110% continuous over fluxing withstand capability.

The neutral terminals of the winding with star connection shall be designed for the highest over current that can flow through the winding.

Overloads shall be allowed within the conditions defined in the loading guide of the applicable standard. Under these conditions, no limitations by terminal bushings, tap changers or other auxiliary equipment shall apply.

Temperature Rise shall be continuously rated for full load. The temperature rise shall not exceed 45 degree C by thermometer in oil or 55 degree centigrade by resistance over an ambient of **50** degree C.

- 110%- Continous for all transformers.
- 125% - For 1 Minute for generator transformers unit auxiliary tranformers and other special transformers.
- 140% - For 5 Seconds for transformers as specified.

- For Transformers with tappings, the category of voltage variation will be as specified in Data Sheet A. For tranformers with (a) constant flux voltage variation (CFVV) and (b) variable flux voltage variation (VFVV) full power tappings shall be provided. (CbVV) the tapping power shall be as applicable in specified standards.
- Transformers designed for mixed cooling shall be capable of operating under the natural cooled condition upto the specified load. The forced cooling equipment shall come into operation by preset contacts in winding temperature indicator and the tranformer will operate as a forced cooled unit. The manufacturer shall set the controls to operate at the temperature he recommends as being proper for the transformer design. He shall state on the test report the actual temperature settings which have been applied.
- Starting from hot condition, tranformers shall be capable of remaining in operation for following

conditions without injuries heating, after failure of forced cooling:-

- At full load for not less than 10 minutes, after outage of all forced cooling.
- Transformers fitted with two coolers each capable of dissipating 50 percent of the lossess shall be capable of remaining in operation at full load for not less than 20 minutes in the event of failure of all forced cooling associated with one cooler.

- Transfomers, complete with bushings/cable boxes, shall be designed and constructed to with stand without damage, the effects of external short circuits as per the specified standards. Account shall be taken of the different forms of system faults that can a rise in service, such as line to earth faults and line to line faults associated with the relevant system and transformer earthing conditions. The short circuit levels will be specified by the PURCHASER in the Data sheet A.
- Transformers with territory / stabilising windings shall be capable of with standing the mechanical and thermal effects of short circuits resulting from different forms of system faults that can arise in service associated with relevant system earthing conditions, including transfomer surges which could be reflected through capacitive couplings with HV & LV windings.
- The Thermal ability to with stand short circuit shall be demonstrated by the VENDOR by calculations.
- The dynamic ability to with stand short circuit shall be demonstrated by tests or by reference to tests on similar transformers.
- The neutral terminal of windings with star or zig-zag connection shall be designed for the highest fault current that can flow through this winding.
- Every care shall be taken to ensure that the design and manufacture of all transfomers shall be such as to reduce noise and vibration to the level obtained in good modern practice. The VENDOR shall ensure that the noise level shall be as per the NEMA TR1.
- The transformers shall be designed with particular attendtion to the suppression of harmonic voltage, especially the third and fifth, so as to eliminate wave form distortion and from any possibility of high frequency disturbances reaching such a magnitude as to cause interference with communication circuits.
- Following tests shall also be conducted as stipulated in IS depending upon the rated volatge of the transformer:-
    - Switching impulse with stand voltage as specified in the applicable standards.
    - Partial discharge test at the line and neutral terminals of the winding as specified in the applicable standards.
- All rated quantities subject to the VENDOR's guarantees shall be within the tolerances given in applicable standards.
- Polarity for single phase transformers shall be subtractive

13. Earthing:

- Two separate earthing terminals to be provided at the bottom of the tank on opposite sides. The terminals shall be suitable for connection to grounding strip.
- Internal Earthing:
  The frame work and clamping arrangements of core and oil shall be securely earthed inside the tank by adequately sized copper strip connections to the tank.

14. Fittings And Accessories:

The transformer shall be provided with all standard fittings and accessories specified in the applicable standard for the size and type of transformer concerned. The accessories and fittings shall generally be as specified below:

- Lifting Lugs:
  The arrangement for lifting the active part out of the transformer tank along with the cover by means of lifting lugs without disturbing the connections.
- Swivel Type Rollers:

The transformer to be provided with 4 No's Bi-Directional rollers fitted on cross channels to facilitate the movement of the transformer in both directions.

- Oil Conservator:
  The transformer to be provided with an oil conservator with welded end plates. It is to be bolted to the cover and can be dismounted for purpose of transport. It has to be provided with magnetic oil level gauge and an oil filling hole 1 1/4" BSF size with a cap, which can be used for filtering oil. For draining purpose a plug shall provided. A connection pipe between the conservator and the main tank is to be provided which projects inside the conservator and the main tank is to be provided which projects inside the conservator.

- Air release Valve:
  An air release valve is to be provided on the top of the tank cover facilitate the release of the entrapped air and filling of oil.

- Breather:
  The transformer to be provided with an indicating dehydrating silica gel breather of sufficient capacity.

- Drain-cum-oil Filter Valves:
  The transformer is to be provided with a drain-cum-oil filter valve of 1 1/4" BSF size at the bottom of the tank.

- Diagram and rating plate:
  Diagram and rating plate shall be provided indicating the details of transformer, connection diagram, vector group, tap changing diagram etc.
  Dial type Magnetic thermometer (150 mm dia) with maximum set pointer at 75 deg C and electrical contacts for electrical alarm at high temperature.
- Winding temperature indication and electrical contacts for trip / alarm
- Buchholz relay of double float type with electrical contacts for low oil level alarm and high gas pressure trip suitable for 24 volts DC supply.
- Filter valve of 1 1/4" BSF at top.
- Explosion vent.
- Repeater for Oil and Winding Alarm and Trip for BMS connection.
- RTD for temperature signal to BMS.
- Oil Surge Relay

15. Drawings And O&M Manuals:
    Four copies of manual of complete instructions for the installation, operation, maintenance and repairs circuit diagrams, foundation and trenching details shall be provided with the transformers. List of spare parts shall also be indicated.

    Two copies of the drawings incorporating the following particulars shall be submitted with the offer for preliminary study.

    GA drawing showing dimension, net weight and shipping weight, quantity of insulating oil etc.

    Suitable capacity of crane requirements for assembly and dismantling of the transformer.

    Drawing indicating GA of bus duct/cable box and its dimension for cable entry cut out requirements etc.

    The drawings in (four sets) are to be furnished by the supplier for approval after acceptance of his order and shall include the following.

GA showing front and side elevations and plan of transformer and all accessories and external features, detailed dimensions, crane lift for untanking, oil quantity, H.T./L.T. clearances etc.

Drawings of Bus duct/cables termination arrangement.

HV cable box arrangement & disconnecting chamber GA & details drawings.

Drawing of each type of bushing.

Name plate and terminal making and connection diagram.

Control wiring & schematic diagram showing polarity and vector group of windings, CTs and OTI, WTI, circuits, Alarm/trip circuits etc.

Reproducible copy of the above drawings for records

Maximum allowable Power losses shall be as per IEC/CBIP norms.

Testing:
The transformer shall be subjected to all routine tests in accordance with IS : 2026 at the factory before dispatching the same and test certificates shall be furnished.

Testing at site:

a) Insulation test of HT and LT winding
b) Oil dielectric strength test
c) Ratio test of transformer
d) Oil bd Test
e) Oil Moisture PPM Test
f) Transformers turn ratio tests by TTR meter
g) CT ratio test , CT polarity test, CT knee point voltage tests
h) Tan delta / Loss angle test of bushing

Four copies of the test reports in bound volume shall be submitted for approval.
SOAK PIT AND DRAIN PIT (Wherever required) shall be provided as per IS 10028- 2.

The transformers foundation shall be surrounded by a suitable soak pit enclosed by a 150 mm high non- combustible curb. This soak pit shall be filled with coarse crushed stones about 25mm in diameter to a minimum depth of 300 mm. The volume of the soak pit minus the volume of the stones should be sufficient to contain the entire oil content of the transformer if the oil content is less than or equal to 5 kl. In case the oil content is more than 5 kl, the volume of soak pit minus the volume of stones should be sufficient to contain at least one third of the total oil content. The excess should be led through two or more hume /concrete pipes (min. 150 dia.) from bottom of pit to a central remote burnt oil tank.

16. Bushings

a. All porcelain used in bushings shall be homogeneous, non porous, uniformly glazed to brown colour and free from blisters, burns and other defects
b. Stresses due to expansion and contraction in any part of the bushing shall not lead to deterioration.
c. Bushings shall be designed and tested to comply with the applicable standards.

d. Liquid / Oil filled bushings 36 kV and above shall be equipped with liquid level indicators and means for sampling and draining the liquid. The angle of inclination to vertical shall not exceed 300.
e. Oil in oil filled bushings shall meet the requirements of the transformer oil standards.
f. Bushings rated 72.5 KV and above shall be of the oil filled condenser type with a central tube and draw in conductir which be connected to the connector housed in the helmet of the bushings. The pull through lead shall be fitted with a gas bubble deflector. Condenser type bushings shall be equipped with following in addition to requirements of clause 16.4.
    - Provision for power factor testing without disconnecting main leads.
    - Bushings of 123 kV and above shall have taps brought out for use with potential devices.
    - Stress rings and lower end shields
    - Current transformers shall be provided, if specified and the bushing shall be so arranged that it can be removed without distrubing the current transfomers and secondary terminals.
    - Bushing turrets shall be provided with vent pipes which shall beconnected to route any gas collection through a Buchholz relay.
g. Bushings rated for 400A and above shall have non ferrous flanges and hardware.
h. Fittings made of steel or malleable iron shall be galvanized.
i. Bushings shall be so located on the transfomers that full flashover strength will be utilised and minimum clearances as required for the BIL shall be realised between live parts and live parts to earthed structures.
j. All applicable routine and type tests (if certifcates of same are not available), as stated in the specified bushing standards shall be carried out. Also, following type tests shall be applicable for condenser type bushings:-
    - Thermal stability test
    - Measurement of partial discharge
    - Power frequency withstand voltage test of voltage and test tappings insulation
    - Switching implse withstand voltage test for bushings rated 300 kV and above.

17. Blusings Current Transformers

a. Current transfomers shall comply with specified standard.
b. It shall be possible to remove turret mounted CT's from the transfomer tank, without removing the cover.
c. All secondary leads, including tappings, shall be brought to a weatherproof outlet box near the busingg. The VENDOR shall arrange conduit wiring from this outlet box upto the transformer marshalling box or control cabinet.
d. Busing current transformer name plate shall be mounted on the equipment tank adjacent to the terminal box of th esame be indicated in the rating and diagram plate of the transformer.

18. Remote Tap Changer Control Panel (RTCC) for 66/11kV, 5/6.3MVA transformer

RTCC panel shall be of sheet steel cabinet for indoor installation, floor mounting type. The RTCC panel shall be totally enclosed, completely dust and vermin proof and shall be with hinged doors, Neoprene gasket and padlocking arrangement. RTCC panel shall be suitable for the climatic conditions as specified in Special Conditions. Steel sheets used in the construction of RTCC panel shall be 14 SWG CRCA sheet steel and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal. The general construction shall confirm to IS-8623-1977 (part-I) for factory built assembled switchgear & control gear for voltage upto and including 1100 V AC.

All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with wing nuts. Self threading screws shall not be used in the construction of RTCC panel. A base channel of 75 mm x 40 mm x 5 mm thick shall be provided at the bottom for floor mounted panel.

The following components shall be provided in the RTCC panel:

a) Digital Tap Position Indicating Meter
b) Raise/Lower Push Buttons for Remote Control of OLTC
c) Tap Change in Progress Signal Lamp.

d) Supply on Signal Lamp
e) Local / Remote Control Indicating Lamps
f) Panel illuminating lamp with door switch.
g) Space Heater with Switch and Thermostat.
h) Automatic Voltage Regulator with Time Delay Element.
i) Selectors switch for Auto/Manual Operation.
j) Undrilled Gland Plate for Cable entry.
k) Earthing Terminal
l) Lifting Eyes Bolts.

66kV, aluminium conductor, XLPE, corrugated aluminum sheathed cable

Scope of work

The scope of this section includes supply & laying of 3C X 300Sqmm, 66kV, HT cables.
Unless otherwise stated, rating, characteristics, tests and procedures etc connecting 66kV XLPE cable shall be preferably as per IEC, IS standards given below and shall be in compliance with the latest editions or revisions thereof and meeting the constructional details and testing requirements as stipulated in foregoing also.

| S. no. | Standards | Title |
|---|---|---|
| 1 | IEC-60229 | Tests on cable over sheaths |
| 2 | IEC-60230 | Impulse tests on cables and their accessories |
| 3 | IEC-60270 | Partial discharge measurements |
| 4 | IEC-60287-1-1 | Calculation of continuous current capacity |
| 5 | IEC-60502 | Power cables with extruded insulation and their accessories. |
| 6 | IEC-60840 | Power cables with extruded insulation and their accessories for rated voltage above 30kV up to 150kV |
| 7 | IEEE : 48 | Test procedure and requirements for high voltage cable terminations. |

General

1. Supply of 66kV 3C X 300mm Aluminum conductor,XLPE, cable, the manufacturer shall meet the compliance with the provision of this specification does not relieve him of the responsibility of furnishing 66kV XLPE cable and accessories of proper design, electrically and mechanically suited to meet the operating guarantees at the specified service conditions.
2. If there are, in the opinion of the bidder, any conflicts between these codes and this specification, these contradictions shall be brought to the attention of the owner.
3. The cable shall be laid in RCC trench.

Material and cable construction:

1. Conductor
   a. The miliken segemental type shall be made of aluminum complying to the requirements of flexibility class-2 of IEC-60228/ IS:8130.
   b. The minimum number of wires in conductor and D.C. resistance shall be as per Table-II of IEC-60228/ IS:8130. The grade and quality of the aluminium used for the conductor shall be as per IEC/IS.
   c. The material area of conductor shall be as per BOQ.

2. Conductor screen

a. The conductor screen consisting of semi conducting cimpound layier shall be procided over the conductor by extrusion which will not only eliminate the risk electric discharge at the interface between conductor and insulation but will also present a very smooth protrusion free interface with the insulation to eliminate any localized stress concentration. The screen shall be firmly bonded to XLPE insulation.

b. The minimyum thickness of extruded conductor screen shall be 1.0mm. The outer surface of the conductor scree shall be circular and free from irregularities. A non-hygroscopic semi-conducting tape, if required shall be applied to the conductor under extruded layer to prevent penetration of compound in to the conductor interstices.

3. Insulation
   a. The insulation composed of a special super clean grade layer of cross linked polyethylene (XLPE) comply with the requirement of IS-7098 (Part-III)/ IEC. The insulation shall be applied by extrusion over the conductor screen and vulcanized using dry curing process to form a compact homogeneous body free from micro voids and contaminants.
   b. The eccentricity of insulation should not be more than 10%.

4. Inslulation screening
   a. The insulation screening shall consists of two parts, namely, non metallic and metallic.
      i. Non-Metallic Part ( Extrusion)
         1. A non- metallic insulationscreen of semi-conducting compound similar to conductor screen similar puepose shall be applied directl over the insulation core by extrusion and shall be continuous and cover whole surdace area of isnsulation. It shall be firmly bonded to the insulation.
         2. Theminimum thickness of extruded insulation screen layer shall be 0.8mm, the ovality of the core shall be not more than 5%.
      ii. Non-metallic part (taped)- Longitudnal water barrier
         1. Under-sheath, water barrier shall consist of synthetic semi-consucting moisture swellable layer (non woven synthetic tape with suitable swellable absorbent tape with suitable overlap) covering the whole surface area of the insulation screen. The barrier shall restrict longitudinal water penetration under the metallic sheath. The nominal thickness of water swellable tape shall be 0.3mm.
      iii. Metallic part-Radial water barrier

      Corrugated Aluminium Sheath
      i. When the corrugated aluminium sheath is used, it shall be applied by extrusion/ seam-weld and then passing through a corrugated head. The corrugating head contains rotating dies to form the valleys between the ribs like sine wave and produce to correct diameter of sheath to fit over the insulation.
      ii. Anti-corrosive compoint shall be applied over the aliminium sheath.

5. Outersheath
   a. The outer sheath shall consist of an extruded layer of black, PE or PVC type ST-2 as per IEC/ IS-7098 (part-3)
   b. The nominal thickness of outer sheath shall not be less than the value calculated as per the recommendation of IEC-60502-2/IS-7098 (Part-3). The outer sheath shall be of sufficient hardness to discourage termite and rodent attack.

6. Outers conductive coating/ layer:

The outer conductive layer shall be of graphite coating applied at works. This conductive layer/ coating must facilitate testing of the non-metallic outer sheath. This test is important to ensure the physical integrity of the cable from time to time be it at the factory, after transportation directly after laying upon completion of installation.

CABLE JOINTING ACCESSORIES

The cable jointing accessories shall include the end terminating kits, straight through joints. These shall be CLASS-I as defined in IEEE STANDARD-48 rated for 31.5kA for 66kV. The sheath voltage under full load conditions shall not exceed 65kV specified/ allowed in relevant standards for safety of personal as well satisfactory working of cable. The sheath shall be solidly grounded.

The termination shall be fire resistant. The complnents of kits shall have flame retardant property.

All the cable sealing end/end termination kits an straight through joints shall be pre-moulded/ cold shrinkable/ heat shrinkable type completer with accessories from reputed manufactrurer of proven design which has already been extensively used and fully type tested.
The joint shall preferably be build-up from the same material as the main cable and shall have electrical and mechanical withstand capabilities same as or better than the main cable. The joints shall be tropical climatic condition. The straight through joints shall be suitable for underground/ masonary trench installation with incorporated back fill and chances of flooding by water. The straight through joint should impervious to the entry of water.

The end termination shall be outdoor Pre-moulded/ Cold shrinkable/heat shrinkable type with accessories. The outdoor terminal should be suitable of heavily polluted atmospheric conditions and protected from creepage distance of not more than 50% of the total creepage distance.

The cable end terminals for terminating the cable shall be fully compatible with the cables to be supplied. Field tests of sealing end terminals shall be made in conjunction with the cales after installation of the cables and terminals.

The testing of cable termination, sealing ends and straight through joint shall be as per IEC-60840. All the type test, samples tests and routine tests shall be as per IEC-60840.

## 11.18 (B) DISTRIBUTION TRANSFORMER 11 KV/0.415 KV - OIL TYPE

1. Scope

Design, manufacture, testing, supply, Installation, testing and commissioning of outdoor type 11 KV /0.415 KV transformers with ONAN cooling complete with all the accessories and fittings for efficient and trouble free operation.All other specifications shall be followed as per CPWD. First filling of oil shall be at site by contractor.

2. Standards:

The equipment and accessories covered by this specification shall be designed, manufactured and tested in compliance with the latest relevant standards published by the Indian Standards institution wherever available in order that specific aspects under Indian conditions are taken care of.

The equipment and accessories for which Indian Standards are not available shall be designed, manufactured and tested in accordance with the latest standards published by any other recognized national standards institution.

The equipment shall also conform to the latest Indian Electricity Rules as regards safety, earthing and other essential provisions specified therein for installation and operation of electrical plants.

3. General Design And Constructional Features:

All materials used shall be of best quality and of the class most suitable for working under the site conditions and shall withstand the variations of temperature and atmospheric conditions, overloads, over-excitation, short circuits as per applicable standards, without distortion or deterioration or the setting up of undue stresses in any part, and also without affecting the strength and suitability of the various parts for the work which they have to perform.

The design shall be such that the risks of accidental short-circuit due to birds or vermin's are obviated. All apparatus, including bushing insulators and fittings shall be so designed that water cannot collect at any point. Marshaling kiosks, boxes etc. shall be adequately ventilated to prevent condensation of moisture and so treated internally as to prevent growth of fungi on any coils, wires and insulating materials used.

The transformers shall operate with minimum noise and vibration. The cores, tank and other structural parts shall be properly constructed so that the mechanical vibrations are kept to the minimum, thus reducing the noise.

The design of the transformer shall be such that changes in transformer connection can be made by a simple change of link connection inside the tank. The transformers shall be designed to suppress harmonic voltages, specially the third and fifth, so as to eliminate distortion in wave form, and the possibility of circulating currents between the neutrals at different transformer stations.

All transformers shall be of the latest design, oil filled as called for in the main specification. All transformers shall be suitable for outdoor installation. The type of cooling and the corresponding ratings for each transformer shall be as indicated in the BOQ.

The magnetic circuit of each transformer shall be so designed as to minimize eddy- current and hysteresis losses in the core.

All electrical connections and contacts shall be of ample section for carrying the rated current without excessive heating.

All mechanisms shall be of stainless steel, brass, gunmetal, or other suitable material to prevent sticking due to rust or corrosion.

4. Tank:

The transformer tank shall be made of steel plate, shaped in such a way that minimum of welding is required. The tank shall be electrically welded and all welding stresses shall be properly relieved. Tank walls shall be reinforced by adequate stiffeners to ensure mechanical rigidity permitting hoisting of complete transformers filled with oil and also to damp transformer noise. The tank shall be sufficiently strong to withstand shocks likely to be encountered during transport of the transformer without any deformation or weakening of joints. The joints shall be oil tight. Guides shall be welded on the inner side of the tank to facilitate tanking and untanking of the transformer core and coil assembly.

Tank cover shall be bolted on to the flanged rim of the tank with a suitable weather-proof, hot-oil-resistant gasket in between for oil tightness. The bolted tank cover shall be so arranged that it can be removed and the core inspected without removal of the radiators. All requisite access and inspection holes shall be provided with bolted oil tight, gasket seated cover plates. Bushing turrets, covers of access holes, covers of pockets to prevent leakage of water into the tank shall be provided.

The exterior of tank and other steel surface exposed to the weather shall be thoroughly cleaned and have a priming coat of zinc chromate applied. The second coat shall be of an oil and weather resistant nature preferably of distinct colour from the prime and finish coats. The final coat shall be of a glossy, oil and weather resisting non-fading paint of specified shade. The interior of the tank shall be cleaned by shot blasting and painted with two coats of heat resistant and oil insoluble paint.

Steel bolts and nuts exposed to atmosphere shall be galvanized however; surfaces of the transformer or other parts of the transformer or auxiliary equipment which are in contact with oil shall not be galvanized.

The transformer tank, auxiliary equipment and fittings shall be provided with necessary devices for lifting and haulage facilities. The tank shall be mounted on a substantial under-carriage.

Unless otherwise stated the tank together with radiators, conservator, bushings and other fittings shall be designed to withstand without permanent distortion the following conditions.

- Full vacuum of 760mm of Hg for filling oil by vacuum.
- Internal gas pressure of 0.35 Kg/Sq.cm. with oil at operating level.
- Valves shall not leak nor any welded joints sweat under above conditions.

Adequate space shall be provided at the bottom of the tank for collection of sediments.

5. Core:

The magnetic circuit shall be built of transformer grade cold rolled grain oriented low loss steel stampings having high permeability and conforming to adopted standards. Stampings shall be insulated from each other with material having high inter-lamination insulation resistance and rust inhibiting property and also capable of withstanding pressure, mechanical vibration and action of heat and oil, thus reducing the possibility of sludge formation to a minimum.

The framework, clamping arrangement and general structure of the cores of each transformer shall be of robust construction and shall be capable of withstanding any shock to which they may be subjected during transport, installation and service. The assembled core shall be securely clamped, on the limbs and the yoke, to build up a rigid structure. The clamping pressure shall be uniform over the whole of the core and so adjusted as to minimize noise and vibration in the core when the transformer is in service. The framework and the core bolts shall be efficiently insulated from the core so as to reduce the circulating currents to a minimum.

The core clamping frame shall be provided with lifting eyes for the purpose of tanking and untanking

the core with winding mounted thereon and shall have ample strength to take the full weight of the core and winding assembly.

An approved type of core grounding system shall be used; the grounding connections being located at the top of the core for easy access from the inspection hole.

6. Winding:

The coils used for transformer winding shall be flat in shape, made of paper insulated, continuous and smooth, tinned or enameled electrolytic copper conductors of high conductivity.

The transformer winding shall be designed for basic impulse insulation level not lower than that specified in the main specification.

Liberal ducts shall be provided to prevent any hot spot temperature in the winding that may adversely affect the life of the transformer. Adequate supports, wedges and spacers of hard insulating material shall be so fitted that they will neither move nor permit relative movement of any part of winding during transit of normal service or under terminal short circuit, nor damage the winding insulation in any way. All leads and connections shall be robust, adequately insulated, protected and clamped. The winding assembly shall be dried in vacuum with tested insulating oil of approved standard. The windings shall be subjected to a thorough shrinking and seasoning process so that no further shrinkage of windings occur during service at site. However adjustable devices shall be provided for taking up any possible shrinkage of coils in service. The assembly shall be held in position under adequate axial compression to withstand the axial thrust likely to occur under terminal short circuit.

The end turns on the high voltage winding shall have reinforced insulation to take care of the voltage surges likely to occur during switching or any other abnormal system condition.

The transformers shall be suitable for operation at full rated power on all tappings without exceeding the specified temperature rise as indicated in the applicable standards.

7. Insulating Materials:

The insulating oil shall conform to IS-335 and shall be suitable in all respects for operating the transformer at the rating and under conditions specified in the main equipment specification. Sufficient oil shall be supplied for the first filling of transformer, the oil circulating equipment and the tank containing tap-changing mechanism and an extra 10% shall be supplied in non-returnable drums. The tender shall contain information about the grades of oil recommended by the transformer manufacturer for use in the transformer. Test certificates for the oil shall be furnished before dispatch of transformer and acceptance by owner.

8. Transformer Tappings:

Transformer shall be provided with ‘OFF’ load tap changing on 11 KV side. The tapings to be provided for variation on HV side from +5% to – 7.5% in steps of 2.5% each. Provision of bushing shall be made for neutral and neutral CTs shall also be provided.

9. Cooling Equipment:

Natural cooling by means of banks of detachable type radiators made from pressed/round tubes around transformer tank shall be provided. The radiators shall be of seamless mild steel sheet with clean bright internal surface and shall be suitably braced to protect them from shock.

10. Terminal Arrangement

- High Voltage Side (11kV)

Cable box shall be provided suitable for terminating one no. 3C x 240 sq.mm XLPE insulated armoured 11 KV cable complete with disconnecting chamber, compression glands, tinned copper

lugs, Armour earth clamp and body earth terminal.

Cable box shall be fitted with bushing insulators for H.T. cable termination side.

- Low Voltage Side (415 V )

- Disconnecting Chamber
  The disconnecting chamber shall be air insulated and complete with seal off bushing, removable flexible connectors / links and removable covers. It shall be possible to trail out the transformer without having disconnecting the bus duct / cables.

  Phase to phase and phase to ground clearances within the chamber shall be such as to enable either the transformer or cable to be subjected separately to H.V. test.

- Bushing:
  Bushings shall confirm to IS: 2099 and other relevant standards.
  Bushings shall be supplied with terminal connector clamp suitable for connecting the bushing terminal to the owner's conductor.
  Creepage distance of bushing shall be (31mm/kv phase ground) adequately,

11. Marshalling Box
    Whenever optional fittings, temperature indicators, with auxiliary contacts, Buchholtz Relay and Bushing CT's are specified then the bidder shall provide a Marshalling box and Marshall to it all the contact terminals of electrical devices mounted on the transformer. It shall be in the contractor's scope to provide:

- The interconnection cabling between the Marshalling box and the accessory devices either by PVC insulated copper wire in G.I. conduits or PVC insulated copper conductor armoured cables.
- Necessary compression type brass cable glands at the Marshalling box for above cables.
  The Marshalling box shall be tank mounted, water/dust tight sheet steel (2mm thick) enclosed with hinged door having padlocking facility. All doors, covers and plates shall be fitted with neoprene gaskets. Top surface shall be sloped and bottom shall be atleast 600mm from floor and provided with gland plate and cable glands as required.

  Terminals shall be clipon type rated for 10A. All contacts for alarm/trip indication shall be potential free, wired up to the terminal block. Wiring shall be done with stranded copper conductor wires of sizes not less than 1.5 sq.mm for control and 2.5 sq.mm for CT circuits. C.T. terminals shall be provided with shorting facility.

12. Electrical & Performance Requirement:
    Transformer shall operate without injurious heating at the rated KVA at any voltage within +/- 10% of the rated voltage of that particular tap.

    Transformer shall be designed for 110% continuous over fluxing withstand capability.

    The neutral terminals of the winding with star connection shall be designed for the highest over current that can flow through the winding.

    Overloads shall be allowed within the conditions defined in the loading guide of the applicable standard. Under these conditions, no limitations by terminal bushings, tap changers or other auxiliary equipment shall apply.

    Temperature Rise shall be continuously rated for full load. The temperature rise shall not exceed 45 degree C by thermometer in oil or 55 degree centigrade by resistance over an ambient of 38

degree C.

13. Earthing:

- Two separate earthing terminals to be provided at the bottom of the tank on opposite sides. The terminals shall be suitable for connection to grounding strip.

- Internal Earthing:
  The frame work and clamping arrangements of core and oil shall be securely earthed inside the tank by adequately sized copper strip connections to the tank.

14. Fittings And Accessories:
The transformer shall be provided with all standard fittings and accessories specified in the applicable standard for the size and type of transformer concerned. The accessories and fittings shall generally be as specified below:

- Lifting Lugs:
  The arrangement for lifting the active part out of the transformer tank along with the cover by means of lifting lugs without disturbing the connections.
- Swivel Type Rollers:
  The transformer to be provided with 4 No's Bi-Directional rollers fitted on cross channels to facilitate the movement of the transformer in both directions.
- Oil Conservator:
  The transformer to be provided with an oil conservator with welded end plates. It is to be bolted to the cover and can be dismounted for purpose of transport. It has to be provided with magnetic oil level gauge and an oil filling hole 1 1/4" BSF size with a cap, which can be used for filtering oil. For draining purpose a plug shall provided. A connection pipe between the conservator and the main tank is to be provided which projects inside the conservator and the main tank is to be provided which projects inside the conservator.

- Air release Valve:
  An air release valve is to be provided on the top of the tank cover facilitate the release of the entrapped air and filling of oil.

- Breather:
  The transformer to be provided with an indicating dehydrating silica gel breather of sufficient capacity.

- Drain-cum-oil Filter Valves:
  The transformer to be provided with a drain-cum-oil filter valve of 1 1/4" BSF size at the bottom of the tank.

- Diagram and rating plate:
  Diagram and rating plate shall be provided indicating the details of transformer, connection diagram, vector group, tap changing diagram etc.
  Dial type Magnetic thermometer (150 mm dia) with maximum set pointer at 75 deg C and electrical contacts for electrical alarm at high temperature.
- Winding temperature indication and electrical contacts for trip / alarm.
- Buchholz relay of double float type with electrical contacts for low oil level alarm and high gas pressure trip suitable for 24 volts DC supply.
- Filter valve of 1 1/4" BSF at top.
- Explosion vent.
- Repeater for Oil and Winding Alarm and Trip for BMS connection.
- RTD for temperature signal to BMS.
- Oil Surge Relay

- Gas collecting device

15. Drawings And O&M Manuals:

Four copies of manual of complete instructions for the installation, operation, maintenance and repairs circuit diagrams, foundation and trenching details shall be provided with the transformers. List of spare parts shall also be indicated.

Two copies of the drawings incorporating the following particulars shall be submitted with the offer for preliminary study.

GA drawing showing dimension, net weight and shipping weight, quantity of insulating oil etc.

Suitable capacity of crane requirements for assembly and dismantling of the transformer.

Drawing indicating GA of busduct/cable box and its dimension for cable entry cut out requirements etc.

The drawings in (four sets) to be furnished by the supplier for approval after acceptance of his order shall include the following.

GA showing front and side elevations and plan of transformer and all accessories and external features, detailed dimensions, crane lift for untanking, oil quantity, H.T./L.T. clearances etc.

Drawings of Bus duct/cables termination arrangement.

HV cable box arrangement & disconnecting chamber GA & details drawings.

Drawing of each type of bushing.

Name plate and terminal making and connection diagram.

Control wiring & schematic diagram showing polarity and vector group of windings, CTs and OTI, WTI, circuits, Alarm/trip circuits etc.

Reproducible copy of the above drawings for records

Maximum allowable Power losses shall be **strictly** as per IS 1180 part 1 **EEL2** (2014).

Testing:

The transformer shall be subjected to all routine tests in accordance with IS : 2026 at the factory before dispatching the same and test certificates shall be furnished.

Testing at site:

i) Insulation test of HT and LT winding
j) Oil dielectric strength test
k) Ratio test of transformer

Four copies of the test reports in bound volume shall be submitted for approval.

SOAK PIT AND DRAIN PIT (Wherever required) shall be provided as per IS 10028- 2.

The transformers foundation shall be surrounded by a suitable soak pit enclosed by a 150 mm high non- combustible curb. This soak pit shall be filled with coarse crushed stones about 25mm in diameter to a minimum depth of 300 mm. The volume of the soak pit minus the volume of the stones should be sufficient to contain the entire oil content of the transformer if the oil content is less than or equal to 5 kl. In case the oil content is more than 5 kl, the volume of soak pit minus the

volume of stones should be sufficient to contain at least one third of the total oil content. The excess should be led through two or more hume /concrete pipes (min. 150 dia.) from bottom of pit to a central remote burnt oil tank.

16. Transformer Spares List

- Complete set of gaskets
- One bushing of each type
- One CT of each types
- Cooler fan/ fan motors.
- Oil pump/ pump motor
- Dial type
- Thermometer
- Oil level gauge
- Complete set of WTI equipment
- One cable sealing end of each type
- OLTC motor
- One motor contactor of each type
- Silica-gel breather
- One valve of each type
- Buchholtz relay or fault pressure relay
- Precision vacuum gauge

17. Transformer Tests

The offered transformer should be fully type tested & routine tested as per the IEC-60214

All routine tests as per IS2026-1977 / IS: 11171-1985 in addition to IEC 60214 which is applicable shall be carried out at the factory and copies of test reports shall be submitted for approval and records.

- Heat Run Test shall be carried out at an approved test lab as per IS: 2026-1977 at no extra cost.
- Impulse test shall be carried out at an approved test lab as per IS: 2026-1977
- Measurement of winding resistance.
- Ratio polarity and phase relationship.
- Impedance voltage.
- Measurement of short circuit impedance and Load Losses.
- No-Load losses and no-load current.
- Measurement of Insulation resistance.
- Induced over voltage with-stand.
- Temperature rise.
- Voltage tests on auxiliary circuit.
- Functional test.
- Verification of complete wiring.
- Test on load tap changers

18. Transformer Technical data sheet

The following technical data sheets to be filled by the vendor/ manufacturer:-

| Particulars | 5/6.3 MVA, 66/ 11 kV, Oil Type |
|---|---|
| Type and class of insulation | |
| Output in kVA (continuous rated) | |
| Rated voltage<br>(a) HV (Volts)<br>(b) LV (Volts) | |
| Rated current<br>(a) HV (Amps)<br>(b) LV (Amps) | |
| No. of phase | |
| Type of cooling | |
| Frequency | |
| Winding connections | |
| Tapings | |
| Vector Group | |
| Ref. Ambient temperature<br>Temperature rise winding<br>Class of insulation | |
| Physical dimensions<br>(a) Length (in mm)<br>(b) Width (in mm)<br>(c) Height (in mm) | |
| Percentage (%) Impedance | |
| X/R Ratio | |
| Iron losses at normal voltage ratio at full load | |
| Copper losses at normal voltage ratio at full load | |
| Efficiency at unity power factor<br>(a) Full load<br>(b) 75% load<br>(c) 50% load | |
| Regulation at unity power factor | |
| Regulation at 0.8 power factor | |
| Approximately weight<br>(a) Core and Winding (Kgs.)<br>(b) Total weight (Kgs.) | |
| Oil Ltrs) | |

| Particulars | 2500 kVA, 11/ 0.415 kV, Oil Type |
|---|---|
| Type and class of insulation | |
| Output in kVA (continuous rated) | |
| Rated voltage<br>(a) HV (Volts)<br>(b) LV (Volts) | |

| | |
|---|---|
| Particulars | 2500 kVA, 11/ 0.415 kV, Oil Type |
| Rated current<br>(a) HV (Amps)<br>(b) LV (Amps) | |
| No. of phase | |
| Type of cooling | |
| Frequency | |
| Winding connections | |
| Tapings | |
| Vector Group | |
| Ref. Ambient temperature<br>Temperature rise winding<br>Class of insulation | |
| Physical dimensions<br>(a) Length (in mm)<br>(b) Width (in mm)<br>(c) Height (in mm) | |
| Percentage (%) Impedance | |
| X/R Ratio | |
| Iron losses at normal voltage ratio at full load | |
| Copper losses at normal voltage ratio at full load | |
| Efficiency at unity power factor<br>(a) Full load<br>(b) 75% load<br>(c) 50% load | |
| Regulation at unity power factor | |
| Regulation at 0.8 power factor | |
| Approximately weight<br>(a) Core and Winding (Kgs.)<br>(b) Total weight (Kgs.) | |
| Oil Ltrs) | |
| Particulars | 2000 kVA, 11/ 0.415 kV, Oil Type |
| Type and class of insulation | |
| Output in kVA (continuous rated) | |
| Rated voltage<br>(a) HV (Volts)<br>(b) LV (Volts) | |
| Rated current<br>(a) HV (Amps)<br>(b) LV (Amps) | |
| No. of phase | |
| Type of cooling | |
| Frequency | |

| Particulars | 2500 kVA, 11/ 0.415 kV, Oil Type |
|---|---|
| Winding connections | |
| Tapings | |
| Vector Group | |
| Ref. Ambient temperature<br>Temperature rise winding<br>Class of insulation | |
| Physical dimensions<br>(a) Length (in mm)<br>(b) Width (in mm)<br>(c) Height (in mm) | |
| Percentage (%) Impedance | |
| X/R Ratio | |
| Iron losses at normal voltage ratio at full load | |
| Copper losses at normal voltage ratio at full load | |
| Efficiency at unity power factor<br>(a) Full load<br>(b) 75% load<br>(c) 50% load | |
| Regulation at unity power factor | |
| Regulation at 0.8 power factor | |
| Approximately weight<br>(a) Core and Winding (Kgs.)<br>(b) Total weight (Kgs.) | |
| Oil Ltrs) | |

| Particulars | 1600 kVA, 11/ 0.415 kV, Oil Type |
|---|---|
| Type and class of insulation | |
| Output in kVA (continuous rated) | |
| Rated voltage<br>(a) HV (Volts)<br>(b) LV (Volts) | |
| Rated current<br>(a) HV (Amps)<br>(b) LV (Amps) | |
| No. of phase | |
| Type of cooling | |
| Frequency | |
| Winding connections | |
| Tapings | |
| Vector Group | |
| Ref. Ambient temperature<br>Temperature rise winding | |

| Particulars | 1600 kVA, 11/ 0.415 kV, Oil Type |
|---|---|
| Class of insulation | |
| Physical dimensions<br>(a) Length (in mm)<br>(b) Width (in mm)<br>(c) Height (in mm) | |
| Percentage (%) Impedance | |
| X/R Ratio | |
| Iron losses at normal voltage ratio at full load | |
| Copper losses at normal voltage ratio at full load | |
| Efficiency at unity power factor<br>(a) Full load<br>(b) 75% load<br>(c) 50% load | |
| Regulation at unity power factor | |
| Regulation at 0.8 power factor | |
| Approximately weight<br>(a) Core and Winding (Kgs.)<br>(b) Total weight (Kgs.) | |
| Oil Ltrs) | |

## 11.19 66KV GIS SWITCHGEARS (SF6 GAS INSULATED METAL ENCLOSED)

1. Scope

This specification covers design, engineering, manufacture, supply, delivery to site, transportation from place of storage to erection site, erection, testing & commissioning and handing over the following 66 kv indoor GIS complete with circuit breaker, disconnector switches & earth switches, control wiring up to cabinet CT, PT, etc, termination at both the ends along with all equipments & accessories as per key SLD & main SLD & enclosed with the specification. All works shall be carried out as per shop drawings and technical submittals approved by Engineer-in-Charge. All works shall be carried out as per instructions / direction of the Engineer-in-Charge.

2. General Characteristics

The SF6 gas insulated metal enclosed switchgear shall be totally safe against inadvertent touch of any of it's live constituent parts. It should be designed for indoor (as specified) application with meteorological conditions at site as per Section Project.
All parts of the switchgear should be single phase/three enclosed.

The arrangement of gas sections or compartments shall be such as to facilitate future extension of any make on either end without any drilling, cutting or welding on the existing equipment. To add equipment, it shall not be necessary to move or dislocate the existing switchgear bays.

The design should be such that all parts subjected to wear and tear are easily accessible for maintenance purposes. The equipment offered shall be protected against all types of voltage surges and any equipment necessary to satisfy this requirement shall be deemed to be included. The required overall parameters of GIS are as follows:-

| Sl. No. | Technical Particulars | 66 kV System |
|---|---|---|
| a) | Rated Voltage | 72 kV (rms) |
| b) | Rated frequency | 50 HZ |
| c) | Grounding | Effectively earthed |
| d) | Rated power frequency withstand Voltage (1 min ) line to earth | 275 kV (rms) |
| e) | Impulse withstand BIL (1.2/50/mic. Sec) Line to earth | ±325 kVp |
| f) | Rated short time withstand current | 31.5 kA (rms) for 3 Sec |
| g) | Rated peak withstand current | 78.75 kA (peak) |
| h) | Guaranteed maximum gas losses for complete installation as well as for all individual sections in %. | As per IEC- 62271-203 |
| i) | Seismic level | Zone- V, as per IS-1893, Year-2002 |
| j ) | Internal arc | As per IEC |

The metal-enclosed gas insulated switchgear, including the operating devices, accessories and auxiliary equipment forming integral part thereof, shall be designed, manufactured, assembled and tested in accordance with the IEC 62271-203 publications including their parts and supplements as amended or revised to date.

3. Reference Standards

The metal- enclosed gas-insulated switchgear, including the operating devices, accessories and auxiliary equipment forming integral part thereof, shall be designed, manufactured, assembled and tested in accordance with the following International Electro-technical Commission (IEC) Publications including their parts and supplements as amended or revised to date:

| | |
|---|---|
| IEC 62271-203 | Gas Insulated metal-enclosed switchgear for rated voltages Above 52 KV |
| IEC 62271-207 | Seismic qualification for gas-insulated switchgear assemblies For rated voltages above 52 kV |
| IEC 60376 | New sulphur hexafluoride |
| IEC 62271- 100 | High voltage alternating current Circuit breakers |
| IEC 62271-1 | Common clauses for high voltage Switchgear and control-gear standards |
| IEC 62271-102 | Alternating current disconnectors(isolators) and earthing switches |
| IEC 61869-2 | Current transformer |
| IEC 61869-3 | Voltage transformer |
| IEC 60137 | Bushings for alternating voltages above 1000 V |
| IEC 62271-209 | Cable connections for gas-insulated switchgear |
| IEC 60480 | Guide to checking of sulphur hexafluoride taken from electrical equipment |
| IEC 60099 -1/4 | Non-linear resistor type arresters for AC systems |
| IEC 60439 | Factory-built assemblies of low-voltage switchgear and Control Gear. |
| IEEE 80 (2000) | IEEE Guide for Safety in AC Substation grounding. |
| CIGRE-44 | Earthing of GIS- an application guide. (Electra no.151,Dec'93). |
| IEC 62271-211 | Direct connection between power transformers and gas-Insulated metal- enclosed switchgear for rated voltages above 52 kV |

The components and devices which are not covered by the above standards shall conform to, and comply with, the latest applicable standards, rules, codes and regulations of the internationally recognized standardizing bodies and professional societies as may be approved by the Employer. The manufacturer shall list all applicable standards, codes etc. and provide copies thereof for necessary approval.

In case the requirements laid down herein differ from those given in above standard in any aspect the switchgear shall comply with the requirements indicated herein in regard thereto.

4. Definitions

- Assembly

  Assembly refers to the entire completed GIS equipment furnished under contract.

- Bay

  Bay refers to the area occupied by one Circuit Breaker and associated equipments used to protect one feeder/line/bus coupler in double bus scheme.

- Compartment

  When used in conjunction with GIS equipment, compartment refers to a gas tight volume bounded by enclosure walls and gas tight isolating barriers.

- Enclosure (Aluminum alloy)

  When used in conjunction with GIS equipment, enclosure refers to the grounded metal housing or shell which contains and protects internal Power system equipment (breaker, disconnecting switch, grounding switch, voltage transformer, current transformer surge arresters, interconnecting bus etc.)

- Manual Operations

  Manual operation means operation by hand without using any other source of Power.

- Module

  When used in conjunction with GIS equipment, module refers to a portion of that equipment. Each module includes its own enclosure. A module can contain more than one piece of equipment, for

example, a module can contain a disconnecting switch and a grounding switch.

- Reservoir

  When used in conjunction with GIS equipment reservoir refers to a larger gastight volume.

5. General Design & Safety Requirement

- The GIS assembly shall consist of separate modular compartments e.g. Circuit Breaker compartment, Bus bar compartment filled with SF6 Gas and separated by gas tight partitions so as to minimize risk to human life, allow ease of maintenance and limit the effects of gas leaks failures & internal arcs etc. These compartments shall be such that maintenance on one bus-bar/compartment may be performed without de-energizing the second bus-bar/feeders. These compartments shall be designed to minimize the risk of damage to adjacent sections and protection of personnel in the event of a failure occurring within the compartments. Rupture diaphragms with suitable deflectors shall be provided to prevent uncontrolled bursting of pressures developing within the enclosures under worst operating conditions.
- The workmanship shall be of the highest quality and shall conform to the latest modern practices for the manufacture of high technology machinery and electrical switchgear.
- The switchgear shall be of modular design. The conductors and the live parts shall be mounted on high graded epoxy resin insulators. These insulators shall be designed to have high structural strength and electrical dielectric properties and shall be shaped so as to provide uniform field distribution and to minimize the effects of particle deposition either from migration of foreign particles within the enclosures or from the by-products of SF6 breakdown under arcing conditions.
- Gas barrier insulators and support insulators shall have the same basis of design. The support insulators shall have holes on both sides for proper flow of gas.
- Gas barrier insulators shall be provided so as to divide the GIS into separate compartments. They shall be suitably located in order to minimize disturbance in case of leakage or dismantling. They shall be designed to withstand any internal fault thereby keeping an internal arc inside the faulty compartment.
- The material and thickness of the enclosures shall be such as to withstand an internal flash over without burn through for a period as per IEC. The material shall be such that it has no effect of environment as well as from the by-products of SF6 breakdown under arcing condition.
- Each section shall have plug- in or easily removable connection pieces to allow for easy replacement of any component with the minimum of disturbance to the remainder of the equipment.
- The material used for manufacturing the switchgear equipment shall be of the type, composition and have physical properties best suited to their particular purposes and in accordance with the latest engineering practices. All the conductors shall be fabricated of aluminum/ copper tubes of cross sectional area suitable to meet the normal and short circuit current rating requirements. The finish of the conductors shall be smooth so as to prevent any electrical discharge. The conductor ends shall be silver plated and fitted into finger contacts or tulip contacts. The contacts shall be of sliding type to allow the conductors to expand or contract axially due to temperature variation without imposing any mechanical stress on supporting insulators.
- Each pressure filled enclosure shall be designed and fabricated to comply with the requirements of the applicable pressure vessel codes and based on the design temperature and design pressures as defined in IEC-62271-203.
- The manufacturer shall guarantee that the pressure loss within each individual gas-filled compartment shall not be more than 0.1% per year.
- Each gas-filled compartment shall be equipped with static filters, density switches, filling valve and safety diaphragm. The filters shall be capable of absorbing any water vapour which may penetrate into the enclosures as well as the by-products of SF6 during interruption. Each gas compartment shall be fitted with separate non- return valve connectors for evacuating & filling the gas and checking the gas pressure etc.
- The switchgear line-up when installed and operating under the ambient conditions shall perform satisfactorily and safely under all normal and fault conditions. Even repeated operations up to the permissible servicing intervals under 100% rated and fault conditions shall not diminish the performance or significantly shorten the useful life of the switchgear. Any fault caused by external reasons shall be positively confined to the originating compartment and shall not spread to other parts of the switchgear. The internal components shall be maintenance free for at least 10 years. Routine replacements of insulating gas shall not be required in intervals of less than ten years.
- The thermal rating of all current carrying parts shall be minimum for three sec. for the rated

symmetrical short-circuit current.

- The switchgear shall be of the free standing, self-supporting with easy accessibility to all the parts during installation & maintenance with all high-voltage equipment installed inside gas-insulated metallic and earthed enclosures. It shall be suitably sub-divided into individual arc and gas-proof compartments at least for :
  - Bus bars
  - Circuit breakers
  - Bus/Line disconnectors
  - Voltage Transformers
  - Gas Insulated bus section between GIS and XLPE cable

- The arrangement of the individual switchgear bays shall be such so as to achieve optimum space-saving, neat and logical arrangement and adequate accessibility to all external components.
- It is required that the three phases of each switchgear bay be arranged side by side. The arrangement of the equipment offered must provide adequate access for operation, testing and maintenance (applicable for 66KV GIS).
- Local Control & Substation Automation System:-
  Separate control cubicle including gas monitoring kiosk shall be provided for each bay which shall be installed near the switchgear for local control & monitoring of respective switchgear bay.
  Local control cubicle for GIS shall be equipped with suitable hardware & software for remote control operation and conform to the bay level controller as detailed in Section: Substation Automation System.
- All the elements shall be accessible without removing support structures for routine inspections and possible repairs. The removal of individual enclosure parts, or entire breaker bays shall be possible without disturbing the enclosures of neighboring bays.
- It should be impossible to unwillingly touch live parts of the switchgear or to perform operations that lead to arcing faults without the use of tools or brute force.
- In case of any repair or maintenance on one busbar disconnectors, the other busbar/other equipments should be live and in service.
- All interlocks that prevent potentially dangerous mal-operations shall be constructed such that they can not be operated easily, i.e. the operator must use tools or brute force to over-ride them.
- The enclosure shall be of continuous design and shall meet the requirement as specified in clause no. 10 (special considerations for GIS) of IEEE- 80, Year-2000 and by using FEA method.
- The enclosure shall be sized for carrying induced current equal to the rated current of the Bus. The conductor and the enclosure shall form the concentric pair with effective shielding of the field internal to the enclosure.
- The fabricated metal enclosures shall be of Aluminium alloy having high resistance to corrosion, low electrical loses and negligible magnetic losses. All joint surfaces shall be machined and all castings shall be spot faced for all bolt heads or nuts and washers. All screws, bolts, studs and nuts shall conform to metric system. The other type of non-magnetic enclosures may be considered.
- The breaker enclosure shall have provision for easy withdrawal of the interrupter assemblies. The removed interrupter assembly must be easily and safely accessible for inspection and possible repairs.
- The enclosure shall be designed to practically eliminate the external electromagnetic field and thereby electrodynamic stresses even under short circuit conditions.
- The elbows, bends, cross and T-sections of interconnections shall include the insulators bearing the conductor when the direction changes take place in order to ensure that live parts remain perfectly centered and the electrical field is not increased at such points.
- The Average Intensity of electromagnetic field shall not be more than 500 micro Tesla. The contractor shall furnish all documents in support of the above during detailed engineering.
- The Bidder shall furnish the following information regarding the loosely distributed metallic particles within the GIS encapsulation.
  - The methodology and all the equipment for electrical partial discharge (PD) detection will be of UHF methods, including that mentioned in the specification else-where.

  - Partial discharge with permitted partial discharge intensity greater than 5 pc shall be considered acceptable if the discharge level does not exceed 10 pc.

- The switchgear shall have provision for connection with ground mat risers. This provision shall

consist of grounding pads to be connected to the ground mat riser in the vicinity of the equipment.

- The ladders and walkways shall be provided wherever necessary for access to the equipment. A portable ladder with adjustable height shall also be supplied to access to the equipment.
- Wherever required, the heaters shall be provided for the equipment in order to ensure the proper functioning of the switchgear at specified ambient temperatures. The heaters shall be rated for 230V AC supply and shall be complete with thermostat, control switches and fuses, connected as a balanced 3-phase 4-wire load. The possibility of using heaters without thermostats in order to achieve the higher reliability may be examined by the bidder and accordingly included in the offer but it shall be ensured by the bidder that the temperature rise of different enclosures where heating is provided should be within safe limits as per relevant standards. One copy of the relevant extract of standard to which the above arrangement conforms along with cost reduction in offer. If any, shall also be furnished along with the offer. The heaters shall be so arranged and protected as to create no hazard to adjacent equipment from the heat produced.
- The sealing provided between flanges of two modules / enclosures shall be such that long term tightness is achieved.
- Alarm circuit shall not respond to faults for momentary conditions. The following indications including those required elsewhere in the specifications shall be generally provided in the alarm and indication circuits.
- Gas Insulating System:
  - Loss of Gas Density.
  - Loss of Heater power(if required)
  - Any other alarm necessary to indicate deterioration of the gas insulating system.

- Operating System:
  - Low operating pressure
  - Loss of Heater power
  - Loss of operating power
  - Loss of control
  - Pole Disordance

- The equipment will be operated under the following ambient conditions:
  - The ambient temperature varies between 0 degree-C and 50 degree-C. However, for design purposes, ambient temperature should be considered as 50 degree-C.
  - The humidity will be about 95% (indoors)
  - The elevation is more than 1200 meters.

- Temperature rise of current carrying parts shall be limited to the values stipulated in IEC 62271-1, under rated current and the climatic conditions at site. The temperature rise for accessible enclosure shall not exceed 20 degree C above the ambient temperature of 50 degree C. In the case of enclosures, which are accessible but need not be touched during normal operation, the temperature rise limit may be permitted upto 30 degree C above the ambient of 50 degree C.
- In case of any internal arc fault regardless whether it occurs in a bus bar section, a bus bar isolator or the circuit breaker, repair works should be possible without shutting down the substation; at least one busbar and the undisturbed feeder should remain in operation. It should be possible to remove and replace a fully assembled circuit breaker without interfering the operation of the adjacent feeder. All circuit breakers should be interchangeable.
- The GIS equipments shall be arranged in such a manner that in case of maintenance works on any of the equipment, at least one bus bar should be available for operation.
- The inter bay width shall be sufficient to allow access to all drive mechanisms and other termination boxes without the need of dismantling other apparatuses.
- These conditions shall be taken into account by the supplier in the design of the equipment.

6. Bellows or Compensating Units:-

Adequate provision shall be made to allow for the thermal expansion of the conductors and of differential thermal expansion between the conductors and the enclosures. The bellows shall be metallic (preferably of stainless steel) of following types or other suitable equivalent arrangement shall be provided wherever necessary.

- Lateral / Vertical mounting units: These shall be inserted, as required, between sections of busbars, on transformer and XLPE cable etc. Lateral mounting shall be made possible by a sliding section of enclosure and tubular conductors.

- Axial compensators : These shall be provided to accommodate changes in length of busbars due to temperature variations.
- Parallel compensators: These shall be provided to accommodate large linear expansions and angle tolerances.
- Tolerance compensators: These shall be provided for taking up manufacturing, site assembly and foundation tolerances.
- Vibration compensators: These bellow compensators shall be provided for absorbing vibrations caused by the transformers when connected to SF6 switchgear by oil- SF6 bushings.

7. Indication And Verification Of Switch Positions

Indicators shall be provided on all circuit breakers, isolators and earth-switches, which shall clearly show whether the switches are open or closed. The indicators shall be mechanically coupled directly to the main contact operating drive rod or linkages and shall be mounted in a position where they are clearly visible through glass windows.

8. Pressure Relief:-

Pressure relief devices shall be provided in the gas sections to protect the main gas enclosures from damage or distortion during the occurrence of abnormal pressure increase or shock waves generated by internal electrical fault arcs (preferably in downward direction).

Pressure relief shall be achieved either by means of diaphragms or plugs venting directly into the atmosphere in a controlled direction.

If the pressure relief devices vent directly into the atmosphere, suitable guards and deflectors shall be provided. Contractor shall submit to the Employer the detailed criteria design regarding location of pressure relief devices/rupture diaphragms.

9. Pressure Vessel Requirements

The enclosure shall be designed for the mechanical and thermal loads to which it is subjected in service. The enclosure shall be manufactured and tested according to the pressure vessel code (ASME/CENELEC code for pressure Vessel.)

Each enclosure has to be tested as a routine test at 1.5 time the design pressure for one minute. The bursting strength of Aluminium castings has to be a at least 5 times the design pressure. A bursting pressure test shall be carried out at 5 times the design pressure as a type test on each type of enclosure.

10. Grounding

The grounding system shall be designed and provided as per IEEE-80-2000 and CIGRE-44 to protect operating staff against any hazardous touch voltages and electro-magnetic interferences.

As the area involved is small, contractor has to take special measures for the same.

The GIS supplier shall define clearly what constitutes the main grounding bus of the GIS. The GIS supplier must supply the entire material for grounding bus of GIS viz. conductor, clamps, joints, operating and safety platforms etc. The GIS supplier is also required to supply all the earthing conductors and associated hardware material for the following:

- Connecting all GIS equipment, enclosures, control cabinets, supporting structure etc. to the ground bus of GIS.

The enclosure of the GIS may be grounded at several points so that there shall be grounded cage around all the live parts. A minimum of two nos. of grounding connections should be provided for each of circuit breaker, transformer terminals, cable terminals, surge arrestors, earth switches and at each end of the bus bars. Subassembly to subassembly bonding shall be provided to provide gap & safe voltage gradients between all intentionally grounded parts of the GIS assembly & between those parts and the main grounding bus of the GIS.

Each marshalling box, local control panel, power and control cable sheaths and other non current carrying metallic structures shall be connected to the grounding system of GIS via connections that are separated from GIS enclosures.

The grounding connector shall be of sufficient mechanical strength to withstand electromagnetic forces as well as capable of carrying the anticipated maximum fault current without overheating. At least two grounding paths shall be provided to connect each point to the main grounding bus. Necessary precautions should be under taken to prevent excessive currents from beinginduced into adjacent frames, structures of reinforcing steel and to avoid establishment of current loops via other station equipment.

All flexible bonding leads shall be tinned copper. All connectors, for attaching flexible bonding leads to grounding conductors and grounding conductors to support structures shall be tinned bronze with stainless steel or tinned bronze hardware.

The contractor shall provide suitable measure to mitigate transient enclosure voltage caused by high frequency currents caused by lightning strikes, operation of surge arrestor, ph./ earth fault and discharges between contacts during switching operation. The grounding system shall ensure safe touch & step voltages in all the enclosures. The contractor shall provide suitable barrier of non-linear resistor/ counter discontinued SF6/ Air termination, SF6/ Transformer termination, SF6/ HV cable bushing etc. to mitigate transient enclosure voltage.

11. Circuit Breakers General

SF6 gas insulated metal enclosed circuit breakers (for 66 KV) shall comply with the latest revisions of IEC-62271-100 & relevant IEC except to the extent explicitly modified in the specification and shall meet with requirements specified.

Circuit breakers shall be equipped with the operating mechanism. 66kV SF6 Circuit breakers shall be of single pressure (puffer) type. Complete circuit breaker with all necessary items for successful operation shall be supplied. The circuit breakers shall be designed for high speed single and three phase reclosing with an operating sequence and timing as specified.

- Duty Requirements

  Circuit breaker shall be $C_2$ - $M_2$-$E_2$ class O – 0.3s - CO- 3min- CO as per IEC 62271-100.

  Circuit breaker shall meet the duty requirements for any type of fault or fault location also for line charging and dropping when used on 66kV effectively grounded system and perform make and break operations as per the stipulated duty cycles satisfactorily.

- The circuit breaker shall be capable of:
  - Interrupting the steady and transient magnetizing current corresponding to 66 Kv/11 kV class transformers of 5/6.3 MVA ratings on 66 kV side.
  - Interrupting line/cable charging current as per IEC without re-strikes and without use of opening resistors.
  - Clearing short line fault (Kilometric faults) with source impedance behind the bus equivalent to symmetrical fault current specified.
  - Breaking 25% the rated fault current at twice the rated voltage under phase opposition condition.
  - The breaker shall satisfactorily withstand the high stresses imposed on them during fault clearing, load rejection and re-energisation of lines with trapped charges.

- Total Break Time

  The total break time shall not be exceeded under any of the following duties:
  - Test duties (with TRV as per IEC- 62271-100 )
  - Short line fault (with TRV as per IEC-62271-100 )

    The Bidder may please note that total break time of the breaker shall not be exceeded under any duty conditions specified such as with the combined variation of the trip coil voltage (70-110%), hydraulic pressure and SF6 gas pressure etc. While furnishing the proof for the total break time of complete circuit breaker, the bidder may specifically bring out the effect of non simultaneity between poles and show how it is covered in the total break time.

    The values guaranteed shall be supported with the type test reports.

- Constructional Features

  The features and constructional details of breakers shall be in accordance with requirements stated hereunder:

- Contacts

  All making and breaking contacts' shall be sealed and free from atmospheric effects. Contacts shall

be designed to have adequate thermal and current carrying capacity for the duty specified and to have a life expectancy so that frequent replacement due to excessive burning will not be necessary. Provision shall be made for rapid dissipation of heat generated by the arc on opening.

- Any device provided for voltage grading to damp oscillations or, to prevent re-strike prior to the complete interruption of the circuit or to limit over voltage on closing, shall have a life expectancy comparable of that of the breaker as a whole.
- Breakers shall be so designed that when operated within their specified rating, the temperature of each part will be limited to values consistent with a long life for the material used. The temperature rise shall not exceed that indicated in IEC-62271-100 under specified ambient conditions.
- For 66KV C.B's, the gap between the open contacts shall be such that it can withstand atleast the rated phase to ground voltage for eight hours at zero pressure above atmospheric level of SF6 gas due to its leakage. The breaker should be able to withstand all dielectric stresses imposed on it in open condition at lockout pres-sure continuously (i.e. 2 pu. power frequency voltage across the breaker continuously)
- For 66KV C.B's In the interrupter assembly there shall be an adsorbing product box to minimize the effect of SF6 decomposition products and moisture. The material used in the construction of the circuit breakers shall be such as to be fully compatible with SF6 gas decomposition products.
- Provisions shall be made for attaching an operational analyzer to record travel, speed and making measurement of operating timings etc. after installation at site.
- Operating Mechanism
  - General Requirements:
    - Circuit breaker shall be operated by spring charged mechanism. The mechanism shall be housed in a dust proof cabinet and shall have IP: 65 degree of protection.
    - The operating mechanism shall be strong, rigid, not subject to rebound or to critical adjustments at site and shall be readily accessible for maintenance.
    - The operating mechanism shall be suitable for high speed reclosing and other duties specified. During reclosing the breaker contacts shall close fully and then open. The mechanism shall be anti-pumping and trip free (as per IEC definition) under every method of closing.
    - The mechanism shall be such that the failure of any auxiliary spring will not prevent tripping and will not cause trip or closing operation of the power operating devices.
    - A mechanical indicator shall be provided to show open and close position of the breaker. It shall be located in a position where it will be visible to a man standing on the ground level with the mechanism housing closed. An operation counter shall also be provided in the central control cabinet.
    - Working parts of the mechanism shall be of corrosion resisting material, bearings which require grease shall be equipped with pressure type grease fittings. Bearing pin, bolts, nuts and other parts shall be adequately pinned or locked to prevent loosening or changing adjustment with repeated operation of the breaker.
    - The bidder shall furnish detailed operation and maintenance manual of the mechanism alongwith the operation manual for the circuit breaker.
    - Anti pumping feature – Pole Discrepancy closing : <5 ms opening : <3ms

  - Control
    - The close and trip circuits shall be designed to permit use of momentary-contact switches and push buttons.
    - Each 66KV breaker pole shall be provided with two (2) independent tripping circuits, valves, pressure switches, and coils each connected to a different set of protective relays.
    - The breaker shall normally be operated by remote electrical control. Electrical tripping shall be performed by shunt trip coils. However, provisions shall be made for local electrical control. For this purpose a local/remote selector switch and close and trip control switch/push buttons shall be provided in the breaker central control cabinet.
    - The trip coil shall be suitable for trip circuit supervision during both open and close position of breaker.
    - Closing coil and associated circuits shall operate correctly at all values of voltage between 85% and 110% of the rated voltage. Shunt trip and associated circuits shall operate correctly under all operating conditions of the circuit breaker upto the rated breaking capacity of the circuit breaker and at all values of supply voltage between 70% and 110% of rated voltage. If additional elements are introduced in the trip coil circuit their successful

operation and reliability for similar applications on circuit breakers shall be clearly brought out in the additional information schedules. In the absence of adequate details the offer is likely to be rejected.

- Densimeter contacts and pressure switch contacts shall be suitable for direct use as permissive in closing and tripping circuits. Separate contacts have to be used for each of tripping and closing circuits. If contacts are not suitably rated and multiplying relays are used then fail safe logic/schemes are to be employed. DC supplies for all auxiliary circuit shall be monitored and for remote annunciations and operation lockout in case of dc failures.
- The auxiliary switch of the breaker shall be positively driven by the breaker operating rod.

➢ Spring operated Mechanism

- Spring operated mechanism shall be complete with motor in accordance with Section GTR. Opening spring and closing spring with limit switch for automatic charging and other necessary accessories to make the mechanism a complete operating unit shall also be provided.
- As long as power is available to the motor, a continuous sequence of the closing and opening operations shall be possible. The motor shall have adequate thermal rating for this duty.
- After failure of power supply to the motor one close open operation shall be possible with the energy contained in the operating mechanism.
- Breaker operation shall be independent of the motor which shall be used solely for compressing the closing spring. Facility for manual charging of the closing spring shall also be provided. The motor rating shall be such that it required preferably not more than 60 seconds for full charging of the closing spring.
- Closing action of circuit breaker shall compress the opening spring ready for tripping.
- When closing springs are discharged after closing a breaker, closing springs shall automatically be charged for the next operation and an indication of this shall be provided in the local and remote control cabinet.
- Provisions shall be made to prevent a closing operation of the breaker when the spring is in the partial charged condition.
- Mechanical interlocks shall be provided in the operating mechanism to prevent discharging of closing springs when the breaker is in the closed position.

The spring operating mechanism shall have adequate energy stored in the operating spring to close and latch the circuit breaker against the rated making current and also to provide the required energy for the tripping mechanism in case the tripping energy is derived from the operating mechanism.

In addition to the above the circuit breaker shall comply with-

- Rated frequency
- Rated transient recovery voltage for terminal fault & short line fault.
- Rated characterstics for short line circuit.
- Rated out of phase breaking current
- Rated capacitive current switching
- Rated power frequency withstand voltage

- Tests

➢ In accordance with the requirements stipulated under Section GTR the circuit breaker alongwith its operating mechanism shall conform to the type tests as per IEC-62271-100.

➢ Routine Tests

Routine tests as per IEC: 62271-100 shall be performed on all circuit breakers.

In addition to the mechanical and electrical tests specified by IEC, the following shall also be performed.

Speed curves for each breaker shall be obtained with the help of a suitable operation analyzer to determine the breaker contact movement during opening, closing, auto-reclosing and trip free operation under normal as well as limiting operating conditions (control voltage, pneumatic pressure etc.). The tests shall show the speed of contacts directly at various stages of operation, travel of contacts, opening time, closing time, shortest time between separation and meeting of contacts at break make operation etc. This test shall also be performed at site for

which the necessary operation analyzer alongwith necessary transducers, cables, console etc. shall be furnished as mandatory maintenance equipment.

- Technical Parameters - Circuit Breaker

| Sl. | Technical particulars | 66 kV System |
|---|---|---|
| | | |
| a) | Rated voltage kV | 72 |
| | (rms) | |
| b) | Rated frequency (Hz) | 50 |
| c) | No. of poles | 3 |
| d) | Type of circuit | Sf6 iNSULATED |
| | breaker | |
| e) | Rated continuous | 1600 |
| f) | Rated short circuit capacity | 31.5 kA with percentage of DC component as per IEC- 62271-100 corresponding to minimum opening conditions as specified. |
| g) | Symmetrical interrupting capability kA (rms) | 31.5 |
| h) | Rated short circuit making current kAp | 78.75 |
| i) | Short time current carrying capability for one second kA (rms) | 31.5 |
| j) | Rated line charging interrupting current at 90 deg. Leading power factor angle (A rms) | As per IEC |
| | The breaker shall be able to interrupt the rated line charging current with test voltage immediately before opening equal to the product of U/√3 and 1.4 as per IEC- 62271-100) | |
| | | |
| k) | First pole to clear factor | 1.3 |
| l) | Rated break time as IEC (ms) | 60 |
| | Total break time (ms) | 65 |
| m) | Total closing time | 65 |
| | (ms) | |
| n) | Rated operating duty | O-0.3s-CO-3 min-CO |
| | cycle | |
| o) | Reclosing auto | Three phase |
| | reclosing | |
| p) | Rated insulation levels | As per IEC |
| i) | Full wave impulse | |
| | with stand voltage | |
| | (1.2x50 micro sec.) | |
| | - between line terminals and ground | ±325 kVp |
| | - between terminals with circuit breaker | 325 kVp |

| Sl. | Technical particulars | 66 kV System |
|---|---|---|
| | | |
| | frequency withstand | |
| | Voltage | |
| | - between line | As per IEC |
| | terminals and ground | |
| | | |
| | - between terminals | As per IEC |
| | with circuit breaker | |
| | Open | |
| j) | Max. difference in the | As per IEC |
| | instants of | |
| | closing/opening of | |
| | contacts (ms) between | |
| | Poles | |
| k) | Trip coil and closing | 220V, 1-ph AC to 220VDC, 2kVA converter |
| | coil voltage | variation as specified |
| | | in Sec. GTR |
| | | |
| l) | Auxiliary Contacts | Each circuit breaker |
| | Auxiliary switch shall | pole shall be provided |
| | also comply with | with an auxiliary |
| | requirements as given. | switch with 20% of |
| | Independent single | spare - NO and 20% |
| | pole reversible | spare NC contact for |
| | contacts (from NO to | use in future. |
| | NC & vice versa) | |
| | | |
| i) | Rating of Auxiliary | 10A at 220V DC |
| | Contacts | |
| ii) | Breaking capacity of | 2A DC with the |
| | Aux. Contacts. | circuit time constant |
| | | of not less than 20 ms. |
| | | |
| | | |
| m) | System neutral | Effectively earthed. |

12. Disconnectors (Isolators)

- General
  Disconnectors shall be of the single-pole, group operated type, installed in the switchgear to provide electrical isolation of the circuit breakers, the transformers, double bus and transmission lines/cables. The disconnectors shall conform to IEC- 62271-102 and shall have the following ratings as specified.

Technical Parameter

| S.N | Particulars | 66 Kv |
|---|---|---|
| | | |
| a) | Rated voltage (rms) Un | 72.5 kV |
| b) | Rated frequency | 50 HZ |
| c) | System earthing | Effectively |
| | | Earthed |
| d) | Type | SF6 insulated |
| e) | Rated continuous current (A) | 1250/2500 |
| | at 400C ambient temp. | - 1250 for |
| | | outgoing bays.<br>- 2500 for bus coupler breaker and incomer bays. |
| f) | Rated short time withstand current of isolator and earth switch | 31.5 kA for 3 Sec |
| g) | Rated dynamic short circuit withstand current withstand current of isolator and earth switch | 78.75 kAp |
| h) | Rated insulation level:<br>One minute power freq. Withstand voltage: | |
| | To earth : | As per IEC |
| | Across isolating distance | As per IEC |
| h) | Rated insulation levels; 1.2/50 micro sec. Lighting impulse withstand voltage (+ve or –ve polarity) | |
| | To earth: | +325 kVp |
| | Across Isolating distance | ±375 kVp |
| i) | Rated mechanical terminal load | As per IEC |
| j) | No. of spare auxiliary contacts on each isolator | 6 NO and 6 NC |
| k) | No. of spare auxiliary contacts on each earthing switch | 6 NO and 6 NC |

- Construction & Design
  - The three pole group operated disconnectors shall be operated by electric motor suitable for use on 220V DC system and shall be equipped with a manual operating mechanism for emergency use. The motor shall be protected against over current and short circuit.
  - Disconnectors shall be designed as per relevant IEC. These shall be suitable to make and break the charging currents during their opening and closing. They shall also be able to make and break loop current which appears during transfer between bus bars. The contact shielding shall also be designed to prevent restrikes and high local stresses caused by transient recovery voltages when these currents are interrupted.
  - The disconnecting switches shall be arranged in such a way that all the three phases operate simultaneously. All the parts of the operating mechanism shall be able to withstand starting torque of the motor mechanism without damage until the motor overload protection operates.
  - It shall be possible to operate the disconnecting switches manually by cranks or handwheels. The contacts shall be both mechanically and electrically disconnected during the manual operation.
  - The operating mechanisms shall be complete with all necessary linkages, clamps, couplings, operating rods, support brackets and grounding devices. All the bearings shall be permanently lubricated or shall be of such a type that no lubrication or maintenance is required.
  - The opening and closing of the disconnectors shall be achieved by either local or remote

control. The local operation shall be by means of a two-position control switch located in the bay module control cabinet.

- Remote control of the disconnectors from the control room shall be made by means of remote/ local transfer switch.
- The disconnector operations shall be inter-locked electrically with the associated circuit breakers in such a way that the disconnector control is inoperative if the circuit breaker is closed.
- Each disconnector shall be supplied with auxiliary switch having six normally open and six normally closed contacts for future use over and above those required for switchgear interlocking and automation purposes. The auxiliary switch contacts are to be continuously adjustable such that, when required, they can be adjusted to make contact before the main switch contacts.
- The signaling of the closed position of the disconnector shall not take place unless it is certain that the movable contacts will reach a position in which the rated normal current, peak withstand current and short-time withstand current can be carried safely.
- The signaling of the open position of the disconnector shall not take place unless the movable contacts have reached such a position that the clearance between the contacts is at least 80 percent of the rated isolating distance.
- All auxiliary switches and auxiliary circuits shall be capable of carrying a current of at least 10 A DC continuously.
- The auxiliary switches shall be capable of breaking at least 2 A in a 220 V DC circuit with a time constant of not less than 20 milliseconds.
- The disconnectors and safety grounding switches shall have an electrical inter-locks to prevent closing of the grounding switches when isolator switches are in the closed position and to prevent closing of the disconnectors when the grounding switch is in the closed position.
- The local control of the Isolator and high-speed grounding switches from the bay module control panel should be achieved from the individual control switches with the remote/local transfer switch set to local.
- All electrical sequence interlocks will apply in both remote and local control modes.
- Each disconnector shall have a clearly identifiable local, positively driven mechanical position indicator, together with position indicator on the bay module control cabinet and provisions for taking the signals to the control room. The details of the inscriptions and colouring for the indicator are given as under :

| | SIGN | COLOUR |
|---|---|---|
| Open position | Open | Green |
| Closed position | Closed | Red |

- All the disconnecting switches shall have arrangement allowing easy visual inspection of the travel of the switch contacts in both open and close positions, from the outside of the enclosure.
- The disconnecting switches shall be provided with rating plates and shall be accessible for inspection.
- The disconnecting switches shall be capable of being padlocked in both the open and closed positions with the operating motor automatically disengaged. The padlocking device shall be suitable for a standard size lock with a 10 mm shank. The padlock must be visible and directly lock the final output shaft of the operating mechanism. Integrally mounted lock when provided shall be equipped with a unique key for such three phase group. Master key is not permitted.

13. Safety Grounding Switches

- Three-pole, group operated, safety grounding switches shall be operated by electric motor for use on 220 V DC ungrounded system and shall be equipped with a manual operating mechanism for emergency use. The motor shall be protected against over-current and short circuit.
- Each safety grounding switch shall be electrically interlocked with its associated disconnector and circuit breaker such that it can only be closed if both the current breaker and disconnector are in open position. Safety grounding switch shall also be mechanically key interlocked with its associated disconnector.
- Each safety grounding switch shall have clearly identifiable local positive driven mechanical indicator together with position indicator on the bay module control cabinet and provision for taking the signal to Control room.
- The details of the inscription and colouring for the indicator are given as under

| | SIGN | COLOUR |
|---|---|---|
| Open position | Open | Green |
| Closed position | Closed | Red |

- Interlocks shall be provided so that manual operation of the switches or insertion of the manual operating device will disable the electrical control circuits.
- Each ground switch shall be fitted with auxiliary switches having six normally open and six normally closed contacts for use by others over and above those required for local interlocking and position indication purposes.
- Provision shall be made for padlocking the ground switches in either the open or closed position.
- All portions of the grounding switch and operating mechanism required for grounding shall be connected together utilizing flexible copper conductors having a minimum cross-sectional area of 50 sq. mm.
- The main grounding connections on each grounding switch shall be rated to carry the full short circuit rating of the switch for 3 sec. and shall be equipped with a silver- plated terminal connector suitable for steel strap of adequate rating for connection to the grounding grid.
- The safety grounding switches shall conform to the requirements of IEC-62271- 102
- Mechanical position indication shall be provided locally at each switch and remotely at each bay module control cabinet/ substation automation system.

14. High Speed Make Proof Grounding Switches

- Grounding switches located at the beginning of the feeder bay modules shall be of the high speed, make proof type and will be used to discharge the respective charging currents, in addition to their safety grounding function. These grounding switches shall be capable of interrupting the inductive currents and to withstand the associated TRV.
- Single phase switches shall be provided with operating mechanism suitable for operation from a 220V DC.
- The switches shall be fitted with a stored energy closing system to provide fault making capacity.
- The short circuit making current rating of each ground switch shall be at least equal to its peak withstand current rating. The switches shall have inductive/ capacitive current switching capacity as per IEC-62271-102.
- Each high speed make proof grounding switch shall have clearly identifiable local positive driven mechanical indicator together with position indicator on the bay module control cabinet and provision for taking the signal Control Room.
- The details of the inscription and colouring for the indicator shall be as under:-

| | SIGN | COLOUR |
|---|---|---|
| OPEN POSITION | Open | Green |
| CLOSED POSITION | Closed | Red |

- High speed ground switch operation should be possible locally from the bay module control cabinet, or remotely from the control room in conjunction with opening of the associated disconnector.
- These high speed grounding switches shall be electrically interlocked with their associated circuit breakers and disconnectors so that the grounding switches cannot be closed if the circuit breakers and disconnectors are closed.
- Interlocks shall be provided so that the insertion of the manual operating devices will disable the electrical control circuits.
- Each high speed ground switch shall be fitted with auxiliary switches having six NO & six NC auxiliary contacts for use by others, over and above these required for local interlocking and position indication. All contacts shall be wired to terminal blocks in the local bay control cabinet. Provision shall be made for padlocking the ground switches in their open or closed position.
- All portion of the grounding switches and operating mechanism required for connection to ground shall be connected together utilizing copper conductor having minimum cross-sectional area of 50 sq. mm.
- The main grounding connection on each grounding switch shall be rated to carry the short time withstand current rating of the switch for 1 sec. and shall be equipped with a silver plated terminal connector suitable for steel strap of adequate design for connection to the grounding grid.
- The high speed make proof grounding switches shall confirm to the requirements of IEC-62271-102.
- The rated Induced Current and Voltage for earth switches for both electrostatic and electromagnetic coupling shall be as per IEC 62271-102.

15. Instrument Transformers

- Instrument Transformers 14.1.1 Current Transformers

**15.1** General:

- The current transformers and accessories shall conform to IEC: 61869-1&2 and other relevant standards except to the extent explicitly modified in the specification.
- The particulars of the various cores may change within reasonable limits as per the requirements of protection relay supplier. The manufacturer is required to have these values confirmed from the purchaser before proceeding with design of the cores. The other characteristics of CTs shall be as given in TECHNICAL PARAMETER of Current Transformer.

**15.2** Ratios and Characteristics

The number, rating, ratios, accuracy class, etc. for the individual current transformers secondary cores shall be in accordance with Table provided in GTR.

**15.3** Rating and Diagram Plates

Rating and diagram plates shall be as specified in the IEC specification incorporating the year of manufacture. The rated extended current rating voltage and rated thermal current shall also be marked on the name plate.
The diagram plates shall show the terminal markings and the relative physical arrangement of the current transformer cores with respect to the primary terminals (P1 & P2).
The position of each primary terminal in the current transformer SF6 gas section shall be clearly marked by two plates fixed to the enclosure at each end of the current transformer.

**15.4** Constructional Details:

b) The current transformers incorporated into the GIS will be used for protective relaying and metering and shall be of gas insulated, metal-enclosed type. The secondary windings shall be gas insulated with terminals brought out for secondary connection. All the current transformers shall have effective electromagnetic shields to protect against high frequency transients.

c) Each current transformer shall be equipped with a marshalling box with terminals for the secondary circuits, which are connected to the local control cubicle. The star/ delta configuration and the inter connection to the line protection panels will be done at the CT terminal block located in the local control cubicle.

d) Current transformers guaranteed burdens and accuracy class are to be intended as simultaneous for all cores.

e) The rated extended primary current shall be 120% at all ratios.

f) The instrument security factor at all ratios shall be less than five (5) for metering core. ISF shall be verified without use of any auxiliary reactor. (applicable only if electromagnetic meters are used)

g) The wiring diagram, for the interconnections of the three single phase CTs shall be provided inside the marshalling box.

h) The current transformers shall be suitable for high speed auto-reclosing.

i) Provisions shall be made for primary injection testing either within CT or outside.

j) Electromagnetic shields to be provided against high frequency transients typically 1-30 MHz.

k) The bidder will take care for the compatibility of the CT vis-à-vis burden of relay and connecting leads, however for calculation purpose fault current may be taken as 50kA for 66kV & 31.5kA for 11kV and secondary current may be calculated accordingly.

**15.5** Voltage Transformers

b) General

The voltage transformers shall conform to IEC- 61869-1&3 and other relevant standards except to the extent explicitly modified in the specification.

Voltage transformers shall be of the electromagnetic type with SF6 gas insulation. The earth

end of the high voltage winding and the ends of the secondary winding shall be brought out in the terminal box.

c) Ratios and Characteristics

The rating, ratio, accuracy class, connection etc. for the voltage transformers shall be in accordance with Table II-A.

d) Rating and diagram plates

Rating and diagram plate shall be provided complying with the requirements of the IEC specification incorporating the year of manufacture and including turns ratio, voltage ratio, burden, connection diagram etc.

e) Secondary Terminals, Earthing and Fuses

The beginning and end of each secondary winding shall be wired to suitable terminals accommodated in a terminal box mounted directly on the voltage transformer section of the SF6 switchgear.
All terminals shall be stamped or otherwise marked to correspond with the marking on the diagram plate. Provision shall be made for earthing of the secondary windings inside the terminal box.

f) The transformer shall be able to sustain full line to line voltage without saturation of transformer. The accuracy class will be at maximum tap.

g) Constructional Details of Voltage Transformers:

- The voltage transformers shall be located in a separate bay module on the bus and will be connected phase to ground and shall be used for protection, metering and synchronization.
- The voltage transformers shall be of inductive type, nonresistant and shall be contained in their own-SF6 compartment, separated from other parts of installation. The voltage transformers shall be effectively shielded against high frequency electromagnetic transients. The voltage transformers shall have three secondary windings

b) Voltage transformer's secondary shall be protected by HRC cartridge type fuses for all the windings. In addition fuses shall be provided for the protection and metering windings for fuse monitoring scheme. The secondary terminals of the VT's shall be terminated to the stud type non-disconnecting terminal blocks in the secondary boxes via the fuse.

c) The voltage transformer should be thermally and dielectrically safe when the secondary terminals are loaded with the guaranteed thermal burdens.

d) The accuracy of 0.2 on secondary III should be maintained through out the entire burden range upto 100VA on all the three windings without any adjustments during operation.

e) The diagram for the interconnection of the VTs shall be provided inside the marshalling box.

f) Tests

Current and voltage transformers shall conform to type tests and shall be subjected to routine test in accordance with IEC.
Technical Parameters:

- Current Transformers

| S. No. | Particulars | 66kV |
|---|---|---|
| a) | Rated voltage Un | 72kV (rms) |
| b) | Rated frequency | 50 Hz |
| c) | System neutral earthing | Effectively Earthed |
| d) | Rated short time thermal current | 31.5 kA for 3 Second |
| e) | Rated dynamic current | 78.5 kAp |
| f) | Rated insulation levels | |
| | i)1.2/50 micro second impulse voltage | ±325 kVp |
| | ii)1 Minute power | 275 kV (rms) |

| | | |
|---|---|---|
| | frequency withstand voltage | |
| g) | One minute power frequency withstand voltage between secondary terminal & earth | 3kV (rms) |
| h) | Maximum temperature rise over an ambient temperature of 400C | As per IEC |
| i) | Partial discharge level | ≤5 pico Coulomb |

- Voltage Transformers

| Sl.No. | Particulars | 66 kV |
|---|---|---|
| a) | Rated system voltage (Un) | 72 kV (rms) |
| b) | Rated frequency | 50 Hz |
| c) | System neutral earthing | Effectively earthed |
| d) | System fault level | 31.5 kA for 3 second |
| e) | Rated insulation levels | |
| | i)1.2/50 micro second impulse voltage. | ±325 kVp |
| | ii)1 Minute power frequency withstand voltage. | 275 kV (rms) |
| f) | One minute power frequency withstand voltage for Secondary | 3kV (rms) |
| g) | Rated total thermal burden | 200VA |
| h) | Partial discharge level | ≤10Pico coulomb |

**15.6** Outdoor Bushings

a. General

Outdoor bushings, for the connection of conventional external conductors to the SF6 metal enclosed switchgear, shall be provided where specified and shall conform to the requirements given in GTR.

The dimensional and clearance requirements for the metal enclosure will be the responsibility of the manufacturer and their dimensions must be coordinated with the switchgear.

Bushings shall generally be in accordance with the requirements of IEC publication 137 as applicable.

b. Insulation levels and creepage distances

All bushings shall have an impulse and power frequency withstand level that is greater than or equal to the levels specified for GIS.

The creepage distance over the external surface of outdoor bushings shall not be less than 31 mm/kV.

c. Bushing types and fitting

Condenser type bushings will be preferred but alternative types can also be considered.

Liquid filled bushings shall be provided with liquid level gauges clearly visible from ground level, preferably of the direct reading prismatic type or the magnetic type. Other types of liquid level gauges will only be accepted if specifically approved.

d. Mechanical forces on bushing terminals

Outdoor bushings must be capable of withstanding cantilever forces due to weight of conductor, wind force and short circuit forces etc. Design calculations in support of the cantilever strength chosen shall be submitted for Employers review and approval.

**15.7** Surge Arrestors

The surge arrestors shall confirm in general to latest IEC –60099-4.

**15.8** Selection of Surge Arrestor

The locations of surge arrestors shown in single line diagram are indicative only. If the bidders feel that at some more locations the surge arrestors are required to be provided the same should also be included in the offer. If distance between Surge Arrestor and transformer bushing terminal inclusive of head length is more than 60 m or 170 ft then one surge arrestor shall be with GIS System and another shall be with transformer.

**15.9** Duty Requirements

- The surge arrester shall be SF6 filled, heavy duty station class and gapless (Metal oxide) type without any series or shunt gaps.
- The surge arresters shall be capable of discharging over-voltages occurring during switching of unloaded transformers and long lines.
- 245kV class arrester shall be capable of discharging energy equivalent to class 3 of IEC for 245kV system on two successive operations.
- The reference current of the arresters shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage.
- The surge arresters are being provided to protect the followings whose insulation levels are indicated in the table given below:-

| Equipment to be protected | Lightning impulse (kVp) for 66 kV system |
|---|---|
| Power Transformer | + 325 |
| Instrument Transformer | + 325 |
| CB/Isolator Phase to ground | + 325 |
| Across open contacts | + 375 |

**15.10** Constructional Features

The nonlinear blocks shall be of sintered metal oxide material. These shall be provided in such a way as to obtain robust construction, with excellent mechanical and electrical properties even after repeated operations.

The arrestor enclosure shall be vertically or horizontally mounted to suit the layout of the switchgear as suggested by the manufacturer and shall be fitted with a discharge counter located in an easily accessible position.

The main grounding connection from the surge arrestor to the earth shall be provided by the bidder. The size of the connecting conductor shall be such that all the energy is dissipated to the ground without getting overheated.

**15.11** Fittings and Accessories for outdoor SA

- Self contained discharge counters, suitably enclosed and requiring no auxiliary or battery supply for operation shall be provided for each single pole unit. Suitable leakage current meters should also be supplied within the same enclosure. The reading of milli ammeter and counters shall be visible through an inspection glass panel.
- Microprocessor based instrument for monitoring resistive current or watt loss of the arrester shall also be provided.

**15.12** Tests

In accordance with the requirements stipulated the surge arrestors shall conform to type tests and shall be subjected to routine and acceptance tests in accordance with IEC document.

Each metal oxide block shall be tested for the guaranteed specific energy capability in addition to the routine/acceptance test as per IEC-60099.

Test on Surge Monitors:

The Surge monitors shall also be connected in series with the test specimens during residual voltage and current impulse withstands tests to verify efficacy of the same. Additional routine/functional tests with one 100A and 10 kA current impulse, (8/20 micro sec.) shall also be performed on the surge monitor.

**15.13** Parameters

Following are the parameters generally adopted by Employer for their installations. These parameters are indicative and not binding. The actual parameters required for the installation shall be evolved by contractor.

Surge Arrestor

| Sl. No. | Particulars | 66 kV |
|---|---|---|
| a) | Rated system voltage | 72 kV |
| b) | System neutral earthing | Effectively Earthed |
| c) | Rated arrestor voltage | 66 kV |
| d) | Nominal discharge current | 10 kA of 8/20 micro Second Wave |
| e) | Rated frequency | 50 Hz |
| f) | Minimum discharge capability voltage | 5 KJ/kV (referred to rated arrestor) |
| | corresponding to minimum | |
| | discharge characteristics | |
| g) | Continuous operating | 72kV |
| | voltage at 500C | |
| h) | Min. switching surge | __ |
| | residual voltage (1 kA) | |
| | Max. switching surge | 325 kVp |
| | residual voltage (1 kA) | |
| i) | Max. residual voltage at i) 5 kA | 325 kVp |
| | ii) 10 kA nominal discharge current | 325 kVp |
| | iii) 20 kA nominal discharge current | |
| j) | Long duration discharge class | 3 |

| | | |
|---|---|---|
| k) | High current short duration test value (4/10 micro second wave) | 100 kAp |
| l) | Current for pressure relief test | 31.5 kA rms |
| m) | Pressure relief class: | A |
| n) | RIV at 1.1 Un/√3 kV rms(micro volts) | Less than 500 |
| o) | Partial discharge at 1.05 COV | Not more than 5 pc |
| p) | Reference ambient temp. | 50 degC |
| q) | Steep current impulse voltage | 325kVp |

**15.14** Seismic Design Criteria:

The equipment shall be designed for operation in seismic zone for earthquake resistance. The seismic loads are due to the horizontal and vertical acceleration which may be assumed to act non concurrently. Seismic level Zone- V, as per new IS- 1893, Year-2002 has to be considered for the design of equipment. The seismic loads shall be equal to static loads corresponding to the weight of the parts multiplied by the acceleration. The equipments along with its parts shall be strong enough and sufficiently well connected to resist total operating stresses resulting from the forces in normal operation but in case of abnormal condition shall also resist with forces superimposed due to earthquakes. The copies of type test reports for similar rated equipment, if tested earlier, should be furnished along with the tender. If the equipment has not been type tested earlier, design calculations of simulated parameters should be furnished along with the offer.

To prevent the movement of GIS sub assemblies i.e. various bay modules during the earthquake, suitable devices shall be provided for fixing the sub assemblies to the foundation. The contractor shall supply necessary bolts for embedding in the concrete foundation. The fixing of GIS sub assemblies to the foundation shall be designed to with-stand the seismic events. It will also be ensured that the special devices as well as bolts shall not be over stressed. The details of the devices used and the calculations for establishing the adequacy shall be furnished by the supplier and shall be subject to the purchase's approval.

**15.15** SF6 Gas Detector Meter & Dew Point Meter

SF6 Gas Detector Meter & Dew point meter shall be offered as per relevant schedule of BPS and shall be considered for evaluation of bid. The specifications are enclosed at Section-Special Equipment.

**15.16** Quality Of SF6 Gas

- The SF6 gas insulated metal-clad switchgear shall be designed for use with SF6 gas complying with the recommendations of IEC 376, 376A & 376B, at the time of the first charging with gas. All SF6 gas supplied as part of the contract shall comply with the requirements of IEC as above as a minimum & should be suitable in all respects for use in the switchgear under all operating conditions.
- The high pressure cylinders in which SF6 gas is supplied & stored at site shall comply with the requirements of following standards & regulations:
- IS: 4379 Identification of the contents of industrial gas cylinders.
- IS : 7311 Seamless high carbon steel cylinders for permanent & high pressure liquefiable gases. The cylinders shall also meet Indian Boilers Regulations. (Mandatory)
- Test

SF6 gas shall be tested for purity, dew point, air, hydrolysable fluorides and water contents as per IEC:376, 376A & 376B and test certificates shall be furnished to the Employer indicating all test results as per IEC standards for each lot of SF6 gas. Further site tests for moisture, air con-tent, flash point and dielectric strength to be done during commissioning of GIS. Gas bottles should be

tested for leakage during receipt at site.

- The bidder shall indicate diagnostic test methods for checking the quality of gas in the various sections during service. The method proposed shall, as a minimum check the moisture content & the percentage of purity of the gas on annual basis.
- The bidder shall also indicate clearly the precise procedure to be adopted by maintenance personnel for handling equipment that are exposed to the products of arcing in SF6 Gas so as to ensure that they are not affected by possible irritants of the skin and respiratory system. Recommendations shall be submitted for suitable protective clothing, method of disposal of cleaning utensils and other relevant matters.
- The bidder shall also indicate the details and type of filters used in various gas sections, and should also submit the operating experience with such filters.
- Instruments for automatic & continuous monitoring of SF6 gas in the atmosphere of the switchgear room shall be provided as integral part of the system at no extra cost.

**15.17** SF6 Gas Monitoring Devices And Alarm Circuits

Dial type temperature compensated gas density or density monitoring devices with associated pressure gauge will be provided. The devices shall provide continuous & automatic monitoring of the state of the gas & a separate device shall be provided for each gas compartment so that each compartment can be monitored simultaneously as follows:-

- Compartments except circuit breaker
  - Gas Refill level

    This will be used to annunciate the need for the gas refilling. The contractor shall provide a contact for remote indication.

  - Zone Trip' level

    This is the minimum level at which the manufacturer will guarantee the insulation rating of the assembly. Contacts shall be in accordance with requirement.

- Circuit Breaker ( for 66kV level )
  - Gas Refill' level

    This will be used to annunciate the need for gas refilling. The contractor shall provide a contact for remote indication.

  - Breaker Block' level

    This is the minimum gas density at which the manufacturer will guarantee the rated fault interrupting capability of the breaker. At this level the breaker block contact shall operate & the tripping & closing circuit shall be blocked.

  - 'Zone Trip' level

    This is the minimum level at which the manufacturer will guarantee the insulation rating of the assembly. Contacts shall be in accordance with requirement.

    The bidder should furnish temperature v/s pressure curves for each setting of density monitor along with details of the monitoring device.

    It shall be possible to test all gas monitoring relays/devices without de-energizing the primary equipment & without reducing pressure in the main section. Plugs & sockets shall be used for test purposes. It shall also damp the pressure pulsation while filling the gas in service, so that flickering of the pressure switch contacts does not take place.

- Gas Leakage

  The maximum gas leakage shall not exceed 0.5% (half percent) per year for the whole equipment

and for any individual gas compartment separately.

- Gas Supply

The contractor shall include the supply of all SF6 gas necessary for filing & putting into operation the complete switchgear installation being supplied. In addition 20% of total gas requirement shall be supplied in separate cylinders as spare requirement, over & above the requirement of gas for successful commissioning. Pl. refer list of mandatory spares in Annexure C.

**15.18** Gas Filling And Evacuating Plant

The selection of gas filling and evacuation plant will be in the scope of manufacturer depending upon the highest volume of gas that has to be handled. Manufacturer has to justify the same with calculations/documents.

**15.19** Painting Of Enclosure

All enclosures shall be painted externally as per manufacturer's painting procedure. The painting procedures as followed shall be enclosed with the bid.

Wherever required, heaters shall be provided to prevent moisture condensation. Heaters are not allowed in side the main circuit.

**15.20** Identification & Rating Plate

- Each bay shall have a nameplate showing

A listing of the basic equipment such as a breaker, disconnectors grounding switches current transformers, voltage transformers, and bushings.

- Each module will have its own Identification & rating plate.

The rating plate marking for each individual equipment like circuit breaker, disconnectors grounding switches, current transformer, voltage transformers, surge arrester etc shall be as per their relevant IEC.

**15.21** Sealing end box for GIS XLPE cable Termination

a) Suitable SF6 gas fitted cable sealing end box shall be provided for accommodating XLPE single core copper cable terminations. The boxes shall be designed to accept the cable along with its termination core from below.

b) The cable connections shall generally comply with IEC 60159.

c) The SF6 – XLPE cable at the power cable port head termination shall allow for power cable disconnection from the gas insulated bus through a removable link and provide means to permit high voltage AC field testing of cable.

d) All the GIS apertures intended for future cable termination shall be sealed with effective cover plate to safeguard against SF6 leakage.

e) Effective & long lite gas tight seal shall be provided between cable sealing end & cable termination enclosure.

Instruments for automatic & continuous monitoring of SF6 gas in the atmosphere of the switchgear room shall be provided as an integral part of the system at no extra cost.

**15.22** Pre - commissioning Tests to be carried in the GIS at Site :

- Dielectric test on main circuit
- Test on auxilliary & control circuit
- Measurement of Resistance of main circuit
- Gas tightness test
- Mechanical operation tests
- Interlock checking.
- Gas pressure test on partition
- CT ratio, knee point & polarity tests.
- PT ratio tests

- Dew point measurement
- Working of pressure Relay
- High voltage test
- Pole discrepency test

**15.23** 66 Kv Voltage Transformers

| Sl. | PARTICULARS | 66 kV | | | |
|---|---|---|---|---|---|
| | | | | | |
| 1. | Rated primary voltage | 72/√3 kV | | | |
| | | | | | |
| 2. | Type | Electromagnetic | | | |
| | | | | | |
| 3. | No. of secondaries | 3 | | | |
| | | | | | |
| 4. | Rated voltage factor | 1.2 continuous | | | |
| | | | | | |
| | | 1.5-30 seconds | | | |
| | | | | | |
| 5. | Phase angle error | ±20 minutes | | | |
| | | | | | |
| | | | | | |
| | | Sec I | | Sec II | Sec III |
| | | | | | |
| 6. | Rated voltage (V) | 110/√3 | | 110/√3 | 110/√3 |
| | | | | | |
| 7. | Application | Metering | | Protection | Protection |
| | | | | Main-I | Main-II |
| | | | | | |
| 8. | Accuracy | 0.2 | | 3P | 3P |
| | | | | | |
| 9. | Output burden (VA) (minimum) | 50 | | 50 | 50 |
| | | | | | |

## 11.20 11 KV HT SWITCHGEARS

1. Scope

Supply, Manufacturing , installation, testing commissioning of integrated cubicle type metal clad, floor mounted and draw out type free standing, front operated indoor type 11KV switchgear as per following specifications :

2. General

The switchgear enclosure shall conform to degree of protection **IP -4X**.

The switchgear shall be made from MS sheet steel 2 mm thick (CRGO) and shall be folded and braced as necessary to provide a rigid support for all components.

The switchgear assembly shall form a continuous dead front line up of free standing vertical cubicles. Each cubicle shall have a lockable front hinged door and a removable bolted back cover. All covers and doors shall be provided with neoprene gaskets. Suitable arrangement for lifting of each cubicle shall be provided. Design and construction of the switchgear shall be such as to permit extension at either end.

Vacuum Circuit breaker shall be provided with surge arresting device for protection against lightning and switching over voltage. Two separate and distinct connections to earth shall be provided for each surge arrestor.

Suitable earthing trolley/ truck shall be provided separately for each substation.

3. Breaker Compartment

Vacuum Circuit Breaker shall be mounted in draw out truck with front plate which covers the cubicle when the breaker is in service position. Draw out mechanism shall be horizontal type. This front plate shall be provided with view glass to facilitate observation of mechanical ON/OFF indication of Circuit breaker, Spring charged / discharged indication and operation counter. Necessary orifice shall be provided for manual charging of the springs. ON/OFF push button for opening and closing of the circuit breaker shall also be provided. The draw out truck shall have two positions for the circuit breaker VIZ isolated / Test & Service.

4. Bus Bar Compartment

Bus bars of rectangular cross section of copper conductor supported by cast epoxy insulator to withstand full short circuit currents 26.3 kA for 11Kv system shall be provided at the rear. Bus bar chamber shall be provided with inter panel barriers with epoxy cast seal off bushings.

5. CT and Cable Compartments

At the rear of the panel sufficient space shall be available to accommodate three numbers epoxy CT's of double core and two numbers three core cable termination. The cable entry shall be from the top / bottom.

6. Separate Compartments

Circuit breakers, instrument transformer, bus bars, cable etc shall be housed in a district different compartments as required partition class PM, compartmentalization. All relays, switches, lamps, etc. comprising the control, indication and protective devices shall be housed in a separate compartment on the front of the cubicle.

Technical Particulars of Vacuum Circuit Breaker

| S.NO. | DESCRIPTION | Kv |
|---|---|---|
| A | Rated Current | 630 A/ 800 A / 1250 A |
| B | Rated Voltage | 11kV |
| C | Rated Frequency | Hz |
| D | Rated Short Circuit breaking Current | 26.3 kA for 1 sec |

| | | |
|---|---|---|
| E | Rated short circuit making current (KAP) | 65.75 |
| F | Insulation level (Kv rms/Kvp) | 28kVrms / 75kVpeak |

7. Isolating Contacts

The breaker isolating contacts shall consist of two parallel flat silver plated copper bars with ball point contacts to give a vertical tolerance of ±10 mm.

8. Low Voltage Plug and Socket Connector

A twenty pin plug and socket connection along with flexible leads shall be provided to connect control instrumentation and interlock circuits on the breaker truck and in the panel. The plug and socket assembly shall be suitably interlocked with the truck positions like service and test/isolated position

9. Interlocks and Safety Devices

The following interlocks shall be provided:

- The truck cannot be moved from either test to service position or vice versa, when the circuit breaker is 'ON'.
- The circuit breaker cannot be switched 'ON' when the truck is in any position between test and service position.
- Front part of the truck cannot be removed when the breaker in 'ON' position.
- The truck cannot be inserted when the earthing switch is 'ON'.
- The low voltage plug and socket cannot be disconnected in any position except test/isolated position.
- The truck cannot be moved inside the panel, when the LT plug and socket is disconnected.
- Earthing switch cannot be switched 'ON' when the truck is inside the panel.

Safety Devices

The following Safety devices shall be provided for the safety of the operating personnel:

- Individual explosion vents shall be provided for breaker chamber/bus bar/cable chambers on the top of the panel to let out the gases under pressure generated in case of fault inside the panel.
- Cubicle with front plate to withstand the pressure for internal arc fault as per IEC recommendation.
- Circuit breaker and sheet metal enclosure shall be fully earthed.
- Self locking shutters shall be provided which shall close automatically when the truck is withdrawn to 'Test position' and no separate padlocking of the shutter shall be required.

10. Protective Earthing

The earthing connection between the truck and the cubicle shall be by means of sliding contacts so that the truck is earthed in the isolated position when inserted and remains earthed when the truck is pushed further into the connected position or when the truck is being withdrawn until the truck has moved part the isolated position.

11. Current Transformer

General Requirements

Accommodation shall be provided in the circuit breaker panel, to mount one set of duel ratio CT. Access to the CTS for cleaning, testing or changing shall be from the front, back or top of the panel.

Rating

Duel ratio CTS of suitable burden (but each not less than 15 VA) shall be preferred with 5 amps secondaries.

Instrument Security Factor (ISF) of each CT shall not be more than 5.

The CTs shall conform to relevant Indian Standards. The design and construction shall be oil type, epoxy resin cast robust to withstand thermal and dynamic stresses during short circuits. CT terminals shall be shorting type. Current & voltage circuits shall be laid in separate wire ways.

Secondary terminals of CTS shall be brought out to a suitable terminal block which will be easily accessible for terminal connections. Test terminal block shall be provided in the front side of the panel for testing purpose.

CT'S shall have 2 Nos. of cores for following application:

| | |
|---|---|
| Core -1 | for metering |
| Core -2 | for over current & earth fault protection. |

Class of accuracy for winding

| | |
|---|---|
| Metering class | 0.5 |
| Protection class | 5P20 |

12. Potential Transformers

The potential transformers shall be confirming to IS 3156/ IEC 60185.The primary windings of the potential transformers shall be insulated and shall be of the cast rest in type.

Potential transformer (PT'S) shall be mounted on a draw out trolley and housed in separate metal compartment and shall have control fuses on the H.V. side and a miniature circuit breaker on the L.V. side of the windings.HT HRC Control fuses shall be confirming to IS – 9385/ IEC – 60282.Miniature Circuit breaker shall comply with IS – 8828/ IEC – 60898.

Padlocking facilities shall be provided for both service and isolated position.

The potential transformer shall be as specified below:

| | | |
|---|---|---|
| Ratio | : | 11000 /√3/ 110/ √3/ 110 V/ √3 |
| V A Burdan | : | 100 V A for both 110/√3 V winding |
| Class | : | CL –1 for both the windings. |
| Basic Insulation level | : | Same as mentioned for VCB in clause -6. |
| Over voltage factor | : | 1.2 Continuous |

Single phase PT'S shall be used and shall be connected in Star/ Star.

13. Protection and Tripping Arrangement

Protection

All protection relay shall be numeric type of approved make.

The protection and tripping arrangement of circuit breaker shall be Provided as per BOQ & as mentioned below:-

- Numeric type instantaneous short circuit protection Device No.50 Range 500 – 2000% shall be provided on all phases.
- Numeric type back up over current protection for Phase faults Device No.51 Range 50 – 200% shall be provided on all phases.

Numeric type ground fault protection Device No.50G. CT's. Range 20 – 80% shall be provided.

Surge Arrestor

Lockout and trip supervisory relays etc shall be provided with manual reset facility.

Auxiliary relay for transformer fault.

14. Control Wiring

The control wiring shall be carried out with 1.5/2.5 sq. mm. PVC insulated copper conductor cables. The wiring shall be securely fixed and neatly arranged to enable easy tracing of wires. Identification PVC ferrules shall be fitted to all wire terminals to render easy identification and facilitate checking in accordance with IS 5578 and 11353.

15. Metering Instrument Panel Accessories

Metering

Digital type Trivector meter of approved make (Smart demand controller) shall be provided on the incomer feeder. Specification of the meter shall be as follows:

Accuracy : Class 0.5, compliant to revenue class certification.
: Real time measurement per phase & average
V, I, PF, Kw, Kvar, Kva
: Peak demand, sliding window. Protected.
: V & I unbalance, Phase reversal
: Time of Use (TOU)

Power Quality Measurement:
: Total Harmonics

Logging & recording for all measurements:
: Interval or event-based, 32 channel measurement & recording
: Event logging
: "Bust" data recording
: Min/ Max recording
Alarming: Over & under measurement detection by 24 set point functions.
Multiport
Communication: One each of RS 485 and RS 232 ports.

Instrument Panels

The instrument panel shall be part of the housing. Relays, meters and instruments shall be mounted as per general arrangement drawings to be submitted by the vendors. They shall be of flush mounting type.

Instrumentations

- Digital type Voltmeter of class 1.0 accuracy and 96 x 96 mm square in size as per IS-1248 shall be provided at incomer panel, with selector switch. The instrument shall be calibrated for the ranges specified.
- Digital type Ammeter of specified range to class 1.0 accuracy and 144 x 144 sq mm in size as per IS – 1248 shall be provided at both incomer and outgoing panels along with necessary selector switches.
- Digital type frequency meter class of 1.0 accuracy conforming to IS:1248 shall be provided at incomer panel.
- Digital type Power factor meter of class of 1.0 accuracy conforming to IS : 1248 shall be provided at incomer panel.

The following minimum indication lamps shall be provided in the front of cubicle.
Breaker open / closed / tripped, spring charged, trip circuit healthy and control supply healthy. Lamps shall be clustered LED type and trip circuit supervision scheme shall be of continuous supervision type.

After meeting all necessary control and indication requirements 2 nos. NO and 2 nos.. NC auxiliary of the breaker shall be made available for the owner, wired up to terminal block.
Separate MCB's shall be provided for lamps, heaters and other instrumentation etc. on each panel.
Anti-condensation space heaters suitable for operation on 240 V single phase, 50 Hz A.C. for each cubicle and with thermostat control one incandescent lamp with switch and 3 pin 5 amps plug socket.

16. Inspection and Testing

After manufacturing of switchgear panels tests shall be carried out on the equipment as per relevant IS and Electricity Regulations.

17. Quality Assurance

Vendor shall submit in substantial detail a quality assurance plan indicating all activities step by step at various manufacturing/fabrication stages to meet the requirement of this specification and various standards/regulations/practices to enable comprehensive assessment of its merits and reliability.

## 11.21 COMPACT SUBSTATION WITH OIL TYPE TRANSFORMER

The Compact substation shall comprise the following components connected with cables/ solid bus bar connection and housed in an enclosure made of 2 mm thick G.I sheet, painted in an approved shade complete as required. The enclosure shall be IP 54 for HT and LT switchgear and IP34 for Oil Type Transformer compartment.

1. Isolator:

3.5.1 The Isolators offered shall conform to IS: 4710/9920 as amended to date. The isolator shall be triple pole, spring assisted, hand operated, non-automatic type with quick break contacts. The operating handle shall have three positions 'ON', 'OFF' and 'EARTH' which shall be clearly marked with suitable arrangement to padlock in any position. A safety arrangement for locking shall be provided by which the isolator operation shall be prevented from 'ON' position to 'EARTH' position or vice versa.

Switchgear:

a. Sealed for life, the enclosure shall meet the "sealed pressure system" criteria in accordance with IEC: 298 (a system for which no handling of gas is required through out service life of approximate 30 years.) There shall be no requirement to 'top up' the SF6 gas. In addition, manufacturer shall confirm that maximum leakage rate is lower than 0.1% per year. It shall provide full insulation, making the switchgear insensitive to the environment. Thus assembled, the active parts of the switchgear unit shall be maintenance free.

b. The switchgear & switchboard shall be designed so that the position of different devices is visible to the operator on the front of the switchboard & operations are visible as well. The switchboard shall be designed so as to prevent access to all live parts during operation without the use of tools.

c. RMU should be tested for internal arc fault test.

Circuit Breaker:

The Unit shall consist Tee-off spring assisted, three pole SF6 breaker, with integral fault making / dead breaking earth switch. The function shall be naturally interlocked to prevent the main & earth switch from being switched 'ON' at the same time & the circuit breaker not allowed to trip in 'Earth On' position. The selection of the main/earth switch lever on the panel, which is allowed to move only if the main or earth switches in the off position. The lever shall be able to pad locked in either the main or earth position.

Protection :

Protection Relays: The Circuit breaker shall be fitted with static type self powered relay inside the front cover to avoid any tampering.

2. 11 KV SWITCH BOARD (H.T SWITCH GEAR)

- Description Of Work
  Supply of 11 KV single VCB panel boards inside compact enclosure.

- Applicable Codes, Standards And Applicable Publications
  All equipments and materials specified herein or not shall be designed, manufactured and tested in accordance with the latest applicable standards and bureau of Indian standards.

All electrical equipment shall also confirm to the latest electricity rules as regards safety rules and other provisions.

All electricity work shall comply with the requirements of the following Rules/Acts/Codes as amended upto date:

a) Indian Electricity act.
b) Indian electricity rules.
c) National electric code.
d) All relevant IS codes of practice.

| | | |
|---|---|---|
| IEC 61330 | : | High voltage low voltage compact substation. |
| IS 13118, IS 3427,IEC60694 & IEC60298 | : | 11 KV Switchgear cubicles |
| IS 9920 &IEC 60265 | : | 11KV Switchgear |
| IS 2026 | : | Distribution Transformers |

- Submittals
  - Drawings and Data
    The tenderer shall furnish relevant technical data on circuit breakers and associated equipment along with the offer for evaluation of the offer.
    As part of the shop drawings, the Contractor shall furnish relevant descriptive and illustrative literature on breakers and associated equipment and the following for approval before manufacture of the panel.
  - Complete assembly drawings of the panel showing plan, elevation and typical section views and locations of compact substation.
  - Typical and recommended schematic diagrams of circuit breakers.
  - Foundation plan showing location of foundation channels, anchor bolts and anchors, floor plans and openings for cables etc.
  - Type test certificates of Compact substation.
  - All drawings and data shall be in English.

- Tests and Test Reports
  Routine tests shall be carried out on completely assembled equipment as per relevant standards & test reports submitted.

  Copies of the test certificates for all bought out items shall be submitted for approval before dispatch of the equipment. Bound copies of complete test results as specified in the specification shall be furnished with the equipment. These shall include complete reports and results of the routine tests as also certified copies of type tests carried out on equipment of identical design.

- SPECIFICATIONS
  - Construction Features
    11KV Compact secondary substation outdoor type designed for natural cooling having type tested equipment comprising distribution transformers and VCB switchgear enclosed in laser sealed/welded stainless steel tank, low voltage switchboard, interconnection between HT switchgear and transformer using cables and transformer to LT switchgear using Al bus bars/cables, factory built ready for connection type, internal earthing factory completed and other associated equipment etc. complete as required conforming to detailed specifications.

    The enclosure shall have modular construction using G.I sheets and shall be painted with polyurethane paint from the exterior. The enclosure for HT & LT switchgear shall be provided with IP54 ingress protection. The transformer compartment will have IP34 ingress protection. The transformer used shall be of Oil type with OCTC specially designed for low losses. The combinations of Compact substation shall be as per details below:

  - Design Criteria
    Unitized Sub-station consisting of 11KV VCB + Transformer + L.T. Switchgear with all connection accessories, fitting & auxiliary equipment in an Enclosure to supply Low-voltage energy from high-voltage system as detailed in this specification. The complete unit shall be

installed on a substation plinth (base) as Outdoor substation. The Vacuum Circuit Breaker shall be used to control and isolate the 11kV/415 V Distribution transformer. The transformer L.T. side shall be connected to L.T. switchgear. The connection cables shall be taken out from the L.T. switchgear.

The prefabricated-unitized substation shall be designed for a) Compactness, b) fast installation, c) maintenance free operation, d) safety for worker/operator.

The Switchgear and component thereof shall be capable of withstanding the mechanical and thermal stresses of short circuit listed in ratings and requirements clause without any damage or deterioration of the materials.

For continues operation at specified ratings temperature rise of the various switchgear components shall be limited to permissible values stipulated in the relevant standard and / or this specification.

- CIRCUIT BREAKERS
  - 11KV VCB:

    1No. 11KV, 630 Amps., 21kA for **1sec** VCB Breaker comprising of single panel as indicated below:

    Air insulated metering module with 11KV PT and Voltmeter (As specified in BOQ).

    VCB Breaker complete with operating mechanism, protection system and One Number of cable box accessible from the front.

    The above breaker, Bus bars should be mounted inside a sealed, stainless steel tank of 3 mm thick sheet metal.

    General Finish: Totally enclosed, metal clad, vermin and dust proof suitable for tropical climate use as detailed in the specification.

    Ratings: The bus bars shall have continuous rating of **630 Amps**. VCB breaker shall have a continuous rating of 630 Amps. In accordance with relevant IS / IEC standard

    Breaking & Making Capacity : Circuit Breaker shall be capable of having rupturing capacity of 21KA symmetrical at 11000 volts three phase.

  - Busbar: Switchgear shall be complete with all connection, bus-bars etc. Copper bus bars continuous rating shall be **630 Amps.**

    Protection :
    Protection Relays: The CB shall be fitted with microprocessor based self powered relay inside the front cover to avoid any tampering.

    Locking Arrangement : Suitable padlocking arrangements shall be provided as stated below
    a) CB manual operating handle in the “OFF” position.
    b) Each feeder Panel operating handle in ‘Closed’ ‘Open” or ‘Earth’ position.

  - Tests For Circuit breaker: Each type of 11kV VCB Switchgear shall be completely assembled, wired, adjusted and tested at the factory as per the relevant standards i.e. IS:9920, IS:3427, IS:13118, IEC:265, IEC:298 and during manufacturing and on completion

- Routine Tests : The tests shall include but not necessarily limited to the following:-

  - ✓ Operation under simulated service condition to ensure accuracy of wiring, correctness of control scheme and proper functioning of the equipment.
  - ✓ All wiring and current carrying part shall be given appropriate High Voltage test.

3. TRANSFORMER (OIL – TYPE with Off load tap changer)

- Requirement: 11000/433 Volt OIL TYPE, oil type suitable for installation at outdoor in Enclosure for ground mounting. The transformer should be designed for low losses.
- Voltage Ratio: No load voltage 11000/433 volts within tolerance as stipulated in IS:2026.
- Rating: The transformer shall have a continuous rating as specified at any of the specified tapping position and with the maximum temperature rise specified.
- Temperature Rise: The maximum temperature rise at the specified maximum continuous output shall not exceed 90°C corresponding class-A.
- Type of Load: The transformer shall be suitable for carrying load within temperature rise indicated in the Indian Standard specification IS.
- Overloads: The transformers shall be suitable for carrying overload within temperature rise indicated in IS.
- Connections: H.V. Delta and L.V Star connected with neutral brought out on the secondary side for connection to earth; Vector group Dyn11 of IS:2026.
- Cleaning & Painting :
  - All steel surfaces shall be thoroughly cleaned by sand blasting or chemical agents, as required to produce a smooth surface free of scales, grease and rust.
  - The external Surfaces, after cleaning, shall be given two coats of high quality epoxy based rust resisting primer as per IS:2074 followed by filler coats.
  - The transformer shall be furnished with coats of weather resisting battleship gray epoxy based enamel paint as per IS:2932 specially recommended for transformer use.
  - The paints shall be carefully selected to withstand tropical heat rain, effect of proximity to the sea etc. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling.
  - Special care shall be taken by the manufacturer to ensure against rusting of nuts, bolts and fittings during operation. All bushings and current carrying parts shall be cleaned properly after final painting.

- Both H.V. and L.V. bushings shall have creepage corresponding to very heavily polluted atmosphere.

- Phase Marking & Danger Plate: Phase markings in fluorescent paint on small non-corrodible metallic tags shall be permanently fixed for H.V. and L.V sides. Phase markings tags shall be properly fixed with proper alignment. Danger plates shall be provided on the H.V & LV sides, mentioning the Corresponding Voltages.

- Core and Coil :
  - Core :
    The core shall be constructed from high grade, cold rolled, non-ageing, low loss, high permeability, grain oriented, cold-rolled grain oriented silicon steel laminations. The transformer shall be so designed as to have minimum humming noise. The percentage harmonic potentials with the maximum flux density under any conditions shall be such that capacitors connected in the system shall not be overloaded.

  - The core and coil assembly shall be securely fixed in position so that no shifting or deformation occurs during movement of transformer. The core and coil assembly shall be capable of withstanding without injury, the thermal and mechanical effects of short circuit at the terminals of any winding as per IS.

  - Impedance Volts:
    The Percentage impedance value at 75 Deg. C at any tap shall be 5% subject to tolerance as specified in relevant IS. The value of the impedance volts at each tapping over the specified range shall be specified in the bid.

- Regulation:
  The regulation at 75° C at full load at unity and 0.8 power factor subject to the usual tolerance as per IS shall be specified in the bid.

- Power Freq. High Voltage & Insulation Level (Impulse voltage):
  The distribution transformer shall be designed so that they are capable of withstanding high voltage & impulse voltages as per IS:2026 and as given below:
  - Impulse Voltage for 11kV winding: 75 kV (1.2/50 Microsecond wave shape).
  - High Voltage : 28kV rms.

- Fittings & Accessories For Oil Type Transformer :
  - The following accessories conforming to IS:3639 shall be provided for 11 kV/0.433 kV, distribution transformer.
  - Two earthing terminals with copper lugs. The lugs shall be provided in such a way that they shall not obstruct the movements of rollers. The earthing continuity for all the connected equipments shall be properly done.
  - Two lifting lugs for complete transformer as well as enclosure.
  - OFF load circuit tapping switch shall be rotary type, 3 pole gang operated, top mounting draw out type only. Tap switch shall be suitable for rated current considering 100% overloading & operating voltage. Switch shall be provided with externally operating hand wheel handle with indicator and locking device, with direction changing facility and locking arrangement.
  - Rating plate and diagram plate of durable non-corroding metal giving information as required under IS. Rating plate shall also include Transformer Actual %Z, No-Load Loss & Full-Load Loss at 75°C along with details like Purchase Order Number, date. The name plate marking shall be done with fluorescent colour. Each equipment shall carry individual name-plate with proper instructions & affixed with screws.

4. L.T. PANEL :

- System:-
  - Declared voltage :– 3 Phase,415V (±6%) 50 Hz,
  - Neutral :– Solidly earthed at substation.

- General finish:- Tropical, totally enclosed, metal-clad, weather-proof, vermin and dust proof.

- Construction :
  Enclosure:- Type of enclosure shall be able to provide the degree of protection IP:54 .

- Circuit Ways:
  As per the requirement given in the specifications / schedule of requirement.

- Construction :
  - The terminals shall be of sufficient mechanical strength and shall provide adequate electrical contact for the appropriate size of cable used. They shall be capable of receiving appropriate size of Aluminum conductors. They shall be provided with stainless steel nut bolts, plane washers and spring washers for cable connection.
  - The enclosure of LT shall be constructed using 2mm CRCA sheet steel.
  - No contact pressure shall be transmitted through insulating material & the gripping of the conductor shall take place between metal faces.

- Earthing :
  - Earthing arrangement shall be provided for earthing each cable, cable gland, neutral busbar, chassis and frame work of the cubicle with separate earthing terminals at two ends. The main earthing terminals shall be suitably marked .The earthing terminals shall be of adequate size, protected against corrosion, and readily accessible. These shall be identified by means of sign marked in a legible manner on or adjacent to terminals.
  - Neutral bus bar strip shall be connected to Earthing terminal with help of copper strip of suitable capacity & nut-bolt arrangement.

- Accessories: The following accessories shall be supplied duly mounted..
- One incandescent lamp (with necessary fuse) to illuminate the fuse board internally.

5. TYPE / ROUTINE TEST ON COMPACT SUBSTATION:
TYPE TESTS FOR THE UNITIZED SUBSTATION:
The offered unitized substation should be fully type tested as per the IEC-1330

- Routine Tests: The routine tests shall be made on each complete prefabricated substation.
  - Voltage tests on auxiliary circuit.
  - Functional test.
  - Verification of complete wiring.
- Test Witness: Routine test shall be performed in presence of customer representative if so desired by the customer.
- Test Certificates:
- Test report for the test mentioned under Type tests clause shall be submitted along with offer.

6. 11 KV SINGLE H.T VCB PANEL BOARDS:

- General:
  This specification covers the assembly, factory test, supply at site of 11 KV VCB, indoor (as specified in BOQ) switchgear, complete in all respects with all equipment fittings and accessories for efficient and trouble-free operation as specified here in under.

  The switchboard shall be suitable for the following system:

| | | |
|---|---|---|
| Rated Voltage | : | 3 Phase, 11 KV Earthed System |
| Maximum System Voltage | : | 12 KV |
| Rated Frequency | : | 50 Hz |
| Ambient Temperature | : | $45^{O}C$ |

- Standard & Codes:
  Unless otherwise stated, HT switchboard shall conform to the following relevant Indian standards and Indian Electricity Rules and Regulations.

| | | | |
|---|---|---|---|
| i) | IS-2516 (Part- IV/Sec.-2) 1980 amended upto date | : | Circuit Breakers |
| ii) | IS-3427 | : | Metal enclosed switchgear and control gear for voltage above 1000V but not exceeding 12000V A.C. |
| iii) | IS-2705 | : | Current Transformer |
| iv) | IS-3156 | : | Potential Transformer |
| v) | IS-1248 | : | Electrical Direct acting indicating instruments |
| vi) | IS-722 | : | A.C. electricity Meter of Induction type |
| vii) | IS-3231 | : | Electrical Relays |

- Equipment to be Furnished:
  - One complete 11 KV metal clad, cubicle type 3- panel board, indoor switchgear consisting of the following circuits:
    One (1) No. 11 KV, 630A VCB, 350MVA, Draw out type as incomer / outgoing with CTs.
  - All supporting structures and installation materials including steel foundation frame, anchor bolts, holding down bolts, etc.
  - Tenderer shall be required to supply all his distribution equipment for the control power supply as required.
  - Special tools and tackle required for erection, operation and maintenance of equipment.
  - Drawings, technical details, installation and maintenance manual for the switchgear and auxiliary equipment.
  - General Design Features:
  - The equipment shall be installed indoor in a hot, humid climate. All equipment, accessories and wiring shall be provided with tropical finish to prevent fungus growth. Space heaters shall be provided so that humidity does not effect the components.
  - The maximum temperature rise in any part of the equipment at specified rating shall not exceed the permissible limits as stipulated in relevant standards.

The rated peak short circuit current or the rated short time current carried by the equipment shall not cause:

- Mechanical damage to any part of the switchgear.
- Separation of contacts
- Insulation damage of "Current Carrying Part"

- All controls shall be suitable for 110V A/C.

7. Construction Features:

- General

The switchgear shall be indoor, metal-clad (cubicle type), floor mounted, draw-out truck type design. Each panel shall comprise essentially of two portions.

- The fixed portion housing bus bars, current transformers, voltage transformers, relays and instruments, cable pot heads and other accessories.
- The moving portion comprising of circuit breaker.

The switchgear shall have structural steel framework, enclosed on all sides and top by CRCA sheet of minimum 2mm thickness.

The moving portion of the switchgear shall consist of circuit breaker mounted on a carriage. The operating mechanism of the circuit breaker shall be located at the front of the carriage.

The moving carriage shall be complete with self-aligning primary and secondary disconnecting devices.

The moving carriage shall have three positions –

- Service
- Test
- Isolated

The switchgear shall be required to operate in the following manner.

- In "service" position all the power contacts and control contacts shall be maintained and the circuit breaker can be closed and tripped in the normal way.
- In "test" position, the power contacts shall be disconnected and control contacts shall be maintained. In this position, the circuit breaker can only be closed and tripped from local panel only.
- In "isolated" position, both the power and control contacts shall be disconnected and the carriage shall be ready for removal.

The switchgear shall be designed in such a way that power contacts of the fixed portion shall be covered by a shutter when the moving carriage is withdrawn from the switchgear.

Each switchgear assembly consisting of all the units shall be mounted and bolted to a common channel. The channel in turn shall be bolted to the foundation at site. All equipment foundation, anchor bolts, etc. shall be furnished.

The standard phase arrangement when facing the switchgear shall be R-Y-B from left to right, from top to bottom and front to back. All relays, instruments, other devices, buses and equipment involving three phase circuit shall be arranged and connected in accordance with the standard phase arrangement.

- Bus Bars:

The switchgear buses shall be rated for continuous current of magnitude as specified. Maximum temperature rise of bus and connection shall be limited to 50 $^{O}$C ambient.

The bus bars, of the switchgear section shall be of copper liberally sized with high safety factor for required current rating and shall be of the same cross-section.

The busbars, connection and their insulated supports shall be mechanically strong, and shall withstand all the stresses which shall be imposed upon them in ordinary working due to fixing, vibration, fluctuation in temperature, short-circuit or other causes.

The bus bars shall have the marking, colour coding and arrangement according to the relevant IS and shall run in a separate bus bar chamber. The bus bars and joints shall be fully insulated and so enclosed as not to leave any exposed live parts.

Provision shall be made for expansion and contraction of the busbars and connections with variation of temperature.

- Circuit Breakers
  The circuit breakers shall be vertically and horizontally draw out type VCB mounted on the moving carriage. The circuit breaker shall be of modular design. The rating of the circuit breaker shall be as specified.
  - Normal Service Conditions :
    Ambient temperature : 50 degree Celsius
  - System:
    - System Voltage : 11 KV, Effectively earthed system
    - Highest system voltage : 12 KV
    - Frequency : 50 Hz
- Main circuit terminal : Circuit breaker should be provided with 3 main terminals and 3 load side terminals.
- Closing mechanism & Antipumping device : Motor operated closing mechanism and Mechanical and electrical antipumping device shall be provided. Motor operating mechanism shall be complete with universal motor, opening spring, closing spring, and all necessary accessories. Spring charged/ discharged indicator shall be provided. The Mechanism shall work on 220 V AC.
- Coil voltage for shunt trip and release coil : 110V A/C
- The symmetrical breaking capacity in MVA shall remain constant for 11 KV breaker.
- Breakers shall be capable of making, carrying and breaking starting and full load currents.
- Breakers shall be suitable for local electrical operation. Mechanical interlocks shall be provided to prevent:
  - A closed circuit breaker from being moved from service position to test position/isolated position.
  - Closing and opening of the circuit breaker in an intermediate position between “Service Test”.
  - Circuit breaker can be racked in to service position only with the front door closed.
- Breakers shall be complete with the following accessories.
  - Mechanical operating device for manual closing and tripping of the breaker.
    Device for manual charging of the closing spring.
    At least three (3) NO and three (3) NC mechanically operated auxiliary contacts of sufficient rating (in addition to those required for breaker operation) shall be wired out to terminal block for external connection. In the case of 11 KV breaker in addition to the circuit breaker auxiliary contacts provided on breaker trolley for circuit breaker operation, a mechanically operated switch shall be provided on a stationary part of switchgear. This switch shall be positively operated by the breaker mechanism when the breaker is in “service” position but not when the breaker is isolated. The switch shall be provided with at least six (6) normally open and at least six (6) normally closed adequately rated auxiliary contacts for each circuit breaker for inter locking.

    In case a switch with six (6) NC contacts cannot be offered as required then a switch with six (6) normally closed and two (2) normally open contacts may be offered along with an

auxiliary relay having four (4) normally open and two (2) normally closed contacts (out of which any four contacts shall be wired out), shall be provided on each feeder cubicle.

Each circuit breaker, disconnector and bus VT cubicle shall have necessary limit switches for service and test positions, which shall provide the required contacts for breaker operation and interlocking, position indication and disconnection of remote control circuits.

- Each breaker shall have the following protections :-
  - Short circuit and overload protection:-
    Short circuit and overload protection shall be provided through inverse definite minimum time (IDMT) type of relay. This relay shall be provided with shunt reinforcement alongwith the hand reset flag. Relay rated time shall be less than 1.3 seconds. This relay shall be having the non-directional feature. The relay shall be induction disc type with adjustable time current characteristics. Relay shall be of high torque and shall ensure high contact pressure even at currents near pickup values. The relay shall be of three (3) element type. Two elements for overload protection and one element for earth fault protection. Current setting range of the relay shall be 50-200%.

    Earth fault protection shall be provided through an earth fault relay. The relay shall be of heavily damped induction disc type with an adjustable inverse time voltage characteristic. The relay shall have a setting range of 20-80%.

  - Master Trip Relay:-
    The relay shall be fast acting multi contact, attracted armature with high mechanical stability. It shall be suitable for tripping duties requiring simultaneous switching operation. The relay shall be suitable on 24 V DC. The operating time shall not exceed more than ten (10) milli second. The number of hand reset contact NO/NC shall be as per final approved scheme plus 25% spare. The contact used for tripping circuit breakers shall be blow out type.

    Each breaker shall be power operated by stored energy, charged spring mechanism for both closing and opening operations. Accidental failure of any spring shall not trip or close a breaker. Spring shall be charged full at all times.

    Breaker shall close, upon closing a contact in its closing circuit momentarily. A second closing impulse shall have no effect on the closing mechanism.

    Red lights, indicating ‘Breaker-closed’ shall be wired to supervise shunt trip circuit. Green lamps mounted on remote panels indicating ‘Breaker-open’ shall be wired to light up only when remote/local switch is on ‘Remote’ position.

    All protective relays shall be provided with flag indicators, and all relays directly tripping the breakers shall be provided with hand reset contacts in addition to the flag indicator.

  - Rated short circuit making current of circuit breaker shall be 2.5 times the rms value of the AC component of the rated short breaking current.

8. Instrument Transformer

- Current Transformer
  The current transformers shall be of epoxy encapsulated/cast resin type, mounted on stationary portion of the switchgear and shall be easily accessible for maintenance and testing purpose.

  The current transformers shall be capable of withstanding the short circuit stresses corresponding to a fault level of the system.

  The ratio and ratings of the current transformers shall be suitable to meet the requirements of metering and protection of the corresponding feeder.

  The current transformers shall conform to the latest edition of IS. Unless specified otherwise, insulation, temperature rise and all other phases of manufacture and testing shall conform to that

given in the standards. A type test certificate of a CT of similar design for temperature rise test shall be furnished along with the offer.

Facilities for shorting and grounding the terminals shall be provided at the terminal block.

- Potential Transformers

  The potential transformers shall be epoxy encapsulated /cast resin design and Star type on L.T. side.

  A manually operated disconnecting device shall be mounted on the primary side of potential transformer. This device shall be designed to operate externally without access into the line portion of the switchgear.

  The connections from main circuit to potential transformers shall be capable of withstanding short circuit stresses of the system.

  The high voltage winding of the potential transformer shall be protected by current limiting fuses. Low voltage fuses, sized to prevent harmful overload, shall be installed.

  The manufacture, testing, insulating and temperature rise of the potential transformer shall conform to the latest revision of the relevant IS.

  The 110V bus in the switchboard shall be sectionalized.

9. Instruments & Meters

The instruments shall be the flush type preferably with the square face of 144mm as specified. They shall be fully tropicalised, dust tight and shall conform to the relevant standards.

Marking of the scale shall be black on white background and shall be suitable for direct reading.

Zero adjustment shall be provided for the operation from the front of the cases.

The instruments shall be capable of indicating accurately when operating continuously under the ambient condition specified.

The scale range of the AC ammeter shall generally be equal to 1.5 times the rated primary current of the C.T. feeding them. The scale range of the voltmeter shall be about 15% in excess of the normal circuit voltage.

Ammeter for transformer circuits shall be marked with a red mark to indicate the full load current of the transformer.

10. Auxiliary And Control Power Supply

- AC Power Supply for Space Heater and Cubicle Illumination Lamps:

  Each carriage control panel including the breaker operating mechanism shall be provided with thermostatically controlled space heater. The thermostat shall have adjustable range. The space heaters shall be rated for 230 volts, 1 phase, 50 Hz. For cubicle illumination, receptacle arrangement at suitable location of each control panel shall be provided so that hand lamp connection may be taken from this receptacle during inspection and maintenance.

  Wiring for space heaters shall be suitably grouped so as to form a more or less balanced conditions on 230 V, 1 phase, 50 Hz supply. Suitable number of space heaters alongwith thermostat may be provided.

  Each space heater and hand lamp circuit shall be provided with ON/OFF switch and suitable protection.

- Control Supply:

  The power for breaker control and indication shall be taken from 110V A/C supply.

In addition, each cubicle shall be provided with one double pole, single throw switch for its control circuit power supply.

- Fuse:
  All control and power fuses shall be link type "HRC" fuses. Plug fuses (screw-in type) shall not be accepted.

11. SECONDARY AND SMALL WIRING
- All wiring for the equipment and devices located on or within the switchgear shall be carried out. The wiring shall be complete in all respects so as to ensure proper functioning of control, indication, measurement, protection and interlocking scheme.
- All the wiring shall be marked in accordance with the relevant standards. Numbered ferrules, reading from the terminals onward shall be provided at both ends of all the wiring for easy identification.
- The internal wiring shall be of PVC insulated cable of 1100 grade of minimum size 2.5 sq.mm copper.

12. Alarm Annunciation System
The annunciator shall be provided on each panel to indicate the various circuit condition and shall be placed at suitable height. The various function shall be as follows:
Circuit breaker closed
Circuit breaker open
Trip circuit healthy
Alarm & Auto trip – fault
C/B in test

Hooter/Buzzer shall be provided with a manually operated switch so that it can be silenced.

It shall have built in test, reset and accept push button.

13. Cable Termination
- Power Cable
  Cable pot heads for termination of 11 KV XLPE type insulated cables shall be furnished.

  All power cable entry shall be from the top/bottom and the cable pot heads shall be self-supported, detachable type.

  Where more than one cable pot heads are used per phase, the Contractor shall be required to arrange pot heads in such a way that detachment of any pot head is possible without disturbing the other units. The gap between termination & gland plate shall be min. 900mm.

- Control Cable
  All control cables shall enter the switchgear from top/bottom. Removable plates at the top/bottom of the panel shall be furnished with compression type cable glands to make entry dust-tight and no weight is transferred on the terminal. The glands shall be suitable for terminating cable armour.

  All connections and accessories required to complete the whole installation shall be supplied by the Sub Contractor.

14. Terminal Blocks
Terminal blocks shall be provided as specified and shall be clipon type. They shall be shrouded preferably by a transparent acrylic sheet. The terminal block of different voltage classes shall be segregated.

15. Accessories
Following accessories shall be provided for each switchgear:

Channel base and foundation bolts Lifting lugs Maintenance closing handle for circuit breaker Draw handle for circuit breaker Hook stick, indoor use, 1.5 m long Test plug for draw out type relay

16. Nameplate

Nameplates of approved design shall be furnished at the front of each compartment of the cubicles. Rating plates for each circuit breaker and at each instrument, relay and auxiliary switches as mounted on the face or inside the cubicle shall also be furnished.

Instruments and devices mounted on the cubicle door of the switchgear shall be identified on the rear also with the respective numbers on or adjacent to the instrument or device case.

17. Ground Bus

A ground bus of 25 mm x 6 mm Copper flat shall be furnished along with the full length of the panel. Each stationary unit shall be connected directly to this ground bus.

Grounding terminals at two end of the ground bus shall be provided for connection to station ground grid.

The frame of each draw-out carriage containing circuit breaker shall be grounded through heavy multiple finger contacts at all times except when the unit primary disconnecting devices are separated by a safe distance.

18. Tests :

The circuit breakers, voltage transformers and current transformers shall be subjected to the following routine and type tests in accordance with the details specified in the relevant Indian Standards, as amended from time to time.

- Routine Test

  Each of the following equipment shall be subjected to standard routine tests as per applicable clauses of relevant IS specifications:
  - Verification of terminal markings and polarity.
  - Power-frequency dry withstand tests on primary windings.
  - Power frequency dry withstand tests on secondary windings.
  - Determination of errors according to the requirements of the appropriate accuracy class.

- Design Test

  Typical type test report of the tests mentioned below conducted on similar equipments in the past shall be furnished alongwith the tender.
  - Verification of terminal markings and polarity.
  - Power frequency dry withstand tests on primary windings.
  - Power frequency dry withstand tests on secondary windings.
  - Determination of errors according to the requirements of the appropriate accuracy class.
  - Temperature-rise test
  - Impulse voltage tests on voltage transformers for service in electrically exposed installations.

- Test Certificates

  Test certificate shall be furnished in required number of copies.

  The routine and type test certificates shall be furnished to the Engineer-in-charge for approval before dispatch of the equipment from the works. The approval in writing shall be required to effect the dispatch of the equipment.

  The routine and type test certificates of the miscellaneous components shall also be furnished to the Engineer-in-charge for approval.

  The report shall furnish complete identification of data including serial number of each equipment.

- Performance Guarantee

  The performance guarantee figures quoted on the schedule of technical data shall be guaranteed within the tolerances permitted by standard and will become a part of successful Tenderer's Contract.

19. Drawings, Data And Manuals:

- After award of contract, the successful Bidder shall submit the required number of copies of the following drawings for approval of the Engineer-in-charge :

  Confirmed outline dimensional drawing of the various switchgears showing the general arrangement and indicating the following:

  Space required in the front for breaker withdrawal.
  Control cable entry points and termination arrangement.
  Power cable entry points and termination arrangement.
  Bus bar clearance phase to phase and phase to ground.
  Configuration of bus bar.
  Technical detail of supporting insulator and their spacing.
  Location of instrument transformers.
  Control panel details with equipment layout.
  Terminal block details.
- Single and three line diagram of all switchgears showing instrument transformers control switches, instruments and indication, etc.
- Control schematic diagram of each breaker showing all safety and operation interlocks, annunciation, etc.
- Transport/shipping dimensions with weights.
- Foundation and anchor bolt details including dead load and impact load.
- Cross-section with parts list.
- Cubicle wiring diagram with terminal board disposition.
- Any other relevant data, drawing and information necessary for review of items whether specifically mentioned or not, shall be furnished by the Contractor along with those information.
- The responsibility of correctness of wiring diagram shall be with Contractor. The Engineer-in-charge will check the final schematic after submission. If any modification, addition or alteration is considered necessary to comply with the approved schematic drawing as stated herein above, the said modification, addition or alteration shall be carried out by the Contractor either in their works if it is before delivery, or at Site after delivery at no cost to the Owner.
- Before starting manufacture of the equipment, the Contractor shall have to take approval of these design drawings from the Engineer-in-charge in writing. Any manufacturing done prior to approval of drawings shall be rectified in accordance with the approved drawing by the Contractor at his own cost and the equipment shall be supplied within the stipulated period.

## 11.22 HT CABLE (UE)

1. General

Cables shall be aluminium conductor, unearth type , FRLS, cross linked polyurethane construction and shall be supplied, inspected, laid, tested and commissioned in accordance with drawings, specifications, relevant Standard Specifications and cable manufacturer's instructions.

2. Material

Conductor

The Conductor shall be made from electrical grade aluminum, stranded wires compacted together.

Insulation

High quality TROPOTHEN – X (XLPE) unfilled insulating compound of natural colour shall be used for insulation. Insulation shall be provided by extrusion process and shall be chemically cross linked in continues vulcanization process.

Shielding

Cables shall be provided with conductor shielding as well as insulation shielding and shall consist of extruded semi-conducting compound, additionally insulation shield shall be provided with semi-conducting and metallic tape shield over the extruded insulation shield. XLPE insulation and outer core shielding shall be extruded in one operation.

Armouring

Armouring shall be provided over the inner sheath and shall comprise of flat steel wires (strips).

Outer Sheath (with FRLS)

Tough outer sheath of heat resisting PVC compound shall be FRLS extruded over the armoring in case of armored cables, or over inner sheath in the case of unarmored cables.

3. Tests

Cables shall be type tested and routine tested in accordance with IS:7098 (Part II).

The following tests shall be carried out at site for insulation between phases and between phase and earth before and after the cable laying is complete.

- Insulation Resistance Test.
- Continuity resistance test.
- Sheathing continuity test.
- Earth test.
- High Voltage test.

Cables shall be laid with a clearance of at least 75 mm between two cables.

Before laying of cables megger values shall be taken and shall be recorded.

4. End Termination Of HT Cable

Pre-moulded cable terminations for XLPE cable shall be used as per manufacturer's instructions. The heat shrinkable raychem shall consist of highly track resistant insulating section vulcanised to a semi-conducting section. The pad material shall have cold-flow properties and shall be flame retardant.

Each end terminal shall undergo Hi Pot Test at site. Necessary equipment shall be arranged at site by contractor.

5. Laying of HT Cables

Direct In Ground

The work shall involve digging of outdoor trench in ground and laying cable(s) as indicated in specifications and Schedule of Quantities.

The depth of the trenches shall not be less than 1500 mm for 66 kV , 900mm for 11kV plus radius of cable, from the upper surface of ground. Where more than one multicore cable is laid in the

same trench, a horizontal inter spacing of 250 mm shall be left in order ro reduce mutual heating and also to ensure that fault occuring on one cable will not damage the adjacent cable.

Cable shall be laid in cement pipes encased in concrete or hume pipes at all road crossing. Cables shall be laid in trenches over rollers placed inside the trenches. After the cable has been properly laid and straightened, it shall covered with 80 mm thick layer of sand. Cable shall then be lifted and placed over the sand cushion. Again, the cable shall be covered with 80 mm layer of sand. Over this cable protection shall be provided by providing tiles which shall overlap cables 50 mm on either side. Trenches shall then be back-filled with earth and shall be consolidated. Suitable cable markers made of cast iron with aluminium paint indicating the voltage grade, direction of run and size of cables shall be provided at regular intervals.

RCC/MASONRY TRENCH

For laying of HT cable in RCC/Masonry trench refer detail on sub-station layout drawing and IS-1255-1983.

## 11.23 IGBT BASED INTEGRATED HYBRID POWER FACTOR CORRECTION SYSTEM

Design, fabrication, assembling, wiring, supply, installation, testing and commissioning of HPFC (hybrid power factor correction) panel having IGBTs, microprocessors, capacitors, reactors and other associated accessories, as explained below.

The HPFCpanel shall be fabricated out of 14/16 gauge CRCA sheet steel in cubicle compartment, free-standing, floor-mounted, dust and vermin proof with reinforcement of suitable size, angle iron, channel, 'T' sections and/or flats wherever necessary. Pre-treatment of panel shall be carried out before epoxy powder coating with at least eight tank processes. The HPFC panel shall adhere to IP 41 protection standard.

Cable gland plates shall be provided on top / bottom /both (as per client's requirements) of the HPFC panel. Lifting hooks shall also be provided at least on all four corners of the panel.

The HPFC panel shall be suitable for 415V, 3 phase, 4 wire, 50Hz supply system. Thepanel shall have a tolerance of 10% for the voltage and 5% for the frequency.Two numbers of earthing terminalsshall be provided on either sideof the panel.

Unless otherwise stated below, the HPFCpanel shall comply with the following standards (and their latest amendments):

- Semiconductor Converters: IEC 60146
- Semiconductor Converters: IEC 602040
- International Electro-technical Vocabulary : IEC 60050
- Environmental Testing: IEC 60068
- Harmonics and Interharmonics: IEC 61000
- Application of Filters and Shunt Capacitors : IEC 61642
- IS 13340-1993, IS 13341-1992, IEC 60831-1+2
- MCCB: ISI3947 (part 2), IEC60947-2
- Contactor: IS/IEC 60947-4-1
- AC Capacitors: IS 13340-1993
- Detuned Reactors: IEC 60289, IS-5553
- DC Capacitors: IEC 60068-1, 60384-4, 60068-2-6
- Gate Driver Card: IEC 60068-1
- SMPS: UL1012, UL60950, TUV EN60950 approved
- Sensor: EN50178

The HPFCpanel shall, in its default configuration, shallimplement the following:

- Step-less Power Factor Correction (for both leading and lagging current)
- Harmonics Compensation up to 51st order (2nd priority)
- Load Current Balancing in the three phases (3rd priority)
- Neutral Current Compensation in the neutral phase
- The HPFC panel shall comprise:

1. Incomer
   i. A suitably sized three pole MCCB or ACB having microprocessor based over-current and short-circuit protection and at least 50kA breaking capacity (Ics) as the incomer of the panel 100% Icu breakers shall be used
2. Metering and Indication
   i. R, Y, B indication lights for the incomer ACB
   ii. On, Off & Trip indication lights for the incomer ACB
   iii. A digital multifunction meter showing voltage, current, frequency, PF, THD, kW, kVA, and other related parameters
   iv. Three number of cast resin CTs of suitable rating

v. One number of three phase digital ammeter showing current in three phases of HPFC panel

vi. Three numbers of control fuses or MCBs (6A-SP-10kA-C Curve)

3. An active filter part and a passive filter part; the ratio of the rating of active filter to that of the passive filter shall be at least 1:1

   The exact distribution of total capacity between the active and passive part shall depend on the rating of the HPFC panel

4. Specific number of fixed detuned capacitor banks

   Each fixed detuned capacitor bank unit shall comprise:

   i. Incomer

      a. A suitably sized three pole, thermal magnetic based MCCB having over-current and short-circuit protection and at least 25kA breaking capacity as the incomer

         100% Icu breakers shall be used

      b. Three pole capacitor duty contactor of suitable rating

   ii. Power Circuit

      a. One unit of three phase delta connected capacitor bank of suitable rating

         The capacitor unit shall be heavy-duty MPP type and have an AC voltage rating of 525V

      b. A series detuned reactor of suitable rating connected to the capacitor bank

         The series detuned reactor shall be a 7% (or 5.6% or 14%, depending on the client's requirements) reactor having linearity of at least 180%

      c. Heavy duty exhaust fans and suitably placed ventilation louvers for proper heat dissipation from the reactors and capacitors shall be provided

   iii. Control Circuit

      a. On and Off indication lights for each detuned capacitor bank

      b. Start and Stop push buttons for each detuned capacitor bank

      c. Auto/Manual selector switch for auto mode (through the active filter's DSP microprocessor) or manual mode of operation of the capacitor banks

      d. On delay timer for the detuned capacitor bank so that all the detuned banks don't get switched on at the same time

5. Specific number of active filter units of suitable rating

   Active filter units shall provide the required reactive power in a step-less mode to meet the requirement for power factor correction, harmonic compensation, load balancing and neutral compensation

   Each active filter unit shall comprise:

   i. Incomer

      a. A suitably sized three pole (for 3Ph active filter) or four pole (for 4Ph active filter) MCCB having thermal magnetic based over-current and short-circuit protection and at least 36kA breaking capacity (Ics) as the incomer of the active filter

         100% Icu breakers shall be used

      b. Three (for 3Ph active filter) or four (for 4Ph active filter) number of high sensitivity and fast reaction fuses of suitable rating

ii. Metering and Indication

a. Healthy and Trip indication for the active filter

b. On/Off selector switch for the active filter

iii. Power Circuit

a. A suitably sized three phase (for 3Ph active filter) or four phase (for 4Ph active filter) inverter stack. Alternatively, the 3Ph or 4Ph inverter stack may be replaced with equivalent number of single phase inverter stacks depending on the rating of the active filter

The inverter stack shall be rated for the full rating of active filter and shall have sufficient margins for overloading the filter

b. Four single phase inductor chokes of suitable rating

Inductor chokes shall have overload margin of at least 150% for 1 minute

c. A suitably sized three pole AC3 duty (for 3Ph active filter) or four pole AC1 duty (for 4Ph active filter) power contactor

The contactor shall be connected to the input of an IGBT power stack

d. The inverter stack shall comprise suitable number and rating (with sufficient margin for overload) of IGBTs, DC Capacitors and IGBT driver circuits to meet the full power output of the inverter stack

e. Resistors, capacitors and other passive components of suitable rating (with sufficient margin) and quantity to continuously carry the full load of the filter

f. Cables, bus-bars and other associated hardware of suitable rating (with sufficient margin) to continuously carry the full load of the filter

g. Heavy duty exhaust fans and suitably placed ventilation louvers for proper heat dissipation from the inverter stacks and inductor choke shall be provided

h. Heavy duty PWM filter comprising capacitors, resistances and/or inductors to filter out the switching ripple from the filter output

iv. Control Circuit

a. Control MCB of rating 10A-FP-10kA-C Curve to provide power supply to the control circuit of the active filter

b. Advanced DSP microprocessor controller which shall monitor the voltage and current in the four phases (Red, Yellow, Blue and Neutral) to compute the exact power requirement in the four phases, and thus, implement the following features - step-less compensation of leading and lagging power factor, harmonics compensation, load balancing and neutral compensation

c. Suitable number and rating of voltage and current sensing circuits

d. Necessary control and firing cards with proper wiring and lugs of required rating shall be provided

e. Suitable number and rating of any other items, e.g. relays, SMPS, etc.

6. The HPFC panel shall have the following features, in addition to those already mentioned above:

i. Panel shall be suitable for operation within an ambient temperature between $0^0$C and $45^0$C

ii. Panel shall have an audible noise level lesser than 70db

iii. Panel shall have a filtering efficiency of at least 97%

iv. Panel shall have a reaction/response time of at least 200 micro-seconds

v. Power factor correction shall always be set at first priority

Target PF level shall be programmable at the time of commissioning

vi. Priority selection between the remainder features - harmonics compensation, load balancing and neutral compensation - shall be programmable at the time of commissioning

In the default mode, harmonics compensation is set at 2nd priority, load balancing is set at 3rd priority and neutral compensation is set at 4th priority

vii. Auto fold-back of the HPFC panel if total current requirement exceeds the rated capacity of the panel

viii. Bus-bars or cables shall be suitably color coded and mounted using appropriate insulator supports

Suitable clearances shall be provided for the bus-bars and other live parts of the system as per international standards

ix. All live parts of the system shall be properly shrouded

x. Inspection terminal strip, number ferruling, and other labeling shall be suitably provided

xi. Stickers marked with “DANGER” shall be provided wherever required

xii. Detailed drawings and manuals shall be provided wherever required

xiii. Following protections shall be provided:

a. Over voltage (AC) protection
b. Over voltage (DC) protection
c. Over current protection
d. Over temperature protection
e. Protection circuits for the inverter stack and its components

xiv. All components and wiring used in the system shall adhere to the relevant ISI and IEC standards

## 11.24 DIESEL GENERATORS

1. Scope

The scope of this section consists of but not necessarily limited to the following in accordance to Technical specification prescribed in tender:

a) The contractor shall design, manufacture supply, deliver to site, hoisting into position, install, test and commission the Prime rated power generating set together with the necessary controls and switchboards as specified and indicated in the Drawings. Protection circuits, control wiring and interlock circuits not specified or indicated in the Drawings, but deemed necessary for the safe operation of the generating system shall be provided without any additional cost to complete the system.

b) Provide manufacturer's factory representative's services, including coordination, and start-up and testing supervision.

c) Testing (factory and field), start-up supervision, training and providing necessary documentation and tools for operation.

d) Carry out performance test run at site with first fill of HSD, Load bank & Lube oil etc. arranged by contractor.

2. Engine

Engine shall be multiple cylinder vertical, 4 stroke cycle, Prime rated, multi-cylinder direct injection, compression ignition type operating at a speed of 1500 rpm and shall be silent, vibration free while in operation and comply Center / State Pollution Control Board , turbo charged after cooled as BS 5514/ISO 3046, 1500 RPM. Engine shall deliver not less than **1200KW** at site at 0.8 lagging power factor and shall be suitable for sustaining of 10% overload for 1 hour in every 12 hours of continuous operation at full load without damage. Engine shall be with the following accessories:

a) Flywheel to suit flexible coupling.

b) Oil type air cleaner. Replaceable air cleaner elements with mechanical air restriction gauge mounted on air cleaner. The filter shall be suitable for operation under dusty conditions.

c) Exhaust Residential Type silencer with flexible connections and thermal lagging.

d) Electronic Instrument panel comprising of:
   - Power Command Control Module or equivalent ( for Synchronizing System )
   - Sensors
   - Fuel control actuators
   - Fuel shut-off valves
   - Starting switch with key.
   - Lube Pressure Gauge.
   - Water temperature gauge.
   - Battery charging ammeter & voltmeter.

e) Hour meter with RPM indicator.

f) Safety control for low lube, oil pressure, high water temperature and over speed.

g) Lube oil cooler with all standard accessories.

h) Lube oil filter with replaceable type filter element as required.

i) Fuel oil system comprising.
   - 5 mm thick epoxy coated from inside MS Steel sheet daily service fuel tank of 990 liters capacity including with glass type level indicator and level controllers with potential free contacts.
   - Fuel transfer pump including piping, fitting valves, strainers, filters between day tank and engine.
   - All instrumentation and control for day tank.

j) 4 No. 12 volt 25 plate lead acid batteries in series and parallel connection to make 24 volts, 4 x 180 Ah batteries duly charged along with connecting leads mounted on acid resistant frame work.

k) Anti vibration mounts as per manufacturer recommendation.

l) Electronic Governor with governing class 'A' direct. The governor characteristics shall comply with the requirement of class A1 of ISO 3046, the governor shall be provided with an electrically operated speeder gear for remote adjustments of generator frequency, suitable for operation on DC voltage. The characterstics of the Diesel generator governing & generator excitation system shall permit manual starting running up to full speed & loading DG set with in 3 minutes from the time generator breaker is closed . The governor shall be capable of responding to a step change of load either switch in and/ or throw off.

m) All moving parts to be mechanically guarded to minimize hazard to people around.

n) CT Adaptor Box for mounting CT's for differential protection (if required).

Air intake and exhaust systems with filters, residential type silencers, ducts, pipes, dampers, fittings, supports and other necessary accessories.

The exhaust gas expulsion system shall be in accordance with the drawings. The exhaust piping shall be fitted with hospital type silencer in order to limit the sound level. Expansion joints shall take care of thermal deformations. The pressure drop in exhaust piping including silencer, bends, expansion joints etc., shall be compatible with exhaust gas leaving the engine. The exhaust piping shall be duly covered through out the length from engine outlet upto the outlet point with mineral wool insulation and aluminium sheet cladding. The exhaust piping shall be independent for each engine and shall be with minimum bends. The bending radius of bends shall be not less than 3-internal diameters of chosen piping. A drain plug shall be fitted at the lowest point of piping for condensate extraction. The exhaust pipe shall meet the following regulations of pollution board as mentioned. Suitable supports shall be provided for proper installation of exhaust pipes.

3. Emission Limits For Diesel Engines (More Than 800 kW) For Generator Sets (Gensets) Applications

Emission Limits

Emission standards for Diesel Engines (Engine rating more than 800 KW) for generating sets

| Parameter | | Area Category | Total engine rating of the plant (includes existing as well as new generator sets) | Generator sets commissioning date | |
|---|---|---|---|---|---|
| | | | | Between 1.7.2003 and 1.7.2005 | On or A after 1.7.2005 |
| $NO_x$ (as $NO_2$) (at 15% $O_2$ ), dry basis, in ppmv | | A | Upto 75 MW | 970 | 710 |
| | | B | Upto 150 MW | | |
| | | A | More than 75 MW | 710 | 360 |
| | | B. | More than 150 MW | | |
| NMHC (as C) (at 15% $O_2$ ), $mgNm^3$ | | Both A and B | | 100 | |
| PM ( at 15% $O_2$), $mgNm^3$ | Diesel Fuels HSD & LDO | Both A and B | | 75 | |
| | Furnace Oils – LSHS & FO | Both A and B | | 100 | |

| Parameter | Area Category | Total engine rating of the plant (includes existing as well as new generator sets) | Generator sets commissioning date | |
|---|---|---|---|---|
| | | | Between 1.7.2003 and 1.7.2005 | On or after 1.7.2005 |
| CO (at 15% $O_2$ ), $mgNm^3$ | Both A and B | | 150 | |
| Sulphur Content in fuel | A | | <2% | |
| | B | | <4% | |
| Fuel specification | For A only | Upto 5 MW | Only diesel fuels (HSD, LDO) shall be used. | |
| Stack height (for generator sets commissioned after 1.7.2003) | Stack height shall be maximum of the following in meter : 14 $Q^{0.3}$, Q=Total $SO_2$ emission from the plant in Kg / hr Minimum 6 m above the building where generator is installed. 30 m. | | | |

Acronyms Used

- MW : Mega ($10^6$) Watt
- $NO_x$ : Oxides of Nitrogen
- $NO_2$ : Nitrogen Dioxide
- $O_2$ : Oxygen
- NMHC : Non-Methane Hydrocarbon
- C : Carbon
- PM : Particulate Matter
- CO : Carbon Monoxide
- $SO_2$ : Sulphur Dioxide
- ppmv : Part per million ($10^6$) by volume
- FO : Furnace Oil
- HSD : High speed diesel
- LDO : Light Diesel Oil
- LSHS : Low Sulphur Heavy Stock
- kPa : Kilo Pascal
- mm : Milli ($10^3$) meter
- kg/hr : Kilo ($10^3$) gram per hour
- mg / $Nm^3$ : Milli ($10^3$) gram per Normal metre cubic

Area Categories A & B are defined as follows:

Category A : Areas within the municipal limits of towns / cities having population more than 10 lakhs and also upto 5 km beyond the municipal limits of such towns / cities.

Category B : Areas not covered by Category A

The standards shall be regulated by the Central Pollution Control Boards or Pollution Control Committees, as the case may be.

4. Limits Of Noise For Power Generating Sets Manufactured On Or After The 1st January, 2005

Applicability

These rules apply to Generator sets of rated output, installed on or after 1st January, 2005.

Requirement of Certification

Every manufacturer or importer of Power Generating set must have valid certificates of Type Approval and also valid certificates of conformity of production for each year, for all the product models being manufactured or imported after 1st January, 2005 with the specified noise limit.

All Power Generator shall have a valid Type Approval certificate and conformity of production certificate.

All Power Generator shall have conformance label meeting the requirements.

The conformance label shall contain the following information:

a) Name and address of the supplier (if the address is described in the Client's manual, it may not be included in the label).
b) Statement "This product conforms to the Environment (Protection) Rules, 1986"
c) Noise limit viz. 75 dB(A) at 1 m.
d) Type approval certificate number.
e) Date of manufacturer of the product.

Authorized agencies for certification

The following agencies are authorized to carry out such tests as they deem necessary for giving certificates for Type Approval and Conformity of production testing of Generator and to give such certificates :

a) Automotive Research Association of India, Pune.
b) National Physical Laboratory, New Delhi.
c) Naval Science & Technology Laboratory, Palghat
d) National Acrospace Laboratory, Bangalore

5. Alternator

The alternator shall be brushless synchronous and suitable for 3 phase, 11000 volts, 50 Hz., 0.8 p.f. and 1500 RPM.
The alternator shall be suitable for coupling directly to the engine described in clause no. 1.3 It shall be drip proof screen protected as per IP23. The alternator shall be double bearing type. Capacity 1500 kVA & Above.

The alternator shall be continuously rated and shall have class "H" insulation designed and built to withstand tropical conditions. It shall be confirming to BS:5000 (Part-99) or IS:4722-1992. The output of the alternator shall be 1600 KW rated output at site conditions at 0.8 lagging power factor and shall be suitable for sustaining of 10% overload for 1 hour in any 12 hours period without damage.

Six nos. embedded Resistant Temperature Detector (RTDs) of plantinum, 100 ohms resistance at 0 degree to measure the winding temperature and 2 Nos. BTDS to measure bearing temperature shall be provided.

The leads of embedded RTDs shall be wired upto the terminal block in a separate terminal box. Manufacturer shall indicate the setting values for each RTD / BTD for alarm and trip.
Greasing facility with grease nipples and grease relief device shall be provided.
All external nuts and bolts shall be of high tensile steel only.

Alternator shall be provided with anti-condensation space heater of adequate rating suitable for 240 V, 50 Hz, 1 Phase AC supply and shall be wired upto a separate terminal box.
The independent earth terminals on the frame, complete with nuts, spring washer and plain washer shall be provided.

Alternator shall be provided with suitable adaptor box for termination of cables. Suitable arrangement shall be provided in the terminal box for formation of star point for Alternator neutral earthing.

QDCT for synchronizing relay i.e. DG Set shall be capable of working in synchronizing with other DG sets. The supply of any relays, contactors, CT's etc required for this purpose shall be included. Alternator shall be suitable for bearing the starting current of Transformer after changeover.

6. Excitation System

The alternator shall be provided with a complete rotating diode type brushless excitation system, capable of supplying the excitation current of the generator under all conditions of output from no load to full load and capable of maintaining voltage of the generator constant at one particular value.

The exciter shall have class 'H' insulation.

The excitation system shall comprise a shaft driven AC exciter with rotating rectifiers. The rectifiers shall have in-built protection for over voltage.

The exciter shall be fast response type and shall be designed to have a low time constant to minimize voltage transients under severe load changes. The excitation voltage response ratio shall be at least 0.8.

The rated current of the main exciter shall be at least 10% more than the alternator rated exciter current and it shall have 40% overload capability for 10 seconds.

No external supply shall be required during starting and normal running of the alternator.

7. Automatic Voltage Regulator

An automatic high speed, dead band type voltage regulator shall be provided, complete with all accessories. The regulation system shall be provided with equipment for automatic and manual control.

The regulator shall regulate the output voltage from generator current and potential signals. Series compounding transformer shall be provided to enable maintaining adequate terminal voltage in the event of terminal faults. Alternatively excitation system shall be provided with arrangement for field forcing. Contractor shall coordinate suitability of protection relays for generator with the operational characteristics of automatic voltage regulator, specially under short circuit conditions.

Voltage regulation and steady state modulation shall be within +/- 0.5% of the line voltage.

Necessary equipment for field suppression and surge protection shall be provided as integral part of alternator.
The response time of exciter and the generator shall be properly matched to avoid hunting.

AVR system shall be provided with equipment for automatic and remote operation / control.
AVR shall be suitable for 24 V supply.

Necessary equipment shall be furnished for the following.

- To prevent automatic rise of field voltage in case of failure of potential supply.

7.1 Acoustic Enclosure For Diesel Generator

Acoustic Enclosure for DG Set shall be as given below:

a) DG Set Capacity : 11kV, 1500kVA

b) Structure : As per approved shop drawing

c) Panels : As per approved shop drawing

d) Thickness of panels : As per approved shop drawing

a. Outer sheet :
b. Inner Sheet :
c. Frame & Strainer :

e) Insulation : Mineral wool as per IS 8183 – 1993

f) Thickness : 100 mm thick (50 mm x 2 slabs)

g) Density : 64 Kg / m3 or as per dB loss design

h) Air Circulation System

- Air Intake System : Axial flow fans of suitable Capacity for 1500 KVA DG Set offered.
- Air Exhaust System : Axial flow fans of suitable capacity for KVA DG set offered

i) Finishing : Weather proof polyurethane paint (Shade approved by Consultant / OWNER. Paint coating to be done after each component goes through 7 tank process.)

j) Noise Level : 75 dBA at a distance of one meter (as per CPCB)

k) Insertion Loss : 25 dBA

l) ΔT inside enclosure : should not exceed from 7 degree C above

i. Ambient temperature. 1 No. dial gauge temperature monitor shall also be provided.

m) Location : Outdoor type

n) Lighting / Switch / : Proper arrangement shall be provided inside

i. Wiring / Fans the acoustic enclosure

8. Microprocessor Based Auto Starting & Auto Synchronizing Panel

8.1 General

The auto synchronizing shall be provided as mentioned below and as per Schedule of Quantity.

8.2 Sequence of operation

Sequence of Operation in Auto Mode.

Synchronizing panel logic shall be to automatic start Master GENERATOR set (Selected by Microprocessor based generators control and engine management & monitoring package) through cranking relay & close its CB/NIS after verifying frequency and voltage and shall start feeding the essential load.

On failure of mains, number of DG sets shall come on automatically and synchronize with the bus. The required number of DG sets shall switch ON depending upon the emergency load monitored. The combined synchronized power should be fed to the incomer bus of main 11kV panel when the generator output reaches 90% of its rated voltage and frequency.

As load increases beyond 75% on the generator which is running, other generator will start and synchronize on the same bus.

Similarly as load increases further other generators shall start automatically and synchronize on the same bus. As the load increases or decreases accordingly switching ON and OFF of the generator on the synchronizing bus shall continue with the help of microprocessor based generator control package. If any time only one Generator coming and the load is increased suddenly more than the available capacity then non critical load (to be decided in consultation with Engineer in charge) shall drop out from the bus automatically through microprocessor based generator control package and same shall come on automatically if other Generator shall start and synchronize on the same bus.

Auto Synchronizing system shall verify the phase angle of all the sets and also compensate for CB closing time by initiating closing of the breaker ahead of the actual predictable synchronism thereby ensuring a phase difference of zero degree. The breaker closing command shall not be given at a phase angle difference of + 4% in any circumstances.

The synchronizing system shall operate the generator ISOCHRONOUS mode by setting Droop to Zero. The system shall have a direct analogue interface with the AVR & Governor for direct bias control. No motorized potentiometers shall be acceptable.

Failure of any synchronizing module shall not disturb the synchronizing of other generator.
Failure of generator control package shall not affect the synchronizing system which shall be independent of each other.

System shall also monitor the slip frequency and the Beat Voltage of the machine or system.

NIC of First generator shall remain in Ckt. In the event of shutting OFF of First Set, NIC of any other generator shall close first before tripping NIC of first set. It shall be possible to alter sequence of generator starting through, manual selection or through generator control package

Active and reactive power shall be made equal on all the machines automatically with the help of ACTIVE LOAD BALANCING System through Governor Control.

In event of set failing to Synchronize, Alarm from annunciator shall invite attention of OPERATOR for manual intervention.

LOAD MANAGEMENT SYSTEM shall have output contacts for tripping various loads by field wiring and also trip the VCB of different generator and give ALARM for shutting OFF generator in accordance with predefined parameters to avoid underloading, overloading, cascading effect of tripping and unnecessary FUEL WASTAGE.

On the removal of load, generator circuit breaker & Bus Coupler CB's shall be switched OFF in preset sequence with time delays to cover DIPS. Generator shall continue to run for 3 Minutes or predefined after generator CB has been switched OFF.

It shall be possible to alter crucial setting / time delays through MAN MACHINE INTERFACE.

All auxillaries (supply air fans etc) to come on automatically.

Engine start stop control system shall be mounted on the generator panel.

Note :
5.0 KVA on-line single phase input / single phase output (230 V) UPS with 30 minutes battery backup to be provided along with the synchronizing panel.

Sequence of Operation in Manual Mode

In the manual mode master generator set shall be started by pressing 'Engine Start' Push Button (PB)

When Engine starting push button is pressed cranking relay shall be energized and give starting signal to the engine.

After full voltage is build up, breaker of the Master generator shall close manually with the help of breaker control switch.

When breaker Control switch is turned to 'CLOSE' position, breaker as per following sequence:

a) PLC/Main Selector Switch shall be in Manual Mode.
b) Solo/Parallel Selector Switch being in 'Solo' mode.
c) With the conditions mentioned above fulfilled and breaker control switch in 'Close' position, Neutral contactor shall be energized.
d) Closing command to the generator breaker shall be given.

In manual mode care shall be taken, to synchronize the follower generator sets with the 'Master' before closing its breaker.

For synchronizing the guarantee in manual mode, voltage/frequency raise/low commands shall be given to Alternator/Engine with the help of 'Joy sticks' provided in the Relay/Synchronizing Panel or internally through genset digital controller While synchronizing the generator, manually, all the parameters viz. voltage, frequency and phase rotation shall be monitored with the help of Double voltmeter, Double Frequency Meter and Synchronoscope provided in the Control & Relay/Synchronizing Panel and breaker shall be closed only when all the three parameters are matched properly or internally through genset digital controller. Active/Reactive load sharing between all the running sets in manual mode shall be managed by raising/lowering voltage/frequency with the help of joy sticks or internally through genset digital controller. During the parallel operation of Power Generating sets in 'Manual Mode', Neutral contactor of only master generator shall close. This shall be assured by inter locking the neutral contactors of all the generator.

Summary of functions

The following functions shall be required for Synchronizing the generating sets.

a) Automatic starting of generating sets.
b) Automatic Synchronization of all available generating sets.
c) Automatic load sharing between generators, active as well as reactive load sharing.
d) Starting & stopping of generators as per load requirement.
e) Monitoring of engine & alternator condition and protections.
f) Monitoring of Mains
g) Complete load management as per requirement.

The control functions shall be as follows:

Engine Control

a) Engine pre-glow control
b) Fuel solenoid control
c) Engine starter control
d) Speed monitoring
e) Over-speed protection
f) Oil pressure monitoring
g) Water temperature monitoring
h) Battery voltage monitoring.

Engine Protective Features

a) High / Low coolant temperature
b) High / Low oil pressure
c) Over-speed
d) Start Failure

Generator Protective Features

a) Over / under voltage.
b) Over / Under Frequency
c) Reverse Power (Inverse time delay)
d) Loss of Excitation
e) Over Current (Inverse time delay)
f) Loss of Utility power detection
g) Load Surge
h) Current Unbalance
i) Voltage Unbalance
j) Earth Fault

Real (KW) Load Control

a) True RMS power calculations accurate control
b) Configurable loading / unloading ramp rates.
c) Isochronous load sharing
d) Soft Utility transfer function
e) Externally adjustable base load of process reference levels with independent ramp rates (PLC)
f) Base load control for optimum fuel efficiency (PLC)

Dynamic Synchronizing (Mandatory Features)

a) Digital signal processing to eliminate harmonic issues
b) Adjustable phase window, voltage window, dwell times
c) Safe dead bus closing logic internal to the control
d) Multiple shot re-closing with adjustable time delays
e) Manual voltage & speed adjusts for manual synchronizing or internally through genset digital controller.
f) Synchronization across generator & mains breakers.
g) PLC shall have Ethernet port for communication of PC with open TCP / IP, TCP.
h) PLC shall have modular (RS 485).

Reactive (KVAR) Control

a) VAR sharing on isolated busses using %age base reactive load sharing.
b) Power factor or VAR control when base loaded
c) Externally adjustable VAR of PF set point levels.

Automatic Generator Sequencing

Automatic starts & stop genesets based on plant bus or process demand.
Configurable plant bus demand start/stop levels & timers.
Online engine priority sequence configurability from any synchronizing unit or PC to equalize run time of DG all DG sets.

Control System

a) All the electrical parameters are monitored centrally through intelligent processing. All the electrical data is brought to the PLC & then PLC controls the complete Synchronizing, Load Control & Management system.
b) There are two options provided for control, monitoring & data logging functions.
c) Graphic display terminal with printer option

8.3 Synchronizing logic

The system shall be capable of a dynamic synchronization, where the generator frequency is controlled to be slightly higher than the bus bar frequency, when the breaker closes. This shall ensure that the generator will start to take load the moment the generator breaker is closed. The frequency difference between generator & bus bar at the moment of synchronization shall be programmed. Breaker time shall be adjusted to ensure breaker closure at the exact point of synchronization. System shall control the voltage under synchronization if necessary.

During synchronization system shall supervising the frequency of the generator voltage to make sure that the gen-set is not unstable due to a cold fuel / gen-set or an uneven fuel supply. The two frequencies must be within the accepted slip-frequency in 200 mili sec before synchronization.

The system shall synchronize the generator to the bus, when all below conditions are fulfilled :

a) A control order is given by setting the input “start synchronizing / regulating”
b) Feedback signal from breaker “GCB open” is present.
c) Bus bar voltage is present
d) Generator voltage is present

The voltage regulator in the system shall start when the frequency is within 90% of nominal frequency.

System shall close the breaker without synchronization, when all the following conditions are fulfilled :

a) Display setting “Black busbar operation is ON.
b) A control order is given by setting the input “start synchronizing / regulating”
c) Feedback signal from breaker “GCB open” is present.
d) Bus bar voltage is not present (Black bus bar)
e) Generator voltage is present.

Monitoring

Following electrical parameters shall be monitored by PLC based system, which shall be connected through set of CT / PT’s & shall indicate the following:

a) Voltage – all phases (Line & Phase both)
b) Current – all phases.
c) Frequency
d) Power factor
e) KVAR
f) KVARH
g) KW
h) .KWH

All these parameters shall be displayed & shall be used for Load Management & Safety functions. Limits can be assigned to each parameter in the PLC for alarm & recording / logging purposes.

System shall include the following features:

The system shall work on Isochronous principle thus avoiding the problem of Droop adjustment. The frequency shall remain constant at all loads.

Automatic dead bus closing.

Active & reactive load sharing.

Modular system & each module shall be independent of the other. The breakdown of one section shall not effect the other.

The synchronizing module shall directly communicate with the electronic governors and shall connect to the load control lines of governor directly.

Solid state Annunciators for auto synchronizing panel or internally through genset digital controller.

| Channel No. | Inscription | |
|---|---|---|
| | | |
| 01 | G-1 Fails to Synchronize | |
| 02 | G-1 Fails to Start | |
| 03 | G-1 Neutral Discrepancy | |
| 04 | G-1 CB Fails to Close | |
| 05 | G-1 Engine Fault | |
| 06 | G-1 Electrical Relay Fault | |
| 07 | G-2 Fails to Synchronize | |
| 08 | G-2 Fails to Start | |
| 09 | G-2 Neutral Discrepancy | |
| 10 | G-2 CB Fails to Close | |
| 11 | G-2 Engine Fault | |
| 12 | G-2 Electrical Relay Fault | |
| 13 | G-3 Fails to Synchronize | To be installed in future |
| 14 | G-3 Fails to Start | |
| 15 | G-3 Neutral Discrepancy | |
| 16 | G-3 CB Fails to Close | |
| 17 | G-3 Engine Fault | |
| 18 | G-3 Electrical Relay Fault | |

Indication

a) 1 No. Spring charged Indicating Light.
b) 1 No. Neutral ON Indicating Light.
c) 1 No. Neutral OFF Indicating Light
d) 1 No. Trip Indicating Light
   i. Nos. Ph. Indicating Light
e) 1 No. CB ON Indicating Light
f) 1 No. CB OFF Indicating Light
g) 1 Set Control MCB.
h) 1 set push buttons for generator start / stop, master changing, speed decrease / speed increase, voltage decrease / voltage increase.

8.4 Protection Through Relays (For DG Set)

Following protection shall be provided through Numerical relay both for the stator side and the rotor side if not provided in the controller:

a) Voltage restrained over current protection (50/51)

Relay shall not work when a over current fault occurs, due to higher current levels. There shall be drop in terminal voltage for the same fault impedance, the fault current shall reduce (with respect to terminal voltage) to a level below the pick-up setting. Consequently, relay shall not pick-up. It shall be necessary to have a relay whose pick-up setting shall be automatically reduce in proportion to terminal voltage. Hence, the over current protection shall be voltage restrained. Two levels over current protection shall be provided i.e. low set and high set (for short circuit protection)

b) Thermal overload (49)

It monitors the thermal status of machine for current between 105% to the low set O/C level (normally 150%).

c) Current unbalance (46)

Generators shall be expected to feed unbalanced loads whose level has to be monitored. If the unbalance exceeds 20%, it may cause overheating of the windings. This heating will not be detected by the thermal overload relay since the phasé currents will be well within limits. A two level monitoring for unbalance shall be provided first level for alarm, and the second level for trip.

d) Loss of Excitation (40)

When excitation is lost in a running generator, it will draw reactive power from the bus and get overheated. This condition to be detected from the stator side CT inputs by monitoring the internal impedance level and position of generator.

e) Reverse Power (32)

Generator shall operate in parallel, which may cause reverse power flow at certain times (during synchronization or when there is a PF change due to load fluctuation or when there is a prime mover failure). When reverse power occurs, the generator along with prime mover will undergo violent mechanical shock.

f) Under Power (37)

It is not economical to run generators below a certain load level. This protection will monitor the forward power delivered by the machine and give alarm when levels, goes below a set point.

g) Under / Over Voltage (27 / 59)

This will protect the machine from abnormal voltage levels, particularly during synchronization and load throw off conditions.

h) Under / Over Frequency (81)

This will protect the machine from abnormal frequency levels, particularly during synchronization and load throw of conditions. This will also help in load shedding scheme for the generator.

i) Breaker Failure Protection (52 BF)

This protection detects the failure of breaker to open after receipt of trip signal. Another trip contact is generated under breaker fail conditions, with which more drastic measures (like engine stoppage, etc.) can be taken.

j) Earth fault protection (64B)

In the event of several machines operating in parallel, or when the network contains several earthing points, either it is necessary to provide a means of automatically switching in and out the different earthing points in order to leave only one in service. If this is not possible, one can use sensitive directional earth-fault relays such as the digital RMSD7912 or the ITD7112. These relays are generally supplied from a ring (or core-balance) CT in order to achieve maximum sensitivity.

In those cases where the earth-fault current is not limited to a value below the nominal current of the machine, a fast-acting differential protection should be used. This is the case where the machine is low impedance or solidly earthed.

Operation of this protection should immediately trip the generator main breaker, the earth connection and the field, causing the field-shorting breaker to close.

k) Differential Protection (87 G)

This type of protection operates on the principle of current comparison in the same phase but at the two extremities of the protected equipment and has two main advantages:

- It may be instantaneous, because it only reacts to faults inside the protected zone,

- It will operate for the transfer of energy in either direction, which is particularly important in the event of multiple sources

It may also allow a grading step to be eliminated, thus reducing the tripping time for faults on the upstream network. To counterbalance these advantages however, it requires pilot links and matched class X current transformers are generally recommended with stabilizing resistors for the differential protection of transformers, rotating machines and bus bars.

l) Over fluxing V/F (24)

m) Frequency Relay fault locator (81 FL)

Relay shall be percentage biased, low impedance differential relay with following features:

- Relay shall provide percentage biased differential protection with dual slope characteristics.
- Relay shall have REF protection element (87 N), which will monitor the generator for internal earth faults. It has a built-in O/C protection, as a backup.

In addition to above, following relays to be provided
Master Trip Relay
Trip Circuit Supervision Relay
Engine Cranking Relay
Note-All above relays shall be numeric type.

8.5 Metering For Each DG
As mentioned in the Schedule of Quantities.

8.6 Annunciation
Annunciators with Hooter, Test, Accept and Reset P.B. and Annunciator.

16 Window Solid State Annunciator for each DG sets.

| Channel No. | Inscription |
|---|---|
| 01 | Set fails to start (only alarm) |
| 02 | Over current (breaker trip) |
| 03 | Earth Fault (Breaker trip) |
| 04 | Excitation Failure (Engine should be stop with breaker trip) |
| 05 | Reverse Power (Breaker trip) |
| 06 | Over speed (Breaker will trip with engine stop command) |
| 07 | Low Lube Oil pressure (Breaker will trip with engine stop command) |
| 08 | High Water Temperature (Breaker will trip with engine stop command |
| 09 | Over / Under Voltage (Breaker trip) |
| 10 | Bearing Temperature high (breaker will trip with engine stop command) |
| 11 | Under / Over Frequency (Breaker trip) |
| 12 | Winding Temperature High Breaker with trip with engine stop command) |
| 13 | Differential Fault (Engine / Alternator field shall cut off) |
| 14 | DC control supply failure. |
| 15 | Generator Fault |
| 16 | Staring air pressure low |

## 9. Battery Charger (For DG Set)

9.1 General

The battery charger shall be Float cum Boost type Thyristor controlled. The charger shall have selector switch for Auto Float – Boost / Manual Float / Manual Boost Mode of operation. During Auto Float – Boost Mode, Automatic Changeover shall take place from Float Mode to Boost mode and Vice-Versa. This means that when the Batteries are fully charged the charging shall automatically change from Boost charge to trickle charge.

9.2 Construction Feature

The battery charger shall be housed in sheet steel cubicle of Angle Iron frame work with sheet steel panels of 1.6 mm thickness. Louvers shall be provided in the cabinet for the ventilation. The cubicle shall be painted in Siemens Grey shade RAL7032 of IS-5. Four wheels shall be provided at the base.

9.3 Performance

The D.C output voltage of Float / Boost charger shall be stabilized within + 2% for AC input variation of 230 V + 10%, frequency variation of 50 Hz + 5% and DC load variation of 0-100%. The voltage regulation shall be achieved by a constant voltage regulator having fast response IGBT control. The ripple content will be within 3% of DC output nominal voltage.

There shall be provision to select Auto Float / Manual Float / Manual Boost modes. During Auto Float Mode the battery charging shall automatically changeover from Boost Mode to Float Mode and Vice Versa. During Manual Float / Boost modes it shall be possible to set the output volts by separate potentiometers.

The battery charger shall have automatic output current limiting feature.

9.4 Components

The battery charger shall essentially comprise of the following

6. No. double pole ON/OFF MCB at AC input.
7. No. pilot lamp to indicate charger ON.
8. No. Main Transformer : Double wound, naturally air cooled, having copper winding.
9. set single phase full wave bridge rectifier consisting of 2 Nos. diodes and 2 Nos. IGBTs, liberally rated, mounted on heat sinks and complete with resistor / condenser network for surge suppression.
10. No. rotary switch to select auto float / manual float / manual boost. During auto float mode automatic changeover shall take place from float mode to boost mode and vice versa.
11. set solid state constant potential controller to stabilize the DC output voltage of the float cum boost charger at + 2% of time set value for AC input voltage variation of 230 V + 10%, frequency variation of + 5% from 50 Hz and simultaneous load variation of 0-100% and also complete with Current Limiting Circuit to drop the Float Charger output voltage upon overloads to enable the battery to take over.
12. No. electronic controller to automatically changeover battery charging from boost to float and vice versa..
13. No. DC ammeter and toggle switch to read charger output current and battery charge / discharge current.
14. No. moving coil DC voltmeter to read the DC output voltage.
15. set potentiometer to adjust the output voltage during manual /auto float and boost modes.
16. No. double pole ON/OFF MCB at DC output, 1 No. at charger output & the other at load.
17. set DC output terminals. 1 set for the load and the other set for the battery.

Alarm Annunciation : Visual and audible alarm with manual accept reset facility shall be provided for the following :

**a)** AC mains Fail
**b)** Charger Fail
**c)** Load / Output over volt.

Rating

| | | |
|---|---|---|
| AC Input | : | 230 V + 10% AC 50 Hz single phase. |
| DC Output | : | To float / boost charge 180 AH batteries and also supply a continuous load. |
| Current Rating | : | 30.0 Amps |
| Float Mode | : | 27.0 V nominal (Adjustable) between 24-28.0 V. |
| Boost Mode | : | 29.0 V nominal (Adjustable) between 24-32.0 V. |
| Voltage Regulation | : | + 2% for AC input variation of 230 V + 10%. Frequency Variation of 50 Hz + 5% and DC load variation 0-100% |

10. Neutral Grounding Resistor

10.1 Scope

The Contractor shall furnish and install the neutral grounding resistor as specified.

10.2 References

The neutral grounding resistor shall be designed and factory tested to IEEE Standard 32-1972.

10.3 General

The grounding resistor(s) shall be as follows:

| | | |
|---|---|---|
| Resistor | : | 33 ohm |
| Rated current | : | 200 Amps |
| System\Line-to-ground voltage rating | : | 6600 volts line to ground. |
| Time rating | : | 10 seconds extended |
| Temperature rise | : | 375 degree C rise |

Resistor units shall have double insulated stainless steel stamped grid elements. Resistor terminals shall be stainless steel. All resistor end frames, hardware, and non-current carrying spacers shall be zinc-plated steel. Sizing of resistor shall be rated to limit the current to full load current of single DG set of the synchronized set of generators and shall be rated for 10 sec.

The neutral ground resistor shall be provided with an indoor safety enclosure. The enclosure shall have a solid top, screened bottom louvered or screened side covers, and top mounted eye bolts for handling ease. It shall be designed for IP22 protection. The enclosure shall be mill galvanized or RAL 7032. Gray unless otherwise specified.
The assembly shall be suitable for indoor mounting to a permanent structure.

10.4 Accessories

a) Provisions for mounting current transformers.
b) Provisions for mounting potential transformers.
c) Base insulators.
d) Entrance bushings and terminal lugs.

10.5 Testing at Works

Standard factory tests shall be performed on the equipment provided under this section. The neutral ground resistor shall conform to IEEE Standard 32-1972.

The Engineer In charge may carry out inspection and testing of equipments at manufacturer's works. No equipment shall be delivered without prior written confirmation from Engineer In charge. Upon completion of work the performance test shall demonstrate the following among other things:

a) Equipment installed complies with specification in all respects and is of the correct rating for the duty and site conditions.
b) All items operate efficiently and quietly to meet the specified requirements.
c) All circuits are correctly protected and protective devices are properly coordinated.
d) All non current carrying metal parts are properly and safely grounded in accordance with the specifications and appropriate codes of practice.
e) Manufacturing / Assembly defects.

The Contractor shall provide all necessary instruments and labor for testing. He shall make adequate records of test procedures and readings and shall repeat any tests requested by the Engineer Incharge. Test certificate duly signed by authorized person shall be submitted for scrutiny.

If it is proved that the installation or part thereof is not satisfactorily carried out then the Contractor shall be liable for the rectification and retesting of the same as called for by the Engineer Incharge. All tests shall be carried out in the presence of Client's Inspection team.

The DG shall be tested in the presence of Client's Inspection team at Supplier's works in accordance with latest prevailing IS standards and codes. The successful passing of any such tests will not however prejudice the right of Purchaser to reject the DG and its accessories, if they do not comply with specifications when erected or perform complete satisfactory operation as intended. Supplier shall provide the test certificate for the bought out items used, if any in the assembly of DG.
DG sets shall be tested at varying loads at manufacturers work site prior to dispatch of the sets to site. Due notice for the programmed of performance testing at works shall be given to the Clients to enable them to arrange for their representatives for this inspection to be at manufacturers works/site for this inspection and testing.

The performance test on each DG sets shall be of minimum 6 hours duration on full load. It should also include measurement of noise and emission as per standards and CPCB guidelines. Vibration measurement shall also be done as per engine manufacturer's recommendation and ISO – 8528 Part – 9.

The following parameters shall be noted on the test report

Description Time ( After start of Load test)
1 hr 2hrs 3hrs 4hrs 5hrs 6hrs 7hrs

a) Load in kW
b) Power factor
c) Voltage
d) Current
e) Frequency
f) Alternator winding temperature
g) Alternator bearing temperature
h) Lube oil pressure
i) Lube oil temperature
j) Fuel consumption though flow meter
k) Cylinder head temperature

All instruments, materials, consumables (fuel oil, lube oil etc.) load and labor required for carrying out of the test shall be provided by the Contractor.

Following test acceptance criteria shall be applicable.

| | | |
|---|---|---|
| 1. | Fuel consumption at 50%, 75%, 100% and 110% load. | ± 5% of guaranteed performance. Actual alternator efficiencies as determined in the manufacturers works tests shall be used as the basis of calculation of specific fuel consumption ratio. |
| 2. | Voltage regulation from no load to full load | ± 1% |
| 3. | Frequency regulation from no | ± 0.5% |

| | | |
|---|---|---|
| | load to full load | |
| 4. | Maximum lube oil temperature | ± 5% of guaranteed performance |
| 5. | Minimum lube oil pressure | ± 5% of guaranteed performance |
| 6. | Lube Oil consumption | ± 5% of guaranteed performance |

PRE-COMMISSIONING CHECKS

All standards checks including the ones elaborated in the specifications to ensure that the installation of the DG sets and associated systems has been carried out satisfactorily shall be done on completion of installation. These shall include.

DG sets

- Checking of piping interconnections
- Checking electrical interconnections
- Checking of insulation resistance
- Checking of earthing
- Checking of instruments and controls.
- Checking of alignment
- Checking of vibration transmission to building a structure.
- Checking of expansion joints.

Exhaust system

- Checking of silencer operation
- Checking of surface temperature of exhaust piping

Fuel system

- Checking of automatic operation of fuel transfer pumps.

Upon completion of work the performance test shall demonstrate the following among other things:

a) Equipment installed complies with specification in all respects and is of the correct rating for the duty and site conditions.
b) All items operate efficiently and quietly to meet the specified requirements.
c) All circuits are correctly protected and protective devices are properly coordinated.
d) All non current carrying metal parts are properly and safely grounded in accordance with the specifications and appropriate codes of practice.

11. DG Sets – Test Procedure

The Tenderer shall enclose copies of type test certificates, wherever applicable, for all the equipments and materials, quoted by him, along with the bid for Employer's reference as per the relevant standards specified.

All the type tests, if not conducted earlier on similar type of equipments, covered under the relevant standards, shall be conducted, wherever required, by the suppliers for all the equipment and materials at manufacturer's works in the presence of the Employer's representative. The test certificates of all the equipments / materials shall be approved by the Employer's representative before dispatch / acceptance of the equipment and materials. Routine tests for all equipment will be witnessed by Engineer's Representative.

The following tests shall be done at works before dispatch,

Tests on alternator:

| | |
|---|---|
| 1 | DC Resistance Measurement |
| 1.1 | Stator |
| 1.2 | Rotor |
| 1.3 | Exciter Stator |
| 1.4 | Exciter Rotor |
| 1.5 | PMG Stator(if applicable) |
| 2 | Insulation Resistance Measurement, before and after High Voltage Test |
| 2.1 | Stator |

| | |
|---|---|
| 2.2 | Rotor |
| 2.3 | Exciter Stator |
| 2.4 | Exciter Rotor |
| 2.5 | PMG Stator |
| 3 | High Voltage Test |
| 3.1 | Stator |
| 3.2 | Rotor |
| 3.3 | Exciter Stator |
| 3.4 | Exciter Rotor |
| 3.5 | PMG Stator |
| 4. | Functioning Tests on RTDs |
| 4.1 | DC Resistance Measurement |
| 5 | Characteristics |
| 5.1 | No Load Saturation Tests |
| 5.1.1 | Open Circuit Magnetization Characteristics |
| 5.1.2 | Voltage Measurement |
| 5.1.3 | Symmetry of generated voltage |
| 5.1.4 | Phase Sequence (Phase Rotation) check |
| 5.1.5 | Direction of Shaft Rotation check |
| 5.1.6 | Sustained 3Phase Short Circuit Magnetization Characteristics |
| 5.2 | Vibration Measurement |
| 5.2.1 | During No Load Mechanical Run |
| 5.2.2 | During No Load Open Circuit Magnetization Test |
| 5.2.3 | During Sustained 3Phase Short Circuit Magnetization Test |
| 5.3 | Over speed test (120% of rated speed for 2 minutes). |
| 5.4 | Regulation Tests |
| 5.4.1 | Voltage & current |
| 5.6 | Temperature Rise Test |
| 5.7 | No Load losses |
| 5.8 | Determination of efficiency |

The following tests shall be carried out on Generator and Excitation system:

a) Insulation Resistance Tests
b) Winding Resistance Test
c) Phase sequence Test
d) Open and Short Circuit Characteristic Test
e) AVR response / Regulation Test.
f) Load test on Generator at both unity and 0.8 PF.
g) Excitation at full load and under specified variation of voltage and speed
h) Measurement of voltage dips at the generator terminals while feeding the base load 75% and on simultaneous starting of the largest motor.
i) EMPLOYER reserves the right to reject the equipment if the guaranteed performance is not met with.
j) All instruments required for performance testing of the equipment covered in this specification shall be provided by the TENDERER at no extra cost to the purchaser for entire duration of the performance test.
k) The TENDERER shall ensure that instruments and gauges to be used for testing and inspection of critical parameters as identified in the specification shall have valid calibration and the accuracy can be traceable to National Standards.
l) In addition to the above guarantees, TENDERER shall also guarantee the period for completing supply, erection, testing and commissioning as six (6) months for DG set and accessories from the date of Letter of Award.

Load / Run Test at Site:

DG sets shall be tested at different loads at site after dispatch and installation at site.

In case at any point of the test a trip should occur the test shall be conducted again. The necessary fuel oil, lube oil & consumables required for the test shall be provided by contractor. No extra payment shall be made in this regard.

Copies of manufacturer's type test for the engine and the alternator of all ratings shall be enclosed along with the dispatch of the DG sets as per relevant standard/ codes.

The contractor shall provide all necessary instruments and labour for testing. He shall make adequate records of test procedures and readings and shall repeat any tests requested by the Engineer In charge. Test certificate duly signed by an authorized person shall be submitted for scrutiny.

If it is proved that the installation or part thereof is not satisfactorily carried out then the contractor shall be liable for the rectification and retesting of the same as called for by the Engineer In charge. All tests shall be carried out in the presence of Client inspection team.

These tests shall form part of this contract. Above tests shall be conducted for all DG sets. The test results shall match with the technical requirements specified in the technical data sheet.

The Engineer In charge shall have the right to accept or reject the modules if it does not meet the technical requirements.

The load test shall be conducted through resistive load bank at unity power factor.
Before conducting test, following shall be recorded on test report :

a) Engine serial no.
b) Engine model & make No.
c) Alternator serial No.
d) Engine & alternator rating
e) Date of testing
f) Rated speed, voltage & kW

Loads & duration: Engine shall be given a test run for atleast six hours with alternator supplying full rated load at site and overload test to the extent of 10% over the rated load shall be conducted immediately after the full load run test
No load: 5 mins
25% load – 30 mins
50% load – 30mins
75% Load – 30 mins
100% Load- 4.5 hrs
110% Load – 1 hr

The following parameters shall be noted on the test report

Description Time (After start of Load test)
1 hr 2hrs 3hrs 4hrs 5hrs 6hrs 7hrs

l) Load in kW
m) Power factor
n) Voltage
o) Current
p) Frequency
q) Alternator winding temperature
r) Alternator bearing temperature
s) Lube oil pressure
t) Lube oil temperature
u) Fuel consumption though flow meter
v) Cylinder head temperature

Impact test:
A block load of at least 50% shall be put on the DG from no load condition & similarly when DG is 100% loaded, the load is removed & the parameters like voltage, frequency & RPM is noted. The readings should be with in acceptable limits.

Performance Tests

a) The following items of performance shall be guaranteed during site performance tests in respect of the DG and the auxiliaries for the specified site conditions:
b) Net electrical output (continuous)
c) Freedom from vibration and noise
d) Governor response, over-speed trip and speeder gear capability
e) Voltage regulator response

f) Excitation at full load and under specified variation of voltage and speed.

Start-up & testing at site

A equipment manufacturer's representative approved by the Consultant / Client shall be engaged to perform start-up and load test upon completion of installation with the Consultant / Client in attendance. A certified test record shall be provided.

Tests shall include, but are not be limited to, the following:

- Check fuel, lubricating oil, and antifreeze in liquid cooled models for conformity to the manufacturer's recommendations under environmental conditions present.
- Test, prior to cranking of engine, for proper operation of accessories that normally function while the set is in a standby mode.
- Check, during start-up test mode, for exhaust gas leaks outside the building, cooling air flow, movement during starting and stopping, vibration during running, line-to-line voltage and phase rotation.
- Test by means of simulated power outage, automatic start-up by remote- automatic starting, transfer of load, and automatic shutdown. Engine generator sets are to be synchronized and paralleled during tests. Monitor throughout the test, engine temperature, oil pressure, battery charge level, generator voltage, amperes, and frequency.
- Tests shall demonstrate capability and compliance of system with operating requirements. Where possible, correct malfunctioning units at site then retest to demonstrate compliance; otherwise remove and replace with new units, and proceed with retesting. Retesting to be at no cost to the Consultant / Client.
- This section includes a very basic outline of the start-up sequence. The actual sequence will be determined after the final design is completed. The commissioning of the new generators will occur on weekends and after-hours depending upon the scheduling requirements of the business.

12. Rejection

The purchaser may reject any DG Sets during tests or service any of the following conditions arise and the provision under the relevant clause of the general conditions of contract shall immediately become applicable:

If it is not adhering to:-

- GUARANTEED TECHNICAL PARTICULARS- Diesel Engine.
- GUARANTEED TECHNICAL PARTICULARS- Generator
- DG Sets fails on performance guarantee test at works.
- DG Sets fails on performance guarantee test at site.
- Proven performance in number of running hours for the type / Model of the DG set
- DG Sets is proved to have been manufactured not in accordance with the agreed specification.
- The purchaser reserves the right to retain the rejected DG Sets and take it into service until the tenderer replaces the defective DG Sets by a new acceptable DG Sets at no extra cost. The tenderer shall repair or replace the DG Sets within a reasonable period mutually agreed time to the satisfaction of the purchaser at no extra cost.

# ANNEXURE-II

## CONTROL AND RELAY PANEL

**Panels/Boards shall be suitable for operation on 3 Phase/single phase, 415/240 volts, 50 cycles, 4 wire system with neutral grounded at transformer. All Distribution panels shall be CPRI tested design and manufactured by a approved manufacturer. CPRI certificate shall be made available.**

**Distribution panels shall comply with the latest Relevant Indian Standards and Electricity Rules and Regulations and shall be as per IS-13947-1993.**

### 1. Construction Features

**Distribution panels shall be 2 mm thick sheet steel cabinet for indoor installation, dead front, floor mounting / wall mounting type and shall be form 3b construction. The Distribution panels shall be totally enclosed, completely dust and vermin proof and shall be with hinged doors and folded covers, Neoprene gasket, padlocking arrangement and bolted back. All removable/ hinged doors and covers shall be grounded by flexible standard connectors. Distribution panel shall be suitable for the climatic conditions as specified in Special Conditions. Steel sheets used in the construction of Distribution panels shall be 2 mm thick and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal. The general construction shall confirm to IS-8623-1977 (Part-1) for factory built assembled switchgear & control gear for voltage up to and including 1100 V AC.**

**All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with wing nuts. Self threading screws shall not be used in the construction of Distribution panels. A base channel of 75 mm x 40 mm x 5 mm thick shall be provided at the bottom for floor mounted panels. Minimum operating clearance of 275 mm shall be provided between the floor of Distribution panels and the lowest feeder compartment.**

**Distribution panels shall be of adequate size with a provision of spare switchgear as indicated on the Single Line Diagram. Feeders shall be arranged in multi-tier. Knockout holes of appropriate size and number shall be provided in the Distribution panels in conformity with the location of cable/conduit connections. Removable sheet steel plates shall be provided at the top to make holes for additional cable entry at site if required.**

**Every cabinet shall be provided with Trifoliate or engraved metal name plates. All panels shall be provided with circuit diagram engraved on PVC sheet. All live accessible connections shall be shrouded and shall be finger touch proof and minimum clearance between phase and earth shall be 20 mm and phase to phase shall be 25 mm.**

### 2. Bus Bar Connections

**Bus bar and interconnections shall be of high conductivity electrolytic grade aluminium / copper as indicated in the bill of quantities complying with requirement of IS : 5082 – 1981 and of rectangular cross section suitable for carrying the rated full load current and short circuit current and shall be extendable on either side. Bus bars and interconnections shall be insulated with heat shrinkable sleeve of 1.1**

**KV grade and shall be colour coded. Bus bars shall be supported on glass fiber reinforced thermosetting plastic insulated supports at regular intervals to withstand the force arising from in case of short circuit in the system. All bus bars shall be provided in a separate chamber and all connections shall be done by bolting. Additional cross sectional area to be added to the bus bar to compensate for the holes. All connections between bus bars and breakers shall be through solid copper / aluminium strips of proper size to carry full rated current and insulated with insulating sleeves. Maximum current density for the busbars shall be 1A/sq.mm for aluminium and 1.4 A/sq.mm for copper bus bars.**
**Maximum allowable temperature for the Bus bar to be restricted to 85 deg C**

**2.1 Temperature - Rise Limit**

**Unless otherwise specified, in the case of external surface of enclosures of bus bar compartment which shall be accessible but do not need to be touched during normal operation, an increase in the temperature rise limits of 25° C above ambient temperature shall be permissible for metal surface and of 15° C above ambient temperature for insulating surfaces as per IS 8623(Part-2) 1993.**

**All main distribution panels and sub distribution panels shall be provided with MCCB of appropriate capacity as per Single Line Diagram. All final Distribution boards shall be provided with Miniature Circuit Breakers. Final Single Phase Distribution boards shall be connected to the incoming supply through double pole MCB units & earth leakage circuit breakers. All wiring for final distribution boards shall be concealed behind 5 mm thick bakelite sheet or M S sheet cover. All Distribution boards shall be completely factory wired, ready for connection. All the terminals shall be of proper current rating and sized to suit individual feeder requirements. Each circuit shall be clearly numbered from left to right to correspond with wiring diagram. All the switches and circuits shall be distinctly marked with a small description of the service installed.**

**Continuous earth bus sized for prospective fault current shall be provided with arrangement for connecting to station earth at two points. Hinged doors/ frames shall be connected to earth through adequately sized flexible braids.**

**2.2 Cable Compartments**

**Cable compartment of adequate size shall be provided in the Distribution panels for easy clamping of all incoming and outgoing cables entering from the top/bottom. Adequate supports shall be provided in cable compartment to support cables.**

## 11.25 SCADA

1. Introduction

- SAU intends to establish Centralized Monitoring and control system through state of the art SCADA system and substation automation at various 66 KV, 11 kV and 415V substations from the bidders having at least 5 years of experience in Substation Control & Monitoring Systems. It has been proposed to provide substation automation for controls, monitoring and protection system to enhance operational reliability and security.
- The SCADA system will be implemented to monitor all the substations covered under the project. Control will be executed over selected devices. The system executes the command and collects the data online through communication network and associated communication infrastructure and analyzing the data at a central monitoring station of the university.
- The proposed system shall have following functionalalities.
  - Remote / local monitoring
  - Remote / local control
  - Reports
  - Trends
  - Alarms
  - Event logging
  - Fault Analysis

2. scope of work

- This scope of the bidder includes all the equipments, hardware, softwares and services covered under supply, installation and commissioning of centralized SCADA plus Substation Automation system including control & monitoring and other related aspects of substation operations for efficient and trouble free operation.
- This specification shall be used in conjunction with all specifications, data sheets, single line diagrams, and other drawings attached to the specification / purchase requisition.
- The system shall comprise of following elements as and when required

  Hardwares

  - RTU conforming, IEC 61850, IEC-103, IEC-101, IEC-104 and Modbus-RTU Protocols.
  - CAT-6 Cable
  - Standard mounting racks
  - Communication cables
  - Communication Interface Devices (Ethernet Switches, Hubs etc.)
- SCADA Software
  - Software for proper operation of OWS with licence for adequate number of tags to meet system requirement.
  - Configuration Software for protection relays
  - Configuration Software for RTU

- It is proposed that each substation shall have a RTU for control and monitoring purpose of complete substation. The RTU shall support IEC -103 & Modbus-RTU for substation level and IEC-101 or IEC-104 for telecontrol level.
- One (1) EWS and Two (2) OWS are envisaged in a Central Control Room building for the complete system.

- The software license provided in this project should not be computer specific and they should be reusable on another computer, as and when required, provided only one computer is active in the system.
- One no. of laptop with latest configuration.
- Operational and maintenance manuals including drawings
- The system shall conform in all respects to high standards of engineering, design and workmanship. The offered system shall be complete with all components and softwares necessary for their intended purpose. The details of equipments are provided in Annexure-1 (GTP).

3. Functional requirement of SCADA / SA System

- The RTU shall have 19" design, so that it can be mounted in a frame or swing frame, for special cases, where no frame is available, it shall also be possible that the RTU can be wall mounted.
- The RTU must present an open, expandable and future-proof system, by taking into account latest standards, such as e.g. flash card technology, integrated PLC functionality; modular system concept, etc.
- The configuration data and the software of the RTU (firmware and parameters) shall be stored centrally on an exchangeable, non-volatile storage card.
- The RTU shall be equipped in hot standby mode with redundant processor/ inbuilt feature so that even if the processor fails – RTU Functioning shall not get affected, redundant power supply, redundant communication & processing cards for reliable operation.
- The RTU shall have standardized, parameter-settable acquisition, processing and output functions of the process periphery signals, taking into account the methods and procedures according to IEC 61850/IEC 60870-5-101/104 / OPC for:
  - Single-Point Information
  - Double-Point Information
  - Integrated Totals via Count Pulses
  - Currents
  - Temperatures
  - Pulse commands
  - Binary Information Output
  - Setpoint Values by means of Currents and Voltages
- The RTU shall support IEC 61650, IEC-103, IEC-101, IEC-104, MODBUS , OPC and many other IEC protocols for substation and telecontrol level communication.
- Programming tool with IEC 61131-3 compliant programming environment for logic programming of functions. These functions shall be supported by offered RTU.
- The RTU shall be suitable for operation in Substation or High Electromagnetic Interference environment.
- Sizing & Scalability: The system shall be scalable and shall be able to add more bays in future.

  Main Requirements of SCADA:-
  1. To control (trip, ON,OFF) the 66kv breakers
  2. To control (ON, OFF, Trip) DG sets supply breakers i.e (11 kV DG sync panel i/c).
  3. To control (ON, OFF, Trip) 11 kV breakers of main HT panels.
  4. Monitor 11 kV, 66 kV incomers & outgoing feeders.
  5. Monitoring of incomer of all LT isolator panels.
  6. Automatic control of incomers of both normal and emergency Main LT panels
  7. In case of DG set running (main power failure) the normal ACB of ESS- isolator panel shall trip down automatically.

4. Interfacing equipments

The scope for interface equipments shall include but not limited to the following:

- Any interfacing equipments such as star couplers, converters, hubs, switches etc shall be in bidder's scope. However any interfacing equipment required for integrating the DG set, BMS with PDMS will be in scope of respective supplier along with necessary cables. For signal exchange, the FO cable shall be brought upto LIU for future connection.
- PDMS supplier has to provide sufficient ports in his system to integrate BMS and DG set. All connections to these systems shall be redundant.
- Communication cables (UTP / RS485 etc) for relays and energy meters shall be in the scope of bidder. Required communication Loop up to RTU shall be in bidder's scope.
- The supplier shall procure, install and commission all the required interface equipments at substations
- Communication cables (Mono-mode Fiber Optic, UTP, RS 485 etc) along with necessary equipments required for relay and energy meters.
- The communication protocol shall be
  - Between numerical relays and SCADA through interface equipment: IEC 61850.
  - Between RMU (FRTU) & SCADA through IEC – 60870-104.
  - Between energy meters and RTU through interface equipment: Modbus-RTU
  - Between substation RTU to SCADA through interface equipment: IEC-60870-104 / IEC 61850.
  - Between DG set and RTU through Modbus-RTU. However no control of DG set is envisaged from PDMS.
  - Between BMS and RTU through IEC 61850 / Modbus / 104. However no control of BMS is envisaged from PDMS.
  - Between SCADA and RTU through IEC-60870-104 and OPC.
  - Between DG set and RTU through IEC-60870-104 and OPC. However no control of DG set is envisaged from PDMS.
  - Between BMS and RTU through IEC-60870-104 and OPC. However no control of BMS is envisaged from PDMS.
  - DG Synchronization shall be by IEC 104 protocol / Modbus RTU.

5. Communication System

- The bidder shall furnish detailed communication system topology with all equipments, hardware and softwares along with the offer. The bidder shall also indicate the list of equipments to be supplied by him under the project.
- Communication hardware: All hardware like Star coupler, mono-mode FO glass/plastic, cables, RS 485 cables and protocol converters required for interfacing IEDs like protection relays and multifunction meters to RTU should be included in scope of supply.

6. RTU ( Remote terminal unit)

- The RTU must be non-PLC based industrial grade and present an open, expandable and future-proof system, by taking into account latest standards, such as e.g. modular system concept, etc.
- RTU should be having power supply and central processor. The central processor is responsible to communicate all IEDs / meters on RJ45/RS485 connectivity. The central processor should have the capability to integrate IEC 61850, IEC104 and Modbus RTU Master. Central Processor will be connected to LAN Switch for communication with HMI. These are responsible for communication between the RTU with Central control centre. The protocol for two way communication between RTU & Central control centre should be IEC 104/IEC 61850.
- The RTU shall have standardized, parameter-settable acquisition, processing and output functions of the process periphery signals, taking into account the methods and procedures according to IEC 60870-5-104 for:

- Single-Point Information
- Double-Point Information
- Integrated Totals via Count Pulses
- Currents
- Pulse commands
- Binary Information Output
- Setpoint Values by means of Currents and Voltages

- The RTU shall support IEC-103, IEC-104, MODBUS-RTU and many other IEC protocols for substation and telecontrol level communication.
- Digital Inputs: All Inputs should be suitable for 48V or 220 VDC. They will be connected to potential free contact from field.
- Digital Outputs: All Outputs should be suitable for 48V or 220 VDC. They will be connected to potential free contact in field. The control of ACBs shall be through DOs of the RTU.
- Analog Inputs: Analog signals are to be configurable as 4-20mA as required.
- Control Voltage: Voltage converter to be provided by bidder for converting control DC voltage to required DC in the RTU Panel in case the control voltage is different from station supply.
- RTU will read all the signals coming from IEDs & MFMs) as Soft signals on standard protocols.
- Numerical relays in HT VCB Panel should be IEC 61850 compatible. The relays should have redundant communication port on Fibre Optic medium. All the hardware required to extend the relay signals to the RTU shall be supplied along with the switchboards. All hardware required for compatibility with SCADA shall be in bidder's scope.
- Programming tool with IEC 61131-3 compliant programming environment for logic programming of functions. These functions shall be supported by offered RTU. All software and configuration tools required for configuration of RTU and Network should be included in scope of supply.
- The RTU shall be suitable for operation in Substation or High Electromagnetic Interference environment.
- Sizing & Scalability: The system shall be scalable and shall be able to add more bays in future.
- Each RTU shall be provided with minimum one AI/ AO/ DI & DO cards. Al each RTU, minimum 30 % spare ports shall be considered for each type of card. Calculation shall be furnished during detailed engineering.
- RTU mounted in RMU shall follow specification mentioned in the category of RMU and to be termed as FRTU specifically for feeder automation.
- PDMS will only monitor the information provided by BMS and DG SCADA.
- Any command / control / data exchange between BMS or DG SCADA should be through direct interface with each other and PDMS will not act as interface for exchange of such information.
- RTU should have redundancy in power supply, communication and processor such that failure of any single component should not result in loss of communication.

7. Central Control Room at MRS

Hardware

The Central Monitoring Station shall be equipped with Hardware and latest Software required for successful operation of the system. This includes

- Servers- 1 OWS, Server-2 Red. OWS and Server-3 EWS (The minimum specification of the same shall be in line with GTP)
- Peripherals and Printers : One(1) A4 Laserjet printer
- Communication equipments : As required
- Any additional equipments required, if any, to fulfill the specification requirement.
  - All these Servers will be connected on Local Area Network.
  - The bidder shall supply the system in line with the Annexure-1 GTP.

8. INTERFACE WORK DETAILS

- Installation, testing and commissioning of RTU Panel.
- Installation testing commissioning of protocol converter, connection converter, star coupler, switches, hubs etc.

9. RTU Panels

Simplex type - Panels shall be completely metal enclosed, free standing, floor mounting type and shall be dust, moisture and vermin proof. Panels shall be free from undulations, dents and other flaws.

The panel enclosure shall provide a degree of protection not less than IP-32 if it is located in air-conditioned area and shall not be less than IP-54 if located in other areas. Panels/desks shall be fabricated of cold rolled sheet steel of not less than 2.5mm for front and rear and 2.0 mm for sides, top and bottom portions with gland plate of 3 mm thick.

Panel shall consist of a vertical front panel with equipment flush mounted thereon and having wiring access from the rear. Doors shall have handles with built-in locking facility. The panel shall consist of a vertical panel with equipment mounted on a swing frame on the front side of the panel . A transparent door shall be provided in front of the swing frame. Access to wiring is gained by opening first the transparent door and then the swing frame.

Pre-treatment of all sheet steel work, including degreasing, rust/scale removal and phosphating shall be carried out as per applicable standard. The phosphate coating shall be sealed by the application of two coats of ready mixed, zinc chromate primer.

After application of the primer, two coats of finishing synthetic enamel paint/epoxy paint shall be applied (second coat to be applied after completion of tests). The colour of the finishing coat shall be as specified by the purchaser.

All wiring shall be carried out with 1100V grade, single core, stranded tinned copper conductors with FRLS PVC insulation.

Terminal blocks shall be 1100V grade, 10 amps rated one piece moulded, complete with insulating barriers and identification strips. Marking on the terminal strips shall correspond to numbers on the wiring diagrams.

All necessary cable terminating accessories such as removable gland plates, double compression glands, crimp type tinned copper lugs, supporting clamps and brackets, fire retardant wiring troughs and gutters, etc. for terminating the cables shall be included in the scope of supply.

10. UPS

Separate dual redundant online UPS with 2 hour backup shall be installed at MRS. control rooms for feeding power to SCADA system. For ESS location, either DC system shall be used for feeding power to RTUs or separate Ups shall be considered there also.

11. GPS

The GPS time synchronizing signal (LAN based) for the synchronization of the entire system shall be provided. The RTUs, Relays, releases etc at each substation shall also be synchronized from this GPS system.

12. Redundant Work station:

Processor and RAM shall be selected in such a manner that during normal operation not more than 30% capacity of processing and memory are used. Supplier shall demonstrate these features.

The capacity of hard disk shall be selected such that the following requirement should occupy less than 50% of disk space:

- Storage of all analogue data (at 2 Minutes interval)and digital data including alarm , event and trend data for thirty(30) days.
- Storage of all necessary software,
- 100GB space for OWNER'S use.

Supplier shall demonstrate that the capacity of hard disk is sufficient to meet the above requirement.

13. Switches

The bidder shall provide the redundant switched optical Ethernet communication infrastructure for SAS. The bidder shall keep provision of 50% spare ports for future use. All switches shall be identical as far as possible.

All the switches shall be network managed Ethernet switches, IEC-61850 compliant and shall have speed matching with the fastest IED connected. Test certificates for the same shall be furnished during detailed engineering.

Ethernet switches shall have redundant power supply i.e dual AC/DC power supply card and the switches shall be without cooling fans.

Switch shall be considered at the panel level with FO connection from relay to switch. Industrial grade switches shall be considered inside the panel, 61850 compliant.

14. System Design

The SCADA offered shall be user-friendly in nature, having state-of-the-art technology and employing industry standard protocols & database. Keeping in view future system expansion plan, as may be necessary, the proposed system should have a provision of 40% expansion without affecting the overall system response time.

The SCADA hardware and software shall be suitable for handling the signals as per the attached IO list. All the IOs for 13 ESS and the MRS shall be considered for calculating the number of Tags.

The SCADA hardware and software shall be suitable for handling the signals as per the attached IO list. All the IOs for 13 ESS and the MRS shall be considered for calculating the number of Tags.

15. Source Code & Software

The source code for SAU specific application software for SCADA like data freezing, report generation etc to be provided with proper documentation.

All necessary information for any future integration of the proposed SCADA system with any other system shall be documented and handed over to the purchaser. This shall include files like ICD, SCD, PICS, MICS, PIXIT etc.

16. Response Time

Contractor shall indicate the response time for the following. Response time shall be considered from actuation from field to updation on the HMI screen or command on the screen to actuation in the field.

Digital Input
Digital Output
Analog Input
Analog output

17. Select-before-execute

For security reasons the command is always to be given in two stages: selection of the object and command for operation under all mode of operation except emergency operation. Final execution shall take place only when selection and command are actuated.

18. Run Time Command cancellation

Command execution timer (configurable) must be available for each control level connection. If the control action is not completed within a specified time, the command should get cancelled.

19. Self-supervision
Continuous self-supervision function with self-diagnostic feature shall be included for the complete SACDA system.

20. User configuration
The monitoring, controlling and configuration of all input and output logical signals and binary inputs and relay outputs for all built-in functions and signals shall be possible both locally and remotely. It shall also be possible to interconnect and derive input and output signals, logic functions, using built-In functions, complex voltage and currents, additional logics (AND-gates, OR gates and timers). (Multi-activation of these additional functions should be possible).

21. Measurements
Analogue inputs of energy (kWHr), active power (W), reactive power (VAR), frequency (Hz), and the rms values for voltage (V) and current (I) shall be displayed.
The measured values shall be displayed in the control centre. The abnormal values must be discarded. The analogue values shall be updated every 2 seconds.

22. Event and alarm handling
Events and alarms are generated either by the switchgear, by the control IEDs, or by the sub station level unit. They shall be recorded in an event list in the HMI. Alarms shall be recorded in a separate alarm list and appear on the screen. All, or a freely selectable group of events and alarms shall also be printed out on an event printer. The alarms and events shall be time-tagged with a time resolution of 1 ms. Time tagged data from the IED level shall be transferred to the SCADA system.

23. Trend display (historical data)
It shall be possible to illustrate all types of process data as trends - input and output data, binary and analogue data. The trends shall be displayed in graphical form as column or curve diagrams with a maximum of 10 trends per screen. Adjustable time span and scaling ranges must be provided.
It shall be possible to change the type of value logging (direct, mean, sum, or difference) on-line in the window. It shall also be possible to change the update intervals on-line in the picture as well as the selection of threshold values for alarming purposes.

24. Automatic disturbance file transfer
All recorded data from the IEDs with integrated disturbance recorder as well as dedicated disturbance recording systems shall be automatically uploaded (event triggered or once per day) to a dedicated computer and be stored on the hard disc.

25. Disturbance analysis
The work station shall have necessary software to evaluate all the required information for proper fault analysis.

26. IED parameter setting
It shall be possible to access all protection and control IEDs for reading the parameters (settings) from the station HMI. The setting of parameters or the activation of parameter sets shall only be allowed with proper authorization after entering a password.

27. Automatic sequences
The available automatic sequences in the system should be listed and described, (e.g. sequences related to the bus transfer). It must be possible to initiate pre-defined automatic sequences by the operator and also define new automatic sequences.

28. System Sizing & Extendibility
The SCADA shall be able to support tags as per the system requirement + 100 % additional tags. The hardware and software openness of SCADA shall allow the customer to smoothly upgrade the proposed system. Common upgrading needs include (but not limited to) the following items.

## 11.25.1. ANNEXURE I

The components being supplied should meet the following requirement as minimum.

| GTP For SAS Equipment | | | |
|---|---|---|---|
| 1 | HMI Workstation / Engineering Workstation / DR Workstation (OWS/EWS) | | |
| | Make & type | Dell / IBM / HP / Advantech / Portwell Laxsons - Server grade with RAID-1 type storage | Bidder Confirmation |
| | CPU | i5 | Yes / No |
| | Chipset | Intel | Yes / No |
| | DVD Drive | DVD R/W | Yes / No |
| | Hard Disk | 500 GB | Yes / No |
| | RAM | 4 GB DDR3 | Yes / No |
| | Ethernet Port | Ethernet Port that support teaming | Yes / No |
| | Ports: | 2x USB2.0 Front, 2x USB2.0 Rear, 1x VGA, 1x Parallel, 1x Serial | Yes / No |
| | Operating System | Windows 7 Professional / Latest version available. | Yes / No |
| | Power Supply | 110/230 V AC, single phase | Yes / No |
| | Monitor | 1280x1024 Resolution, 21.5" LCD, Make: Dell / Fujitsu / IBM / HP / Samsung / Benq | Yes / No |
| | Keyboard | Standard 102 keys Keyboard | Yes / No |
| | Mouse | Optical mouse | Yes / No |
| 2 | A4 COLOR LASER PRINTER | | |
| | Make | HP / Canon / Xerox / Epson | Bidder Confirmation |
| | Auxilliary Voltage | 230 V AC | Yes / No |
| | Built in Testing Facility | YES | Yes / No |
| | Offline/Online Mode Selector | YES | Yes / No |
| | Print Speed | Color A4:upto 8 ppm,Black: Upto 12 ppm | Yes / No |
| | First page out | Less than 25.5 sec | Yes / No |
| | Resolution | 600 by 600 dpi | Yes / No |
| | Processor | 400 MHz | Yes / No |
| | Memory | 96 MB | Yes / No |
| | Duty Cycle | Upto 30000 pages per month | Yes / No |
| | Standard Media Sizes | A4, A5 | Yes / No |
| | Interfaces | Hi-Speed USB 2.0, 10/100Base-TX with RJ45 connector | Yes / No |
| | Operating systems | Microsoft Windows 7, XP Home, XP Professional, Server 2003; | Yes / No |
| | Network Interface | 10/100Base-TX with RJ45 connector | Yes / No |
| 3 | GPS Time Synchronization Equipment | | |
| | Make | Masibus / HOPF / Arbiter / Meinberg | Bidder Confirmation |
| | Mounting arrangement | Rack Mount | Yes / No |
| | I/ps andO/Ps ports | INPUT PORT-BNC - P | Yes / No |
| | | 2 ports | Yes / No |
| | | 2 TCP/IP 100/10 BASE RJ45 CONNECTOR | Yes / No |

| | | | |
|---|---|---|---|
| | Power supply | 110-220 V DC | Yes / No |
| | Operating Temperature Range | As per IEC-60255 | Yes / No |
| | Storage temperature range | As per IEC-60255 | Yes / No |
| | Humidity | Non Condensing | Yes / No |
| | Whether able to give real time IST corresponding to(taking into consideration all factors like voltage, temperature variation & propagation/processing delay) | Yes | Yes / No |
| | Whether O/p signal programmable at site | Yes | Yes / No |
| | Periodicity of time correction facility | 1 sec | Yes / No |
| | Time Display Unit | Real time display in hour,min,sec,in 24 Hrs. mode,size approx. 100mm height | Yes / No |
| 4 | CAT 6 Cable | | |
| | Make | Schneider / Preston / Belden | Bidder Confirmation |
| | Type | CAT 6 UTP | Yes / No |
| | Nos of Cores | 4 twisted pair | Yes / No |
| | Outer Diameter | 6.0 mm | Yes / No |
| | Jacket Material | PVC | Yes / No |
| | Color | Gray | Yes / No |
| | Conductor Type | 24 AWG bare solid copper | Yes / No |
| | Insulation Resistance | 500mΩ km @ 500 Vdc | Yes / No |
| 5 | Managed Ethernet Switch | | |
| | Make:- | Ruggedcom / Hirschmann / Garrettcom / Schneider | Bidder Confirmation |
| | Type of ports | LC 62.5 µm Multimode / RJ45 | Yes / No |
| | Speed of Ports | 100 Mbps | Yes / No |
| | No. of Power supplies | Single | Yes / No |
| | Aux. Power Supply | 88-300VDC or 85-264VAC | Yes / No |
| | Operating Temp. | -45°c to +85°c | Yes / No |
| | EMI Immunity and | IEC61850-3 ELECTRIC UTILITY | Yes / No |
| | Environmental compliance | SUBSTATION | Yes / No |
| | Mounting | 19" Rack mountable | Yes / No |
| 6 | Laptop | | |
| | Make:- | Dell / IBM / HP | Bidder Confirmation |
| | CPU | i3 | Yes / No |
| | Chipset | Intel | Yes / No |
| | DVD Drive | DVD R/W | Yes / No |
| | Hard Disk | 320 GB | Yes / No |
| | RAM | 4 GB DDR3 | Yes / No |
| | Ports: | 2x USB2.0 ,1x VGA, 1xRJ45 | Yes / No |
| | Operating System | Windows 7 Professional | Yes / No |
| | Screen | 14" inch TFT | Yes / No |

### 11.25.2. ANNEXURE II

List OF EQUIPMENTS

At minimum following equipments should be provided by bidder. However if any contractor offers slightly modified BOM based on their standard practice without compromising the working, the same shall be subject to approval during detailed engineering.

| Sl. No. | CODE | DESCRIPTION | QTY | MAKE |
|---|---|---|---|---|
| | | | | |
| 1 | SOFTWARES | REDUNDANT HMI SOFTWARE | 1 SET | SIEMENS / ABB / SCHNEIDER |
| 2 | SOFTWARES | HMI PARAMETERIZATION SOFTWARE | 1 | SIEMENS / ABB / SCHNEIDER |
| 3 | SOFTWARES | RTU PARAMETERIZATION SOFTWARE | 1 | SIEMENS / ABB / SCHNEIDER |
| 4 | RTU | RTU | 17 | SIEMENS / ABB / SCHNEIDER |
| 5 | PC (OWS, Red. OWS, EWS) | XEON based server grade with RAID-1 type storage, 500 GB HDD, 4 GB RAM, intel i3 processor. | 3 | Dell / IBM / HP / Advantech / Portwell Laxsons |
| 6 | MONITOR | LED TFT | 3 | Dell / Fujitsu / IBM / HP / Samsung / Benq |
| 7 | CABLE | LAN CABLE (LUMPSUM) | 305m | Schneider / Preston / Belden |
| 8 | PANEL | PANEL OF SUITABLE DIMENSION | 17 | SIEMENS / ABB / SCHNEIDER |
| 9 | MANAGED ETHERNET SWITCH | MANAGED ETHERNET SWITCH | 34 | Ruggedcom / Hirschmann / Garrettcom / Schneider |
| 10 | FURNITURE | Furniture (1 table + 1 chair) | 3 | Godrej / Cosmos / Pyrotech |
| 11 | PRINTER | Laserjet printer (A4) color with network port | 1 | HP / Canon / Xerox / Epson |
| 12 | GPS | Time Synchronization Equipment | 1 | Masibus / HOPF / Arbiter / Meinberg |
| 13 | Laptop | 320 GB HDD, 4 GB RAM, intel i3 processor | 1 | Dell / IBM / HP |
| 14 | UPS | Dual Redundant configuration 2 KVA | 1 | Numeric / Emerson / GE/ Schneider |

A. GENERAL TECHNICAL REQUIREMENTS OF HMI

- The HMI shall have an intuitive graphical design to ensure effective use of the SCADA with minimal confusion. The amount of keyboard typing needed for using the SCADA shall be minimized.
- The HMI shall be strictly divided into various levels depending on the system security levels.
- The Single Line Diagram of the system shall be displayed on one or more graphical displays. A high-level overview display shall be provided, with the ability to zoom to more detailed displays. Different colors shall be used to differentiate voltage levels, selected object on screen, selected object for command, blocked / tagged equipment etc. on the graphical displays. A library of standard symbols shall be used to represent equipment on the graphical displays.
- The status in terms of actual values of currents, voltage, frequency, active and reactive power as well as the positions of the circuit breakers shall be displayed on the station single line diagram.
- All workstations shall work on the same Operating system, preferably Windows 7. Latest anti-virus software shall be supplied on all workstations.
- PDMS shall be developed based on HMI server based software and Microcontroller based hardware Automation Units for monitoring, controlling and reporting.
- All data shall be recorded chronologically date wise. The user shall be able to export the data file in .txt or .csv format.
- Representation of monitored data shall be in graphics mode or in tabulation form. All instantaneous data can be shown in the computer screen. The computer screen details shall be shared with customer during detailed engineering. During detailed engineering, vendor has to take approval for the HMI screens from the customer.

B. SOFTWARE LICENSE AND UPGRADES

- The vendor shall provide all software licenses for all the software being used in SCADA system. The licenses shall not be hardware/machine specific i.e. if any hardware/machine is changed, the same software licenses shall be valid and the owner shall not have to seek fresh licenses or renewal of licenses.
- Suitable Anti Virus licensed software valid for one year shall be provided by the vendor.
- The Bidder shall guarantee that all software are defect free and meet the system specifications.
- Vendor to confirm that all software versions in components of the HMI shall be of latest official releases as on the date of shipment from works and shall include all software updates etc. released till the date.

C. HISTORICAL DATA MANAGEMENT AND TRENDING

- The HMI shall maintain historical data in bulk non-volatile memory. The historical data shall he available for review by authorized user.
- The historical data shall include all sequence of Event logs calculated from relays.

D. REPORTS

- The HMI should be capable of generating different types of reports, which can be presented in the operator interface screen upon request or programmed for on demand presentation in printers. It shall be possible to generate reports with information from historical database.

E. MASS STORAGE BACKUP

- An industry Standard DVD writer shall be provided to permit mass storage of all information existing in the computer's hard disks such as application programs, data base configuration, historical data, operations log etc.
- Data of at least one month should be available at site and after one month the data should be moved to a permanent location (DVD/CD) on demand.
- From this permanent location data should be retrieved as and when required without any time/cost implication.

F. REPORT GENERATION SOFTWARE

- Daily generation reports
- Weekly generation reports
- Monthly generation reports
- Yearly generation reports

- Reports between two given dates

G. SYSTEM SECURITY

- To ensure system security the complete functionality of the SCADA shall be divided into various system security levels. Each security level shall offer certain functionality of the SCADA to users:
  - SECURITY LEVEL 0: display only of graphics, real time and historical data.
  - SECURITY LEVEL 1: normal control operations, access to acknowledge alarm logs.
  - SECURITY LEVEL 2: restricted control operation, access to edit or defeat bay interlocks.
  - SECURITY LEVEL 3: complete access, engineering and maintenance of configuration and databases.

- The user shall be grouped into various user groups with each user having the username and the password. The level of accessibility to each user group shall be predefined.
- The system admin group shall have complete access to SCADA and shall be able to add or remove users and redefine access rights.
- The various system security levels and various user groups shall be defined by the owner during detail engineering.

| SUBSTATION | BOARD DESIGNATION | FEEDER | SUB-EQUIPMENT | INFORMATION TYPE | NATURE OF INFORMATION | INFORMATION | INTERFACE | PROTOCOL |
|---|---|---|---|---|---|---|---|---|
| ESS-1 | MAIN NORMAL PANELS | I/C-1 | NORMAL SUPPLY-1 ACB | DI | Status | CB OPEN | Hardwired | -- |
| ESS-1 | MAIN NORMAL PANELS | I/C-1 | | DI | Status | CB CLOSE | Hardwired | -- |
| ESS-1 | MAIN NORMAL PANELS | I/C-1 | | DI | Status | CB TRIP | Hardwired | -- |
| ESS-1 | MAIN NORMAL PANELS | I/C-1 | NORMAL SUPPLY-1 EEM | AI | Metering | Voltage | Serial | MODBUS-RTU |
| ESS-1 | MAIN NORMAL PANELS | I/C-1 | | AI | Metering | Curent | Serial | MODBUS-RTU |
| ESS-1 | MAIN NORMAL PANELS | I/C-1 | | AI | Metering | Power | Serial | MODBUS-RTU |
| ESS-1 | MAIN NORMAL PANELS | I/C-2 | NORMAL SUPPLY-2 ACB | DI | Status | CB OPEN | Hardwired | -- |
| ESS-1 | MAIN NORMAL PANELS | I/C-2 | | DI | Status | CB CLOSE | Hardwired | -- |
| ESS-1 | MAIN NORMAL PANELS | I/C-2 | | DI | Status | CB TRIP | Hardwired | -- |
| ESS-1 | MAIN NORMAL PANELS | I/C-2 | NORMAL SUPPLY-2 EEM | AI | Metering | Voltage | Serial | MODBUS-RTU |
| ESS-1 | MAIN NORMAL PANELS | I/C-2 | | AI | Metering | Curent | Serial | MODBUS-RTU |
| ESS-1 | MAIN NORMAL PANELS | I/C-2 | | AI | Metering | Power | Serial | MODBUS-RTU |
| ESS-1 | MAIN EMERGENCY PANELS | I/C-1 | EMERGENCY SUPPLY-1 ACB | DI | Status | CB OPEN | Hardwired | -- |
| ESS-1 | MAIN EMERGENCY PANELS | I/C-1 | | DI | Status | CB CLOSE | Hardwired | -- |
| ESS-1 | MAIN EMERGENCY PANELS | I/C-1 | | DI | Status | CB TRIP | Hardwired | -- |
| ESS-1 | MAIN EMERGENCY PANELS | I/C-1 | EMERGENCY SUPPLY-1 EEM | AI | Metering | Voltage | Serial | MODBUS-RTU |
| ESS-1 | MAIN EMERGENCY PANELS | I/C-1 | | AI | Metering | Curent | Serial | MODBUS-RTU |
| ESS-1 | MAIN EMERGENCY PANELS | I/C-1 | | AI | Metering | Power | Serial | MODBUS-RTU |
| ESS-1 | MAIN EMERGENCY PANELS | I/C-2 | EMERGENCY SUPPLY-2 ACB | DI | Status | CB OPEN | Hardwired | -- |
| ESS-1 | MAIN EMERGENCY PANELS | I/C-2 | | DI | Status | CB CLOSE | Hardwired | -- |
| ESS-1 | MAIN EMERGENCY | I/C-2 | | DI | Status | CB TRIP | Hardwired | -- |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | PANELS | | | | | | | |
| ESS-1 | MAIN EMERGENCY PANELS | I/C-2 | EMERGENCY SUPPLY-2 EEM | AI | Metering | Voltage | Serial | MODBUS-RTU |
| ESS-1 | MAIN EMERGENCY PANELS | I/C-2 | | AI | Metering | Curent | Serial | MODBUS-RTU |
| ESS-1 | MAIN EMERGENCY PANELS | I/C-2 | | AI | Metering | Power | Serial | MODBUS-RTU |
| | **All SOLAR I/C DELETED** | | | | | | | |
| ESS-1 | LT ISOLATOR PANEL-1 | **I/C-1** | NORMAL SUPPLY-1 ACB | DI | Status | CB OPEN | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-1 | **I/C-1** | | DI | Status | CB CLOSE | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-1 | **I/C-1** | | DI | Status | CB TRIP | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-1 | **I/C-1** | | DO | Control | CB Open | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-1 | **I/C-1** | | DO | Control | CB Close | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-1 | **I/C-2** | EMERGENCY SUPPLY-1 ACB | DI | Status | CB OPEN | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-1 | **I/C-2** | | DI | Status | CB CLOSE | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-1 | **I/C-2** | | DI | Status | CB TRIP | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-1 | **I/C-2** | | DO | Control | CB Open | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-1 | **I/C-2** | | DO | Control | CB Close | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-1 | CAP-1 | CAPACITOR PANEL-1 ACB | DI | Status | CB OPEN | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-1 | CAP-1 | | DI | Status | CB CLOSE | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-1 | CAP-1 | | DI | Status | CB TRIP | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-1 | CAP-1 | | DO | Control | CB Open | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-1 | CAP-1 | | DO | Control | CB Close | Serial | MODBUS-RTU |
| | **All SOLAR I/C DELETED** | | | | | | | |
| ESS-1 | LT ISOLATOR PANEL-1 | I/C-2 | GRID I/C-1 ACB | DI | Status | CB OPEN | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-1 | I/C-2 | | DI | Status | CB CLOSE | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-1 | I/C-2 | | DI | Status | CB TRIP | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-1 | I/C-2 | | DO | Control | CB Open | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-1 | I/C-2 | | DO | Control | CB Close | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-1 | I/C-2 | GRID I/C-1 | AI | Metering | Voltage | Serial | MODBUS-RTU |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ESS-1 | LT ISOLATOR PANEL-1 | I/C-2 | MFM | AI | Metering | Curent | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-1 | I/C-2 | | AI | Metering | Power | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-2 | O/G-1 | NORMAL SUPPLY-2 ACB | DI | Status | CB OPEN | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-2 | O/G-1 | | DI | Status | CB CLOSE | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-2 | O/G-1 | | DI | Status | CB TRIP | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-2 | O/G-1 | | DO | Control | CB Open | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-2 | O/G-1 | | DO | Control | CB Close | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-2 | O/G-2 | EMERGENCY SUPPLY-2 ACB | DI | Status | CB OPEN | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-2 | O/G-2 | | DI | Status | CB CLOSE | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-2 | O/G-2 | | DI | Status | CB TRIP | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-2 | O/G-2 | | DO | Control | CB Open | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-2 | O/G-2 | | DO | Control | CB Close | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-2 | CAP-2 | CAPACITOR PANEL-2 ACB | DI | Status | CB OPEN | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-2 | CAP-2 | | DI | Status | CB CLOSE | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-2 | CAP-2 | | DI | Status | CB TRIP | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-2 | CAP-2 | | DO | Control | CB Open | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-2 | CAP-2 | | DO | Control | CB Close | Serial | MODBUS-RTU |
| | **All SOLAR I/C DELETED** | | | | | | | |
| ESS-1 | LT ISOLATOR PANEL-2 | I/C-2 | GRID I/C-2 ACB | DI | Status | CB OPEN | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-2 | I/C-2 | | DI | Status | CB CLOSE | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-2 | I/C-2 | | DI | Status | CB TRIP | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-2 | I/C-2 | | DO | Control | CB Open | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-2 | I/C-2 | | DO | Control | CB Close | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-2 | I/C-2 | GRID I/C-2 MFM | AI | Metering | Voltage | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-2 | I/C-2 | | AI | Metering | Curent | Serial | MODBUS-RTU |
| ESS-1 | LT ISOLATOR PANEL-2 | I/C-2 | | AI | Metering | Power | Serial | MODBUS-RTU |
| ESS-1 | CAPACITOR PANEL-1 | I/C-2 | APFCR-1 | DI | Status | CB OPEN | Serial | MODBUS-RTU |
| ESS-1 | CAPACITOR PANEL-1 | I/C-2 | | DI | Status | CB CLOSE | Serial | MODBUS-RTU |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ESS-1 | CAPACITOR PANEL-2 | I/C-2 | APFC R-2 | DI | Status | CB OPEN | Serial | MODBUS-RTU |
| ESS-1 | CAPACITOR PANEL-2 | I/C-2 | | DI | Status | CB CLOSE | Serial | MODBUS-RTU |
| ESS-1 | 11 kV RMU PANEL | O/G-1 | Relay in RMU | DI | Status | CB OPEN | Ethernet | MODBUS |
| ESS-1 | 11 kV RMU PANEL | O/G-1 | | DI | Status | CB CLOSE | Ethernet | MODBUS |
| ESS-1 | 11 kV RMU PANEL | O/G-1 | | DI | Status | CB TRIP | Ethernet | MODBUS |
| ESS-1 | 11 kV RMU PANEL | O/G-1 | | DO | Control | CB Open | Ethernet | MODBUS |
| ESS-1 | 11 kV RMU PANEL | O/G-1 | | DO | Control | CB Close | Ethernet | MODBUS |
| ESS-1 | 11 kV RMU PANEL | O/G-2 | Relay in RMU | DI | Status | CB OPEN | Ethernet | MODBUS |
| ESS-1 | 11 kV RMU PANEL | O/G-2 | | DI | Status | CB CLOSE | Ethernet | MODBUS |
| ESS-1 | 11 kV RMU PANEL | O/G-2 | | DI | Status | CB TRIP | Ethernet | MODBUS |
| ESS-1 | 11 kV RMU PANEL | O/G-2 | | DO | Control | CB Open | Ethernet | MODBUS |
| ESS-1 | 11 kV RMU PANEL | O/G-2 | | DO | Control | CB Close | Ethernet | MODBUS |
| ESS-1 | 11 kV RMU PANEL | I/C-1 | RTU | DI | Status | Isolator On | Hardwired | -- |
| ESS-1 | 11 kV RMU PANEL | I/C-1 | RTU | DI | Status | Isolator Off | Hardwired | -- |
| ESS-1 | 11 kV RMU PANEL | I/C-2 | RTU | DI | Status | Isolator On | Hardwired | -- |
| ESS-1 | 11 kV RMU PANEL | I/C-2 | RTU | DI | Status | Isolator Off | Hardwired | -- |

Note: Quantities for I/O points to be calculated for four Nos. of ESS (ESS-1, ESS-2, ESS-3 & ESS-4). Normal & Emergency Panels are located inside buildings. Isolator Panels at ESS-2, ESS-3 & ESS_4 are outdoor type.

| SUBSTATION | BOARD DESIGNATION | FEEDER | SUB-EQUIPMENT | INFORMATION TYPE | NATURE OF INFORMATION | INFORMATION | INTERFACE | PROTOCOL |
|---|---|---|---|---|---|---|---|---|
| Control Room | 11 kV HT PANEL BOARD | I/C-1 | **RELAY** | DI | Status | CB OPEN | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | I/C-1 | | DI | Status | CB CLOSE | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | I/C-1 | | DI | Status | CB TRIP | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | I/C-1 | | DO | Control | CB Open | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | I/C-1 | | DO | Control | CB Close | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | I/C-1 | **MFM** | AI | Metering | Voltage | Serial | MODBUS-RTU |
| Control Room | 11 kV HT PANEL BOARD | I/C-1 | | AI | Metering | Curent | Serial | MODBUS-RTU |
| Control Room | 11 kV HT PANEL BOARD | I/C-1 | | AI | Metering | Power | Serial | MODBUS-RTU |
| Control Room | 11 kV HT PANEL BOARD | I/C-2 | **RELAY** | DI | Status | CB OPEN | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | I/C-2 | | DI | Status | CB CLOSE | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | I/C-2 | | DI | Status | CB TRIP | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | I/C-2 | | DO | Control | CB Open | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | I/C-2 | | DO | Control | CB Close | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | I/C-2 | **MFM** | AI | Metering | Voltage | Serial | MODBUS-RTU |
| Control Room | 11 kV HT PANEL BOARD | I/C-2 | | AI | Metering | Curent | Serial | MODBUS-RTU |
| Control Room | 11 kV HT PANEL BOARD | I/C-2 | | AI | Metering | Power | Serial | MODBUS-RTU |
| Control Room | 11 kV HT PANEL BOARD | I/C-3 | **RELAY** | DI | Status | CB OPEN | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | I/C-3 | | DI | Status | CB CLOSE | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | I/C-3 | | DI | Status | CB TRIP | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | I/C-3 | | DO | Control | CB Open | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | I/C-3 | | DO | Control | CB Close | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | I/C-3 | **MFM** | AI | Metering | Voltage | Serial | MODBUS-RTU |
| Control Room | 11 kV HT PANEL BOARD | I/C-3 | | AI | Metering | Curent | Serial | MODBUS-RTU |
| Control Room | 11 kV HT | I/C-3 | | AI | Metering | Power | Serial | MODBUS- |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | PANEL BOARD | | | | | | | RTU |
| Control Room | 11 kV HT PANEL BOARD | I/C-4 | **RELAY** | DI | Status | CB OPEN | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | I/C-4 | | DI | Status | CB CLOSE | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | I/C-4 | | DI | Status | CB TRIP | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | I/C-4 | | DO | Control | CB Open | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | I/C-4 | | DO | Control | CB Close | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | I/C-4 | **MFM** | AI | Metering | Voltage | Serial | MODBUS-RTU |
| Control Room | 11 kV HT PANEL BOARD | I/C-4 | | AI | Metering | Curent | Serial | MODBUS-RTU |
| Control Room | 11 kV HT PANEL BOARD | I/C-4 | | AI | Metering | Power | Serial | MODBUS-RTU |
| Control Room | 11 kV HT PANEL BOARD | O/G-1 | **RELAY** | DI | Status | CB OPEN | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | O/G-1 | | DI | Status | CB CLOSE | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | O/G-1 | | DI | Status | CB TRIP | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | O/G-1 | | DO | Control | CB Open | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | O/G-1 | | DO | Control | CB Close | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | O/G-1 | **MFM** | AI | Metering | Voltage | Serial | MODBUS-RTU |
| Control Room | 11 kV HT PANEL BOARD | O/G-1 | | AI | Metering | Curent | Serial | MODBUS-RTU |
| Control Room | 11 kV HT PANEL BOARD | O/G-1 | | AI | Metering | Power | Serial | MODBUS-RTU |
| Control Room | 11 kV HT PANEL BOARD | O/G-2 | **RELAY** | DI | Status | CB OPEN | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | O/G-2 | | DI | Status | CB CLOSE | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | O/G-2 | | DI | Status | CB TRIP | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | O/G-2 | | DO | Control | CB Open | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | O/G-2 | | DO | Control | CB Close | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | O/G-2 | **MFM** | AI | Metering | Voltage | Serial | MODBUS-RTU |
| Control Room | 11 kV HT PANEL BOARD | O/G-2 | | AI | Metering | Curent | Serial | MODBUS-RTU |
| Control Room | 11 kV HT PANEL BOARD | O/G-2 | | AI | Metering | Power | Serial | MODBUS-RTU |
| Control Room | 11 kV HT PANEL BOARD | O/G-3 | **RELAY** | DI | Status | CB OPEN | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | O/G-3 | | DI | Status | CB CLOSE | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | O/G-3 | | DI | Status | CB TRIP | Ethernet | IEC 61850 |

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|---|---|---|---|---|---|---|---|---|
| Control Room | 11 kV HT PANEL BOARD | O/G-3 | | DO | Control | CB Open | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | O/G-3 | | DO | Control | CB Close | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | O/G-3 | **MFM** | AI | Metering | Voltage | Serial | MODBUS-RTU |
| Control Room | 11 kV HT PANEL BOARD | O/G-3 | | AI | Metering | Curent | Serial | MODBUS-RTU |
| Control Room | 11 kV HT PANEL BOARD | O/G-3 | | AI | Metering | Power | Serial | MODBUS-RTU |
| Control Room | 11 kV HT PANEL BOARD | O/G-4 | **RELAY** | DI | Status | CB OPEN | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | O/G-4 | | DI | Status | CB CLOSE | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | O/G-4 | | DI | Status | CB TRIP | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | O/G-4 | | DO | Control | CB Open | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | O/G-4 | | DO | Control | CB Close | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | O/G-4 | **MFM** | AI | Metering | Voltage | Serial | MODBUS-RTU |
| Control Room | 11 kV HT PANEL BOARD | O/G-4 | | AI | Metering | Curent | Serial | MODBUS-RTU |
| Control Room | 11 kV HT PANEL BOARD | O/G-4 | | AI | Metering | Power | Serial | MODBUS-RTU |
| Control Room | 11 kV HT PANEL BOARD | O/G-5 | **RELAY** | DI | Status | CB OPEN | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | O/G-5 | | DI | Status | CB CLOSE | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | O/G-5 | | DI | Status | CB TRIP | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | O/G-5 | | DO | Control | CB Open | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | O/G-5 | | DO | Control | CB Close | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | O/G-5 | **MFM** | AI | Metering | Voltage | Serial | MODBUS-RTU |
| Control Room | 11 kV HT PANEL BOARD | O/G-5 | | AI | Metering | Curent | Serial | MODBUS-RTU |
| Control Room | 11 kV HT PANEL BOARD | O/G-5 | | AI | Metering | Power | Serial | MODBUS-RTU |
| Control Room | 11 kV HT PANEL BOARD | O/G-6 | **RELAY** | DI | Status | CB OPEN | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | O/G-6 | | DI | Status | CB CLOSE | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | O/G-6 | | DI | Status | CB TRIP | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | O/G-6 | | DO | Control | CB Open | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | O/G-6 | | DO | Control | CB Close | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | O/G-6 | **MFM** | AI | Metering | Voltage | Serial | MODBUS-RTU |
| Control Room | 11 kV HT | O/G-6 | | AI | Metering | Curent | Serial | MODBUS- |

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|---|---|---|---|---|---|---|---|---|
| | PANEL BOARD | | | | | | | RTU |
| Control Room | 11 kV HT PANEL BOARD | O/G-6 | | AI | Metering | Power | Serial | MODBUS-RTU |
| Control Room | 11 kV HT PANEL BOARD | O/G-7 | | DI | Status | CB OPEN | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | O/G-7 | | DI | Status | CB CLOSE | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | O/G-7 | **RELAY** | DI | Status | CB TRIP | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | O/G-7 | | DO | Control | CB Open | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | O/G-7 | | DO | Control | CB Close | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | O/G-7 | | AI | Metering | Voltage | Serial | MODBUS-RTU |
| Control Room | 11 kV HT PANEL BOARD | O/G-7 | **MFM** | AI | Metering | Curent | Serial | MODBUS-RTU |
| Control Room | 11 kV HT PANEL BOARD | O/G-7 | | AI | Metering | Power | Serial | MODBUS-RTU |
| Control Room | 11 kV HT PANEL BOARD | O/G-8 | | DI | Status | CB OPEN | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | O/G-8 | | DI | Status | CB CLOSE | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | O/G-8 | **RELAY** | DI | Status | CB TRIP | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | O/G-8 | | DO | Control | CB Open | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | O/G-8 | | DO | Control | CB Close | Ethernet | IEC 61850 |
| Control Room | 11 kV HT PANEL BOARD | O/G-8 | | AI | Metering | Voltage | Serial | MODBUS-RTU |
| Control Room | 11 kV HT PANEL BOARD | O/G-8 | **MFM** | AI | Metering | Curent | Serial | MODBUS-RTU |
| Control Room | 11 kV HT PANEL BOARD | O/G-8 | | AI | Metering | Power | Serial | MODBUS-RTU |
| Control Room | 11 kV HT PANEL BOARD | B/C | | DI | Status | CB OPEN | Hardwired | -- |
| Control Room | 11 kV HT PANEL BOARD | B/C | | DI | Status | CB CLOSE | Hardwired | -- |
| Control Room | 11 kV HT PANEL BOARD | B/C | RTU | DO | Control | CB Open | Hardwired | -- |
| Control Room | 11 kV HT PANEL BOARD | B/C | | DO | Control | CB Close | Hardwired | -- |
| Control Room | 66 kV SAU PANEL BOARD | I/C-1 | | DI | Status | CB OPEN | Ethernet | IEC 61850 |
| Control Room | 66 kV SAU PANEL BOARD | I/C-1 | | DI | Status | CB CLOSE | Ethernet | IEC 61850 |
| Control Room | 66 kV SAU PANEL BOARD | I/C-1 | **RELAY** | DI | Status | CB TRIP | Ethernet | IEC 61850 |
| Control Room | 66 kV SAU PANEL BOARD | I/C-1 | | DO | Control | CB Open | Ethernet | IEC 61850 |
| Control Room | 66 kV SAU PANEL BOARD | I/C-1 | | DO | Control | CB Close | Ethernet | IEC 61850 |
| Control Room | 66 kV SAU PANEL BOARD | I/C-1 | **MFM** | AI | Metering | Voltage | Serial | MODBUS-RTU |

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|---|---|---|---|---|---|---|---|---|
| Control Room | 66 kV SAU PANEL BOARD | I/C-1 | | AI | Metering | Curent | Serial | MODBUS-RTU |
| Control Room | 66 kV SAU PANEL BOARD | I/C-1 | | AI | Metering | Power | Serial | MODBUS-RTU |
| Control Room | 66 kV SAU PANEL BOARD | I/C-2 | **RELAY** | DI | Status | CB OPEN | Ethernet | IEC 61850 |
| Control Room | 66 kV SAU PANEL BOARD | I/C-2 | | DI | Status | CB CLOSE | Ethernet | IEC 61850 |
| Control Room | 66 kV SAU PANEL BOARD | I/C-2 | | DI | Status | CB TRIP | Ethernet | IEC 61850 |
| Control Room | 66 kV SAU PANEL BOARD | I/C-2 | | DO | Control | CB Open | Ethernet | IEC 61850 |
| Control Room | 66 kV SAU PANEL BOARD | I/C-2 | | DO | Control | CB Close | Ethernet | IEC 61850 |
| Control Room | 66 kV SAU PANEL BOARD | I/C-2 | **MFM** | AI | Metering | Voltage | Serial | MODBUS-RTU |
| Control Room | 66 kV SAU PANEL BOARD | I/C-2 | | AI | Metering | Curent | Serial | MODBUS-RTU |
| Control Room | 66 kV SAU PANEL BOARD | I/C-2 | | AI | Metering | Power | Serial | MODBUS-RTU |
| | **All 66 Kv SAU PANEL BOARD O/G – 1 & 2 DELETED** | | | | | | | |
| Control Room | DG SYNCH. PANEL | DG SET | DG CONTROLLER | DI | Status | Signals as specified by DG Vendor | Ethernet | IEC 104 |
| Control Room | DG SYNCH. PANEL | DG SET | DG CONTROLLER | AI | Metering | Signals as specified by DG Vendor | Ethernet | IEC 104 |
| Control Room | BUILDING MGMT.SYSTEM | BMS | BUILDING MGMT. SYSTEM | DI | Status | Signals as specified by BMS Vendor | Ethernet | IEC 104 |
| Control Room | BUILDING MGMT.SYSTEM | BMS | BUILDING MGMT. SYSTEM | AI | Metering | Signals as specified by BMS Vendor | Ethernet | IEC 104 |

## 11.26 ENERGY AND POWER MANAGEMENT SYSTEM SPECIFICATIONS

**1. General**

a. SUMMARY

- Scope: Furnish and install a Power Management System (PMS) as detailed on the Drawings and as herein specified. The system is defined to include data and analytics functionality in the broad categories of (a) energy performance optimization, (b) power reliability and availability, and (c) sustainability metrics. Features like real-time monitoring, alarming and event management, energy, power, and sustainability data analytics and visualization will facilitate the following functions at a high level:
  - Analyze energy usage and uncover savings opportunities.
  - Meet and exceed energy efficiency and sustainability standards and certifications.
  - Measure return on investment of energy capital projects.
  - Allocate and bill energy costs accurately to processes, tenants, cost centers, and departments.
  - Decrease the frequency and duration of unplanned outages.
  - Improve workplace safety by minimizing exposure to electrical hazards.
  - Provide accurate and automated documentation for regulatory compliance.
  - Improve the effectiveness of equipment maintenance activities.
  - Manage multiple power generation sources effectively.
  - Increase the return on electrical distribution assets.
  - Measure and achieve sustainability targets.

- The work specified in this Section includes but shall not be limited to the following:
  - Hardware—such as metering devices for monitoring, protection, and control; device communication interface hardware; servers; mobile or workstation devices; and ancillary equipment.
  - Software—such as on premise installed software and cloud based software-as-a-service (SaaS) applications.
  - Services, support, and training.

- The PMS shall use Ethernet as the high-speed backbone network for device communications.
- The high-speed network shall allow direct access to data provided by the power monitoring devices for implementing automatic control.
- Data and analytics provided by the PMS system for centralized display, analysis, logging, alarming, event recording, and other PMS operations shall be accessible from a computer workstation with supported operating system and interface software.

b. REFERENCES

- General: The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. The edition or revision of the referenced publications shall be the latest date as of the date of the Contract Documents, unless otherwise specified.
- All metering devices shall be UL 508 listed, CSA approved, and have CE marking.
- The system shall comply with the applicable portions of NEMA standards. In addition, the control unit shall comply with FCC emission standards specified in Part 15, Sub-Part J for Class A application.
- The Energy and Power Management System and components shall comply with codes and standards as applicable.

c. SUBMITTALS

- Product Data: EPMS product catalog sheets and technical data sheets specifying physical data and electrical performance, electrical characteristics, and connection requirements of each device shall be supplied under the EPMS scope of work.
- Drawings, Documentation, Operation and Maintenance (O&M) Manuals:
  - EPMS drawings shall show all relevant field monitoring devices and networking components. Drawings shall identify network connections and protocols. Drawings shall identify device room

locations and recommended installation notations. Specific locations and mounting details are subject to the discretion and responsibilities of the installation contractor.
- Sequence of operation (for control applications such as automatic transfer schemes, load control, etc.), layout drawings, as-built wiring diagrams, bill of material, spare parts list, and component catalog information shall be included in a final documentation package that will be delivered to the owner prior to training.

d. QUALITY ASSURANCE

- Manufacturer Qualifications: Manufacturer shall be a firm engaged in providing EPMS systems, and shall be able to prove an installed base of such systems successfully operating in at least one hundred customer sites for a minimum of five years.
- The EPMS vendor shall bear full responsibility to ensure that the EPMS system performs as specified.
- The EPMS solution shall be fully tested in a test-bed environment with hardware devices representative of a large scale functional power distribution system (including both physical and simulated devices) such as advanced power quality meters, low voltage main meters, low voltage feeder meters, circuit breaker trip units, transformer monitoring units, protective relays, branch circuit power meters, etc. Documented test results including system response times, network performance, and recommended network architectures shall be published and provided upon request.
- No products shall violate patents filed in any country.

## 2. PRODUCTS

a. POWER MANAGEMENT SOFTWARE—GENERAL

- The Power Management Software (PMS) platform shall facilitate applications in the broad categories of (a) energy performance, (b) power availability, quality and reliability, and (c) sustainability performance. At a high level, the feature-set shall provide functions in:
  - Real-time monitoring.
  - Alarming and event management.
  - Energy cost analysis.
  - Energy, power, and sustainability data analytics and visualization.
- The software platform shall be certified for use as a part of an ISO50001 program and verifiably support compliance. In addition, the functionality shall support ongoing ISO:50001 programs per the following areas of Section 4 of the ISO standard:
  - Energy review.
  - Energy baseline.
  - Energy performance indicators.
  - Monitoring, measurement, and analysis.
  - Input to management review.
- The PMS shall verifiably support compliance with EN 16247-1 for energy audits.
- The PMS shall include Modular, licensable optional applications to expand the basic functionalities of the core platform

b. POWER MANAGEMENT SOFTWARE—Real time Monitoring

- The Power Management Software (PMS) shall provide a graphical monitoring and analysis application for power users (trained administrators, power system engineers, energy managers, facility managers, technicians, etc.) that provide a rich set of tools for WAGES energy analysis, Power Quality analysis, power system monitoring and control.
- The graphical monitoring and analysis application shall be able to create a comprehensive set of linked hierarchical graphical diagrams showing all devices and their associated device specific diagrams in the power monitoring network WITH A SINGLE MOUSE CLICK (auto-diagram creation).
- The graphical monitoring and analysis application shall support custom graphics/images and provide the ability to create graphical diagrams of the Power Monitoring system, including electrical one-line diagrams, facility maps, plan views, floor layouts, equipment representations, and mimic displays.

- The graphical monitoring and analysis application shall be capable of writing to device registers for applications such as resetting, triggering, toggling, switching, manual waveform capture, controlling remote devices and equipment, including breakers.
- The graphical monitoring and analysis application shall allow application and HMI design engineers to create custom diagrams with linkages to device registers even if the devices are offline / disabled.
- Web-enabled real-time tables: The system shall have the following capabilities for interactive side-by-side visualization of real-time measurements:
  - Display a tabular view to compare device readings from multiple meters in the power monitoring network quickly.
  - Permit users to create, modify, view and share table views through a browser without the need for a separate software application.
  - Have built-in functions that allow users to easily and instantly filter out measurements when viewing a table.
  - Support both physical and virtual devices defined in the system.
  - Support exporting real time tabular data into Excel formats.
- Power monitoring trending: The PMS shall include graphical charts for real-time trending of power usage (kW, Volt, Amp, and kWh) or any measurement supported by metered equipment such as generators and MV/LV switchgear. These trends shall include the capability to:
  - Trend up to 14 measurements on the same chart (limit may be increased if desired).
  - Customize attributes such as color, line thickness, overlays, display name, and display units for each data series.
  - View the trend using an auto-scaling or manual chart axis.
  - Adjust the desired time viewing window for the trend.
  - Inspect the trend by zooming and panning to focus in on key areas of the trend.
  - Provide drill-down detail for the highlighted trend data point to help identify root causes of concern.
  - Trend measurements with different units on the same chart using two different axes.
  - Provide calculated values of minimum, maximum, and average values for a trend.
  - Configure a target threshold line for comparison against actual measurements.
  - Configure up to two target bands with visual indicators to identify when a measurement is outside specified limits.
  - Display real-time data and/or historical data per data series, with optional back-filling of the real-time data using historical data.
  - Export trend data to .CSV/Excel format.
  - Access trend data from a web browser or mobile environment.
  - Save specified trends in a library for later use.
  - Share trends with other users or restrict use.
  - Simultaneously view multiple trend charts, or alternatively maximize a selected trend to display it in full screen mode.

c. POWER MANAGEMENT SOFTWARE—Alarm and Event Analysis and Notification

- The Power Management Software (PMS) shall provide alarm and event annunciation features that include the following:
  An alarm viewer that provides a summary of the active alarms shall be provided. The viewer shall:
  - Be visible in any screen when logged into the web interface of the system.
  - Display the total number of unacknowledged alarms, and the breakdown of how many of those alarms are high priority, medium priority and low priority.
  - Provide an audible alarm and a simple means for muting the alarm.
  - Allow a simple mechanism to acknowledge alarms for users with appropriate user privileges.
  - Allow a mechanism to sort and group alarms.
  - Allow a mechanism to set configurable alarm thresholds, for example, high, medium, and low.
  - Allow a mechanism to create user defined alarm views that fit user defined criteria.
  - Provide an active alarms view to show alarms currently in the active state.

- The PMS shall provide an alarm notification system.

- The alarm evaluation and notification system shall ensure that appropriate staff members are notified of power system events. The system shall collect data, evaluate alarm conditions, and annunciate the alarms to specified users through email or SMS text messages.
- The alarm evaluation and notification system shall include:
  a. An alarm evaluation engine.
  b. An alarm notification/annunciation engine that supports annunciation through email and SMS text message.
  c. Flexible alarm scheduling capabilities.
  d. Web-based configuration tools for notification configuration, log viewing, and filtering.
  e. The ability to control alarm flooding by intelligent aggregation through alarm filtering and consolidation.
  f. Message delivery mechanisms such as:
  g. Electronic mail (Email)
  h. Text messaging for cell phones (GSM Modem)
  i. Simple Network Management Protocol (SNMP)

d. POWER MANAGEMENT SOFTWARE—Data Analytics and Visualization

- The Power Management Software (PMS) shall provide web-enabled dashboards.
  - The system shall have a web client interface that presents interactive auto-updating dashboard views that may contain water, air, gas, electric, and steam (WAGES) energy summary data, historical data trends, images, and content from any accessible URL address.
  - Users shall be able to create, modify, view, and share their dashboards (including graphics, labels, scaling, measurements, date ranges, etc.) using only a browser and without a separate software application.
  - Users shall be able to create with configurable drag and drop gadgets to show the following data:
    a. Images from any web-based content
    b. Energy consumption
    c. Energy cost
    d. Energy comparison
    e. Energy savings
    f. Emissions
    g. Trends

  - The system shall facilitate kiosk displays by assigning individual dashboards to slideshows to run in unattended mode, scrolling through designated dashboards at a configurable time interval.
  - The system shall permit users to create, save, and share an unlimited number of dashboards and slideshows.

- The system shall provide a web-enabled reporting platform.
  - The system shall provide a web-enabled reporting tool to view historical data in pre-formatted or user-defined report templates.
  - The system shall support reporting on all supported physical devices and virtual (or calculated) meters as defined in the device hierarchy.
  - Users shall be able to create, modify, view and share their reports in the web reports interface.
  - The reporting tool shall provide standard pre-formatted report templates for:
    a. Energy cost
    b. Load profile
    c. System-wide interactive power quality with CBEMA/ITIC evaluation.
    d. EN50160 compliance
    e. EN50160 Edition 4 compliance
    f. Harmonics compliance (IEEE519-1992)
    g. IEC61000-4-30
    h. 100 ms. power quality
    i. Energy Usage: period-over-period, by shift, single and multi-device comparison
    j. Tabular, trend and multi-trend

k. Alarm and event history
l. System configuration
m. Hourly usage report
n. Single and multi-device usage reports
a. The reporting tool shall support exporting to the following output formats: .HTML, .PDF, .TIFF, .Excel, and .XML.

- The reporting tool shall be capable of subscriptions to facilitate automatic distribution of reports according to a configurable schedule by saving to network locations, email, or print.
- The system shall support the ability to trigger the generation and delivery of a pre-configured report based on pre-specified event criteria. The system shall be capable of configuring event monitoring detection filters criteria.
- The reporting tool shall have a framework to support:
- Simple customizations to reports such as colors, image inclusions, turning report sections on/off, and logo changes without programming.
- Additional more complex report customization through a programming kit.
- The reporting tool shall be capable of subscriptions to facilitate automatic distribution of reports according to a configurable schedule by saving to network locations, email, or print.

e. applications—Power Quality Monitoring, COMPLIANCE and Analysis

- Power Quality Monitoring: The Power Management Software (PMS) shall provide power quality specific screens and reports as follows.
- Device Level Power quality summary screen—the data collected by any compliant PQ-capable metering device shall be summarized to show:
  - Voltage disturbances, including the date and time of the last disturbance, the count of the number of transient events, and the count of the number of sag/swell events.
  - Harmonic measurements, including a link to the harmonics log for the particular device. Additionally, there shall be a link to another screen that shall show the real-time Total Harmonic Distortion (THD) content and the maximum THD.
  - Flicker measurements.
  - Logged events, including a link to the event log for the particular device.
  - Waveform logs, including a link for waveforms captured during transients and sag/swell events.
  - Further detailed waveform analysis using a tool shall be provided.

- System Level Power Quality summary screen—the power quality report shall display all power quality events collected in the EPMS for one or more measuring points for a given period of time.
- The report shall show a summary table of all the events in a given time period and provide the means to see further details (power quality details report) for any given event.
- The summary report shall contain a plot of the Information Technology Industry Council (ITI) (also known as ITIC or CBEMA) curve that displays the worst disturbance from each event listed in the summary table. The summary table shall contain the following components for each event:
  - Event identifier.
  - Source.
  - Event timestamp.
  - Phase identifier for the worst disturbance during this event (ex., "V1").
  - Voltage magnitude for the worst disturbance during this event in % of nominal (for example, "68.80%")
  - Voltage magnitude maximum and minimum on phases V1, V2 and V3 for the worst disturbance during this event in % of nominal.
  - Duration for the worst disturbance during this event in seconds (for example, "0.084s").
  - Disturbance type for the worst disturbance during this event (for example, "sag").
  - ITI (ITIC, CBEMA) tolerance curve violations (for example, "outside tolerance").
  - Link to the details report for this event.
  - Link to waveform report for the worst disturbance during this event.

- Each entry in the summary table shall include a link that provides further details for the given event. The details to be shown are:

- Disturbance event timestamp.
- Phase identifier.
- Voltage magnitude in % of nominal (for example, "68.80%")
- Voltage magnitude maximum and minimum on phase V1, V2 and V3 in percentage of nominal.
- Duration in seconds.
- Disturbance type.
- ITI (CBEMA) tolerance curve violations (for example, "outside tolerance").
- Link to waveform report.

- Each entry in the summary table shall include a link that shows the waveforms of the given event (if any exist). The waveforms shown shall be for both the voltage and current readings of the measuring point.

- One hundred (100)-millisecond Power Quality Report
  - This report shall display data recorded at 100 millisecond intervals, with a data table for the measured point and selected measurement containing columns labeled: Timestamp, Source Label, Measurement Label, Measurement Unit, and Data Value.

- IEEE1159.3 Power Quality Data Interchange Format (PQDIF) Support
  The system shall provide a mechanism to export power quality data to the non-proprietary standard PQDIF format with support for the following default templates:
  - Flicker: Short-term and long-term flicker disturbance data on the voltage inputs.
  - Sag/Swell: Sag/swell disturbance data for voltage inputs, including minimum, maximum and average values.
  - Sag/Swell Waveforms: Waveform data for voltage sag/swell.
  - Steady-state: Steady-state (RMS) data for trending.
  - Steady-state Waveforms: Waveform data for steady-state data.

- Disturbance Direction Detection
  - For power quality compliant devices, the system will indicate the direction of the disturbance within the electrical distribution system in event logs, with associated confidence or certainty rating (for example, “Upstream: Confidence Rating - High”, or “Downstream: Confidence Rating – Medium” etc.).

- Power Quality Compliance Reporting
  EN50160 Edition 4 compliance report
  The EN50160 voltage characteristics of public distribution systems compliance report shall display a summary of EN50160 compliance for a set of measuring points in the system for a given time period for the following components:
  - Power frequency.
  - Supply voltage variations.
  - Flicker severity.
  - Supply voltage unbalance.
  - Harmonic voltage.
  - Inter-harmonic voltages.
  - Mains signaling voltages.
  - Interruptions of supply voltage.
  - Supply voltage dips and swells.

- Additionally, the report shall allow for detailed drill-down for a given measuring point and measurement period.

- IEC61000-4-30 report
  The IEC61000-4-30 compliance report shall display a summary of the IEC61000-4-30 compliance for a set of measuring points in the system for a given period. The report shall:
  - Include the following IEC61000-4-30 components: frequency, supply voltage magnitude, flicker, supply voltage unbalance and supply voltage THD.

- Provide a means to manually enter a baseline value for each component.
- Display a series of trends for each component listed with each component's manually entered baseline.
- Include a data table that displays all the power quality-related events for the given report period including voltage dips, voltage swells, and voltage interruptions.

- IEEE 519 Harmonics Compliance report
  The IEEE519 harmonics compliance report shall have the following capabilities:
  - Provide a mechanism to report on IEEE519 limits.
  - Provide a mechanism to report on user defined limits.
  - Ability to determine voltage and Isc/I-l ratio directly from the device, where Isc is the maximum short circuit current at the point of common coupling (PCC), and the I-l is the maximum fundamental frequency demand current.

- For both individual and total harmonic voltage distortion, display the following:
  - The allowable IEEE519 limits.
  - The % time out of compliance.
  - The number of non-compliant three-second intervals.
  - The number of total measured intervals.
  - Number of missing or invalid intervals.
  - Compliance levels of Warning, Out of compliance, or Compliant.
  - A maximum value with a time-stamp of when that distortion was measured.

- For both individual and total harmonic distortion for current, display all the values specified in the previous section for every range of harmonic orders.
- For each phase, voltage, and current provide a graphical plot of THD versus time stamp. On the same plot, plot the allowable limit to allow for visual comparison of compliance.
- Provide a graphical plot of "average value of voltage per harmonic" and "average value of current per harmonic" as a percentage of fundamental frequency, versus harmonic order to allow for visual identification of the worst harmonic problems.
- For each phase voltage and current, provide a graphical plot of harmonic content versus time stamp with simultaneous plot lines for a set of harmonic orders (for example, h <= 11). This allows the user to identify the harmonic orders associated with the worst problems to enable mitigation measures such as active filtering.

- Integration with Power Quality Mitigation Equipment
  - The system shall natively support interfaces with power quality mitigation equipment for power factor correction, harmonic filtering, voltage sag mitigation (UPS), and transient protection to provide end-to-end solutions for monitoring, correction and optimization of power quality.

f. POWER MANAGEMENT SOFTWARE—Technical Infrastructure

- The Power Management Software (PMS) shall provide the following operating system and browser support:
  - All associated core components of the PMS software operate as Windows operating system services.
  - The web client interface shall support multiple browsers.

- The PMS shall provide the following data management support:
  - Microsoft SQL Server database engine per supported configurations.
  - All network configuration settings relating to device routing and addressing, communication gateways, distributed I/O servers, and load-distributing application servers shall be stored in the PMS databases.
  - Archiving, trimming, and on-demand or scheduled capabilities shall be supported.
  - The capability to view historical data from archived databases shall be included.

- The PMS shall be capable of retrieving data from devices in the monitoring network and provide the following abilities:

- Interrogate and download logs of interval, waveform, and alarm data stored onboard metering devices and related circuit breaker trip units.
- Interrogate and download logs of interval data generated by the software system (software-based logging).
- Interrogate and download logs of alarm and event data generated by the software system (software-based alarming).
- Automatically re-arm the waveform recorders upon upload of information.
- Detect unknown measurement quantities provided by devices in the network, and automatically generate appropriate database references for those quantities without user intervention.

- The PMS system shall include an Administrative interface with the following management functions:
  - Security: administer groups and user accounts with role based privileges.
  - Database: initiate backup, archiving, and trimming tasks.
  - Devices: Add or rename devices, map measurements, and communication settings.
  - Connections: Configure connection schedules and manage modem connections.
  - Events: View and manage software system events.

- The PMS system shall function without disruptions (including communications, logging, and alarming) and shall remain online during all system administration functions such as adding, modifying, or removing devices in the system; creating, modifying, or removing graphical diagrams, dashboards, tables, and reports; creating, modifying, or removing application logic programs in the application logic engine

- The PMS shall support the following device support and management features:
  - The system shall include factory-tested native driver support for at least 75 electrical distribution devices (energy and power meters, protection relays, circuit breakers, PLCs, etc.).

- Native comprehensive device support shall include:
  - Pre-engineered, interactive graphical display screens for viewing and analyzing real-time and historical device data.
  - All registers pre-mapped to standard measurement names without additional mapping of internal device registers.
  - Automatic upload of time-stamped onboard data logs, event strings, and waveform captures without additional configuration.
  - Automatic time synchronization.

- The system shall support integration with other third party intelligent electronic devices (IEDs) not directly supported natively.
- The system shall support logical device definitions for user-friendly device and measurement names for inputs/outputs or channels on devices that represent a downstream device (in the case of PLCs and auxiliary inputs) or an individual circuit (in the case of multi-circuit devices). Bulk-import capability to create large numbers of logical devices without manual single-device configuration shall be supported.
- The system shall support the concept of hierarchies to organize devices structurally into various levels. Examples include Tenants/Racks/Circuits, PDUs/RPPs/Panels, or Buildings/Floors/Rooms. The system shall include the ability to:
  - Aggregate data at any location in the hierarchy.
  - Track hierarchy configuration changes over time.
  - Allow administrators to update names in a given hierarchy at any time (even in the past) to ensure accurate reporting of associated data points (for example, report on energy consumption for a Tenant who has re-located, expanded, added, or removed circuits during the billing period).
  - Export the hierarchy structure to Excel format.
  - Bulk-import capability to create and edit large hierarchies without manual per-device setup.

- The system shall support extensibility in the following ways:
  - Provide a graphical, object-oriented application logic engine to create system-wide logic modules with arithmetic, XML data import, PC-based alarming, and logging capabilities.

- The application logic engine shall have a comprehensive set of functions to create customized applications programs for functions such as weather or real-time price import, KPI calculations, energy units conversion, data aggregation, data normalization, data comparison, power loss calculations, power factor control, load shedding, etc.

- The PMS system shall support system integration in the following ways:
  Device-level Modbus interoperability.
  - The system shall be capable of supporting Modbus communicating devices and be capable of functioning as a Modbus master to read/write registers in Modbus devices for monitoring and control applications.
  - The system shall be capable of Modbus device definition (device drivers) creation to enable integration of third-party Modbus protocol devices.

- System-level OPC interoperability.
  - The system shall be OPC DA 2.0.1 compliant (as per the OPC Foundation Compliance Testing process) for OPC Server and OPC Client data sharing applications amongst OPC compliant systems.
  - The system shall provide default OPC Server tag mappings for all natively supported device types without the need to select, configure, or program the mapping of device registers to OPC tags.
  - The system shall provide a flexible means to add or change OPC mappings and shall support the ability to add custom measurements.

- Data-level interoperability.
  - The system shall support the Extract, Transform, and Load (ETL) data log file transfer mechanism to import and export data log files to integrate functions such as manual data entry, offline device data import, push data to the cloud, or to other systems.
  - The system shall include a mapping application for specifying log data file import-export mappings and import schedules to facilitate import/export in formats such as .CSV, .XML, etc.

- Web application level integration.
  The system shall include:
  - The capability to integrate other web applications into its web interface through the use of pluggable web content widgets.
  - The capability to supply content such as dashboards, reports, trends and diagrams to other external web applications through addressable URLs.

- Web services integration.
  The system shall include web services integration capabilities for machine-to-machine interactions with other application software systems with the following characteristics:
  - Based on SOAP (Simple Object Access Protocol) protocol specification.
  - Provide a Web Services Description Language (WSDL), machine-readable description.
  - Allow access to real-time, historical (i.e., time stamped), and alarm/event type data.
  - Provide the ability to acknowledge alarms by authenticated and authorized clients.
  - Provide digest authentication functionality.
  - Provide the ability to be enabled or disabled.

- The system shall support internationalization and regional settings for localization. The languages supported by default are: Chinese (Simplified), Chinese (Traditional), English, French, German, Italian, Russian, Spanish, Polish, Czech, and Japanese.

- The PMS shall support system configuration and advanced analysis tools in the following ways:
  - The system shall include a monitoring and analysis application with a rich set of power tools for water, air, gas, electric, and steam (WAGES) energy analysis, power quality analysis, power system monitoring and control, and include the following capabilities:
  - Auto-diagram creation capability to create a comprehensive set of linked hierarchical graphical diagrams showing devices and their associated device specific diagrams in the network.

- Ability to import custom graphics or images to create electrical one-line diagrams, facility maps, plan views, floor layouts, equipment representations, and mimic displays.
- Support for power quality analysis.
  a. Plot PQ events on an ITIC/CBMEA curve or SEMI F47 curve.
  b. Manual waveform capture.
  c. Visualization or analysis tools for sinusoidal electrical waveforms including waveform overlay, zooming, and calculations for RMS, peak, delta, harmonics spectrum bar charts, and phasor diagrams.

- Ability to write to device registers for applications such as resetting, triggering, toggling, switching, manual waveform capture, controlling remote devices and equipment, including breakers.
- Ability to develop custom graphics screens and application logic programs with the devices being offline or disabled to allow for project development in disconnected mode.

- The system communications infrastructure shall support the following:
  - Multiple communications network topologies including Ethernet/TCP, serial RS-485/RS-232, and Modem dial-up connections.
  - The capability to provide time-synchronization signals over an Ethernet network with 16ms accuracy or better.
  - The capability to communicate simultaneously with multiple devices, including devices on different physical communications channels.
  - Scalability to greater than a thousand devices.
  - The ability to automatically retrieve logged data (interval data, event data, and waveform data) from natively supported devices without additional configuration.
  - The ability to accept or reject duplicate data entries into the database.
  - The ability to schedule connection times for specific time-periods to conserve bandwidth.
  - The ability to automatically disconnect modem connections when all device data is database-synchronized (used to minimize long distance phone charges).
  - Support for modem pooling and assignment of communication sites to specific modems for communications optimization.

g. APPLICATIONS—POWER QUALITY MONITORING, COMPLIANCE AND ANALYSIS

- Power Quality Monitoring: The Energy and Power Management System (EPMS) software shall provide power quality specific screens and reports as follows.
- Device Level Power quality summary screen—the data collected by any compliant PQ-capable metering device shall be summarized to show:
  - Voltage disturbances, including the date and time of the last disturbance, the count of the number of transient events, and the count of the number of sag/swell events.
  - Harmonic measurements, including a link to the harmonics log for the particular device. Additionally, there shall be a link to another screen that shall show the real-time Total Harmonic Distortion (THD) content and the maximum THD.
  - Flicker measurements.
  - Logged events, including a link to the event log for the particular device.
  - Waveform logs, including a link for waveforms captured during transients and sag/swell events.
  - Further detailed waveform analysis using a tool shall be provided.

- System Level Power Quality summary screen—the power quality report shall display all power quality events collected in the EPMS for one or more measuring points for a given period of time.
- The report shall show a summary table of all the events in a given time period and provide the means to see further details (power quality details report) for any given event.
- The summary report shall contain a plot of the Information Technology Industry Council (ITI) (also known as ITIC or CBEMA) curve that displays the worst disturbance from each event listed in the summary table. The summary table shall contain the following components for each event:
  - Event identifier.
  - Source.
  - Event timestamp.

- Phase identifier for the worst disturbance during this event (ex., "V1").
- Voltage magnitude for the worst disturbance during this event in % of nominal (for example, "68.80%")
- Voltage magnitude maximum and minimum on phases V1, V2 and V3 for the worst disturbance during this event in % of nominal.
- Duration for the worst disturbance during this event in seconds (for example, "0.084s").
- Disturbance type for the worst disturbance during this event (for example, "sag").
- ITI (ITIC, CBEMA) tolerance curve violations (for example, "outside tolerance").
- Link to the details report for this event.
- Link to waveform report for the worst disturbance during this event.

- Each entry in the summary table shall include a link that provides further details for the given event. The details to be shown are:
  - Disturbance event timestamp.
  - Phase identifier.
  - Voltage magnitude in % of nominal (for example, "68.80%")
  - Voltage magnitude maximum and minimum on phase V1, V2 and V3 in percentage of nominal.
  - Duration in seconds.
  - Disturbance type.
  - ITI (CBEMA) tolerance curve violations (for example, "outside tolerance").
  - Link to waveform report.

- Each entry in the summary table shall include a link that shows the waveforms of the given event (if any exist). The waveforms shown shall be for both the voltage and current readings of the measuring point.
- One hundred (100)-millisecond Power Quality Report
  - This report shall display data recorded at 100 millisecond intervals, with a data table for the measured point and selected measurement containing columns labeled: Timestamp, Source Label, Measurement Label, Measurement Unit, and Data Value.

- IEEE1159.3 Power Quality Data Interchange Format (PQDIF) Support
  The system shall provide a mechanism to export power quality data to the non-proprietary standard PQDIF format with support for the following default templates:
  a. Flicker: Short-term and long-term flicker disturbance data on the voltage inputs.
  b. Sag/Swell: Sag/swell disturbance data for voltage inputs, including minimum, maximum and average values.
  c. Sag/Swell Waveforms: Waveform data for voltage sag/swell.
  d. Steady-state: Steady-state (RMS) data for trending.
  e. Steady-state Waveforms: Waveform data for steady-state data.
- Disturbance Direction Detection
  a. For power quality compliant devices, the system will indicate the direction of the disturbance within the electrical distribution system in event logs, with associated confidence or certainty rating (for example, “Upstream: Confidence Rating - High”, or “Downstream: Confidence Rating – Medium” etc.).

- Power Quality Compliance Reporting
  a. EN50160 Edition 4 compliance report
     The EN50160 voltage characteristics of public distribution systems compliance report shall display a summary of EN50160 compliance for a set of measuring points in the system for a given time period for the following components:
     - Power frequency.
     - Supply voltage variations.
     - Flicker severity.
     - Supply voltage unbalance.
     - Harmonic voltage.
     -
     - Inter-harmonic voltages.

- Mains signaling voltages.
- Interruptions of supply voltage.
- Supply voltage dips and swells.
- Additionally, the report shall allow for detailed drill-down for a given measuring point and measurement period.

b. IEC61000-4-30 report
The IEC61000-4-30 compliance report shall display a summary of the IEC61000-4-30 compliance for a set of measuring points in the system for a given period. The report shall:
- Include the following IEC61000-4-30 components: frequency, supply voltage magnitude, flicker, supply voltage unbalance and supply voltage THD.
- Provide a means to manually enter a baseline value for each component.
- Display a series of trends for each component listed with each component's manually entered baseline.
- Include a data table that displays all the power quality-related events for the given report period including voltage dips, voltage swells, and voltage interruptions.

c. IEEE 519 Harmonics Compliance report
The IEEE519 harmonics compliance report shall have the following capabilities:
- Provide a mechanism to report on IEEE519 limits.
- Provide a mechanism to report on user defined limits.
- Ability to determine voltage and Isc/I-l ratio directly from the device, where Isc is the maximum short circuit current at the point of common coupling (PCC), and the I-l is the maximum fundamental frequency demand current.

d. For both individual and total harmonic voltage distortion, display the following:
- The allowable IEEE519 limits.
- The % time out of compliance.
- The number of non-compliant three-second intervals.
- The number of total measured intervals.
- Number of missing or invalid intervals.
- Compliance levels of Warning, Out of compliance, or Compliant.
- A maximum value with a time-stamp of when that distortion was measured.

e. For both individual and total harmonic distortion for current, display all the values specified in the previous section for every range of harmonic orders.

f. For each phase, voltage, and current provide a graphical plot of THD versus time stamp. On the same plot, plot the allowable limit to allow for visual comparison of compliance.

g. Provide a graphical plot of "average value of voltage per harmonic" and "average value of current per harmonic" as a percentage of fundamental frequency, versus harmonic order to allow for visual identification of the worst harmonic problems.

h. For each phase voltage and current, provide a graphical plot of harmonic content versus time stamp with simultaneous plot lines for a set of harmonic orders (for example, h <= 11). This allows the user to identify the harmonic orders associated with the worst problems to enable mitigation measures such as active filtering.

i. Integration with Power Quality Mitigation Equipment

j. The system shall natively support interfaces with power quality mitigation equipment for power factor correction, harmonic filtering, voltage sag mitigation (UPS), and transient protection to provide end-to-end solutions for monitoring, correction and optimization of power quality.

## 3. APPLICATIONS—LV BREAKER PERFORMANCE MANAGEMENT

- The Energy Power Management System (EPMS) software shall include LV Breaker aging monitoring to assist preventive maintenance planning on the main low voltage switchgear. The breaker aging shall be take into account the following electrical events and environmental conditions:
- Overload tripping
- Short circuit tripping

- Operation
- Commissioning date
- Ambient temperature
- Vibration
- Humidity

a. The Energy and Power Management System (EPMS) software Shall include a breaker aging report to provide maintenance information related to:
   - Electrical aging in %
   - Environmental aging in %

   The report shall classify the breakers by group and aging status

Execution

Appendix A—codes and Standards

| Category | Usage | Reference Standard | Title |
|---|---|---|---|
| Meters | Active energy measurement requirements | ANSI C12.20 – 2010 | American National Standard for Electromechanical Watt-hour Meters |
| Meters | Construction and safety requirements | ANSI C12.1- 2008 | American National Standard Code for Electricity Metering |
| Meters | Construction and safety requirements | IEC62052-11- 2003 | Electricity metering equipment (AC) – general requirements, tests and test conditions |
| Meters | Active energy measurement requirements | IEC62053-22- 2003 | Electricity metering equipment (AC) – particular requirements – part 22: static meters for active energy, classes 0.2S and 0.5S |
| Meters | Reactive energy measurement requirements | IEC62053-23- 2003 | Electricity metering equipment (AC) – particular requirements – part 23: static meters for reactive energy, classes 2 and 3 |
| Meters | Surge withstand | IEEE C.37-90.1-2002 | IEEE Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems (ANSI) |
| Meters | Electromagnetic capability | IEC61000-4-2 (EN61000-4-2/IEC801-2) – 2008 | Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test (Level 4) |
| Meters | Electromagnetic capability | IEC61000-4-3 (EN61000-4-3/IEC801-3) – 2008 | Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test (Level 4) |
| Meters | Electromagnetic capability | IEC61000-4-4 (EN61000-4-4/IEC801-4) – 2008 | Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test (Level 4) |

| | | | |
|---|---|---|---|
| Meters | Electromagnetic capability | IEC61000-4-5 (EN61000-4-5/IEC801-5) – 2008 | Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test (Level 4) |
| Meters | Electromagnetic capability | IEC61000-4-6 (EN61000-4-6/IEC801-6) – 2008 | Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques - Electrostatic Immunity to conducted disturbances, induced by radio-frequency fields (Level 3) |
| Meters | Electromagnetic capability | IEC61000-4-12 (EN61000-4-12/IEC801-12) – 2006 | Electromagnetic compatibility (EMC) – Part 4-12: Testing and measurement techniques – Oscillatory waves immunity test (Level 4) |
| Meters | Electromagnetic capability | IEEE C62.41- 2002 | IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits |
| Meters | Electromagnetic capability | FCC Part 15, Class B: CFR 47 | Telecommunication – Part 15 – Radio frequency devices – subpart b – Unintentional radiators |
| Meters | Electromagnetic capability | FCC Part 68, Class B: CFR 47 | Telecommunication – Part 68 – Technical Requirements for Connection of Terminal Equipment to the Telephone Network |
| Meters | Electromagnetic capability | ICES-003, Class B | Spectrum management and telecommunications policy – Interference-causing equipment standards |
| Meters | Electromagnetic capability | EN55022 (CISPR 22), Class B | Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement |
| Healthcare Facilities | | AS_NZS_3003 | Electrical Installations- Emergency Power Supplies in Hospitals." Applicable to Healthcare Facilities |
| Critical Buildings | | CSA C282 | Emergency Electrical Power Supply for Buildings." |
| Healthcare Facilities | | CSA Z32 | Electrical Safety and Essential Electrical Systems in Healthcare Facilities |
| Healthcare Facilities | | HTM 06-01 Part B | Health Technical Memorandum 06-01: Electrical Services Supply and Distribution |
| Critical Buildings | | IEC 60364-7-710 | Electrical Installations of Buildings Part 7-710: Requirements for Special Installations or Locations - Medical Locations |
| Healthcare Facilities | | NFP 110 | Standard for Emergency and Standby Power Systems |
| Healthcare Facilities | | NFPA 99 | Healthcare Facilities Code |

Appendix B—Supported Device Matrix

b. Notes.

Device drivers may be categorized as:

- Native—driver available with software.
- Installer—driver available through additional downloadable installer.
- 3rd Party Modbus RTU edition—with support for real-time registers and for PC based data logging only.
- Standard edition—with support for all features including onboard logs, waveforms, control operation, etc.

## 11.27 NITROGEN GAS BASED TRANSFORMER/REACTOR EXPLOSION PREVENTION AND FIRE EXTINGUISHING SYSTEM

*General*

A dedicated Nitrogen gas based transformer explosion prevention and fire extinguishing system (TEP&FES) for each oil filled transformer / reactor which shall use nitrogen as fire quenching medium. The system shall prevent transformer/Reactor oil tank explosion and possible fire in case of internal faults. In the event of fire by external causes such as bushing fire. OLTC fires, fire from surrounding equipment etc, it shall act as a fast and effective fire fighter. It shall accomplish its role as fire preventer and extinguisher without employing water and / or carbon dioxide. Fire shall be extinguished within 30 seconds (maximum) of commencement of nitrogen injection. The fire protection system shall have been in successful operation in Indian SEB/Utilities for at least last three years for protection of transformers. The list of past supplies in Indian SEB/Utilities along with performance certificate and successful activation of system on transformer in various fault conditions from users of the system shall be submitted for approval of purchaser.

**1.** Activation of the fire protective system

Mal-functioning of transformer explosion prevention and fire extinguishing system could lead to interruption in power supply. TEP&FE system ensures that the probability of chances of malfunctioning of TEP&FE system is practically zero. To achieve this objective, the TEP&FE System's scheme of activating signals is simple which is not too complicated to make the TEP&FE system inoperative in case of actual need. The system is provided with automatic control for explosion prevention and fire extinction. Besides automatic control, remote electrical push button/switch control covered with glass at Control box and local manual control in the fire extinguishing cubicle shall also be provided. The following electromechanical signals is taken for activating the TEP&FE system under prevention mode / fire extinguishing mode.

Auto Mode

(a) For explosion prevention:

- Differential relay operation
- Buchholz (Surge) relay trip paralleled with pressure relief valve or RPRR (Rapid Pressure Rise Relay)
- Master (86) relay operation

(b) For extinguishing fire

Fire detector

- Buchholz (Surge) relay trip paralleled with pressure relief valve or RPRR (Rapid Pressure Rise Relay)
- Master (86) relay operation

Manual Mode (Remote electrical)

- Master (86) relay operation associated with transformer / reactor is the pre-requisite for activation of system.

Manual Mode (Mechanical)

- The system shall be designed to be operated manually to release oil and inject nitrogen in case of failure of power supply to fire protection system. System shall have provision for independent oil drain and nitrogen release mechanism.

**2.** General description

Nitrogen gas based transformer explosion prevention and fire extinguishing system is a dedicated system for each oil filled transformer / reactor. It has a Fire Extinguishing Cubicle (FEC) placed on a plinth at a distance of 5-7 m away from transformer / reactor or placed next to the fire wall (if fire fighting wall exists). The FEC is connected to the top of transformer/reactor oil tank for depressurization of tank and to the oil pit (capacity is approximately equal to 10% of total volume of oil in transformer/reactor tank) from its bottom through oil pipes. The fire extinguishing cubicle

houses a pressurized nitrogen cylinder(s) which is connected to the oil tank of transformer/reactor oil tank at bottom. The Transformer Conservator Isolation Valve (TCIV) is fitted between the conservator tank and Buchholz relay. Cable connections are provided from signal box to the control box in the control room, from control box to fire extinguishing cubicle and from TCIV to signal box. Fire detectors placed on the top of transformer/reactor tank are connected in parallel to the signal box by Fire survival cables. Control box is required to be connected to relay panel in control room for receiving system activation signals.

**3.** Operation

On receipt of all activating signals, the system drain pre-determined volume of hot oil from the top of tank (i.e top oil layer), through outlet valve, to reduce tank pressure by removing top oil and simultaneously injecting nitrogen gas at high pressure for stirring the oil at pre-fixed rate and thus bringing the temperature of top oil layer down. Transformer conservator isolation valve blocks the flow of oil from conservator tank in case of tank rupture / explosion or bushing bursting. Nitrogen occupies the space created by oil drained out and acts as an insulating layer over oil in the tank and thus preventing aggravation of fire. Being important protection equipment, system should have facility to operate i.e. both oil drain and nitrogen release, without power and also in case of failure of DC power.

The system shall be designed to test on line i.e. when transformer is energized by simulating oil drain and nitrogen release mechanism.

**4.** System components

Nitrogen injection fire protection system shall broadly consist of the following components. However, all other components which are necessary for fast reliable and effective working of the fire protective system shall be included in the system manufacturer scope of supply.

The system shall work on station DC supply only. Individual system component/equipment should not have working voltage other than station DC voltage. AC-DC / DC-DC converter, timer shall not be used for reliable operation.

(a) Fire Extinguishing Cubicle (FEC)

The FEC frame is be made of CRCA sheet of 3 mm (maximum) thick complete with the base frame, painted inside and outside with post office red colour (shade 538 of IS-5). It has hugged split doors fitted with high quality tamper proof lock. The degree of protection shall be IP55 for whole assembled Fire Extinguishing Cubicle. The following minimum items are to be provided in the FEC.

- Nitrogen gas cylinder with regulator and falling pressure electrical contact manometer for monitoring cylinder pressure and pressure gauge after regulating pressure for monitoring nitrogen injection pressure.
- Oil drain pipe with mechanical quick drain valve of minimum size 125 mm for transformer rated 100 MVA and above, minimum 80 mm for transformer rated below 100 MVA.
- Oil Drain pipe inside the Fire Extinguishing Cubicle shall have oil leakage detection system to detect the oil leakage from drain valve. The oil level switch shall be placed inside the oil collection compartment to trigger an alarm upon detection of leakage of oil from valve.
- Electro mechanical control equipment for draining of oil of pre-determined volume and injecting regulated volume of nitrogen gas.
- Pressure monitoring switch for back-up protection for nitrogen release.
- Individual mechanical locking devices for oil drain and nitrogen release to isolate the system during maintenance and /or testing of the transformer and /or system.
- Individual mechanical release devices for oil drain and nitrogen release to operate system manually in case of operation DC supply failure.
- System nitrogen release scheme shall be designed in such a way that the nitrogen gas shall not enter the energised transformer tank even in case of passing/leakage of valve.

- Limit switches for monitoring of the system
- Butterfly valve with flanges on the top of panel for connecting oil drain pipe and nitrogen injection pipes for transformer/reactors
- Panel lighting (CFL Type)
- Oil drain pipe extension of 150mm size for transformer rated 100 MVA and above, 100 mm for transformer rated below 100 MVA for connecting pipes to oil pit.

(b) Control box

Control box which to be placed in the control room for monitoring system ;operation, au;tomatic control and remote operation. The following alarms, indications, switches, push buttons, audio signal etc. are provided.

System and / or individual component shall be designed to work on station DC voltage only and AC-DC/DC-DC convertor, timers etc. shall not be used for reliable operation.

- System on
- Oil drain valve closed
- Gas inlet valve closed
- TCIV closed
- Fire detector trip
- Buchholz (surge) relay trip
- Oil drain valve open
- Extinct;ion in progress
- Cylinder pressure low
- Oil leakage in quick drain valve
- Differential relay trip
- PRV / RPRR trip
- Master (86) relay of transformer / reactor trip
- System out of service
- Fault in cable connecting fire detector
- Fault in cable connecting differential relay
- Fault in cable connecting Buchholz relay
- Fault in cable connecting PRV / RPRR
- Fault in cable connecting transformer /reactor trip
- Fault in cable connecting TCIV
- Switch : Auto/ Manual / Off
- Switch : Extinction release on / off
- Push Button : Lamp test
- Visual/ Audio alarm
- Visual/ Audio alarm for DC supply fail

(c) Transformer Conservator Isolation Valve

Transformer conservator isolation valve (TCIV)which is to be fitted in the conservator pipe line, between conservator and buchholz relay shall operate for isolating the conservator during abnormal flow of oil due to rupture/ explosion of tank or bursting of bushing. The valve will not isolate conservator during normal flow of oil during filtration or filling or refilling, locking plates are provided with handle for pad locking. It has proximity switch for remote alarm, indication glass with visual closed position indicator similar like buchholz relay glass inspection window for physical checking of the status of valve.

The TCIV are of the best quality as malfunctioning of TCIV could lead to serious consequence. The closing of TCIV means stoppage of breathing of transformer/reactor.

Locking plates are provided for pad locking with handle to keep TCIV out of service mode. Locking plates shall provided for pad locking along with padlock.

(d) Fire detectors

The system will be complete with adequate number of fire detectors 141°C (quartz bulb) fitted on the top cover of the transformer/ reactor oil tank for sensing fire and shall be located at strategic locations specifically bushings/cable box, OLTC, PRV etc

(e) Signal box

The box supplied shall be mounted away from transformer / reactor main tank, preferably near the transformer marshalling box, for terminating cable connections from TCIV & fire detectors and for further connection to the control box. The degree of protection shall be minimum IP55.

(f) Cables

Fire survival cables (capable to withstand 750° C.) of 4 core x 1.5 sq. mm size for connection of fire detectors in parallel are supplied to be used for connecting Fire Detectors. The fire survival cable shall conform to BS 7629-1,BS 8434-1, BS 7629-1 and BS 5839-1,BS EN 50267-2-1 or relevant Indian standards.

Fire Retardant Low Smoke (FRLS) cable of 12 core x 1.5 sq. mm size are supplied to be used for connection of signal box / marshalling box near transformer/reactor and FEC mounted near transformer/reactor with control box mounted in control room.

Fire Retardant Low Smoke (FRLS) cable of 4 core x 1.5 sq. mm size are supplied to be used for connection between control box to DC and AC supply source, fire extinguishing cubicle to AC supply source, signal box/ marshalling box to transformer conservator isolation valve connection on transformer/reactor.

(g) Pipes

Pipes, complete with connections, flanges, bends and tees etc. shall be supplied along with the system.

**5.** Other items to be provided by manufacturer / contractor

(a) Oil drain and nitrogen injection openings with gate valves on transformer / reactor tank at suitable locations.
(b) Flanges with dummy piece in conservator pipe between Buchholz relay and conservator tank for fixing TCIV.
(c) Fire detector brackets on transformer / reactor tank top cover.
(d) Spare potential free contacts for activating the system i.e. in differential relay, Buchholz relay, Pressure Relief Device / RPRR, Master (86) relay of transformer/reactor
(e) Pipe connections between transformer / reactor and FEC and between FEC and oil pit required for collecting top oil.
(f) Cabling for fire detectors mounted on transformer /reactor top cover
(g) Inter cabling between signal box, control box and Fire Extinguishing Cubicle (FEC).
(h) Butterfly valves /Gate valves on oil drain pipe and nitrogen injection pipe which should be able to withstand full vacuum.
(i) Supports, signal box etc. which are to be painted with enamelled paint.

**6.** Technical particulars

| | |
|---|---|
| Fire extinction period from commencement of nitrogen injection | 30 secs.(Max.) |
| Fire extinction period from activation of system | 3 minutes (Max.) |
| Fire detector's (quartz bulb) heat sensing temperature | 141 deg.C |
| Heat sensing area per detector | Upto radius of 800 mm |
| Transformer Conservator Isolation valve setting | 60 ltr / min (Minimum) |
| Capacity of nitrogen cylinder | 68 ltr (Minimum) water capacity and shall hold 10 $m^3$ (Minimum)gas at maximum pressure of 150 $kg/cm^2$ |
| Power supply<br>For Control Box<br>For Fire extinguishing cubicle for lighting | <br>220 V / 110 V DC<br>230V AC |

The doors, removable covers and panels shall be gasketted all round with neoprene gaskets.

**7.** Recommended Mandatory Spares

| | |
|---|---|
| Cylinder filled with Nitrogen of required capacity per substation | 1 No. |
| Fire Detectors per transformer | 3 Nos. |
| Regulator assembly per sub-station | 1 No. |

**8.** Tests

Reports of all type test conducted as per relevant IS/TEC standards in respect of various bought out items including test reports for degree of protection for outdoor panels i.e. FEC, signal box shall be submitted by the supplier.

Valid test report of system issued by Government test laboratory shall be enclosed along with bid.

The supplier shall demonstrate functional test on complete system associated with the following:

- Fire extinguishing Cubicle,
- Control Box.
- Transformer Conservator Isolation Valve, in the supplier's workshop in presence of end user's representative.

Live Performance test on Fire Extinguishing facility should be available during factory test.

The performance test of the complete system is possible to be carried out after erection of the system with transformer at site.

**9.** Detailed layout drawings, equipment drawing alongwith 4 sets of Operation and Maintenance manual along with soft copies (in CDs) shall be submitted along with the consignment.

**10.** The guaranteed and other technical particulars for the offered NIFP system are indicated in Section- "Guaranteed and Other Technical Particulars".

**GUARANTEED TECHNICAL PARTICULARS**

NOTE: This schedule of guaranteed technical particulars for Nitrogen Fire Protection System is to be submitted by the Bidder. It may be carefully noted that filling / reply of each and every clause described below is must.

| S. No. | Description | Details to be filled in by the Bidder |
|---|---|---|
| 1 | Name of Manufacture and country of origin | |
| 2 | Reference standards | |
| 3 | Details of system equipments | |
| 4 | Fire Extinguishing Cubicle (FEC) | |
| 4.1 | Dimensions (LXBXH) mm | |
| 4.2 | Weight | |
| 4.3 | Capacity of Nitrogen cylinder | |
| 4.4 | Number of cylinders | |
| 4.5 | Pressure of Nitrogen filing | |
| 4.6 | Minimum distance of FE cubicle from the transformer | |
| 4.7 | Method of mounting | |
| 4.8 | Whether the following items are provided in FE cubicle. If so furnish make, type & other details. | |
| 4.9 | Contact manometer | |
| 4.10 | Pressure Regulator | |
| 4.11 | Oil Release Unit make and suitable to operate without power | |
| 4.12 | Gas release unit make and suitable to operate without power | |
| 4.13 | Oil drain assembly | |
| 4.14 | Pressure monitoring switch as backup for nitrogen release | |
| 4.15 | Limit switches with No of contacts & spare contacts (NO&NC) | |
| 4.16 | Oil drain valve (above FEC) | |
| 4.17 | Make | |
| 4.18 | Type | |
| 4.19 | Size | |
| 4.20 | Type of metal | |
| 4.21 | Nitrogen Injection Valve (above FEC) | |
| 4.22 | Make | |
| 4.23 | Type | |
| 4.24 | Size | |
| 4.25 | Oil drain pipe | |
| 4.26 | Size | |
| 4.27 | Length | |
| 4.28 | Number of openings in the transformer tank | |
| 4.29 | Material | |
| 5 | Control Box | |
| 5.1 | Dimensions (LXBXH) mm | |
| 5.2 | Weight | |
| 5.3 | Type & Thickness of sheet steel | |
| 5.4 | Details of components provided in the control box | |

| S. No. | Description | Details to be filled in by the Bidder |
|---|---|---|
| 5.5 | Control voltage | |
| 5.6 | Method of mounting | |
| 5.7 | Whether audio and visual alarms provided? | |
| 6 | Transformer Conservator Isolation Valve | |
| 6.1 | Make | |
| 6.2 | Type | |
| 6.3 | Location | |
| 6.4 | Whether suitable for pipe of size 80mm dia | |
| 6.5 | No of contacts & spare contacts (NO&NC) | |
| 6.6 | Padlocking provision for service , filtration/refilling/filling | |
| 6.7 | Visual position indicator for inspection | |
| 7 | Fire Detectors | |
| 7.1 | Make | |
| 7.2 | Type | |
| 7.3 | Quantity required | |
| 7.4 | Method of fixing | |
| 7.5 | Effective heat sensing area | |
| 7.6 | Temperature recommended for effective heat sensing | |
| 7.7 | Number of contacts NO/NC | |
| 7.8 | Necessity and Condition of Refilling | |
| 8 | Whether approved by Tariff Advisory Committee of India | |
| 9 | Power Supply | |
| 9.1 | Control box | |
| 9.2 | FEC (lighting) | |
| 10 | Extinction period | |
| 10.1 | On commencement of Nitrogen injection | |
| 10.2 | On system activation | |
| 11 | FEC suitable for capacity | |
| 11.1 | Dimensions (LXBXH) mm | |
| 11.2 | Weight | |
| 11.3 | Nitrogen cylinder capacity | |
| 12 | Control Box | |
| 12.1 | Dimensions (LXBXH) mm | |
| 12.2 | Weight | |
| 13 | Detectors | |
| 13.1 | Heat sensing temperature | |
| 14 | Any other technical details not covered above | |

## 11.28 TESTING

General

At the completion of the work, the contractor shall carry out the pre-commissioning as well as commissioning checks as given below on the entire installation and records be maintained for reference of any statutory authority, Client or their representatives.

Pre - Commissioning Checks

Note - Pre- Commissioning checks are to be carried out by Electrical contractor in presence of Engineer In-charge as follows but not limited to.

| Sr. No. | Component | Points to be checked |
|---|---|---|
| 1 | Wires | ♦ Correct identification of each wire by continuity check and providing correct ferrules as per approved drawings.<br>♦ Correct colour coding and correct connection by proper copper lugs.<br>♦ Wires are dressed and bunched properly.<br>♦ Connections are properly tightened.<br>♦ Not more than two wires are connected on any one side of terminal.<br>♦ IR values of the circuit are measured and recorded. |
| 2 | Switch boxes & Receptacles | ♦ Wires are connected properly as per wiring diagram.<br>♦ Correct colour coding and correct connection by proper copper lugs is done.<br>♦ Wires are dressed and bunched properly.<br>♦ Connections are properly tightened.<br>♦ Not more than two wires are connected on any one side of terminal.<br>♦ Earthing connection is made properly.<br>♦ Functional check is OK<br>♦ IR values of the circuit are measured and recorded. |
| 3 | LT Panels \ UPS panels | ♦ External cables are glanded properly.<br>♦ Wires are connected properly as per wiring diagram.<br>♦ Correct colour coding and correct connection by proper copper lugs is done.<br>♦ Wires are dressed and bunched properly.<br>♦ Connections are properly tightened.<br>♦ Not more than two wires are connected on any one side of terminal.<br>♦ Two Earthing connections are made properly.<br>♦ Functional check is OK<br>♦ IR values of the circuit are measured and recorded.<br>♦ Check proper mechanical operations of circuit breaking devices including alignment of trolley for draw out type device.<br>♦ Check contact alignment. And proper sequence of closing and opening of main and arcing contacts.<br>♦ Check electrical relays, meters & controls for correct wiring.<br>♦ Check polarity and connections of all instrument transformers. |

| | | |
|---|---|---|
| 4 | Light fittings | ♦ Correct colour coding and correct connection by proper copper lugs is done.<br>♦ Connections are properly tightened.<br>♦ Not more than two wires are connected on any one side of terminal.<br>♦ Earthing connection is made properly.<br>♦ IR values of the circuit are measured and recorded. |
| 5 | Lighting Poles | ♦ Concrete foundation is firmly set and cured.<br>♦ Correct colour coding and correct connection by proper copper lugs is done.<br>♦ Connections are properly tightened.<br>♦ Not more than two wires are connected on any one side of terminal.<br>♦ Earthing connection is made properly. |
| 6 | Earthing | ♦ The resistance value of each earth electrode are measured and recorded.<br>♦ Total resistance of earthing system should be as per the design value and in any case, shall not be more than 1 Ohm as per IS-3043.<br>♦ Continuity test for earth continuity conductors with ELV tester. |
| 7 | Battery & battery charger system | ♦ Check physical appearance of the system<br>♦ Check all connections & polarities<br>♦ Check Insulation resistance<br>♦ |
| 8 | UPS | ♦ Check physical appearance of the system<br>♦ Check all connections for correctness and tightness<br>♦ Parallel communication between UPS<br>♦ Low voltage switchgear and control gear assemblies<br>♦ Noise Level<br>♦ Input voltage variation test<br>♦ Load test (full & overload)<br>♦ Input ITHD and output UTHD as per IEEE standards |
| 9 | Elevators | ♦ Check physical appearance of the system<br>♦ Components installation check<br>♦ Components assembly test<br>♦ Alignment test (eg. aligned with floor etc)<br>♦ Speed test<br>♦ Overload test<br>♦ ARD functionality test<br>♦ Electrical parameter checks |
| 10 | Rising main | ♦ Check physical appearance of the system<br>♦ Check all connections & polarities<br>♦ Insulation resistance test<br>♦ Full load test<br>♦ Overload test<br>♦ Heat test |

This is the preliminary list. However final list shall be submitted by the contractor covering the above tests and any other test required for that particular equipment as per the manufactured operation & maintenance manual

Tests at Manufacturer works

Routine test on all equipments shall be conducted at manufacturer works as per latest IS or as per the applicable standard in line with the TS. Tests shall also confirm to International Standards IEC/VDE/DIN/BS (in case corresponding test are not mentioned in IS).

All routine tests shall be carried out at manufacturer's works in the presence of Consultant/ PURCHASER/PMC or their representative.

Following type/ special tests shall be conducted at manufacturer works

i) Temperature rise test on one of each rating of LT switchboard

Only completely type tested design of equipment shall be considered by the contractor for this project. The Contractor shall submit type test certificates as per relevant IS/GTS/TS/IPSS for similar rating & design of equipment under his scope supplied elsewhere. In case valid type test certificate for similar rating & design of equipment is not available with the contractor, the same shall be conducted in the presence of Consultant/ PURCHASER/ PMC or their representative if PURCHASER/ PMC so desires, without any financial implications to PURCHASER.

All the equipment shall also be tested at site to know their condition and to prove suitability for required performance. The site tests and acceptance tests to be performed by contractor are detailed above.

The contractor shall be responsible for satisfactory working of complete integrated system and guaranteed performance at site.

## 11.29 APPLICABLE STANDARDS

| Sr. No. | Description | Standard no. |
|---|---|---|
| | Basic climatic & mechanical durability tests for Components for electronic and electrical equipment | IS 589 |
| | Environmental tests for electronic & Electrical equipment | IS 9000 |
| | Metal clad base material for printed circuits for use in Electronic and telecommunication equipment | IS 5921 |
| | Terminals for electronic equipment | IS 4007 |
| | Factory built assemblies of switchgear and control gear for voltages up to and including 1000V AC and 1200V DC , | IS 8623 / BS 5486/ IEC 439 |
| | HRC Cartridge fuses | IS 9224 / BS 88 / IEC 269.1 |
| | Contactors | BS 775 / IEC 947-4-1 |
| | Control switches / push buttons | IS 6875/ BSEN-60947-6-1 |
| | Direct acting indicating analogue Electrical measuring Instruments & their accessories. | IS 1248/ BS 89 / IEC 51 |
| | Degree of protection | EC 947-1 |
| | Semiconductor converters | IEC 146 |
| | Safety Code for Semiconductor rectifier equipment code | IS 6619 |
| | Essential rating & characteristics of semi conductor device( Thyristers converters) | IS 3700/IEC 747 |
| | Emergency std by power systems | IEEE 446 |
| | Surge withstand capability test | IEEE 472,<br>ANSI C37-1978 |
| | Switchgear General Requirements | IS/IEC - 60947 |
| | High Voltage AC Circuit Breakers | IS 13118 |
| | Switch disconnectors & fuse combination unit | IS/IEC 60947-3 , IEC 947-3 |
| | Electrical accessories circuit breakers for over current protections for house hold & similar indication. | IS 8828 , IEC 60898 |
| | Low Voltage fuse | IS 9224 , IEC-269 |
| | D Type fuses | IS 8187 |
| | Contactors & motors starters | IS 13947(Part 4) IEC 947 |
| | Current transformers | IS 2705 IEC 44-1 |
| | Voltage transformers | IS 3156 IEC 186 |
| | Relays | IS 3231 IEC 255 |
| | Analogue Electrical guide of marking of insulated conductors. | IS 11353 / IS 5578 |
| | AC electricity meters | IS 722 |
| | Code of practice for installation and maintenance of switchgear | IS 10118 |
| | Code of practice for phosphating iron and steel | IS 6005 |
| | Wrought aluminium&aluminium alloys for electrical | IS 5082/ IEC 114 |

| Sr. No. | Description | Standard no. |
|---|---|---|
| | purposes | |
| | Control transformer for switchgear and control gear for voltage not exceeding 1000V AC | IS12021 / IEC947 |
| | Code of practice for Earthing | IS: 62305 |
| | Code of practice for protection of building and allied structures against lightning | IS: 2309 |
| | Guide for safety in AC substation grounding | IEEE: 80 |
| | Lightning protection system( Early Streamer type) | NFC-17-102 |
| | Protection of Structure Against Lightning | IEC 61024 |
| | Industrial Luminaries with metal reflectors and its Amendments. | IS 1777: 1978 |
| | General and safety requirements for luminaries: Part-1 Tubular flourescent Lamps (Second revision). | IS 1913 (Pt 1): 1978 |
| | Code of practice for lighting of public throughfare: Part-5 Lighting for grade separated junctions, bridges and elevated roads (Group D) | IS 1944 (Pt.5): 1981 |
| | Code of practice for lighting of public through fare: Part-6 Lighting for town and city centres and areas of civic importance (Group-E). | IS 1944 (Pt.6): 1981 |
| | Code of practice for lighting of public throughfare: Part-7 Lighting for roads with special requirements (Group F) | IS 1944 (Pt.7): 1981 |
| | Code of practice for lighting of public throughfare: Part 1 and 2 for main and secondary roads (Group A and B) (first revision) (Part 1 and 2 in one column). | IS 1944 ( Pt 1&1): 1970 |
| | Flameproof electric lighting fittings: Part-1 Well-glass and bulkhead types (first revision). | IS 2206 (Pt.1): 1984 |
| | Flameproof electric lighting fittings: Part-2 Fittings using glass tubes. | IS 2206 (Pt.2): 1976 |
| | Flameproof electric lighting fittings: Part-3 Fittings using plastic tubes (Group-1 only). | IS 2206 (Pt.3): 1989 |
| | Flameproof electric lighting fittings: Part-4 Portable flameproof hard lamps. | IS 2206 (Pt.4): 1987 |
| | Waterproof electric lighting fittings | IS 3528: 1966 |
| | Code of practice for interior illumination: Part-1 General requirements and recommendations for welding interiors (first revision). | IS 3646 (Pt.1): 1992 |
| | Code of practice for interior illumination: Part-2 Schedule of illumination and glare index. | IS 3646 (Pt.2): 1966 |
| | Code of practice for interior illumination: Part-3 Calculation of coefficients of utilization by the BZ method. | IS 3646 (Pt.3): 1968 |
| | Recommendation on safety procedures we practice in Electrical Work. | IS 5216 (Pt.1): 1982 |
| | Dust-proof electric lighting fittings. | IS 4012: 1967 |

| Sr. No. | Description | Standard no. |
|---|---|---|
| | Decorative lighting outfits | IS 5077: 1969 |
| | Code of practice for Industrial lighting. | IS 6665: 1972 |
| | Cast acrylic sheets for use in luminaries (first revision) | IS 7569: 1987 |
| | Method of photometric testing of incandescent type luminaries for general lighting service. | IS 7678: 1975 |
| | Electric lighting fittings for division 2 areas. | IS 8224: 1976 |
| | Emergency lighting units. | IS 9583: 1981 |
| | Luminaries: Part-1 General requirements. | IS 10322 (Pt.1): 1982 |
| | Luminaries: Part-2 Constructional requirements. | IS 10322 (Pt.2): 1982 |
| | Luminaries: Part-3 Screw and screw less terminals (superseding IS: 6505) | IS 10322 (Pt.3): 1984 |
| | Luminaries: Part-4 Methods of tests. | IS 10322 (Pt.4): 1984 |
| | Luminaries: Part-5 Particular requirements, Section-1 General purpose luminaries. | IS 10322 (Pt.5/Sec1): 1985 |
| | Luminaries: Part-5 Particular requirements, Section-2 Recessed luminaries. | IS 10322 (Pt.5/Sec2): 1985 |
| | Luminaries: Part-5 Particular requirements, Section-3 Luminaries for Road & Safety lighting. | IS 10322 (Pt.5/Sec3): 1985 |
| | Guide for Electrical layout in Residential Buildings. | IS 4648: 1968 |
| | Ballast for mercury vapour lamp. | IS 6616 |
| | HPMV requirements, test and standard lamp Data Sheet. | IS 9900 (Pt.1&2) |
| | Tubular fluorescent lamps | IS 2418 |
| | Ballast for use in fluorescent lighting fittings. | IS 1534: 1977 |
| | Capacitors for use in FL, HPMV & LPSV lamp circuits. | IS 1569: 1976 |
| | High pressure sodium vapors lamps | IS 9974: 1981 |
| | Emergency light units. | IS 9583: 1981 |
| | Industrial Luminaries with metal reflectors and its Amendments. | IS 1777: 1978 |
| | General and safety requirements for luminaries: Part-1 Tubular fluorescent Lamps (Second revision). | IS 1913 (Pt 1): 1978 |
| | Industrial lighting fittings with plastic reflectors. | IS 3287: 1965 |
| | Code of practice for interior illumination: Part-3 Calculation of coefficients of utilization by the BZ method. | IS 3646 (Pt.3): 1968 |
| | Recommendation on safety procedures we practice in Electrical Work. | IS 5216 (Pt.1): 1982 |
| | Dust-proof electric lighting fittings. | IS 4012: 1967 |
| | Dust-proof electric lighting fittings. | IS 4013: 1967 |
| | Cast acrylic sheets for use in luminaries (first revision) | IS 7569: 1987 |
| | Method of photometric testing of incandescent type luminaries for general lighting service. | IS 7678: 1975 |

| Sr. No. | Description | Standard no. |
|---|---|---|
| | Emergency lighting units. | IS 9583: 1981 |
| | Luminaries: Part-1 General requirements. | IS 10322 (Pt.1): 1982 |
| | Luminaries: Part-2 Constructional requirements. | IS 10322 (Pt.2): 1982 |
| | Luminaries: Part-3 Screw and screw less terminals (superseding IS: 6505) | IS 10322 (Pt.3): 1984 |
| | Luminaries: Part-4 Methods of tests. | IS 10322 (Pt.4): 1984 |
| | Luminaries: Part-5 Particular requirements, Section-1 General purpose luminaries. | IS 10322 (Pt.5/Sec1): 1985 |
| | Luminaries: Part-5 Particular requirements, Section-2 Recessed luminaries. | IS 10322 (Pt.5/Sec2): 1985 |
| | Guide for Electrical layout in Residential Buildings. | IS 4648: 1968 |
| | Tubular fluorescent lamps | IS 2418 |
| | Ballast for use in fluorescent lighting fittings. | IS 1534: 1977 |
| | Code of Practice for installation, operation and maintenance of electric passenger & goods Lifts. | IS-14665 (Part 2) Sec-1 : 2000 |
| | Code of practice for installation, operation and maintenance of electric service Lift. | IS-14665 (Part 2) Sec-2 : 2000 |
| | Safety Rules Section-1 Passenger and Good Lifts | IS-14665 (Part 3) Sec-1 : 2000 |
| | Safety Rules Section-2 – Service Lifts | IS-14665 (Part 3) Sec-2 : 2000 |
| | Outline dimension for electric Lifts. | IS-14665 (Part-1) : 2000 |
| | Inspection Manual for Electric Lifts | IS-14665 (Part 5) : 1999 |
| | Installation and Maintenance of lifts for Handicapped Persons – Code of Practice | IS – 15330 |
| | Specification for lift doors locking device and controls | IS – 7759 |
| | Electric Traction Lifts – Components | IS-14665 (Part 4) Sec-1 to 9 : 2001 |
| | Specification for Lifts cables. | IS-4289 (Par-1) : 1984 Reaffirmed 1991 |
| | Isometrics screw threads. | IS-4218-(Part-II)1976 Reaffirmed 1996 |
| | Classification of insulating materials for electrical machinery and apparatus in relation to their thermal stability in service. | IS-1271-1985 Reaffirmed 1990 |
| | Code of practice for earthing. | IS-3043-1987 |
| | Electrical installation Fire Safety of Building. | IS-1646-1997 |
| | Particular requirements of busbartrunking systems | BS 5486 Part 2/ IEC 60439 –2/ IS 8623 |
| | Degree of protection | IEC 60529 |
| | Self Supporting Chimney | IS : 6533 (Part 1 & 2) |
| | Power Capacitors of Self-healing Type for AC Power Systems having Rated Voltage up to 650 V – Specification | IS 13340-1993 |
| | Requirements for ageing test, self-healing test and destruction test on shunt capacitors of the self-healing type for ac power systems having a rated voltage upto and including 650 V | IS 13341-1992 |
| | Shunt Power Capacitors of the Self-Healing Type for A.C. Systems Having a Rated Voltage up to and Including 1 000 V | IEC 60831-1+2 |
| | Fundamentals definitions | IS 1885 (part I, VIII,X,XI,XVII,XXX,XXXII,XXXVIII) |

| Sr. No. | Description | Standard no. |
|---|---|---|
| | CO2 based fire extinguisher | IS 2878 |
| | Portable Fire extinguisher, Dry Powder (Cartage Type) | IS 2171 |
| | Guide for Preparation of diagrams, charts & tables for electro technology. Definitions and classifications ( superseding IS 2032 – Part I) | IS 8270 (Part I,II,III,IV.V) |
| | PVC Insulated cable for working voltages up to and including 1100 volts (second revision ) (Superseding IS 3035 Part I 1965) | IS 694/1990 |
| | Application guide for non linear resistor type surge arrester for alternating current system | IS 15086 –Part V |
| | Electrical wiring installation ( System voltage no exceeding 650 volts) | IS 732 |
| | High voltage alternating current circuit breaker | IS 13118/IEC 60056 |
| | A.C. Metal enclosed switchgear and control gear for rated voltage above 1kV and up to and including 52kV | IS 3427-1997 |
| | New insulating oils for transformers and switchgears | IS 335 |

**LIST OF ACT / BYE LAWS**

The installations shall also be governed by the following Acts/Bye-laws/Codes as amended upto date in addition to the codes specified in the tender:

a) ANSI/ASME/CENEN 81 CODE

b) National Building Code of India - 2005

c) Indian Electricity Act - 1910

d) Central electricity authority regulation, 2010.

e) Local Lift Act/Bombay Lift Act(if local lift act is not available)

f) Building Bye-Laws

g) Local Fire Prevention and Fire Safety Rules

h) GRIHA

i) ECBC

NOTE:

1. Equipment, accessories, component parts, raw materials and tests shall in general conform to IS AND IEC.
2. Latest edition of above mentioned codes / Bye Laws / Act shall be referred

# 11.30 APPROVED MAKES OF MATERIALS FOR ELECTRICAL & LV WORKS

**11.30. APPROVED MAKE OF MATERIALS FOR ELECTRICAL AND LV WORKS**

| Sr. No. | Material/ Equipment | Vendor |
|---|---|---|
| 1. | Sandwiched Type Bus Duct | Legrand<br>**L & T**<br>Schneider |
| 2. | Protection Relays (Numeric / Electro mechanic Type)/ Auxiliary relays | ABB<br>Schneider Electric<br>Siemens |
| 3. | Potential Transformer | Automatic Electric<br>Gilbert & Maxwell<br>Kappa<br>Pragati |
| 4. | Current Transformer (Cast Resin Epoxy Coated) | Automatic Electric<br>Gilbert & Maxwell<br>Kappa<br>Pragati |
| 5. | Control Transformer | Indcoil<br>Precise<br>NEC<br>Gauss Electricals |
| 6. | Electronic Digital Meter (A/V/PF/HZ/KWH) /MFM with LCD/LED Display. | Schneider<br>Siemens<br>Socomec |
| 7. | HRC Fuse and Fuse Fitting | ABB<br>GE<br>Siemens<br>L&T |
| 8. | ACB / MCCB | ABB<br>Schneider<br>Siemens |
| 9. | Contactors | ABB<br>Schneider<br>Siemens |
| 10. | Change over switch (automatic/ manual) | HPL<br>Hager<br>Socomec |
| 11. | Push Buttons | ABB<br>L&T<br>Schneider<br>Siemens<br>BCH |
| 12. | A. Power Distribution Panels & Boards Totally Type Tested Assembly (TTA) (AS PER IEC61439- 1 & 2).<br>To be sourced directly from OEM or authorized licensed partner. | Siemens Siepan 8PU – By Advance Panels & switchgears (P) Ltd.<br>Schneider blockset –By Adlec Power Pvt Ltd.<br>**ABB MNS** |
| | B. Power Distribution Panels & Boards (Non TTA) | Advance Panels & switchgears (P) Ltd.<br>Adlec Power Private Limited<br>**Tricolite** |

| | | |
|---|---|---|
| 13. | Switches, Time Delay Relay | Schneider<br>Siemens<br>Hager<br>Legrand |
| 14. | Indicating Lamps | Siemens<br>Schneider<br>ABB<br>L&T |
| 15. | Exhaust (Fan Heavy duty) | Crompton<br>Khaitan<br>Havells<br>Orient |
| 16. | HT/ LT Power Cables | Universal<br>Finolex<br>KEI<br>Polycab |
| 17. | HT/ LT Jointing Kit & Termination Kits | Birla-3M<br>Raychem<br>Safe Kit<br>M seal |
| 18. | Termination (Lugs)/ Cable Glands(Double compression ) | Commet<br>Dowell<br>Jainson |
| 19. | Selector Switches | Kaycee<br>ABB<br>Siemens<br>Schneider |
| 20. | Cable Management Systems-Raceways/Floor Boxes/ Trunkings , Cable trays | Legrand<br>OBO-Betterman<br>Indeana<br>Aditya Steel Industries |
| 21. | MS Tubular Poles | Bajaj<br>Philips<br>Schreder |
| 22. | External & Street Lighting | Schreder<br>Wipro<br>Trilux<br>BAJAJ |
| 23. | Landscape Lighting | NOVA<br>REIZ<br>BAJAJ |
| 24. | MS Black Stove Enameled ERW Conduits/GI pipes(ISI Approved) & accessories | AKG<br>BEC<br>RMCON<br>Precision |
| 25. | Copper Conductor PVC Insulated Wires/ Stranded Flexible Wires (FRLS) (including panel wiring) | Finolex<br>RR Kabel<br>KEI<br>Havells |
| 26. | Modular Switches, Socket Outlets And Wiring Accessories With Moulded Cover Plate. | Legrand (Myrius)<br>Schneider (Opale)<br>MK (Blenze) |

| | | |
|---|---|---|
| 27. | Data /Voice Passive Components | Panduit<br>Schneider<br>Simon |
| 28. | Metal Clad Plug & Socket (Industrial) | Legrand<br>Schneider<br>Neptune (Balls) |
| 29. | MCB/RCCB/ SPD | Legrand<br>Schneider<br>Siemens |
| 30. | Final Distribution Boards( MCB DBs) | Legrand<br>Schneider<br>Siemens |
| 31. | Telephone Tag Blocks/ FT | Krone<br>Pouyet<br>R&M<br>Beldon |
| 32. | Field Termination (FT) module | Krone make module<br>Siemens<br>Avaya<br>Alcatel |
| 33. | Telephone Wires/ Telephone Cables | Delton<br>RR Kabel<br>Belden<br>Bonton |
| 34. | Telephone /TV Outlet | Legrand<br>Schneider<br>MK |
| 35. a. | Light Fixtures (General) | Wipro<br>Philips<br>Bajaj<br>Trilux |
| b | Light Fixture (Special ) | Trilux<br>Philips (EU)<br>XAL (Austria) |
| 36. | Electronic Ballast for Fluorescent<br>(To be selected as per fixtures' manufacturer) | Havells<br>Philips<br>Wipro<br>Osram |
| 37. | CFL / T5 Lamps | Philips<br>Osram<br>Wipro |
| 38. | Exit lights | Prolite<br>Legrand<br>Philips<br>Zumtobel |
| 39. | Ceiling Fan ( 5 star rating) | Crompton<br>Bajaj<br>USHA<br>ORIENT |
| 40. | Exhaust Fans (5 star rating) | Crompton<br>Khaitan<br>Havells<br>Orient |

| | | |
|---|---|---|
| 41. | Lightning Protection System | DEHN<br>ONAY<br>J. Propster |
| 42. | Lightning & Surge Voltage Protection | ABB<br>Hager<br>OBO Betterman<br>DEHN |
| 43. | Fire Sealant & Fire Retardant Paint | 3 M India Ltd.<br>HILTI<br>Promat |
| 44. | Terminal Blocks /connectors | Jainson<br>Elmex<br>Connect well<br>Wago |
| 45. | Media Converter –Data /Net System | Cisco<br>D-Link<br>Schneider |
| | **Networking** | |
| 46. | Switches | Cisco<br>Juniper<br>Ayaya |
| 47. | Rack For Data/ Voice | R & M<br>Valrack<br>Legrand<br>Beldon<br>Ritta |
| 48. | Elevator | Thyssenkrupp<br>Otis<br>Kone<br>Schindler<br>Mitshubishi |
| 49. | Single Phase Preventers | Minilec<br>AE<br>L&T |
| 50. | Selector Toggle Switch | Kaycee<br>Salzer (Larsen & Toubro)<br>ABB |
| 51. | UPS | Emerson<br>Schneider (APC)<br>Mitsubishi |
| 52. | Sealed Maintenance Free Batteries | Amar Raja<br>Exide<br>Hitachi<br>Rocket |
| 53. | Battery Charger | Caldyne<br>Chhabi Electricals<br>Max Power(Maha Mai) |
| 54. | Patch Panels & Fiber Optic Cable | Siemon<br>Panduit<br>Schneider |
| 55. | Water barriers/sealing system | Roxtec<br>Rayflate (Tyco Electronics) |

| | | |
|---|---|---|
| 56. | Maintenance Free Earthing | Jef (Loresco) by Vidushi<br>Terec Plus By SGI<br>Erico by Security Shoppe |
| 57. | Fire Survival cables | INDIA-IMPEX(FRTEK)<br>LEONI<br>Bonton<br>Fusion Polymer |
| 58. | Wi-fi Ap (Indoor/Outdoor) | Meraki<br>Alcatel<br>Artix Network |
| 59. | IP-PBX/Ip Phone | Alcatel<br>Siemens<br>Zyxel |
| 60. | Fiber patch SC, Fiber LIU & SMB | Siemon<br>Systimex<br>Panduit<br>Schneider |
| 61. | IPDA | Siemens (Unify)<br>Avaya<br>Alcatel |
| 62. | Boom barrier system | FAAC<br>Brosis<br>Somfy<br>Gunnebo<br>Magnetic auto control |
| 63. | Sensor(Occupancy/Day light Sensor) | Hager<br>Legrand<br>schneider |
| 64. | Hand held Metal Detector | Rapiscan<br>Brosis<br>Somfy |
| | **Fire Detection & Alarm System** | |
| 65. | Addressable Fire Alarm Panel (UL /EN Listed) | Notifier<br>Secutron<br>Siemens<br>Fike<br>Edward |
| 66. | Addressable Detectors and modules (UL/EN Listed) | Notifier<br>Secutron<br>Siemens<br>Fike<br>Edward |
| 67. | PA System | Bose<br>Bosch<br>ATIES<br>Lapp Gruppen |
| 68. | Speaker | Bosch<br>ATIES<br>Lapp Gruppen |
| 69. | Computer | IBM<br>DELL<br>HP |

| | | |
|---|---|---|
| | **Access Control System** | |
| 70. | Electromagnetic Locks | Vanguard<br>Trimec<br>Sprint |
| 71. | Main Access controller | Honeywell<br>Lenel<br>Cardax<br>DDS |
| 72. | Access Control Software | Honeywell<br>Lenel<br>Cardax<br>DDS |
| 73. | Cards, Readers & Tags | HID<br>Honeywell<br>Cardax |
| | **IP CCTV System** | |
| 74. | Cameras | Sony<br>Pelco<br>Panasonic<br>BOSCH |
| 75. | Network Video Recorder | Sony<br>Pelco<br>Bosch<br>Cislo |
| 76. | CCTV Monitor | Samsung<br>Sony<br>Philips<br>Panasonic |
| 77. | a) Outdoor Oil Filled Transformer :<br>66 / 11 KV with ON Load Tap Changer (OLTC) on HV Side.<br>b) Outdoor Oil Filled Transformer :<br>11/ 0.433KV with OFF Load Tap Changer on HV Side. | Crompton Greaves Ltd.<br>BHEL<br>ABB<br>Schneider |
| 78. | Compact Sub station with Oil type transformer | ABB<br>Schneider<br>Siemens |
| 79. | VCB : 11 KV | ABB<br>Siemens<br>Schneider Electric |
| 80. | Static Power Meter & Logger (Trivector Meters) | ABB<br>Conzerv<br>Secure<br>Schneider Electric |
| 81. | Diesel Engine | Cummins<br>Caterpillar<br>MTU |
| 82. | Alternators 11 KV, F grade | AVK **(Stamford)**<br>TDPs (Toyodonky)<br>Leroy Somer |
| 83. | Anti Vibration Mountings | Gerb |

| | | |
|---|---|---|
| | | Resistoflex<br>Kanwar |
| 84. | Battery | Prestolite<br>Exide<br>Amco<br>Amar Raja |
| 85. | Motors | ABB<br>Crompton<br>Siemens |
| 86. | Pipes | Jindal Hissar<br>TATA<br>SAIL |
| 87. | Valves | Audco<br>Intervalve<br>Kruger |
| 88. | Timers | Schneider<br>Siemens<br>L&T |
| 89. | HSD – Storage Tank | Engineers Syndicate<br>Multi Engineering Sermes<br>Hydrotherm Engineering |
| 90. | Flexible Coupling | Resistoflex<br>Kanwal |
| 91. | PVC insulated XLPE aluminium conductor armoured cables 1100V grade | Universal<br>Finolex<br>Havells |
| 92. | Cable lugs & Termination | Commet<br>Dowell<br>Jainson |
| 93. | Residential Silencer | Nelson<br>Cummins<br>Sterling Power<br>Catter Pillar |
| 94. | MS Pipes for Exhaust System | Jindal Hissar<br>Tata<br>SAIL |
| 95. | MS Pipes/ GI pipes for fuel system | Jindal Hissar<br>Tata<br>SAIL |
| 96. | Pressure/Temperature Gauges | H Guru<br>Feibig<br>Emerald |
| 97. | Vibrator Eliminator | Kanwal<br>Resistoflex<br>Dunlop |
| 98. | NGR | SR Narkhade<br>BCH<br>Resistech<br>Contronics |
| 99. | Semi Rotary type hand fuel filling pump | Rotodel<br>Kitty<br>Binks |

| | | |
|---|---|---|
| 100. | Sealed Maintenance Free Batteries | Exide<br>Global<br>Hitachi<br>Shinkobe<br>Amar Raja |
| 101. | Control Cable(ISI Approved) | Universal<br>Finolex<br>Havells |
| 102. | Cable Glands(Double compression ) | Comet<br>Dowell's<br>Jainson |
| 103. | Polycarbonate Sockets | Clipsal<br>MANNEKER<br>Legrand |
| 104. | Water Tight Polycarbonate Boxes | Hensel<br>Legrand<br>Phraser |
| 105. | Astronomical Timer | The ben<br>ABB<br>Siemens |
| 106. | Hybrid Capacitor Panels | Schneider<br>EPCOS<br>ABB |
| 107. | Nitrogen Gas Injection System | CTR<br>Vendre<br>Tetronics |
| 108. | 66 KV GIS Switchgears | Siemens<br>ABB<br>ALSTOM |
| **109.** | **Energy Management System** | **SEIMENS**<br>**ABB**<br>**SCHNEIDER** |
| **110.** | **SCADA** | **SEIMENS**<br>**ABB**<br>**SCHNEIDER** |
| **111.** | **Response Indicator** | **AGNI**<br>**SPECTRUM**<br>**DAKSH** |

# 12.0. HVAC WORKS TECHNICAL SPECIFICATIONS

## 12.1. GENERAL

### 12.1.1. Scope of Work

The general character and the scope of work to be carried out under this contract is illustrated in DBR, Drawings, Specifications and Schedule of Quantities. The Contractor shall carry out and complete the said work under this contract in every respect in conformity with the contract documents and with the direction of and to the satisfaction of the Owner's site representative. The contractor shall furnish all labour, materials and equipment (except those to be supplied by the owner) as listed under Schedule of Quantities and specified otherwise, transportation and incidental necessary for supply, installation, testing and commissioning of the complete HVAC system as described in the Specifications and as shown on the drawings. This also includes any material, equipment, appliances and incidental work not specifically mentioned herein or noted on the Drawings/Documents as being furnished or installed, but which are necessary and customary to be performed under this contract. The HVAC system shall comprise of (but not limited to) the following buildings:-

| | | |
|---|---|---|
| 1. Faculty of Maths and Physics | - | 1 Nos. |
| 2. Faculty of Law and Humanities | - | 1 Nos. |
| 3. Library | - | 1 Nos. |
| 4. Administration | - | 1 Nos. |
| 5. SAARC Studies | - | 1 Nos. |
| 6. Faculty of Art and Convention | - | 1 Nos. |
| 7. Utility Block | - | 1 Nos. |
| 8. External Infra development | - | 1 Nos. |

The system includes:

a) All refrigerant, Chilled/ Hot water piping works including insulation, pressure testing, protection, hanging and support works for all the above mentioned buildings.
b) All ducting works including insulation, pressure testing, protection, hanging and support works for all the above mentioned buildings.
c) Supply and installation of BMS compatible electrical panel for HVAC equipments.
d) Electrical and control wiring from panel to HVAC equipment in case of chilled water AHUs.
e) Electrical wiring from panel to Outdoor and control cabling from outdoor to indoor units. Electrical wiring of indoor units.
f) Earthing (Grounding) System.
g) SITC of all High side equipment that includes,
    a. Centrifugal Chillers
    b. Cooling Towers
    c. Pumps – Primary, secondary, Condenser, Tertiary
    d. Hot water generators
    e. Expansion Tanks
    f. Any other in plant room
h) SITC of site level infra Chilled/ Hot water hydronic piping including trenching, filling and laying of pipe with Valves, chambers etc. to complete the work.
i) A required hydronic pipe tapping for the Life science and earth science building of the tender package 2 as per drawings. This is the responsibility of the contractor to ensure the required flow rate and the required temperatures are met as per the design documents. The contractor is also responsible for co-coordinating with other prime contractor of the tender package 2 building i.e. LSES.
j) SITC of Basement Ventilation system

k) Supply, installation and commissioning of AHUs, FCUs, Ventilation Fans, condensing units and any other HVAC equipment/ accessories mentioned in BOQ or necessary to successfully complete the project as per clients requirements
l) Supply, installation and commissioning of VAVs and related accessories.
m) Supply, installation and commissioning of Pumps and related accessories.
n) SITC of all HRW and its interlocking with all AHUs, fans etc.
o) Foundations for equipments including foundation bolts and vibration isolation spring/pads,
p) Suspenders, brackets and floor/wall supports for suspending/supporting ducts and pipes.
q) Suspenders and/or cable trays for laying the cables,
r) Excavation and refilling of trenches in soil wherever the pipes are to be laid directly in ground, including necessary base treatment and supports. Included in the scope of Lead Contractor.
s) Sealing of all floor slab/ wall openings provided by the lead contractor or contractor for pipes and cables, from fire safety point of view, after laying of the same.
t) Painting of all exposed metal surfaces of equipments and components with appropriate color.
u) Making openings in the Walls/Floors/Slabs or modification in the existing openings wherever provided for carrying pipe line, ducts, cables etc.
v) Providing wooden/ metallic frames for fixing grills/diffusers.
w) Making good all damages caused to the structure during installation and restoring the same to their original finish.
x) All electrical associated works as per BOQ and drawings, specifications.

### 12.1.2. Related Documents

These Specifications shall be read in conjunction with the General conditions of contract, schedule of work, drawings and other documents connected with the work.

### 12.1.3. Terminology

The definition of terms used in these specifications shall be in accordance with IS: 3615-"Glossary of terms used in refrigeration and air-conditioning". Some of the commonly used terms are defined in last chapter of the specification.

### 12.1.4. Colour Scheme for The Equipments and Components

- Color scheme for equipment like chilling unit, pumps, AHUs, cooling tower etc. shall be as per manufacturer's standard colour scheme.
- The scheme of color code painting of pipe work services for air conditioning installation shall be as per National building code and is indicated below:-

| Description | Ground Colour | Lettering Colour | First Colour band |
|---|---|---|---|
| Condenser water piping | Sea Green | Black | French Blue |
| Chilled water piping | Sea Green | Black | Black |
| Central heating piping below 60°C | Sea Green | Black | Canary Yellow |
| Central heating piping 60°C to 100°C | Sea Green | Black | Dark Violet |
| Drain Pipe | Black | White | |
| Vent | White | Black | |
| Valves and pipe line fittings | White with Black Handles | Black | |

| | | | |
|---|---|---|---|
| Belt guard | Black & Yellow diagonal strips | | |
| Machine bases, Inertia Base Plinth | Charcoal grey | | |

- Color bands shall be 150mm wide, superimposed on ground color to distinguish type and condition of fluids. The spacing of band shall not exceed 4.0m.
- In addition to the color bands specified above all pipe work shall be legibly marked with black or white letters to indicate the type of service and the direction of flow identified as follows:
    - Chilled water : CHW
    - Condenser water : CDW
    - Condensate : C

## 12.2. APPLICABLE CODESANDSTANDARDS

### 12.2.1. Application Codes and Standards

Supply, erection, testing and commissioning of all equipment's shall comply with the requirements of Indian Standards and code of practice given below as amended up to the date of submission of Tender. All equipment and material being supplied shall meet the requirements of relevant standard and codes.

**A. General**

| | |
|---|---|
| ASHRAE-2008 | Systems and Equipment's |
| ASTM D 3350, ASTM D 3035 | High Density Polyethylene |
| IS: 2379-1963 | Color code for Identification of pipes |
| IS 3615 | Glossary of terms used in refrigeration & air-conditioning |
| IS : 3696 | Safety code for scaffolding and ladders, |
| IS: 3696 | Code for practice for safety and health Requirements in electrical and gas welding & cutting operations |
| IS: 325 | Three phase induction Motors |
| IS: 655 (Latest Rev.)/ BIS Code | Ducting Fabrication |

**B. Pipes and Fittings:**

| | |
|---|---|
| IS: 1239,<br>IS: 3589 | Mild Steel, ERW Pipes |
| IS: 6392 | Steel Pipe Flanges |
| IS : 4736-1968 | Hot die zinc coated steel pipes |
| IS: 1239 | Pipe Fittings |

**C. Sheet Metal Work:**

| | |
|---|---|
| IS: 737 | Aluminum Sheets/Wires |
| IS: 277-1977 | Galvanized Sheets/Wires |
| IS: 655 (Latest Rev.)/ BIS Code | Ducting Fabrication |

**D. Valves:**

| | |
|---|---|
| IS : 778 | Balancing Valves |
| IS: 13095 | Butterfly valves for general purposes. |
| IS : 5312 | Non return valve |
| IS: 3950 | Specification for surface boxes for sluice valves. |
| IS: 12992 (part - 1) | Safety relief valves, spring loaded design. |

**E. Noise & Vibration:**

| | |
|---|---|
| IS: 2264 | Preferred frequencies for acoustical measurement. |
| IS : 3483 | Code of practice for noise reduction in industrial buildings. |
| IS: 8418 | Specification for horizontal centrifugal self-priming pumps. |

**F. Earthing:**

| | |
|---|---|
| IS: 3043 : 1966 | Code of practice for earthing |
| IS : 3151 : 1965 | Earthing transformer |
| IS: 12776 : 1989 | Galvanized stand for earthing |

**G. Fuses:**

| | |
|---|---|
| IS: 2208 : 1966 | HRC fuses links up to 650 V |
| IS : 2086 : 1963 | Carrier and bases used in rewire able type electric fuses up to 650 V |
| IS: 3106 : 1966 | Code of practice for maintenance of Fuses |

**H. Motor:**

| | |
|---|---|
| IS: 325 | 3 Phase induction motor |
| IS : 996 | Specs for single phase small AC and universal motor |
| IS: 3106 : 1966 | Code of practice for maintenance of Fuses |

**I. Safety Codes:**

| | |
|---|---|
| IS: 660 | Safety code for mechanical refrigeration |
| IS : 659 | Safety code for air conditioning |
| IS: 3016 | Safety code for precaution for precaution in welding and cutting operation |
| IS: 5216 | Code for safety procedure and practice in electrical work |
| IS: 3696 | Code for scaffolds and ladders. |

**J. Pumps and Vessels:**

| | |
|---|---|
| IS: 1520 | Specification for horizontal centrifugal pumps. |
| IS : 9542 | Horizontal mono set pump |
| IS: 8418 | Specification for horizontal centrifugal self-priming pumps. |

In addition below codes shall also be referred:
- NBC-2005
- ECBC-2011
- ANSI/ASHRAE/IESNA-90.1-2013
- AHRI 410-2001 WITH ADDENDA 1,2 AND 3: Forced circulation Air-Cooling and Air-heating coils
- ANSI/AHRI 430-2009: Central Air Handling Units
- ANSI/AHRI 440-2008: Performance Rating of room fan coil units
- AHRI-550 Standard for centrifugal or rotary screw water chilling machines
- AHRI 575: Standard for method of measuring machinery sound within equipment room
- CTI: Cooling Technology Institute
- ATC-105-00: Acceptance test code for water cooling towers (CTI std – 103 code tower standard specifications)
- ATC-201-96: Standard for certification of water cooling tower performance

Note: All codes/ Standards with latest amendments/ Issues shall be referred.
All codes mentioned in the DDR documents shall be referred.

## 1. GRIHA Applicability of Design:

- Water efficiency in air-conditioning system.
- Minimum efficiency requirements in air-conditioning system.
- CFC free refrigerant.
- Zero ozone depletion refrigerants.
- Non–smoke building.
- CO2 monitoring.
- Fresh air as per ASHRAE62.1.2010.
- ASHRAE 55.1 for thermal comfort.

## 12.3. HEATING VENTILATION & AIR-CONDITIONING

### WATER COOLED CHILLERS (CENTRIFUGAL MACHINE)

### 12.3.1. Scope

The scope of this section consists of but is not necessarily limited to the following:

a. SITC including lifting, shifting & Positioning of factory assembled & tested chilling units comprising of centrifugal compressor, water cooled condenser, chiller, water flow switches at inlet and outlet of condenser and chiller, water drain and air purge valves wherever required, connecting refrigerant piping, microprocessor based safeties and controls variable frequency drives including charge of refrigerant & compressor oil.
b. All associated items herein to be supplied delivered and installed.
c. Assembly of chiller components including connection of cooler, condenser, motor, compressor and unit mounted/free standing VFD into complete refrigeration machine.
d. Provide manufacturer's factory representative's services, including coordination, and start-up and erection & testing supervision.
e. Start-up supervision, training and providing necessary documentation and tools for operation.
f. Carry out witness of performance test run on AHRI test certified at factory at 4 points at constant condenser temperature.

### 12.3.2. General:

The water chilling unit shall be packaged factory assembled and tested and complete in all respects and shall generally comply with the specifications as given in subsequent paragraphs.

g. Performance will be certified in accordance with AHRI Standard 550/590. Only Chillers that are listed in the AHRI Certification Program for centrifugal Chiller is Acceptable. The initial charge of refrigerant and oil will be supplied, shipped in containers and cylinders for field installation or factory charged in the chiller.
h. Chiller shall be able to unload to 25% at constant condenser water entering temperature.
i. Computerized selection along with part-load data showing unloading up to 20% for verification shall be submitted along with offer.
j. An RS-232 Port to output all systems operating data, shutdown / cycling message, and a record of the safety shutdowns to a field-supplied printer. Data Logs to a Printer at a set programmable interval.
k. Communication card for following functions thru BMS shall be included in each chiller.
    I. Remote Chiller Start and Stop
    II. Remote leaving Chiller liquid temperature adjust
    III. Remote Current limit Set point adjust
    IV. Remote ready to start contacts
    V. Safety shutdown contacts
    VI. Cycling shutdown contacts
    VII. Run contacts

l. All controls, instrumentation and LCD/LED displays and other electronics and electrical devices should be suitable for indoor operation with possible temperatures when the ambient is 45 deg. C.
m. C.O.P of selected chiller at AHRI conditions shall be higher than 6.3 (Including VFD losses)
n. Guarantee of Chillers to be specified in no. of years and guarantee period will be 24 months after handing over of whole system.
o. Advanced microprocessor control center with graphics and all interconnecting unit piping and wiring
p. BMS Compatibility – Bacnet IP output

### 12.3.3. Quality Assurance Programme

a. Chiller shall be rated in accordance with Parameters indicated in Schedule of Quantities. Pressure vessels shall be designed, constructed, tested, stamped and shall be complete with safety devices with ANSI/ASHRAE 15-1989 Safety Code and ASME or GB Code.

b. (**Deleted)**

c. The chiller shall be designed/manufactured and tested in accordance with the applicable portions of the latest revisions of the following Standards and Codes.

| | |
|---|---|
| ARI 550 / 590 – 2003 | Performance rating of water chilling packages using the vapor compression cycle. |
| ARI 575 | Air Conditioning and Refrigeration Institute. Standard Method of Measuring Machinery Sound Within Equipment Rooms ( Basis of all data presented or field testing of equipment, with relation to sound requirements). |
| ASME CODE | American Society of Mechanical Engineers. (Div. 1 Code for Unfired Pressure Vessels - Section VIII, Design, construction, testing and certification of pressure vessels) or China GB code. |
| ANSI-B9.1 | American National Standards Institute. Safety Code for Mechanical Refrigeration (overall general safety requirements, relief device sizing, etc.) |
| ANSI-B31.5 | American National Standards Institute. Code for Refrigerant Piping. |

### 12.3.4. Capacity

Actual refrigeration capacity of chilling machine shall be as shown on Drawings and in Schedule of Quantities.

### 12.3.5. Centrifugal Compressor

a. The compressor will be a single-stage/multi stage centrifugal type powered by an open-drive / semi – hermetic electric motor. The housing will be fully accessible with vertical circular joints, with the complete operating assembly removable from the compressor and scroll housing. Compressor castings will be designed for 235 psig working pressure and hydrostatically pressure tested at 355 psig for R-134A units. The rotor assembly will consist of a heat-treated alloy steel drive shaft and impeller shaft with cast aluminum, fully shrouded impeller.

The impeller shaft shall be either direct driven or connected to the speed increasing gear. It shall be self-aligned and balanced and shall be assembled in the compressor casing. The driven end of the gear shaft shall be connected with the motor through a flexible coupling. The impeller shall be cast from alloy steel / aluminum alloy. This shall be statically and dynamically balanced to ensure vibration free operation. Casing design shall ensure that major wearing parts, bearings thrust bearings are accessible for maintenance and replacement. Insert-type journal and thrust bearings will be fabricated of aluminum alloy, precision bored and axially grooved.

Internal single helical gears with crowned teeth will be designed so that more than one tooth is in contact at all times to provide even load distribution and quiet operation. Each gear will be individually mounted in its own journal and thrust bearings to isolate it from impeller and motor forces. Shaft seal shall be provided in double bellows, double-seal, and cartridge type. A gravity-fed oil reservoir will be built into the top of the compressor to provide lubrication during coastdown in the event of a power failure.

Condensed liquid refrigerant shall be injected in to the compressor discharge to reduce discharge gas temperature and to reduce sound level of the compressor.

Capacity control will be achieved by use of pre-rotation vanes to provide fully modulating control from maximum to minimum load. The unit will be capable of operating with lower temperature cooling tower water during part-load operation in accordance with AHRI Standard 550/590. Pre-rotation vane position will be automatically controlled by an external electric actuator to maintain constant leaving chilled water temperature.
Compressor drive shall be capable of coming to a controlled, safe stop in event of power failure.

b. Lubrication System: Lubrication oil shall be force-fed to all compressor bearings, gears, and rotating surfaces by an external variable speed oil pump. The oil pump shall vary oil flow to the compressor based on operating and stand-by conditions, ensuring adequate lubrication at all times. The oil pump shall operate prior to start-up, during compressor operation and during coastdown. Compressor shall have an auxiliary reservoir to provide lubrication during coastdown in the event of a power failure.

An oil reservoir, separate from the compressor, shall contain the submersible 2 HP oil pump and a required capacity oil heater, thermostatically controlled to remove refrigerant from the oil. The oil reservoir shall be designed in accordance with applicable pressure vessel code and listed as part of the chiller by a nationally recognized testing laboratory.

Oil shall be filtered by an externally mounted ½ micron replaceable cartridge oil filter equipped with service valves. Oil cooling shall be done via a refrigerant cooled / water cooled oil cooler, with all piping factory installed. Oil side of the oil cooler shall be provided with service valves. An automatic oil return system to recover any oil that may have migrated to the evaporator shall be provided. Oil piping shall be completely factory installed and tested.

i. High efficiency oil filters.

ii. Low/differential oil pressure cutout.

iii. Oil coolers and oil heaters (with built-in-thermostat) to aid maintaining constant temperature.

iv. Oil level indicator.

v. Oil pressure control with pressure gauges and thermometer or as per manufacturer's standard.

The compressor shaft seal shall consist of a spring loaded precision carbon ring high temperature elastomer "O" ring static seal and stress relieved precision lapped collars. The seal must effectively prevent the leakage of refrigerant along the shaft during shut down periods. During operation an oil film under pressure should prevent outward leakage of refrigerant.

Oil cooler shall be in built part of chiller package. Oil cooler shall be shell & tube / PHE type. Condensed liquid refrigerant shall be used for oil cooling purpose or as per the manufacturer's standard.

c. Bearings: The compressor shall incorporate the necessary design feature to take both axial and radial thrusts. The bearing shall be of self-aligning type. The bearing shall be pressure lubricated during the operation and shall be completely sequenced and interlocked with the start up of the machine in such a way that oil pump should start earlier than the machine and the machine should start after some time, provided the required oil temperature and pressure is maintained during the startup period.

**12.3.6. Capacity Control**

The compressor shall be equipped with combination of speed control and PRV position control. Chiller shall be capable of unloading up to 25% of full load even at constant entering condenser water temp without surging and without hot gas bypass. Manufacturer must furnish computerized performance sheet at constant entering condenser water temp for verification of unloading up to 25%.

**12.3.7. Electric Motor**

The main electric motor and drive shall be furnished by chilling machine manufacturer in order to ensure system compatibility and drive train optimization. Motor system shall be suitable for 415±10% volts, 3 phase, 50 cycles AC supply. Motor shall be squirrel cage induction type. The motor shall be suitable for load characteristics and the operational duty of the driven equipment.

Synchronous speed of motor shall not exceed 3000 RPM. **The motor shall be TEFC or SPDP as per installation requirement for open type chillier unit and refrigerant cooled for hermetic / semi – hermetic type chillers.** Motor protection during over current shall be provided through winding temperature sensors in case of refrigerant cooled motors/current sensing in each phase through microprocessor in case of open type air cooled compressor.

The motor shall be capable of successful operation when running at rated load with variations in voltage and frequency as follows:

i. within ± 10% of rated voltage with rated frequency.
ii. within ± 5% of rated frequency with rated voltage.

**12.3.8. Drive :**

The compressor shall be driven directly or through speed increasing gears as required. The gears and pinions shall be pressure lubricated. The gears shall be provided with oil filter and submerged oil pump. The gears should be of helical type with crown teeth designed such that more than one tooth is in contact at all times to provide even distribution of compressor load and quiet operation. Gears should be integrally assembled in the compressor rotor support and be film lubricated. Each gear should be individually mounted in its own journal and thrust bearings to isolate it from impeller and motor shafts.

**12.3.9. Evaporator and Condenser**

a. <u>Evaporator (Chiller)</u>

Evaporator will be of the shell-and-tube, flooded type designed for 235 psig working pressure on the refrigerant side with marine water boxes. Shell will be fabricated from rolled carbon steel plate with fusion welded seams; have carbon steel tube sheets, drilled and reamed to accommodate the tubes; and intermediate tube supports spaced no more than four feet apart. The refrigerant side will be designed, tested and stamped with ASME Boiler and Pressure Vessel Code, Section VIII- Division or equivalent GB code. Tubes shall be high-efficiency, internally and externally enhanced type having plain copper lands at all intermediate tube supports to provide maximum tube wall thickness at the support area. Each tube will be roller expanded into the tube sheets providing a leak-proof seal, and be individually replaceable. Two liquid level sight glasses will be located on the side of the shell to aid in determining proper refrigerant charge. Suction baffles will be located around the sides and above the falling film section to prevent liquid refrigerant carryover to the compressor. The evaporator will have a refrigerant relief device sized to meet the requirements of ASHRAE 15 Safety Code for Mechanical Refrigeration.

Water boxes shall be designed for 150 psig working pressure and hydraulically tested at 225 psig. Water boxes will be removable to permit tube cleaning and replacement. Stubout

water connections having flanged connection will be provided. Vent and drain connections with plugs will be provided on each water box. The tube material will be copper. Intermediate steel tube supports should be provided at intervals not exceeding 1200 mm.

Chiller shall be factory insulated with 19 mm thick nitrile rubber / or equivalent thermal insulation as per manufacturers standard with vapor barrier, thermal insulation material. The insulation shall be applied in such a manner that water boxes and covers shall be removable without damaging it. The chiller shall be provided with eliminator to prevent liquid carry over to the compressor.

The chiller shall be complete in all respects and also include:

I. Supports for mounting
II. In and out connections both for the refrigerant and the water circuit and drain connections or as per manufacturer's recommendation.
III. Relief valve.

b. Condenser

The condenser shall be horizontal, shell and tube type designed for 235 psig working pressure on the refrigerant side with marine water boxes. Shell will be fabricated from rolled carbon steel plate with fusion welded seams; have carbon steel tube sheets, drilled and reamed to accommodate the tubes; and intermediate tube supports spaced no more than four feet apart. The refrigerant side will be designed, tested and stamped with ASME Boiler and Pressure Vessel Code, Section VIII- Division or equivalent GB code. Tubes shall be high-efficiency, internally and externally enhanced type having plain copper lands at all intermediate tube supports to provide maximum tube wall thickness at the support area. Each tube will be roller expanded into the tube sheets providing a leak-proof seal, and be individually replaceable.

Water boxes will be removable to permit tube cleaning and replacement. Stubout water connections having flanged connection will be provided. Vent and drain connections with plugs will be provided on each water box.

**12.3.10. Micro Processor Based Control Panel**

12.3.10.1. Each chilling unit shall be complete with a microprocessor based interactive control console in a locked enclosure factory mounted (directly on the unit), prewired with all operating and safety controls and tested.

12.3.10.2. It will provide start, stop, safety, interlock, capacity control and indications for operation of the chiller units through alphanumeric/graphical display.

12.3.10.3. Controls shall provide to view and change digital programmable essential set points, cause of shutdown and type of restart required.

i) Leaving chilled water temperature
ii) Percent current limit
iii) Remote reset temperature range

12.0.1.1. All safety and cycling shutdowns shall be enunciated through the alphanumeric/ graphical display and consist of day, time, cause of shutdown and type of restart required.

12.3.10.4. Cycling shutdown shall include low leaving chilled water temperature, chiller/ condenser water flow interruption, power fault, internal time clock and anti-recycle.

12.3.10.5. Safety shutdowns shall include low oil pressure, high compressor discharge temperature, low evaporator pressure, motor controller fault and sensors malfunction.

12.3.10.6. The default display screen shall indicate the following minimum information
i) Date and time
ii) Return and leaving chilled water temperatures
iii) Return and leaving condenser water temperatures
iv) Differential oil pressure
v) Percent motor rated current
vi) Evaporator &condenser refrigerant saturation temperatures
vii) Chiller operating hours (hour run) and
viii) Number of compressor starts
ix) Oil sump temperature
x) Status message

12.3.10.7. Security access shall be provided to prevent unauthorized change of set points, to allow local or remote control of the chiller and to allow manual operation of the perforation vanes and oil pump.

12.3.10.8. The chiller shall be provided with ports compatible with any building management system offered, to output all system operating information, shutdown/cycling message and a record of last four cycling or safety shutdowns to a remote printer (option) . The control centre shall be programmable to provide data logs to the printer at a set time interval.

12.3.10.9. Control centre shall be able to interface with an automatic control system to provide remote chiller Start/stop; reset of chilled water temperature, reset of current limit, and status messages indicating chiller is ready to start, chiller is operating, chiller is shut down on a safety requiring reset and chiller is shut down on a recycling safety.

12.3.10.10. The microprocessor control system shall include the interlocking of compressor motor with chilled and condenser water flows, guide vane position of compressor in case of centrifugal units and lubricating oil pump pressure.

12.3.10.11. On initiation of start, the microprocessor control system shall check all pre-start safeties to verify that all prestart safeties are within limits. (If one is not, an indication of the fault will be displayed and the start aborted).

**12.3.11. Refrigerant Piping:**

a. Necessary copper refrigerant pipe lines of heavy class shall be provided for the flow of suction and hot gases and liquid refrigerant.

b. The pipe lines shall be insulated with closed cell foam rubber insulation of required thickness.

**12.3.12. Type of Refrigerant:**

In view of Montreal convention on CFC/HCFC, units using R-134a or R-407c/410 only shall be preferred.

**12.3.13. Compressor Motor Starter**

A variable speed drive will be factory installed on the chiller. It will vary the compressor motor speed by controlling the frequency and voltage of the electrical power to the motor. The adaptive capacity control logic shall automatically adjust motor speed and compressor pre-rotation vane position

independently for maximum part-load efficiency by analyzing information fed to it by sensors located throughout the chiller.
Drive will be PWM type utilizing IGBT's with a power factor of 0.95 or better at all loads and speeds.

**The variable speed drive will be unit mounted / free standing with NEMA 3/ IP-42 enclosure with all power and control wiring between the drive and chiller factory installed, including power to the chiller oil pump.** Field power wiring shall be a single point connection and electrical lugs for incoming power wiring will be provided. **The Chiller's VFD shall be UL certified.**

The following features will be provided:

i. Door interlocked circuit breaker capable of being padlocked.
ii. UL listed ground fault protection.
iii. Over voltage and under voltage protection.
iv. 3-phase sensing motor over current protection.
v. Single phase protection.
vi. Insensitive to phase rotation.
vii. Over temperature protection.

Digital readout at the chiller unit control panel of output frequency, output voltage, 3-phase output current, input Kilowatts and Kilowatt-hours, As part of the filter package; input KVA, total power factor, 3 phase input voltage, 3 phase input current, 3 phase input voltage total harmonic distortion (THD), 3 phase current total demand distortion (TDD), self-diagnostic service parameters. Separate meters for this information will not be acceptable.

KW Meter - The unit's input power consumption will be measured and displayed digitally via the unit's control panel. The KW meter accuracy is typically +/- 3% of reading. KW meter scale is 0 - 788 KW

KWh Meter – The unit's cumulative input power consumption is measured and displayed digitally via the unit's control panel. The KWh meter is re-settable and its accuracy is typically +/- 3% of reading. KWh meter scale is 0 – 999,999 kWh.

Ammeter – Simultaneous three-phase true RMS digital readout via the unit control panel. Three current transformers provide isolated sensing. The ammeter accuracy is typically +/- 3% of readming. Ammeter scale is 0 - 545 A RMS.

Voltmeter – Simultaneous three-phase true RMS digital readout via the unit control panel. The voltmeter accuracy is typically +/- 3% of reading. Voltmeter scale is 0 – 670 VAC.

Elapsed Time Meter – Digital readout of the unit's elapsed running time (0 – 876,600 hours, resetable) is displayed via the unit control panel.

### 12.3.14. Miscellaneous:

Each unit shall include, but not be limited to, all the Items listed in the foregoing paragraphs or in the 'Schedule of Equipment' and drawings for this project. In addition all such items, as may be required, shall be included whether specifically mentioned or not, if considered or found necessary to fulfill the intent and meaning for the purpose of maintaining design operations under all extreme weather conditions.

### 12.3.15. Accessories:

Each unit shall include the following as part of unit price.

a. Ribbed rubber isolation pads to eliminate transmission of vibrations upto 90%.
b. Full charge of refrigerant gas and required quantity of lubrication oil.
c. Other valves as required for cleaning of condenser and draining of water.

### 12.3.16. Execution

a. Examination

a) Examine areas to receive chillers for compliance with requirements for installation tolerances and other conditions affecting chiller performance. Examine proposed route of moving chillers into place and verify that it is free of interferences. Verify piping rough-in locations. Verify branch circuit wiring suitability. Do not proceed with installation until unsatisfactory conditions have been corrected.

b) Final locations of the chillers on the Drawings are approximate, unless dimensioned. Determine exact locations before roughing-in piping and electrical work.

a. Installation

The chilling machine shall be installed over a cement concrete platform and shall be adequately isolated as per manufacturer's recommendations against transmission of vibrations to the building structure. For open type, special attention shall be paid to the alignment of the drive and driven shafts; final alignment shall be checked at site in presence of the Owner's site representative, using a dial indicator. Compressor and motor sole plates, anchor bolts and sleeves and necessary vibration isolation pads shall be included.

### 12.3.17. Painting

The equipment shall be supplied as per manufacturer's standard finish painting. Centrifugal water chilling machine shall be finished with durable enamel paint. Shop coats of paint that have become marred during shipment or erection, shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with enamel paint to match the finish over the adjoining shop-painted surface.

### 12.3.18. Witness Test

Prior to shipment, chilling machines shall be subjected to inspection and witness of performance tests by Consultant and Owner's representative to verify various performance parameters as confirmed by vendor earlier at the time of award of contract. The bidder shall arrange a test witness at factory for two persons from PMC/Engineer in charge/Owner side. However, the cost associated with the travelling and lodging will be paid by owner. Performance test shall be carried out as per procedure laid down by ARI at 100%, 75%, 50% and 25% loading. Chilled water leaving temperature shall be kept constant to design value for partial load testing.

Fouling factor simulation for condenser and evaporator shall be done as per ARI-550/590-2011. Incremental temperature difference ( to be calculated based on Normative appendix-C of ARI-550/590-2003) on account of designed fouling factors shall be added in condenser water entering temperature and shall be subtracted for leaving chilled water temperature. Chiller shall produce design refrigeration capacity and guaranteed power consumption at these corrected set of entering condenser water and leaving chilled water temperature. Outside tube surface area (for condenser and flooded evaporators) and inside tube surface area (for DX-Evaporator), being inputs for ARI mathematical model for fouling, shall be submitted along with the offer.

All instruments and personnel for test shall be provided by the contractor. Contractor shall inform the client about the chiller testing schedule minimum of 20-25 days in advance before the chiller is ready for factory testing.

### 12.3.19. Startup and Operator Training

The services of a factory trained, field service representative will be provided to supervise the final leak testing, charging and the initial startup and conduct concurrent operator instruction.

### 12.3.20. Water Flow Switch - Evaporator

Water flow switch will be supplied for the evaporator circuit. The flow switch will be the paddle type, vapor-proof enclosed SPDT switch (7.4 amps, 115 V.A.C.) suitable for 150 psig. The switch will be shipped loose for contractor field installation in a horizontal section of pipe where there is a straight horizontal run of at least five pipe diameters on each side of the flow switch. Locations adjacent to elbows, orifices or valves should be avoided. An adjustment screw will regulate the amount of flow required to actuate the switch. The switch will conform to NEMA 4X Enclosure (water tight, dust tight, corrosion resistant).

### 12.3.21. Isolation Mounting

Included with the unit are four or required necessary vibration isolation mounts, consisting of 1" thick neoprene isolation pads or per manufacturer recommendation, for field mounting. The pads are to be mounted under the steel mounting pads on the tube sheets. Suitable for ground floor installation.

### 12.3.22. Basis of Design:

| Sr.No | Description | Requirement |
|---|---|---|
| | **General** | |
| 1 | Actual Capacity required at specified design conditions per chilling package-TR | Shall be per loads and schedules |
| 2 | Refrigerant | R134a |
| 3 | Minimum C.O.P at 100% load at ARI conditions | 6.3 (including VFD losses) |
| 4 | Full load IKW (maximum) at design conditions | 0.60 KW/TR (including VFD losses) |
| 5 | NPLV – Max | 0.35 kW/TR |
| 6 | Maximum noise level at a distance of 1 meter | Not exceeding 85 dB |
| 7 | Compressor – type | Open / Semi-hermetic |
| 8 | Lubrication | Forced feed with an oil pump / differential pressure |
| 9 | Capacity control | Thru VSD & inlet guide vanes control |
| | **Compressor** | |
| 1 | Type | Centrifugal |
| 2 | Capacity control | Optimization of guide vanes & motor speed |
| | **Evaporator** | |
| 1 | Type | Flooded Shell and tube |
| 2 | Pressure Vessel Code | ASME/GB |
| 3 | Liquid to be cooled | Water |
| 4 | Chilled water inlet temperature | 56 Deg.F / 13.33 Deg C |
| 5 | Chilled water outlet temperature | 44 Deg.F /6.67 Deg C |
| 6 | Minimum chilled water flow per chilling package - US GPM | 2000 |
| 7 | Fouling factor-water side | 0.0002 (FPS unit) |
| 8 | Chiller and suction line insulation | Minimum 19 mm Closed cell polyvinyl chloride foam |
| 9 | Maximum water side pressure drop | 6 mtr |
| | **Condenser** | |
| 1 | Type | Water cooled, shell and tube |
| 2 | Pressure Vessel Code | ASME/GB |
| 3 | Condenser water inlet temperature | 88 Deg. F / 31.11Deg C |

| | | |
|---|---|---|
| | Condenser water outlet Temperature | 98 F / 36.6 C |
| 4 | Maximum condenser cooling water flow per chilling package | 3000 USGPM |
| 5 | Fouling factor-water side | 0.0005 (FPS unit) |
| 6 | Maximum water side pressure drop | 8 mtr |
| | **VFD** | |
| 1 | Type of starter | VFD factory fitted – Unit mounted/Free standing |
| | **Electrical / Controls** | |
| 1 | Motor | 400 / 415 V +/- 10%, 3 phase, 50 Hz |
| 2 | Control Panel | Common panel for both chiller & VSD, Microprocessor based control panel with Graphical display |
| 3 | Certification | AHRI |
| 4 | BMS software integration protocol | Bacnet/MODBUS |

**12.3.23. Technical Data:**

Bidder should furnish technical data as mentioned below, of the equipment and accessories offered by him as per scheme given in schedule of equipment and Bill of Quantities.

| S.No. | Description | Unit | Condition of Services | Offered by Tenderer |
|---|---|---|---|---|
| **1.0** | **WATER CHILLING UNIT (CENTRIFUGAL TYPE)** | | | |
| 1.1 | Country of Origin | | | |
| 1.2 | Refrigerant quantity | kg. | | |
| 1.3 | Incomer Switchgear size | Amp | | |
| 1.4 | Power cable size (XLPE) | Sq.mm | | |
| 1.5 | Earthing size | mm | | |
| 1.6 | Lubricant oil used | Name | | |
| 1.7 | Quantity of lubricant oil | kg. | | |
| 1.8 | Noise level at 1m distance (Noise spectrum to be submitted) | NC | | |
| 1.9 | Capacity at Design | (Tons) | | |
| 2.0 | Chilled Water Flow | GPM | 2000 GPM | |
| 2.1 | Chilled Water IN Temp. | º F | 56 º F | |
| 2.2 | Chilled Water OUT Temp | º F | 44 º F | |
| 2.3 | Evaporating Temp | º F | | |
| 2.4 | Condenser Water Flow | GPM | 3000 GPM | |
| 2.5 | Condenser Water IN Temp | º F | 88º F | |

2.6 Condenser Water OUT Temp º F

2.7 Condensing Temp º F

2.8 Max Input Power Requirement at Design Conditions (Max.) IKW/TR 0.60(Max)

2.9 Max NPLV IkW/TR 0.35(Max)

3.0 Min C.O.P at ARI Conditions 6.3 including VFD Losses
3.1 Part Load data

| Load | IkW/TR at tender design conditions & with ARI relief | IkW/TR at ARI 550/590 conditions | IkW/TR at tender design conditions & constant condenser water entering temp |
|---|---|---|---|
| 100% | | | |
| 75% | | | |
| 50% | | | |
| 25% | | | |
| IPLV/NPLV | | | |

3.2 Performance sheet at tender conditions and part load with ARI relief on ECWT (100% - 25%)
Provided Yes/ No

3.3 Performance sheet at ARI conditions and part load with ARI relief on ECWT (100% - 25%)
Provided Yes/ No

3.4 Performance sheet at tender conditions and constant ECWT (100% - 25%)
Provided Yes/ No

**2.0 Compressor**

2.1 Make

2.2 Model

2.3 Compressor Type

2.4 Speed (Operating) RPM

2.5 Speed (Maximum) RPM

2.6 Unloading at constant condenser Entering Water temp % 25%

2.7 Design Suction Temp $^{O}$ F

2.8 Design Discharge Temp $^{O}$ F

2.9 Capacity at Design Temperature Tons 1000 TR

2.10 KW Consumed at Design Temperature KW

2.11 Refrigerant Used R 134a

2.12 Type and Make of Capacity Control

| S.No. Description | Unit | Condition of Services | Offered by tender |
|---|---|---|---|
| **3.0 Condenser:** | Unit | | |
| 3.1Manufacturer | Name | | |
| 3.2 Length of Tubes | m | | |
| 3.3 Material of Tubes | | Copper | |
| 3.4 Dia of Tubes | Inch | 1’, max | |
| 3.5 No. of Integral Fins/cm | Nos. | | |
| 3.6 Water Velocity | M/S | 3 max | |
| 3.7 Pressure Drop | m | 8 max | |
| 3.8 Quantity | Nos. | 1 | |
| 3.9 Fouling Factor | (FPS) | 0.0005 | |
| 3.10 Marine type water box provided (Y or N) | | | |
| 3.11 No Of pass | 2 | | |
| **4.0 Evaporator:** | Unit | | |
| 4.1Manufacturer | Name | | |
| 4.2 Length of Tubes | m | | |
| 4.3 Material of Tubes | | Copper | |
| 4.4 Dia of Tubes | Inch | 1”, max | |
| 4.5 Water Velocity | M/S | 3 max | |
| 4.6 Pressure Drop | m | 6 max | |
| 4.7 Quantity | Nos. | 1 | |
| 4.8 Fouling Factor | (FPS) | 0.00025 | |
| 4.9 Marine type water box provided (Y or N) | | | |

| S.No. Description | Unit | Condition of Services | Offered by tender |
|---|---|---|---|
| **5.0 Compressor Motor:** | | | |
| 5.1 Manufacturer | Name | | |
| 5.2 Type of Motor | Type | | |
| 5.3 Rated Output | KW | | |
| 5.4 Current Characteristics | | | |
| **6.0 Starter Panel** | | VSD | |
| 6.1 VFD | | | Yes/ No |
| 6.2 VFD – Factory fitted / calibrated(Y or N) | | | Yes/ No |
| 6.3 VFD – as per global catalogue on website (Y or N) | | | Yes/ No |
| 6..4.1 Phase rotation | | Provided | Yes/ No |
| 6.4.2 Single phase protection | | provided | Yes/ No |
| 6.4.3 VFD parameters in Common microprocessor panel (Y or N) | | | Yes/ No |
| 6.4.4 kW Meter | | Provided | Yes/ No |
| 6.4.5 Ammeter | | Provided | Yes/ No |
| 6.4.6 Voltmeter | | Provided | Yes/ No |
| 6.4.7 Display of all VSD parameters in main chiller panel | | provided | yes/ No |

## 12.4. COOLING TOWERS

### 12.4.1. Scope

The scope of this section comprises the supply, erection, testing and commissioning of cooling towers in accordance with the Drawings and the Schedule of Quantities.
The structural support and foundation shall be designed and constructed based upon certified loads and dimensions provided by the cooling tower manufacturer.

Submit the following: -

1. Tender Stage

   a. Manufacturer's catalogues and equipment details
   b. Certified dimension drawings indicating all equipment dimensions, weight materials.
   c. Equipment layout details indicating equipment arrangement and plinth details.

2. Manufacturing Stage

   a. Performance curves which show leaving water temperature from the tower at the design water temperature range at the design wet bulb.
   b. Packaging, transportation and storage notes.

3. Construction Stage

   a. Installation manuals
   b. Certificates from CTI
   c. Operation and maintenance manuals.

### 12.4.2. Quality Assurance

1. Cooling Towers shall have a capacity not less than that specified. The rated capacity shall be certified by the cooling tower institute (CTI).
2. The manufacturer's shall supply a written guarantee that the cooling tower offered for this project shall be capable of performing the duties required as stated in the schedule and specification, by submission of exact type technical data for the wet bulb temperatures anticipated at the project locality.
3. Guarantee that there shall be no water leakage from the cooling tower, basin and sump.
4. Should the tower fail to perform after installation, according to the approved performance curves steps shall be taken to rectify and make good and defects or inadequacies, at no extra cost to the employers.

### 12.4.3. Type

Cooling Towers shall be Forced/Induced Draft Series in accordance with the Drawings and Schedule of Quantities. These cooling towers should be designed with special emphasis for minimizing water loses especially drift loss and splash losses.

The cooling tower shall be of Induced draft type. The cooling tower shall be made of fiber glass reinforced plastic (FRP) construction with PVC fill and FRP basin. The cooling tower shall be CTI certified for the capacity mentioned in the tender document.

### 12.4.4. Design Parameters

The cooling tower design parameter shall be as follows:

- Rating: The cooling tower shall be rated for the heat rejection capacity specified in the tender specifications.

- Range: The Cooling tower shall be designed to cool the requisite quantity of water through 5.5°C or as specified in the tender specifications, against the prevailing wet bulb temperature.
- Wet Bulb approach: The cooling tower shall be selected for a wet bulb approach of not more than 5.
- Outlet temperature: The cold water temperature from the cooling tower shall match or less than the entering temperature for which the condenser selection is made.
- Flow rate: The water flow rate through the cooling tower shall match that through the condenser.
- Multi cell design: The induced draft cooling tower shall be of one or more cells.

### 12.4.5. Material and Construction:

Cooling Towers shall be suitable for outdoor installation, shall be vertical, Forced/Induced Draft counter flow type in fibre-glass reinforcement plastic construction, complete with fan, motor, surface and spray section, eliminators, steel supports, as called for in Schedule of Quantities.

The structural framework of the cooling tower including all members shall be designed for the load encountered during the normal operation of the cooling tower and its maintenance. The structure shall be rugged and rigid to prevent distortion and shall include tie arrangements as may be necessary.

The air intake shall be from openings all along the circumference of the casing near its base in case of circular shape. Air Intake shall be along the sides in case of square or octagonal/ rectangular cooling tower. These openings shall be covered with hot dip galvanized expanded metal mesh screens.

a) Capacity:
The capacity type and number of tower cells in the cooling tower shall be detailed in the schedule and/or as shown on the drawings.

b) Side Casing:
This shall be made out of FRP with smooth surface for minimum resistance to airflow. It shall have sufficient structural strength to withstand high wind velocities and vibration. The casing shall be installed in the fibre glass-reinforced basin. The tower supporting structure shall be made out of hot dipped galvanized frame. The tower shall have FRP panels with adequate reinforcement.

c) Cold Water Basin:
Cold water basin shall be a deep fiberglass reinforced sump with which cooling tower super structure shall be supported. The basin shall have a holding capacity adequate for operation for at least 30 minutes without addition of make-up water to the basin. The construction should be such as to eliminate the danger of drawing air into the pump when operating with minimum water in the basin.
Basin fittings shall include the following:

a. Bottom Outlet.
b. Drain at under side of suction side sheet with valve.
c. Overflow fixed to inside of casing side sheet.
d. Ball type automatic make-up water connections with valve.
e. Equalizing connection where required.
f. Bleed off with valves from inlet header to overflow pipe.

d) Distribution System:
The water distribution may be either through self-rotating or fixed type sprinklers or through balancing, sub balancing and spreader troughs (unpressurised system) 'open gravity type with polypropylene nozzle", ensuring uniform water loading and distribution of water over the fill. All pipes and fittings shall be of PVC. The sprinklers shall operate from the residual velocity head at

the headers. Due care shall be taken with regard to corrosive effects and maintainability in the design of the water distribution system.

e) Fillings:
Fillings shall be made of corrosion proof and rigid film in cross fluted design and arranged in square / rectangular form, and shall be elevated from the floor of the cold water basin to facilitate cleaning and easy replacement. They shall be arranged in such a manner as to ensure negligible resistance to airflow and to eliminate backwater spots and prevent fouling through scales that may form. In order to reduce carry-over losses through entrainment of moisture drops in air stream, PVC drift eliminators shall be installed. The fills shall be of High efficiency. The filling shall be PVC. The thickness of PVC shall not be less than 0.2 mm.

f) Mechanical Equipment:
Fan shall be made of Cast Aluminium Alloy and the axial flow type, lightweight rotor fitted with multiple aerofoil blades. The entire fan assembly shall be balanced statically and dynamically. Fan shall be direct driven motor 415 +/- 10% volts, 3 phase, 50 cycles AC supply, totally-enclosed, fan-cooled, weather-proof construction, designed and selected to operate in humid air stream. Fan shall be protected by fan guard and shall be easily accessible for inspection and maintenance. A service ladder shall also be provided for greater convenience. The mechanical equipment assembly shall be adequately supported on a rugged steel base welded to tubular support assuring vibration-free support. All fans shall be direct driven.

The fan drive shall be from a three phase induction motor, either direct or through a spiral gear work. The entire drive arrangement shall be designed for a minimum noise and it shall be rigidly supported to the tower structure. The fan motor shall have efficiency class IE-3.

g) Panel Colour
For FRP cooling towers, the contractor shall obtain approval from the Architect/Consultant for available colors for the casing panels. The cooling tower shall be procured of the colour, strictly in accordance with written approval of Architect/Consultants and should have a striking finish.

**12.4.6. Accessories:**
Each cold water basin shall be provided with a deep, non-activating, and outlet sump complete with a suitable suction strainer having duplicate screen. The strainer shall have handles for easy removal.

The cooling tower basin shall be provided with automatic float valve with a stop valve for continuous make up water flow, quick fill arrangement with stop valve, over-flow and drain connections with stop valves.

Steel ladders shall be provided in such a manner and location as necessary to give safe and complete access to all parts of tower requiring inspection. Each ladder shall be made of 40mm x 40mm x 6mm angle iron sides and 16mm straps and shall be bolted to the tower on the top and bottom.

Hot dipped galvanized Bird Screen should be fixed on top to prevent any particles from entering the cooling tower.

All hardware shall be electroplated. All pipe connections shall be hot dip galvanized. All other technical parameters should confirm to FD/ID series cooling towers.

**12.4.7. Execution**
Install, test and commission cooling tower as specified in drawings and specifications in accordance with manufacturer's instructions.

1. INSTALLATION

   a. Cooling towers shall be assembled, rigged and installed in accordance with the manufacturer's recommendations to the satisfaction of the Employer's Representatives. The associated auxiliary structural support shall be supplied.

b. The cooling tower shall be installed on M.S. girders fixed in masonry foundations with cement concrete footing. Second class brick work and cement mortar having one part cement &six parts sand shall be used for the masonry work. 12mm sand cement plaster shall be provided over the brickwork.
c. These may be located at a well-ventilated place either at ground level and contiguous to the plant room, or on the terrace of the building in consultation with the Architect. In case the cooling towers are located on the terrace of the building, the structural loading of the terrace shall be considered. For this respective columns are to be raised by two feet at the terrace. Cooling towers shall be installed in such a way that their load is transferred directly to the columns for which necessary Mild steel-I sections shall be provided by the sub-contractor. The cooling towers shall be rested on Mild Steel-I sections & not on terrace slab. Sufficient free space shall be left all around for efficient operation of the cooling tower.
d. Cooling tower shall be not less than 75cm above the ground/ floor level unless otherwise stated in the tender specifications, 6mm neoprene pads shall be placed between the tower and the girder for vibration isolation whereas directed by the Engineer-in-charge. Guy-wires of suitable sized shall be used to secure firmly to its base wherever necessary.
e. Precautions shall be exercised throughout the assembly of cooling towers to minimize objectionable air-borne noise. Vibrations of the cooling towers must be effectively isolated from the structure of the building.

2. NAME PLATES AND MARKINGS

Nameplates shall be provided and shall be located at a convenient location for easy visibility.
The nameplate shall be inscribed with the following as a minimum requirement:

a. Manufacturer's name
b. Item number
c. Year of construction
d. Design temperatures
e. Design flow rate
f. Fan motor kilowatt

3. SAFETY AND ACCESS

1. The tower shall be designed and equipped to provide comfortable, safe access to all components requiring routine inspection and maintenance.
2. An inspection door (internal walkway) shall be provided to gain entry into the tower to facilitate inspection and easy maintenance. Access ladder shall be installed on the tower permanently.

4. NOISE LEVEL

1. The cooling tower shall be on the low operating noise type. Noise level shall not exceed the sound level as indicated in the schedule.

5. MISCELLANEOUS

1. Supply and install all ancillary including make-up water supply pipe from the makeup tank, quick fill and bleed-offs facilities.

### 12.4.8. Painting

The cooling towers shall be supplied with the manufacturers standard finish painting.

### 12.4.9. Operation

The operations contractor shall bleed off the cooling tower as and when required to maintain the cooling tower water hardness less than 500 PPM.

### 12.0.2. Testing

The testing procedure shall be as per CTI standards & codes.

## 12.5. FACTORY BUILT AIR HANDLING UNITS (AHU), FAN COIL UNITS (FCU), VARIABLE REFRIGERANT SYSTEM (VRV), HEAT RECOVERY UNITS AND AIR COOLED SPLIT UNITS

### 12.5.1. Scope

This chapter covers the detailed requirements of factory built double skin air handling unit (AHU) and single skin fan coil unit (FCU) for central air conditioning system as well as for central heating system. The configuration and details of each AHU shall be verify and co-related with individual building schedule.

### 12.5.2. Factory Built Air Handling Unit (Ahu)

12.5.2.1. Type

The air handling unit shall be of double skin construction, draw through type in sectionalized construction consisting of blower section, coil section, humidification section (where specified), filter section and drain pan. Unless otherwise specified, the unit shall be horizontal type.

12.5.2.2. Rating

i) The capacity of the cooling/ heating coil, the air quantity from the blower fan and static pressure of blower fan shall be as laid down in the tender documents. Where these parameters as calculated by the tenderer exceed the specified values, the coils and the blower fan shall satisfy these calculated values.
ii) The coil shall be designed for a face velocity of air not exceeding 155 m/min.
iii) The requisite static pressure demanded by the air circuit shall be developed by the fan at the selected operating speed. The static pressure value shall not in any case be less than 40 mm water gauge in normal cases, not less than 65 mm water gauge where microvee filters are also used and not less than 100 mm water gauge where absolute filters-are also used. The fan motor HP shall be suitable to satisfy these requirements and the drive losses.
iv) The air outlet velocity from the blower fan shall not exceed 610 m/min.
v) Noise level at a distance of 2M from AHU shall not exceed 75 dBA.

12.5.2.3. Material And Construction

A. Housing / Casing

i) The housing/ casing of the air handling unit shall be of double skin construction. The housing shall be so made that it can be delivered at site in total semi knocked down conditions depending upon the requirements. The main framework shall be of suitable structural sections. The entire framework shall be assembled using mechanical joints to make a sturdy and strong framework for various sections. Framework of all air handling units shall be made of thermal break hollow extruded aluminum profile. **In case of AHU casing design with no contact between inner and outer surface, thermal break profiles can be avoided.**

ii) Double skin panels shall be minimum 25mm thick made of 0.8mm pre-plasticized and pre-painted with PVC guard, GSS sheet on outside and 0.8mm galvanized sheet inside with polyurethane foam insulation of density not less than 38 kg/cum injected in between by injection moulding machine. These panels shall be joined and connected to the framework/ supports with soft rubber gasket in between (if necessary) to make the joints airtight and low air leakage potential. The gaskets shall be inserted within groove in extruded aluminum profile of the framework. For units installed outdoor, the thickness of double skin panels shall be minimum 40 mm.

iii) Frame work for each section shall also be joined together to make the joints air tight. Suitable doors with nylon handles and all access panels should be operable with allen key/ suitable locking arrangement. Aluminium die-cast powder coated/ Nylon hinges & latches shall be provided for access to various panels for maintenance. However, AHU in the form of complete single unit shall also be acceptable with access door(s) for maintenance to various sections. The

entire housing shall be mounted on galvanized steel channel frame work made out of G.I. sheet of thickness not less than 2mm.

B. Drain Pan

Drain pan shall be made out of minimum 1.25 mm stainless steel sheet externally insulated (If Drain pan is outside the unit), with 10mm thick closed cell Polyethylene foam/ equivalent suitable insulation with necessary dual slope to facilitate fast removal of condensate. Necessary supports will be provided to slide the coil in the drain pan.

C. Cooling / Heating Coil

i) The coil shall be made from seamless solid drawn copper tubes. The minimum thickness of tube shall be 0.5 mm for cooling / heating / heating-cum-cooling coils.
ii) The depth of the coil shall be such as to suit the requirements, viz. re-circulated air applications, or 100 % fresh air applications and the bypass factor required shall be specified in the tender specifications. The coil shall be 4 or 6 rows deep for normal re-circulated air application and 8rows deep for all outdoor air application, unless otherwise specified in the tender specifications. In case of 8 rows deep coils, it shall be made of 2x4 rows deep coils with a spacing of 200mm between the two coils, access door and independent drain pan.
iii) U bends shall be of copper, jointed to the tubes by brazing, soft soldering shall not be used.
iv) Each section of the coil shall be fitted with flow and return headers to feed all the passes of the coil properly. The headers shall be of copper and shall be complete with water in/out connections, vent plug on top and drain at the bottom. The coil shall be designed to provide water velocity between 0.6 to 1.8 m/s in the tubes.
v) The fins shall be of aluminum. The minimum thickness of the fins shall be 0.15 mm nominal. The no. of fins shall not be less than 4-5 per cm length of coil. Fins may be of either spiral or plate type. The tubes shall be mechanically expanded to ensure proper thermal contact between fins and tubes. The fins shall be evenly spaced and upright. The fins bent during installation shall be carefully realigned. For coastal areas fins shall be phenolic coated and for 100% FA application fins shall be hydrophilic type.
vi) The coil shall be suitable for use with the refrigerant specified or with water as the case may be. Refrigerating coils shall be designed for the maximum working pressure under the operating conditions. Water coils shall be designed for a maximum working pressure of 10 kg./sq.cm.
vii) Shut off and regulating valves at the inlet and outlet of water shall be provided. In the case of Direct Expansion (DX) coils, solenoid valve and expansion valves shall be provided at the inlet of coil.

D. Supply Air Fan And Drive

i) The supply air fan shall be AMCA certified centrifugal type with forward/ backward curved blades double inlet double width type or Plug type direct driven aerofoil backward curved fans. For static pressure upto 65mm forward curved blades shall be used and for higher sizes backward curved blades shall be used in case of Double Inlet Double Width (DIDW) fans.
ii) The fan housing of Galvanized sheet steel and the impellers shall be fabricated from heavy gauge steel sheet as per approved manufacturer's standard. The side plates shall be die-formed for efficient, smooth airflow and minimum losses. Fan impeller shall be mounted on solid shaft supported to housing using heavy duty ball bearings. Fan housing and motor shall be mounted on a common extruded aluminum base mounted inside the fan section on anti-vibration spring mounts or cushy-foot mount. The fan outlet shall be connected to casing with the help of fire retardant fabric.
iii) The fan impeller assembly shall be statically and dynamically balanced.
iv) If belt drive is applicable, the fan shall be fitted with V belt drive arrangement consisting of not less than two evenly matched belts. Belts shall be of oil resistant type. Adequate adjustments shall be provided to facilitate belt installation and subsequent belt tensioning by movement of the motor on the slide rails. A readily removable door guard shall be provided.

v) The fan motor shall be totally enclosed fan cooled squirrel cage induction motor with IP-54 protection &selected for quiet running. The motor shall be suitable for operation on 415 ± 10%V, 3phase, 50 Hz, A.C. supply. The motor shall conform to IS: 325. "Three phase induction motors" having class F insulation. **The motor shall have efficiency class IE-3 or EFF-1, whichever is more efficient.**

E. Air Filters

The air used in an air-conditioning system must be filtered to maintain a clean atmosphere in the conditioned space. The concentration of contaminants in the air and the degree of cleanliness required in the conditioned space will determine the type of filter or filters that must be used.

E1. Type of Filters

i) **Pre-filters:** Cleanable metallic viscous type filter made out of aluminum wire mesh or of dry cleanable synthetic type minimum 50mm thick, shall be provided on the suction side of AHU as standard equipment with the unit. These filters shall have the efficiency of 90% down to 10 micron particle size. When these filters become loaded or full of dirt, it is removed from service and replaced by another filter. The dirty filter can then be washed in a cleaning solution in a tank, dried and then given a bath of viscous oil. Face velocity across these filters shall not exceed 155 MPM.

ii) **Dry Fabric Fine-filters:** These filters shall have efficiency of 99% down to 5 micron particle size as per EU 7 standard. These filters are provided only where special cleanliness standard is required such as for library, labs , wards, OTs etc. these are provided on the discharge side of AHU after fan section and are always backed by pre-filters provided on the suction side of AHU. Face velocity across these filters shall not exceed 155 MPM.

iii) **HEPA filters:** These filters shall have efficiency of 99.97% down to 0.3 micron particle size as per EU13 standard. These filters are provided only where special cleanliness standard is required such as for Central Instrumentation Area, Radio Active Room and Animal Housing etc. these are provided on the discharge side of AHU after fan section and are always backed by pre-filters provided on the suction side of AHU. Face velocity across these filters shall not exceed 155 MPM. These filters shall be separately measured and paid for.

E2. General Construction of Filters

i) Each AHU shall be provided with a factory assembled filter section containing pre-filters made of cleanable metal viscous filters made of corrugated aluminum wire mesh, or dry cleanable synthetic filters. These shall be minimum 50 mm thick with a frame work of aluminum/GI.
ii) The filter area shall be made up of panels of size convenient for handling. The filter panels shall be held snugly within suitable aluminum framework made out of minimum 1.6 mm GI/ aluminum sheet with sponge neoprene gaskets by sliding the panels between the sliding channels so as to avoid air leakage.
iii) In order to indicate the condition of these filters while in operation, a manometer shall be provided to indicate the pressure drop across the fine filters and absolute filters.
iv) Special filters, if any specified in the tender specifications shall be provided in addition to the above filters. In that event, the latter shall function as pre-filters.
v) Each filter shall carry test certificate from manufacturer.

12.5.2.4. Instruments and Valves

The following instruments shall be provided at the specified locations in the AHUs for the chilled water/ hot water system:
i) Pressure gauges at the inlet and outlet of the coil with tubing and gauge cock
ii) Stem type thermometers at the inlet &outlet of coil with tubing & gauge cock
iii) Butterfly valve at the inlet and outlet of coil
iv) Balancing valve at the outlet of coil

v) Y-strainer at the inlet of coil
vi) Motorized 2-way diverting/ mixing valve along with proportionate thermostat

12.5.2.5. Mixing Box

The mixing box section shall be equipped with opposed action dampers of various sizes for the fresh air, return air and exhaust air, that can be linked together or operate independently.
The damper system permits the use of 100% fresh air with 100% exhaust air or, any other percentage combination of fresh / exhaust air.
Mixing boxes shall be fabricated from 18 gauge galvanized steel.

12.5.2.6. Installation

The air handling unit shall be so installed as to transmit minimum amount of vibration to the building structure. Adequate vibration isolation shall be provided by use of rubber/ neoprene pads and/or vibration isolation spring mountings.

**12.5.2.7. UV Emitters for AHUs**

**a. General :**

**i. The UV Emitters shall be suitable to operate on an electric supply of 230V+/-10V, single phase A.C. supply.**
**ii. The entire UV Emitters shall be a self contained unit, with all components factory assembled and tested in a neat compact package.**
**iii. The UV Emitters shall be suitable for installation in an AHU without any modification to the AHU.**
**iv. The UV Emitters shall be installed downstream of the cooling coil.**
**v. The selection and placement of the UV Emitters hall ensure full irradiation of the entire face area of the cooling coil.**

**b. UV Lamps : UV lamps shall meet following criteria:**

**i. Lamp shall be high output (HO) type, 800 mAmps each.**
**ii. Material of construction shall be special high transmission quartz glass.**
**iii. It shall be single ended, 4 pin type.**
**iv. Special interior coating shall be provided to ensure high UV output over rated life.**
**v. Life shall be 9,000 hrs with full efficiency.**
**vi. The lamp tube shall be 15 mm dia.**
**vii. The lamp shall produce UVC @ 254 nm. It should not produce Ozone or any other secondary contamination.**
**viii. The UV intensity shall be 800µW/cm² at 10 inches from the lamp.**
**ix. UV lamp tubes shall be suitable for the coil size. Preferred lengths are 441,609,847, 1194 and 1550 mm.**

**12.1.1. Fan Coil Units**

12.1.1.1. General

The fan coil units shall be floor/ wall/ ceiling mounted draw through type complete with finned coil, fan with motor, insulated drain pan, cleanable air filters and fan speed regulator and other controls as described.

A. Casing

The casing shall be fabricated out of minimum 1.25mm thick GSS.

B. Cooling Coil

The coil shall be of seamless copper tubes with aluminum fins. The fins shall be uniformly bonded to the tubes by mechanical expansion of the tubes. The coil circuit should be sized for adequate water velocity but not exceeding 1.8 m/s. The air velocity across the coil shall not exceed 155 m/min.

C. Fan

This shall consist of two lightweight aluminum impellers of forward curved type, both statically and dynamically balanced, along with properly designed GI sheet casings. The two impellers shall be directly mounted on to a double shaft, single phase multiple winding motor capable of running-at three speeds.

D. Drain Pan

Drain pan shall be fabricated out of minimum 1.00 mm thick stainless steel sheet covering the whole of coil section and extended on one side for accommodating coil connection valve etc. and complete with a 25mm drain connection. The drain pan shall be insulated with 10mm thick closed cell polyethylene foam insulation and jacketed from outside with single piece moulded Fiberglass Reinforced Polyester (FRP) tray.

E. Air Filter

The filter shall be cleanable type 15 mm thick with 90% efficiency down to 10 micron of dry cleanable synthetic type to be mounted behind the return air grill In the Unit casing.

F. Speed Control

A sturdy switch shall be provided with the unit complete with wiring, for ON/OFF operation and with minimum three speed control of the fan.

G. Automatic Controls

Each unit shall have a room type thermostat and a solenoid valve. The valve shall be fixed at a convenient location. The thermostat shall be mounted along with the speed control switch on a common plate. The plate shall clearly indicate the fan positions. The water valves on inlet line shall be of gun metal ball type with internal water strainers, having Stainless Steel Pipe (SSP) female pipe thread inlet and flare type male pipe thread outlet connection. The valves on return line shall be as above, but without the water strainer.

H. Water Connections

The water lines shall be finally connected to the coil of the fan coil unit, by at least 300mm long, Type'L' seamless solid drawn copper tubing, with flare fittings and connections.

I. Painting

All equipment shall be supplied as per manufacturer's standard finish painting.

### 12.1.2. Air-Cooled Variable Refrigerant Flow System

12.1.2.1. Scope

The scope of this section comprises the supply, erection testing and commissioning of inverter based Variable Refrigerant Volume System with Scroll Compressor conforming to these specifications and in accordance with the requirements of Drawing and Schedule of Quantities. The VRV shall be strictly verified and co-relate with schedules.

12.1.2.2. Type

Units shall be air cooled, variable refrigerant volume air conditioner of R410A gas based consisting of outdoor unit and multiple indoor units. Each indoor units having capability to cool or heat independently for the requirement of the rooms.

It shall be possible to connect several indoor units on one refrigerant circuit. The indoor units on any circuit can be of different type and also controlled individually. Following type of indoor units shall be connected to the system:

a) Cassette unit
b) Ductable type
c) Wall hung

Both indoor units and outdoor unit shall be factory assembled, tested and filled with first charge of refrigerant before delivering at site.

12.1.2.3. Outdoor Unit

The outdoor unit shall be factory assembled, weather proof casing, constructed from heavy gauge mild steel panels and coated with baked enamel finish. The unit should be completely factory wired tested with all necessary controls and switch gears:
The outdoor unit shall be modular in design and should be allowed for side by side installation. The outdoor unit shall be provided with welded steel support with two coats of paint for erection purpose.

- All outdoor units above 8 HP shall have minimum two scroll compressors and be able to operate even in case one of compressor is out of order.
- In case of outdoor units above 14HP, the outdoor unit shall have at least 2 inverter compressors and inverter motor of brushless DC Type so that the operation is not disrupted with failure of any compressor.
- It should also be provided with duty cycling for switching starting sequence of multiple outdoor units.
- The noise level shall not be more than 68 dB (A) at anechoic chamber conversion value, measured horizontally 1m away and 1.5m above ground level.
- The outdoor unit shall be modular in design and should be allowed for side by side installation
- The unit shall be provided with its own microprocessor control panel.

The outdoor unit should be fitted with low noise, aero spiral design fan with large airflow and should be designed to operate compressor-linking technology. The unit should also be capable to deliver 78 Pa external static pressure to meet long exhaust duct connection requirement wherever applicable and per drawings and schedules.
The condensing unit shall be designed to operate safely when connected to multiple fan coil units, which have a combined operating nominal capacity up to 160 % of indoor units for outdoor units up to 40 HP.

12.1.2.4. Compressor

The compressor shall be highly efficient scroll type and capable of inverter control. It shall change the speed in accordance to the variation in cooling or heating load requirement:
The inverter shall be IGBT type for efficient and quiet operation.
All outdoor units shall have at least 10 to 30 steps of capacity control to meet load fluctuation and indoor unit individual control. All parts of compressor shall be sufficiently lubricated stock. Forced lubrication may also be employed. Oil heater shall be provided in the compressor casing. C.O.P for the units shall not be less than 4.5.

12.1.2.5. Heat Exchanger

The heat exchanger shall be constructed with copper tubes mechanically bonded to aluminum fins to form a cross fin coal.

The aluminum fins shall be covered by anti-corrosion resin film.
The unit shall be provided with necessary number of direct driven low noise level propeller type fans arranged for vertical discharge. Each fan shall have a safety guard.

12.1.2.6. Refrigerant Circuit

The refrigerant circuit shall include liquid & gas shut-off valves and a solenoid valves at condenser end.
All necessary safety devices shall be provided to ensure the safely operation of the system.

12.1.2.7. Safety Devices

All necessary safety devices shall be provided to ensure safe operation of the system.
Following safety devices shall be part of outdoor unit; high pressure switch, fuse, crankcase heater, fusible plug, over load relay, protection for inverter, and short recycling guard timer.

12.1.2.8. Oil Recovery System

Unit shall be equipped with an oil recovery system to ensure stable operation with long refrigeration piping lengths.

12.1.2.9. Indoor Unit

This section deals with supply, installation, testing, commissioning of various type of indoor units confirming to general specification and suitable for the duty selected. The type, capacity and size of indoor units shall be as specified in detailed Bill of Quantities

A. Indoor units shall be wall mounted type or ceiling mounted ductable type as specified in BOQ. These units shall have electronic control valve to control refrigerant flow rate respond to lead variations of the room.

a) The address of the indoor unit shall be set automatically in case of individual and group control

b) There shall be localized control only.

B. The fan shall be dual suction, aerodynamically designed turbo, multi blade type, statically & dynamically balanced to ensure low noise and vibration free operation of the system. The fan shall be direct driven type, mounted directly on motor shaft having supported from housing.

C. The cooling coil shall be made out of seamless copper tubes and have continuous aluminum fins. The fins shall be spaced by collars forming an integral part. The tubes shall be staggered in the direction of airflow. The tubes shall be hydraulically/ mechanically expanded for minimum thermal contact resistance with fins. Each coil shall be factory tested at 21kg/sqm. air pressure under water.

D. Unit shall have cleanable type filter fixed to an integrally moulded plastic frame. The filter shall be slide away type and neatly inserted.

E. Each indoor unit shall have computerized PID control for maintaining design room temperature. Each unit shall be provided with microprocessor thermostat for cooling and heating.

F. The outdoor unit shall be pre-charged with first charge of R 410A refrigerant. Additional charge shall be added as per refrigerant piping at site. All the units shall be suitable for operation with 380 - 415 V 50 Hz + 3%, 3 Phase supply for outdoor units & 220 – 240 V, 50 Hz + 3%, 1 Phase supply for indoor units.

G. The units shall be integrated with Fire Alarm system and in case of fire all units shall be switched off.

H. The Al fins of Condenser Coils shall be provided with suitable factory installed protective for corrosion prevention.

I. The outdoor units must be suitable for up to 150m (straight length) refrigerant piping between outdoor unit & the farthest indoor units, total piping of 500m for all the indoor units. Allowable level difference between outdoor unit & indoor units shall be 50m in case of outdoor unit on top & 40 m in case of outdoor unit at bottom. Allowable level difference between various indoor units connected to one out door unit shall be up to 15m.

J. The outdoor unit shall employ system of equal run time for all the compressors, inverter or on/ off type, within each outdoor unit – Single Module or Multi Module.

K. The outdoor units shall be suitable to operate within an ambient temperature range of – 5 Deg C to 43 Deg C, in cooling mode & -20 Deg C to 15 Deg C in heating mode.

L. Air cooled condenser shall have Axial Flow, upward throw fan, directly coupled to fan motors with minimum IP 55 protection. The outdoor unit condenser fan shall be able to develop external static pressure up to 6 mm of H2O.

M. The entire operation of outdoor units shall be through independent remotes of indoor units. No separate Start/ Stop function shall be required.

N. Starter for the Outdoor Unit compressor shall “Direct on Line” type. Inverter compressor of the unit shall start first & at the minimum frequency, to reduce the inrush current during starting.

O. Refrigerant control in the outdoor unit shall be through Electronic Expansion Valve. Complete refrigerant circuit, oil balancing/ equalizing circuit shall be factory assembled & tested
.

P. Outdoor units shall be complete with following safety devices:

a) High pressure switch
b) Fan driver overload protector
c) Over current relay
d) Inverter Overload Protector
e) Fusible Plug

Q. Cassette Unit

a) The Cassette units shall be Ceiling-mounted type. The unit includes pre filter, fan section & DX coil section. The housing of unit shall be light weight powder coated galvanized steel.
b) The unit must have in built drain pump, suitable for vertical lift of 750 mm.
c) Unit must be insulated with sound absorbing thermal insulation material, Polyurethane foam. The noise level of unit at the highest operating level shall not exceed 42 dB(A), at a vertical distance of 1.5 m from the grille of the unit.
d) Unit shall have provision of connecting fresh air without any special chamber & without increasing the total height of the unit.
e) The unit shall be supplied with Resin Net filter with Mold Resistance. The filter shall be easy to remove, clean & re install.
f) The unit will be connected in series to a suitable outdoor unit & it must be possible to operate the unit independently, through corded/ cordless remote specified in the “Bill of quantities”. The unit will be further connected to Intelligent Building Management System (To be supplied by other vendors) & it shall be possible to operate the unit through this IBMS system

R. Ceiling Mounted Ductable Type Unit

a) Unit shall be suitable for ceiling mounted type. The unit shall include pre filter, fan section & DX coil section .The housing of unit shall be light weight powder coated galvanized steel. The unit shall have high static fan for Ductable arrangement.
b) These units shall be ceiling suspended with suitable supports to take care of operating weight of the unit, without causing any excessive vibration & noise. The cold air supplied by

these units will be supplied to the area to be air conditioned, through duct system specified in the tender.

c) Each indoor unit must have electronic expansion valve operated by microprocessor thermostat based temperature control to deliver cooling/ heating as per the heat load of the room.
d) Unit must be insulated with sound absorbing thermal insulation material, Glass Fibre or equivalent. The noise level of unit at the highest operating level shall not exceed 49 dB(A), at a vertical distance of 1.5 m below the units with duct connected to the unit.
e) Unit must have Thermal Fuse for fan motor protection, in case of motor heating. The unit will be connected in series to a suitable outdoor unit & it must be possible to operate the unit independently, through corded/ cordless remote specified in the bill of quantities. The unit will be further connected to Intelligent Building Management System (To be supplied by other vendors) & it shall be possible to operate the unit through this IBMS system.

### 12.1.3. DX Type Air Cooled Split Units

The units shall be wall-mounted type. The units include pre-filter, fan section and Direct Expansion (DX) coil section. The housing of units shall be light weight powder coated galvanized steel. Units shall have an attractive external casing for supply and return air. The air cooled DX units shall match with the capacities given in schedules and drawings. The approval shall be taken before order placement from Engineer in charge.

12.1.3.1. Installation:

The indoor units shall be mounted on ribbed rubber pads for vibration isolation. The contractor shall supply the required charge of refrigerant, lubricant and other consumables, for commissioning and testing of the equipment.

All the equipment shall be thoroughly tested and checked for leaks. All safety controls shall be suitably set and a record of all setting shall be furnished to the project supervisor.

Providing and fixing M.S. structural support for condensing unit with vibration isolator pad in-between support and structure and vibration isolation suspender and pads for evaporating units.

12.1.3.2. Dimensions:

Dimensions given in figures shall be taken in preference to scaled dimensions in all cases. Before commencing any work the sub-contractor shall get clarifications wherever necessary from engineer-in-charge.

12.1.3.3. Painting:

Shop coats of paint that have become marred during transportation or erection shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with enamel paint to match the finish over the adjoining shop- painted surfaces.

12.1.3.4. Condensate Drain Piping:

All pipes to be used for condensate drain shall be Insulated medium class GI pipe & all joints should be Gluing or solvent cementing as per manufacturer recommendation.

12.1.3.5. Refrigerant Piping:

i) All refrigerant pipes and fittings shall be type 'L' hard drawn copper tubes and wrought copper fitting suitable for connection with silver solder.
ii) All joints in copper piping shall be swaged joints using low temperature brazing and/or silver solder. Before jointing any copper pipe or fittings, its interior shall be thoroughly cleaned be passing a clean cloth via wire or cable through its entire length. The piping shall be continuously kept clean of dirt etc. while construction of the joints. Subsequently, it shall be thoroughly blown out using nitrogen.
iii) Refrigerant lines shall be sized to limit pressure drop between evaporator and condensing unit to less than 0.2 kg per Sq.cm.

iv) After the refrigerant piping installation has been completed the refrigerant piping system shall be pressure tested using, Freon mixed with nitrogen at a pressure of 20 Kg per Sq. cm. (High side) and 10 Kg per Sq. cm (Low side) pressure shall be maintained on the system for a minimum of 12 hours. The system shall then be evacuated to a minimum vacuum of 70 cm. of mercury and held for 24 hours, during which time change in vacuum shall not exceed 12 cm of mercury. Vacuum shall be checked with vacuum gauge. Vacuum to be achieved using a vacuum pump. Use of compressor for vacuuming is not permitted.All refrigerant piping shall be installed strictly as per the instructions and recommendations of air conditioning equipment manufacturers.

i) The copper thickness of pipe shall be 20G/22G(0.7 to 1 mm)

ii) Sleeves shall be provided around refrigerant pipes crossing the wall and wooden partition.

iii) Refrigerant pipes should be supported on grooved wooden (teak wood only) strips suitable to accommodate insulated refrigerant pipes. The piping should be clamped to these wooden strips using a 'C' clamps. The distance between two supports should not be more than 5 ft.

iv) Wherever the pipes are running on the floor or exposed to view they should be covered from both side with 18 G GI tray. The tray should be supported at every 8 ft. distance using clamp supports which are painted as approved by Consultant.

v) Refrigerant piping design for VRV system shall be submitted by the vendor for final approval.

vi) Insulation should be Armaflex / K-flex or equivalent make and of closed cell tubing type of specifications give in Duct insulation section.

vii) Clean the outer surface of refrigerant copper piping. Insert the pipes in tubular Armaflex/eq. Join two ends of tubular Armaflex /eq. insulation using suitable adhesive. Tape the joints with masking tapes of the same material. All outdoor piping to be protected with (For ref. Piping,) Woven Fiberglass cloth, 7 mil thickness and 200 gsm weight, with factory laminated, self-adhesive backing should be used. This needs to be finished with 2 coats of UV painting.

12.1.3.6. Power Supply:

Power supply near the indoor unit will be provided from the Main LT panel using Distribution Boards (DBs) by lead contractor with suitable MCBs.

Power supply from MCB to indoor unit and from outdoor unit to Indoor unit to be provided by the sub-contractor along with earthing.

### 12.1.4. Heat Recovery Units

**a. Scope**

The scope of this section comprises of the supply of double-skin "Heat recovery Units conforming to the following specifications.

**b. Type**

The Heat recovery units shall be two stream units in double skin construction thermal break, comprising of supply air section, return air section and Heat Recovery Section. The supply air section shall include Inspection Section.

**c. Capacity**

The Heat recovery units shall be of such capacities and static pressures as mentioned in the Bill of Quantities and schedules.

**d. Casing**

- The housing/ casing of the heat recovery unit shall be of double skin construction. The housing shall be so made that it can be delivered at site in total semi knocked down conditions depending upon the requirements. The main framework shall be of suitable structural sections. The entire framework shall be assembled using mechanical joints to make a sturdy and strong framework for various sections. Framework of all heat recovery units shall be made of thermal break hollow extruded aluminum profile. In case of HRU casing design with no contact between inner and outer surface, thermal break profiles can be avoided.

- Double skin panels shall be minimum 25mm thick made of 0.8mm (Both inner and outer Sheets) with polyurethane foam insulation of density not less than 38 kg/cum injected in between by injection moulding machine. These panels shall be joined and connected to the framework/ supports with soft rubber gasket in between (if necessary) to make the joints airtight and low air leakage potential. The gaskets shall be inserted within groove in extruded aluminum profile of the framework. For units installed outdoor, the thickness of double skin panels shall be minimum 40 mm.
- Frame work for each section shall also be joined together to make the joints air tight. Suitable doors with nylon handles and all access panels should be openable with allen key/ suitable locking arrangement. Aluminium die-cast powder coated/ Nylon hinges & latches shall be provided for access to various panels for maintenance. However, AHU in the form of complete single unit shall also be acceptable with access door(s) for maintenance to various sections. The entire housing shall be mounted on galvanized steel channel frame work made out of G.I. sheet of thickness not less than 2mm. For higher capacity AHUs hot dip galvanized steel channel framework made of minimum 3 mm thick G.S. sheet shall be used.

The Inspection and access panels shall be hinged type. The hinges shall be casted, powder coated Zinc alloy. Flushed Locks and Handles shall be of galvanized steel. Other panels will be screwed on to the frame with sealant and soft rubber gasket thus making the joints air tight. All screws used for panel fixing shall be covered with PVC caps.

Special gaskets and seals shall be used on inspection doors and to create separation between the airstreams to ensure negligible air leakage and mixing.

**e. Supply Air Section**

The supply air section shall comprise of the following:-

Fan Section

The fan shall be centrifugal forward curved or backward curved, double inlet double width type. The impeller and the fan casing shall be made of hot galvanized sheet steel. The impeller shall be mounted on a solid shaft supported to housing with angle iron frame and pillow block heavy duty ball bearing. The impeller shall be statically and dynamically balanced. The fan shall be selected such that unit noise level is less than 85 db. Fan housing and motor shall be mounted on a common galvanized steel or aluminium block base which can be drawn out from side for ease of maintenance. A quarter pin lock arrangement between the slide and guide pin lock arrangement between Fan and Unit outlet should be provided.

Motor And Drive

Fan motor shall be energy efficient with efficiency level of IE-3 or EFF1 whichever is more efficient and suitable for 415□10% volts, 50 cycles, 3 phase squirrel cage, totally enclosed fan cooled with IP – 55 protection. Motor shall be designed for quiet operation. Drive shall be provided through belt – drive arrangement. Belts will be of oil resistant type.

Filter Section (Pre Filter (in supply only))

The air used in an air-conditioning system must be filtered to maintain a clean atmosphere in the conditioned space. The concentration of contaminants in the air and the degree of cleanliness required in the conditioned space will determine the type of filter or filters that must be used.

Type Of Filters

Pre-filters: Cleanable metallic viscous type filter made out of aluminum wire mesh or of dry cleanable synthetic type minimum 50mm thick, shall be provided on the suction side of AHU as standard equipment with the unit. These filters shall have the efficiency of 90% down to 10 micron particle size. When these filters become loaded or full of dirt, it is removed from service and replaced by another filter. The dirty filter can then be washed in a cleaning solution in a tank, dried and then given a bath of viscous oil. Face velocity across these filters shall not exceed 155 MPM.

Damper Section
Damper section shall contain a built in damper of aluminium profile with leakage class III. The damper blades shall be connected with plastic gear wheels with a gasket of silicon rubber to produce tightness between the blades.

Drain Pan
Drain pan shall be made out of minimum 1.25 mm stainless steel sheet externally insulated (If Drain pan is outside the unit), with 10mm thick closed cell Polyethylene foam/ equivalent suitable insulation with necessary dual slope to facilitate fast removal of condensate.

Inspection Section
The Inspection section shall be for inspection of other functional sections. It shall be available in two options; long and short version and shall be selected as defined in the Bill of Quantities.

**f. Return Air Section**

Fan Section
The fan shall be centrifugal forward curved or backward curved, double inlet double width type. The impeller and the fan casing shall be made of hot galvanized sheet steel. The impeller shall be mounted on a solid shaft supported to housing with angle iron frame and pillow block heavy duty ball bearing. The impeller shall be statically and dynamically balanced. The fan shall be selected such that unit noise level is less than 85 db. Fan housing and motor shall be mounted on a common galvanized steel or aluminium block base which can be drawn out from side for ease of maintenance. A quarter pin lock arrangement between the slide and guide pin lock arrangement between Fan and Unit outlet should be provided.

Motor and Drive
Fan motor shall be energy efficient with efficiency level of IE-3 or EFF1 whichever is more efficient and suitable for 415+10% volts, 50 cycles, 3 phase squirrel cage, totally enclosed fan cooled with IP – 55 protection. Motor shall be designed for quiet operation. Drive shall be provided through belt – drive arrangement. Belts will be of oil resistant type. The drive and motor shall be provided outside the air path.

The tank shall be of stainless steel sheet of thickness not less than 1.6mm, having necessary arrangement for inlet water with float valve over flow and drain arrangement.

**g. Heat Recovery Section**

The Heat Recovery section shall include enthalpy wheels and shall have minimum recovery of 75 % of total heat, i.e both sensible and latent (each being 75 %). The recovery of sensible and latent shall be equal. Necessary computerized selection of the wheel should be provided along with the bid to justify the same. The wheel shall be made of pure aluminium foil coated with molecular sieve desiccant with pore diameter of 3oA.The cross contamination between the two air streams shall be nil and leakage less than 0.04%. The vertical and radial run of the wheel shall be less than 1 mm per meter of diameter. The wheels shall have non-contact labyrinth seals for effective sealing between the two air streams.

Detailed specification for the wheel shall be as per 8.0 i.e. “HEAT RECOVERY WHEEL”

**h. Heat Recovery Wheel Specifications:**

The substrate: The substrate or wheel matrix should be only of pure aluminum foil so as to allow.

a) quick and efficient uptake of thermal energy.

b) sufficient mass for optimum heat transfer

c) maximum sensible heat recovery at a relatively low rotational speed of 20 to 25 rpm.

Non metallic substrates made from paper, plastic, synthetic or glass fibre media, will therefore, not be acceptable.

The substrate shall not be made from any material which is combustible or supports combustion like synthetic fibrous media.

The wheel has to be certified as per DIN EN ISO 846 with 0% fungal and bacterial growth at 95% Relative humidity and above.

The wheel should be AHRI & UL certified

The minimum depth of the Wheel shall be 250 mm.

Pressure drop:

The presure drop across the rotary heat exchanger shall not exceed 0.1 inch for every 100 FPM face velocity, or part thereof, for the minimum stated/ required latent recoveries / efficiencies

NECESSARY SOFTWARE SELECTION OF THE WHEEL HAS TO BE ENCLOSED TO JUSTIFY THE PRESSURE DROP AND EFFICIENCY CALCULATIONS.

**The Desiccant**:

The desiccant should be water molecule selective and non-migratory.
The desiccant should be molecular sieve 3Å (Ecosorb 300), so as to keep the cross contamination to absolute minimum and also ensure the exclusion of contaminants from the air streams, while transferring the water vapour molecules.

The desiccant, of sufficient mass which should not be less than 5 kg per 1000 cfm of air, should be coated with non-masking porous binder adhesive on the aluminum substrate so as to allow quick and easy uptake and release of water vapour. A confirmation has to be provided by manufacturer of wheel to this effect. A matrix with desiccants impregnated in non-metallic substrates, such as synthetic fibre, glass fibre, etc. will not be accepted.

Rotor:

With optimum heat and mass through matrix formed by desiccant, of sufficient mass, the rotor should rotate at lower than 20 to 25 RPM, thereby also ensuring long life of belts and reduced wear and tear of seals.

The rotor honeycomb matrix foil should be so wound and adhered as to make a structurally very strong and rigid media which shall not get cracked, deformed etc. due to change of temperature or humidity.

The rotor having a diameter upto 2800 mm shall have spokes to reinforce the matrix. From 2000 mm diameter upwards, the option of a special wing structure, to prevent the rotors from wobbling or deforming due to the successive pressure differentials, will be available.

Sectioned wheels, with pie segments, capable of being assembled in the field, shall be available as an option, above 2000 mm in diameter.
The surface of the wheel/rotor should be highly polished to ensure that the vertical run out does not exceed + 1 mm for every 1 meter diameter, thereby ensuring, negligible leakage, if labyrinth non-contact seals are provided, and minimal drag, if contact wiper seals are provided.

The radial run out also shall not exceed + 1 mm for every 1 meter diameter, thereby minimizing the leakage/drag on the radial seals, and minimizes the fluctuation in the tension of the drive belt.

The number of wraps for every inch of rotor radii shall be very consistent so as to ensure uniform air flow and performance over the entire face in the air stream. Flute height and pitch will be consistent to a very tight tolerance to ensure uniform pressure drop and uniform airflows across the rotor face.

The media shall be cleanable with compressed air, or low pressure steam or light detergent, without degrading the latent recovery.

The Cassette / casing

The recovery wheel cassette/casing shall be manufactured from corrosion resistant tubular / sheet metal structure to provide a self-supporting rigid structure, complete with access panels, purge sector, rotor, bearings, seals, drive mechanism complete with belt.

The rotor/wheel should have a field adjustable purge mechanism to provide definite separation of airflow minimizing the carryover of bacteria, dust and other pollutants, from the exhaust air to the supply air. It shall be possible, with proper adjustment, to limit cross contamination to less than 0.04% of that of the exhaust air concentration.

The face and radial seals shall be four (4) pass non-contact labyrinth seals / brush seals for effective sealing between the two air streams, and also for a minimum wear and tear ensuring long life of the seals.

Bearings: the bearing shall be permanent lubricated corrosion resistant Stainless steel or self-lubricating engineering plastics.

Drive Mechanism: The unit shall be provided with complete drive mechanism having drive motor, drive belt and auto belt tension.

## 12.6. CIRCULATING WATER PUMPS

### 12.6.1. Scope

This chapter covers the general requirements of water circulating pumps for central air-conditioning. This includes Primary pumps, secondary pumps, condenser, tertiary pumps etc. This section does not cover either humidification pumps or spray pumps for spray over coils.
This covers End Suction, vertical in-line

### 12.6.2. Type

The pumps shall be centrifugal type direct driven with a 3 phase, 415 ± 10% volts, 50 Hz, A.C motor. The pumps shall be of End suction top discharge type vertical split casing type with operating speed not exceeding 1500 rpm.

The pump and base frame shall be factory assembled at the pump manufacturer's facility. Installation instructions shall be included with pump at time of shipment. The pump manufacturer shall have complete unit responsibility.

The pump minimum efficiency shall be 75%.

### 12.6.3. Rating

The pumps shall be suitable for continuous operation in the system. The head and discharge requirements shall be as specified in the tender documents. The discharge rating shall not be less than the flow rate requirement of the respective equipment through which the water is pumped. The head shall be suitable for the system and shall take into consideration the pressure drops across the various equipment and components in the water circuit as well as the frictional losses. The pumps offered shall be of high efficiency and meet ASHRAE 90.1 minimum efficiency requirements.

### 12.6.4. Material And Construction

i) The centrifugal pumps shall conform to relevant manufacturer standard. The motor shall be totally enclosed fan cooled type. **The motor shall have efficiency class IE-3 or EFF-1, whichever is more efficient.**
ii) The pump casing shall be of heavy section close grained cast iron. The casing shall be provided with air release cock, drain plug and shaft seal arrangement as well as flanges for suction and delivery pipe connections as required. The casing shall be capable of withstanding 1.5 times the design pressure.
iii) Pump casing shall be EN-GJL-250 Grey Cast Iron according to BS EN 1561: 1997
iv) Flange dimensions are in accordance with EN 1092-2.
v) The impeller shall be of bronze or gunmetal. This shall be shrouded type with machined collars. Wear rings, where fitted to the impeller, shall be of the same material as the impeller. The impeller surface shall be smooth finished for minimum frictional loss. Rile impeller shall be secured to the shaft by a key. All impellers are dynamically balanced to ISO 1940-1: Grade G6.3. The thrust balancing can be of balancing holes or back vanes. The direction of rotation of the impeller is clockwise when viewed from the motor.
vi) The shaft shall be of stainless steel and shall be accurately machined. The shaft shall be balanced to avoid vibrations at any speed within the operating range of the pump.
vii) Shaft shall be designed in such a way that first critical speed will be at least 25% away from the maximum rotating speed.
viii) Shaft run-out shall be limited at the seal face and at the impeller to 0.05 mm.
ix) Shaft shall be provided with Mechanical seal as default fitment to provide the leak free operation.
x) The shaft sleeve shall be of bronze or gunmetal. This shall extend over the full length of the stuffing box or seal housing. The sleeve shall be machined all over and ground on the outside.
xi) The bearings shall be ball or roller type suitable for the duty involved. These shall be grease lubricated and shall be provided with grease nipples/cups. The bearings shall be effectively sealed against leakage of lubricant.
xii) The shaft seal shall be stuffing box type unless otherwise specified, so as to allow minimum leakage compatible with the operation of the seal. The stuffing box shall be of adequate length

and shall be packed with graphite asbestos or any other suitable material for the operating temperature. A drip well shall be provided beneath the seal.

xiii) In the case of HSC (Horizontal Split Case) pumps, the same shall be directly coupled to the motor shaft through a flexible coupling protected by a coupling guard.

xiv) In case of mono block pumps with solid casing, the motor and pumps shall be on a common shaft.

xv) The pump and motor shall be mounted on a common base plate either of cast iron or fabricated from rolled steel section. The base plate shall have rigid, flat and true surfaces to receive the pump and motor mounting feet.

**12.6.5. Accessories**

Each pump shall be provided with the following accessories:-

i) Pressure gauges at suction and discharge sides,
ii) Butterfly valves on suction and discharge, and
iii) Reducers, as may be required to match the sizes of the connected pipe work.
iv) Non-return valve at the discharge.

**12.6.6. Name Plates**

Each pump shall be provided with a name plate indicating the following details:

i. Pump type designation
ii. Pump Model
iii. Rated flow
iv. Rated head
v. Pressure rating/max temperature
vi. Rated speed

**12.6.7. Working Pressure**

Maximum allowable working pressure (MAWP) for all the pressure containing parts shall in no case be less than the maximum discharge pressure produced by the pump at shut off (including tolerances), at the max suction pressure, for the maximum impeller diameter and the maximum continuous speed.

It shall not be less than 10 kg/cm² for pumps with DN150 flanges & 16 kg/cm² for pumps with DN32 to DN250 flanges.

Pump shall be rated for minimum of 10 bar working pressure.

**12.6.8. Sound Level**

Sound pressure level of the pump driver shall **not exceed max 75 dbA* measure at 2.0 m** distance from pumps for the duty points.
(* Note: Based on the motor kW and speed according to ISO 3743)

**12.6.9. Insulation**

The thermal insulation of the pump casing for hot/chilled water circulating pumps shall be of the same type and thickness as provided for the connected pipe work and is discussed in Part XIV.

**12.6.10. Installation**

i) The pump and motor assembly shall be mounted and arranged for ease of maintenance and to prevent transmission of vibration and noise to the building structure or excess vibration to the pipe work.
ii) More than one pump and motor assembly shall not be installed on a single base or cement concrete block. The mass of the inertia block shall not be less than the combined mass of the pump and motor assembly. The inertia block shall be vibration isolated from the plant room floor by 25 mm. neoprene or any other equivalent vibration isolation fittings. Where spring mountings are used for vibration isolation, these shall be complete with leveling screws and lock nuts and shall be placed over a concrete plinth for distribution of the mass of the assembly over the plant room floor. The pump motor sets shall be properly aligned to the satisfaction of the Engineer-in-charge.

### 12.6.11. Painting

The equipment shall be thoroughly cleaned and greased. All rust sharp edges and scales shall be removed. All external and exposed cast iron parts of pumps have an epoxy-based coating made in a cathodic electro-deposition (CED) process which is high-quality dip-painting process and which would prevent rusting and corrosion. The colour code for the finished product shall be per standards.

The pump shaft shall not be painted.

### 12.6.12. Pump & Motor Selection:

I. The pump(s) selected shall conform to EN 733 standards for Preferred Operating Region (POR) unless otherwise approved by the engineer.
II. The pumps shall be factory manufactured, assembled and hydrostatically tested as per Hydraulic Institute standards in an ISO 9001 approved facility.
III. Motor should be of variable frequency drive compatible.
IV. Motor should be selected as non-over-loading type.
V.

### 12.6.13. Inspection & Testing:

Before effecting delivery of the equipment, following inspections and tests as per relevant IS standards shall be carried out.

For Pumps:

I. Hydrostatic Testing
II. Performance Test (Single point / Duty point)
III. Dynamic balancing for pump impeller.

### 12.6.14. Tender Drawings:

The following drawings shall be submitted by the Contractor / Vendor along with their Bids.

I. Preliminary outline dimensional drawing of pump and motor (Suction and discharge connections and foundation details shall also be indicated).
II. Performance curves (capacity Vs total head, efficiency, NPSH and KW requirement) ranging from zero to maximum capacity.
III. Technical Data sheet for Pumps

## 12.7. DUAL FLUID PRECISION AIR CONDITIONING

### 12.7.1. General

The air-conditioner shall be dual fluid type, floor discharge with Scroll compressor, Plug type fan with EC Motor, air-cooled condenser, evaporator, microprocessor controller, fine filters Heaters, Humidifiers. The working refrigerant shall be eco-friendly R-410a/R-407. The unit shall be floor mounted and compressors shall be with Scroll type. The air-conditioner shall be installed within conditioned space while the condenser(s) are placed on terrace level or floor balcony. The equipment shall be designed / suitable for 24/7 operation in all respects.

Below is the brief scope:

- Evaporator unit with mounting brackets/supports
- Air-cooled condensing unit with outdoor support structure. The outdoor support structure shall be painted with 2 coats of epoxy primer and 2 coats of epoxy paint.
- Microprocessor based controls
- Electrical Heater and steam humidifier.
- Single phase preventer
- Isolation Valve, Control valve, B/F valve, Strainer, drain valve etc. with Insulation
- Drain Piping for evaporator unit.
- 1 W + 1 S condensate drain pump
- Sequencing panel for auto operation and change over between working and stanby units. The panel shall have necessary software and hardware for BMS connectivity.
- Necessary contacts for remote operation and monitoring and for shut down of unit based on fire alarm system input.
- Motorized zero leakage dampers

### 12.7.2. Codes And Standards

The design, materials, manufacture, inspection, testing and performance of packaged precision units shall comply with all currently applicable statues, regulations, codes and standards in the locality where the equipment is to be installed. Nothing in this specification shall be construed to relieve the Bidder of this responsibility.
]

### 12.7.3. General Requirements

Each unit shall be a complete assembly of all components viz. Heating, Humidifying arrangement, Electric motor driven fully-hermetic (scroll) compressor, evaporator coils, protective devices, microprocessor panel and local electrical panel, etc. mounted on the unit.

The Air cooled condensers of the units shall be complete with condenser coil assembly, fans, drive motor, etc., complete with interconnecting refrigerant piping, controls as per standards.

All rotating parts shall be statically and dynamically balanced.

In addition to the features specified, if the packaged units require any additional features for safe and efficient operation, the same shall be included in the scope of supply and shall be clearly indicated and described.

The entire unit shall be a fully factory assembled and tested prior to dispatch and test certificates shall be submitted.

Return air to the cooling unit shall be drawn directly from the room into the Precision Air conditioner in case of floor discharge or room discharge units.

Painted Tubular hallow section floor stands shall be provided under the units to support the weight of the unit independently

Service response time during the 24 months or more period as agreed defects liability period shall be **4 hours** at all times.

### 12.7.4. Specifications For Precision Packaged Units Cabinet

The frame and panels shall be constructed of heavy gauge corrosion resistant sheet steel and have modular construction with aluminum based railing and hinged doors.

The double skinned panels shall be 25 mm thick made of galvanized steel, pressure injected with suitable insulation (density 32Kg/m3). This shall be fixed to a minimum of 1.5 mm thick aluminium alloy twin box section structural framework with stainless steel screws. Outer sheet shall be of 0.63 mm thick and inner sheet of 24 gauge GI sheet.

The cabinet shall be powder coated and have a textured finish.

Indoor unit shall have hinged quick-opening insulated access door on fan and filter sections. Access doors shall be double skin type and shall be of same construction as the wall panels.

Indoor unit shall constitute inbuilt Electrical panel with necessary switch gear and electrical protection devices as per Air conditioner capacities in accordance with Electrical rules and standards. lifting lugs shall be bolted to each base section for lifting or placing of indoor unit in place.

### 12.7.5. Micro Processor Controller

Each Air-conditioner should have single microprocessor with following controls.

The controllers shall be microprocessor based, PID based Programmable.

All units shall be with network able controller and controller shall be with RS 485 communication port & necessary interface card with an out put of Modbus RTU Open Communication or Backnet as required for longer distances communication on BMS for Monitoring / operating.

The complete necessary Software & Hard ware to export the unit data on to BMS controller shall be part of Microprocessor

### 12.7.6. Alarms

The alarm should operate with audible signal for the following:

- Compressor 1 High/Low pressure
- Compressor 2 High/Low pressure
- Wet floor
- No air flow
- Filter clog
- Temperature High/Low
- Humidity High/Low
- Humidifier water level
- Compressor function
- Sensor failure
- Controller error
- The control should have an auto-restart feature which will return the unit to normal operation resumption of mains power.

### 12.7.7. Display

In normal operating mode the screen should display, temperature and relative humidity set points and actual, operating status.

The Micro processor shall constitute Menu driven user friendly cursor keys with pass word protection to scroll the data on indoor unit screen. Same time Micro processor shall be capable of exporting data to BMS controller

The controller shall have separate indication of operating modes (cooling, heating, humidifying and dehumidifying), alarm conditions with mute option (temperature high, compressor HP & LP, wet floor, no air flow and), Graphical display of set temperature and achieved temperature with 48 hrs graph status on temperature and humidity, Date, time Unit identification number display, Battery back up charge level status display, Maintenance schedules status and alarm display.

The display and indication shall be visible on the front without removing any external panels. Local and remote alarms will be triggered if an alarm condition is reached.

**12.7.8. Refrigerant Circuit**

The refrigeration system shall be of the dual fluid type and each unit must incorporate hermetic scroll compressors having independent evaporator coil circuit. Compressors shall be complete with isolating valves, crankcase heaters. The system shall include a manual reset HP control and an auto reset LP switch, filter drier and charging port. A thermostatic expansion valve, sight glass and filter drier shall be provided in each circuit as per standards.

The system shall include muffler, refrigerant controls such as thermostatic expansion valves, and system components such as liquid strainers, liquid moisture indicators, purge, relief and charging valves, liquid line sight glass, shut-off valves, suction and discharge valves for isolation of compressor.

**12.7.9. Evaporator Coil**

- Cooling coil shall be of slant arrangement to enhance the efficiency and to handle the designed / required air quantity.

- Precision unit shall comprise of direct expansion as well as chilled water cooling coil of copper tubes expanded into Aluminium fins, firmly bonded. Single coil with DX & CHW rows are mandatory instead of sandwich coils. Face and surface areas shall be such as to assure rated capacity & the air velocity across the coil shall not exceed 140 MPM. The cooling coil shall be multi rows deep and fin space shall not exceed 1.8 mm. The DX coil shall be 4 row deep coil and shall be suitable for achieving the desired inside space conditions.

- Coil selection to be suitable for SHF>0.95 and provided with hydrophilic coating to minimize/eliminate water carry over into the airflow stream.

- SS Drain pan shall be factory insulated with at least 9 mm thick closed cell elastomeric insulation, joints sealed with self-adhesive tape of same material. Fixing of coil section and drain pipe shall be done in such a way to avoid direct metal contact with any other un-insulated metal part in order to avoid condensation.

- Drain piping & refrigerant piping within the unit shall be insulated with at least 9mm thick closed cell elastomeric insulation in tubing form.

The computerized selection and test certificates for the cooling coil shall be submitted by the manufacturer.

**12.7.10. Compressor**

The compressor shall be of the high efficiency compliant scroll design with R410a refrigerant or equivalent

The compressor shall be capable of operating continuously at the design ambient conditions mentioned in the DDR and specs.

Suitable overload protection shall be provided with compressor.

Isolating valve shall be provided at suction and discharge.

### 12.7.11. Blowers

The unit shall be under-floor discharge type and shall be able to deliver 600 CFM/TON. The speed of the fan shall be automatically vary as per the inside conditions during the operation.

Fan motor shall be highly efficient, uses less energy, especially during starting and at partial loads. The fans can be of any number as per manufacturer standard.

The fans shall be statically and dynamically balanced, plug type with EC Motor. Fans shall be made of ultralight polymeric material for higher efficiency & reduced sound level. fan shall be driven by a high efficiency EC Motor.

### 12.7.12. Electrical Heating

The electric heating elements shall be in built and operate at a level not exceeding 60kw/sqm. The low watt density elements shall be of finned tubular nickel plated steel construction. Multi stage heating shall be provided to control the heaters ON/OFF in stages.

The heating circuit shall include all safety controls.

### 12.7.13. Humidification

Humidification shall be provided by boiling water in steam generator. The steam shall be evenly distributed into the supply air stream of the air conditioning unit. The humidifier shall be self-cleaning feature. Microprocessor of the unit shall be able to control the humidification and heating. Heating can be of multiple stages and shall include safety protection.

Steam humidifier of required capacity with 3 phase electrodes having function of auto drain and proportional control for 33%, 66% and 100% capacity complete with steam supply and water drain hose pipe shall be part of unit.

### 12.7.14. Filtration

Air filters shall be provided in the return air side before the cooling coil section. Each unit shall be provided with a factory assembled filter section containing washable synthetic type air filter having a dosed aluminum frame. Filter banks shall be easily accessible and designed for easy withdrawal and renewal of filter cells. Filter banks face velocities shall not exceed 500 FPM. The filter shall be suitable for high efficiency dust filtration.

Filter status switch for clogged filter indication shall be included.

Air filters shall be washable panel type complying with not less than EU4.

### 12.7.15. Air Cooled Condenser

The condenser shall be factory matched to provide a wide operating range of ambient. Condensers shall be suitable for 24 hours operation and be capable of providing vertical or horizontal discharge.

The condenser frame shall be constructed from heavy duty aluminum and incorporate a copper tube and aluminum fin coil.

The condenser fans shall be directly driven by electric motor and shall be low noise level type.

The air cooled condensing unit shall be complete with the following:

a. Condenser coil,
b. Condenser fan with motor,
c. Sheet casing with louvered bird screen etc. ,
d. Suitable base frame on/mounting bracket for outdoor installation,

e. Anti-vibration mounts.,
f. Electrical isolating switch.

Condenser Fan: Axial flow fan for condenser shall be adequately sized and shall be direct driven. The fans shall be selected for low noise level and shall operate at a speed not exceeding 920 rpm. Condenser fan motor shall have IP 55 protection (suitable for outdoor mounting) and all electrical components shall be housed in a water proof enclosure.

**12.7.16. Design Data**

Inside Room conditions : 21 Deg C ± 1 Deg C
Relative Humidity : 50+/5% RH

Noise Level : 50+/-5 dB A

Outside conditions, Summer : 43.3°C DBT

Chilled Water inlet /outlet Temperature: 7°C & 12°C

Operation : 24/7

**12.7.17. Data Sheet:**

| Sr. No | Item Data | Unit | offered by Tenderer |
|---|---|---|---|
| **1** | **Make** | | |
| 2 | Country Of Origin | | |
| **3** | Model | | |
| 4 | Indoor Unit Dimensions - WXDXH - mm | | |
| **5** | Outdoor Unit Dimensions WXDXH -mm | | |
| 6 | Operating weight | | |
| **7** | Total (including heater and humidifier) | | |
| 8 | Rating and Quantity | | |
| | **Constructional Details** | | |
| **9** | Material and thickness of casing | | |
| 10 | Inner casing in mm | | |
| **11** | Outer casing in mm | | |
| 12 | Material of insulation and Thickness | | |
| **13** | Material of cladding and Gauge | | |
| 14 | Drain Pan Material | | |
| | **Fan Details** | | |
| 15 | Type of fan | | |
| 16 | No. of Fans | | |
| 17 | Airflow - CFM/CMH | | |
| 18 | Total Static pressure | | |
| 19 | Operating speed | | |
| 20 | Type of Drive (Direct/belt) | | |
| 21 | IKW | | |
| 22 | Fan outlet velocity | | |
| 23 | Type of bearings whether statically and dynamically balanced? | | |
| 24 | Noise level at 1m from Unit | | |
| | **Cooling Coil Details** | | |
| 25 | Capacity of cooling coil - TR | | |

| | | | |
|---|---|---|---|
| 26 | Coil face area - sq.mt. | | |
| 27 | Total surface area - sq.mt. | | |
| 28 | Material of tube and fins | | |
| 29 | Diameter of tube - mm | | |
| 30 | No. of fins/cm | | |
| 31 | Type of fins | | |
| 32 | ADP - deg C | | |
| 33 | Entering air temperature DB & RH % | | |
| 34 | Leaving air temperature DB & RH % | | |
| 35 | WATER TEMPERATURE “IN” | | |
| 36 | WATER TEMPERATURE“OUT” | | |
| 37 | Working pressure | | |
| 38 | Water Capacity | | |
| 39 | Water flow rate | | |
| | **Compress Details** | | |
| 40 | Make of compressor | | |
| 41 | Type of compressor | | |
| 42 | No. of compressor/machine | | |
| 43 | Refrigerant | | |
| 44 | Capacity at operating conditions | | |
| 45 | IKW at above conditions (per compressor) | | |
| | **Condenser** | | |
| 46 | Airflow - CFM/CMH | | |
| 47 | Fan motor KW | | |
| 48 | No. of Fans/condenser | | |
| 49 | No. of rows of coil | | |
| 50 | Entering air temperature - deg C | | |
| 51 | Leaving air temperature - deg C | | |
| 52 | Operating voltage - volts | | |
| 53 | Noise level at 1m - dBA | | |
| 54 | No. of condensers per machine | | |
| | **Heater Details** | | |
| | **Heater Material and Type** | | |
| 55 | Heater KW and no of stages | | |
| 56 | Heater KW and No. Of stages | | |
| 57 | Humidifier type and capacity | | |
| 58 | Humidifier KW | | |
| | **Filter Details** | | |
| 59 | Type of filter | | |
| 60 | Filter efficiency | | |
| 61 | Media used | | |
| 62 | Face velocity across filter | | |
| 53 | Resistance when clean | | |
| 64 | Method of cleaning | | |
| | **Electrical and Controls** | | |
| 65 | Controls | | |
| 66 | Incomer Switchgear Amp | | |
| 67 | Power cable size | | |

## 12.8. DUCTING

### 12.8.1. Sheet Metal Work

To be as per standard specification respective to Delhi Scheduled Rates (DSR - Item No.-16.12.1 and 16.12.2).

### 12.8.2. Volume Control Dampers

i) At the junction of each branch duct with main duct and split of main duct, splitter dampers must be provided. Dampers shall be two gauges heavier than gauge of the large duct, and shall be rigid in construction to the passage of air.
ii) The volume control dampers shall be of opposed blade type, lever operated and complete with locking devices, which will permit the dampers to be adjusted and locked in any positions. Quantity of volume control dampers for ducts, plenum and grills shall be covered separately in BOQ.
iii) Automatic and manual volume opposed blade dampers shall be complete with frames and bronze bearings as per drawings. Dampers and frames shall be constructed of 1.6 mm steel and blades shall not be over 225 mm wide. The dampers for fresh air inlet shall additionally be provided with fly mesh screen, on the outside, of 0.8 mm thickness with fine mesh specking.
iv) Wherever required for system balancing, provide a volume balancing opposed blade damper with quadrant and thumb Scroll lock. Provide damper rod and damper block with upset screws. Quantity of volume control dampers shall be covered separately in BOQ.
v) After completion of the duct work, dampers are to be adjusted and set to deliver the required amounts of air as specified on the drawings.
vi) A hinged and gasketed access panel shall be provided on duct work at each control device that may be located inside the duct work.

To be as per standard specification respective to Delhi Scheduled Rates (DSR-Item No.-16.13)

**Actuator for Motorized Volume Control Damper:**

Electronic actuation shall be provided. The actuator shall be direct coupled over the shaft, enabling it to be mounted directly to the damper shaft without the need for connecting linkage. The fastening clamp assembly shall be of a "V" bolt design with associated "V" shaped toothed cradle attaching to the shaft for maximum strength and eliminating slippage. Spring return actuators shall have a "V" clamp assembly of sufficient size to be directly mounted to an integral jackshaft of up to 1.05 inches when the damper is constructed in this manner. Single bolt or set screw type fasteners are not acceptable. The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator. Mechanical end switches or magnetic clutch to deactivate the actuator at the end of rotation are not acceptable. For power-failure/safety applications, an internal mechanical, spring return mechanism shall be built into the actuator housing. Non-mechanical forms of fail-safe operation are not acceptable. All spring return actuators shall be capable of both clockwise or counterclockwise spring return operation by simply changing the mounting orientation. Proportional actuators shall accept a 0 to 10 VDC or 0 to 20 mA control signal and provide a 2 to 10 VDC or 4 to 20 mA operating range. An actuator capable of accepting a pulse width modulating control signal and providing full proportional operation of the damper is acceptable. All actuators shall provide a 2 to 10 VDC position feedback signal. All 24 VAC/VDC actuators shall operate on Class 2 wiring and shall not require more than 10 VA for AC or more than 8 watts for DC applications. Actuators operating on 120 VAC power shall not require more than 10 VA. Actuators operating on 230 VAC power shall not require more than 11 VA. All non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 60 in-lb torque capacity shall have a manual crank for this purpose. All proportional actuators shall have an external, built-in switch to allow the reversing of direction of rotation. Actuators shall be provided with a conduit fitting and a minimum three-foot electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections. Actuators shall be CE certified as meeting correct safety requirements and recognized industry standards. Actuators shall

be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque and shall have a 2-year manufacturer's warranty, starting from the date of installation.

**12.8.3. Fire Dampers**

i) Fire dampers shall be provided in all the supply air ducts and return air ducts (where ever provided in the drawings), return air passage in the air-handling unit room and at all floor crossings. Access door will be provided in the duct before each set of fire dampers.
ii) Fire dampers shall be multi blade louvers type. The blade should remain in the air stream in Open position & shall allow maximum free area to reduce pressure drop &noise in the air passage. The blades and frame shall be constructed with minimum 1.6mm thick galvanized sheet &shall be factory fitted in a sleeve made out of 1.6mm galvanized sheet of minimum 400mm long. It shall be complete with locking device, motorized actuator & control panel.
iii) Fire dampers shall be motorized smoke & fire dampers type. It shall be supplied with spring loaded UL (Underwriters Laboratories) stamped motorized link to close fire damper in the event of rise in duct temperature. Fire damper shall also close on receipt of fire alarm signal to cut off air supply instantaneously. An electric limit switch shall also be operated by the closing of fire damper, which in turn shall switch off power supply to AHU blower motor as well as strip heaters.
iv) Fire dampers shall be CBRI tested &certified for 90 minutes rating against collapse & name penetration as per UL 555-1995(Under writers laboratories)
v) Fire dampers shall be compatible with the fire detection system of building & shall be capable of operating automatically through an electric motor on receiving signal from fire alarm panel.
vi) Necessary wiring from fire alarm panel up to AHU electric panel shall be provided by the lead contractor& further from AHU electric panel to fire damper shall be provided by sub-contractor.

**Actuator for Motorized Fire/Smoke Damper:**

Electronic actuation shall be provided with spring return mechanism. The actuator shall be direct coupled over the shaft, enabling it to be mounted directly to the damper shaft without the need for connecting linkage. The fastening clamp assembly shall be of a "V" bolt design with associated "V" shaped toothed cradle attaching to the shaft for maximum strength and eliminating slippage. All actuators shall have a "V" clamp assembly of sufficient size to be directly mounted to an integral jackshaft of up to 1.05 inches when the damper is constructed in this manner. Single bolt or set screw type fasteners are not acceptable. The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator. Mechanical end switches or magnetic clutch to deactivate the actuator at the end of rotation are not acceptable. For power-failure/safety applications, an internal mechanical, spring return mechanism shall be built into the actuator housing. Non-mechanical forms of fail-safe operation are not acceptable. All actuators shall be capable of both clockwise and counterclockwise spring return operation by simply changing the mounting orientation. All 24 VAC/VDC actuators shall operate on Class 2 wiring and shall not require more than 10 VA for holding and 30VA for running in AC applications. Actuators operating on 230 VAC power shall not require more than 17 VA for holding and 30VA for running. Spring return actuators with more than 60 in-lb. torque capacity shall have a manual crank for manual position of dampers. All actuators should be form-fit with minimum IP54 degree of protection. Actuators shall be provided with a conduit fitting and a minimum three-foot electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections. Actuators shall be either CE or UL555 certified as meeting correct safety requirements and recognized industry standards. Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque and shall have a 2-year manufacturer's warranty, starting from the date of installation. All actuators should be maintenance free.

**12.8.4. Access Panels:**

A hinged and gasket access panel shall be provided on duct work at each control device that may be located inside the duct work.

### 12.8.5. Miscellaneous:

i) All ducts above 450 mm are to be cross broken to provide rigidity to the ducts.
ii) All duct work joints are to be true right angle or approaching with all sharp edges removed.
iii) Smoke rated sponge rubber gaskets also to be provided behind the flange of all grilles.
iv) Each branch from the duct, leading to a grille, shall be provided with an air deflector to divert the air into the grille through the branch.
v) Inspection doors measuring at least 450 mm x 450 mm are to be provided in each system at an appropriate location, as directed by Project Manager/Engineer-in-charge/Consultants.
vi) Diverting vanes must be provided at the bends exceeding 600 mm and at branches connected into the main duct without a neck.
vii) Proper hangers and supports should be provided to hold the duct rigidly, to keep them straight and to avoid vibrations. Additional supports are to be provided where required for rigidity or as directed by Project Manager/Engineer in charge/Consultants.
viii) The ducts should be routed directly with a minimum of directional change.
ix) The duct work shall be provided with additional supports /hangers, wherever required or as directed by the directed by Project Manager/Engineer in charge/Consultants, at no extra cost.
x) All duct supports, flanges, hangers and damper boxes etc. shall be either zinc coated or given 2 coats of anti-corrosion red oxide paint before installation and one coat of aluminum paint after the erection, at no extra cost.
xi) All angle iron flanges to be welded electrically and holes to be drilled.
xii) All the angle iron flanges to be connected to the GSS ducts by rivets at 100 mm centers.
xiii) All the flanged joints, to have a 3 mm neoprene rubber gasket to the flanges with Adhesive.
xiv) The G.S.S. Ducts should be lapped 6 mm across the flanges.
xv) The ducts should be supported by approved type supports at a distance not exceeding 2.4 meters and at every vertical floor penetration.
xvi) Sheet metal connection pieces, partitions and plenums required shall be constructed of 1.25 (18 gauge) sheet thoroughly stiffened with 25 mm x 25 mm angle iron braces and fitted with access doors.
xvii) Readymade (factory fabricated) flanges shall be used for all ducting.
xviii) All duct joints shall be filled up by silicon.
xix) All duct penetrations in fire rated walls and slabs shall be filled up by fire resistant materials of fire rating not less than fire rating of wall / slab.
xx) All ducts immediately behind the grilles/diffusers etc. are to be given two coats of black paint in matt finish unless noted otherwise.
xxi) Wherever ducts are acoustically lined the duct size shall be increased by the thickness of the duct lining.
xxii) Wherever MVCDs are provided, an access door shall be provided for the maintenance.

### 12.8.6. Air Outlet And Inlets (Supply And Return)

i) All air outlets and intakes shall be made of extruded aluminum sections & shall present a neat appearance and shall be rigid with mechanical joints.
ii) Square and rectangular wall outlets shall have a flanged frame with the outside edges returned or curved 5 to 7 mm and fitted with a suitable flexible gasket between the concealed face of the flanges and the finished wall face. The core of supply air register shall have adjustable front louvers parallel to the longer side to give upto 22.5 degrees vertical deflection and adjustable back louvers parallel to the shorter side to achieve a horizontal spread air pattern to at least 45 degrees. Return air grilles shall have only front louvers. The outer framework of the grilles shall be made of not less than 1.6 mm thick aluminum sheet. The louvers shall be of aero foil design of extruded aluminum section with minimum thickness of 0.8mm at front and shall be made of 0.8mm thick aluminum sheet. Louvers may be spaced 18 mm apart.
iii) Square and rectangular ceiling outlets/intakes shall have a flange flush with the ceiling into which it is fitted or shall be of anti-smudge type. The outlets shall comprise an outer shell with duct collar and removable diffusing assembly. These shall be suitable for discharge in one or more directions as required. The outer shell shall not be less than 1.6 mm thick extruded section

aluminum sheet. The diffuser assembly shall not be less than 0.80 mm thick extruded aluminum section.

iv) Circular ceiling outlets/intakes shall have either flush or anti smudge outer cone as specified in the tender specifications. Flush outer cones shall have the lower edge of the cone not more than 5 mm below the underside of the finished ceiling into which it is fitted. Anti-smudge cones shall have the outer cone profile designed to reduce dirt deposit on the ceiling adjacent to the air outlet. The metal sheet used for construction of these shall be minimum 1.6 mm thick extruded aluminum sheet.

v) Linear diffusers shall have a flanged frame with the outside edges returned 3.5 mm and shall have one to four slots as required. The air quantity through each slot shall be adjustable. The metal sheet used for the construction of these shall be minimum 1.6 mm thick extruded aluminum sheet.

vi) Grilles and diffusers constructed of extruded aluminum sections shall have grille bars set straight, or deflected as required. These shall be assembled by mechanical interlocking of components to prevent distortion. These grilles and diffusers shall have a rear set of adjustable blades, perpendicular to the face blades for deflection purposes.

vii) All supply air outlets shall be fitted with a **VOLUME CONTROL DEVICE**, made of extruded aluminum gate section. The blades of the device shall be mill finish/ block shade pivoted on nylon brushes to avoid rusting & rattling noise, which shall be located immediately behind the outlet and shall be fully adjustable from within the occupied space without removing any access panel. The volume control device for circular cutlets shall be opposed blade radial/shutter type dampers, or two or more butterfly dampers in conjunction with equalizing grid. Opposed blade dampers shall be used for square and rectangular ceiling/ wall outlets and intakes.

viii) All the products supplied by contractor should supplement 'in performance by selection curves of product ratings from the manufacturer.

ix) Laminar supply air diffusers shall be made of 2mm thick powder coated aluminum sheet duly insulated with 5mm thick dosed cell polyethylene foam insulation having factory laminated aluminum foil and joints covered with self-adhesive aluminum tape and having holes 2/3 mm dia. including frame work.

x) <u>STAINLESS STEEL GRILLS (Wherever applicable)</u>

Stainless Steel supply grilles shall be as per the sizes and mounting types shown on the plans and schedule. The deflection blades shall be available parallel to the short dimension of the grille.

Construction shall be of stainless steel with a 1 3/8-inch wide border on all sides. Screw holes shall be countersunk for a neat appearance. Corners shall be welded with full penetration resistance welds.

Deflection blades shall be contoured to a specifically designed and tested cross-section to meet published test performance data. Blades shall be spaced on ¾-inch centers. Blades shall have friction pivots on both ends to allow individual blade adjustment without loosening or rattling. Plastic blade pivots are not acceptable.

Optional opposed-blade volume damper shall be constructed of heavy gauge steel, aluminum, or 304 stainless steel. Damper must be operable from the face of the grille.

The manufacturer shall provide published performance data for the grille. The grille shall be tested in accordance with ANSI/ASHRAE Standard 70-1991.

xi) <u>ROUND DIFFUSERS FOR UNDER FLOOR AIR DISTRIBUTION</u>

The diffuser shall be constructed of a high impact polymeric material. The diffuser shall have a removable curved slot helical throw diffuser core. The diffuser core design shall produce a vertical, high induction helical air pattern. A high induction swirl air pattern is acceptable. The trim ring shall have a 1-inch flange for use with carpeting. The dust receptacle shall have an integral flow regulator and shall extend 5¾ inches below top of access floor panel.

The diffuser shall have an external open/close indicator and internal open/close stop to allow visual determination of damper position. The flow regulator shall be manually operated without

removing the diffuser core. The diffuser shall have a positive compression quick mount ring for installation into access floor panel. The access floor diffuser shall be assembled such that the access floor panel is not removed from the floor system for installation of the diffuser.

The diffuser core and trim ring finish shall be gray. The dust receptacle, flow regulator and quick mount ring finish shall be black.

The manufacturer shall provide published performance data for the access floor diffuser, tested in accordance with ANSI/ASHRAE Standard 70-1991 at both isothermal and various DT conditions.

### 12.8.7. Fresh Air Intakes

i) Fresh air intake grills/Louvers shall be made of extruded aluminum sections.
ii) A flanged frame using RS sections shall be provided on front face to conceal the gap between the louvers and the adjoining wall face. Corners of frame shall be welded. The frame shall be made structurally rigid.
iii) Louvers made from extruded aluminum section shall be in modular panel form for ease of handling. These shall be free from waves and buckles. Vertical blades shall be truly vertical and horizontal blades shall be truly horizontal. Butt joints in blades shall not be accepted.
iv) Additional intermediate equally spaced supports and stiffeners shall be provided to prevent sagging/vibrating of the louvers, at not more than 750mm centers where the louver's length is longer than 750rnm.
v) A bird wire screen made of 12 mm mesh in 1.6 mm steel wire held in angle or channel frame shall be fixed to the rear face of the louver frame by screens.

### 12.8.8. Variable Air Volume (Vav) Boxes

i) The scope is to provide Variable Air volume cooling only Boxes of imported make. Indian make/model will not be acceptable.
ii) These shall be low velocity variable air volume boxes without re-heat coils, and shall be of open protocol as marketed by a firm specializing in this field. The sub-contractor shall supply and install units to the quantity and locations as specified in the documents, schedules and drawings.
iii) The unit shall be complete with damper, airflow ring, and solid-state electronic controls to provide accurate room temperature control. The damper shall be aero foil type construction with bearings.
iv) Boxes shall be supplied with all internal attenuation treatment and acoustical damped casing necessary to achieve the required noise criteria. Casing shall be of 22G GSS minimum fitted with a completely sealed, easily removable means of access to all internal parts. Access to all boxes must be from the top side only.
v) The actuator shall be of 24V AC Bi-directional, direct coupled to the damper shaft. The required transformer to step down of the voltage range from 230V to 24V shall be part of the unit. The UPS power point with an isolator near the VAV will be provided by other agencies.
vi) The unit shall be complete with transformer, access panel and other accessories as per the standard.
vii) The noise level shall be less than 35 NC.
viii) The static differential range is 20 to 1500Pa. The minimum allowable static pressure to the boxes for its satisfactory operation shall be 20Pa.
ix) Boxes shall be able to reset any air flow between 10% and the maximum air quantity that the boxes can handle without changing orifices or other parts. Air quantity limiters will not be accepted.
x) A suitable device shall be provided for the field adjustment of minimum airflow. All boxes shall be initially factory set at minimum air quantity of 10% and maximum quantity of 110%of the design requirements.
xi) Under shut-off conditions, all boxes shall not have air leakage more than 2% of the maximum air quantity at 75mm static pressure.

xii) The VAVs shall be used in standalone mode complete with its own temperature sensor and controller and shall perform the function of maintaining the temperature and airflow. However, the VAVs shall be BMS compatible to enable to network the VAVs to a Network Control Unit and onto BMS. In this mode all VAV data shall be available at the BMS workstation and it shall be possible to change set points and flow settings from the BMS workstation.

xiii) All boxes shall be electrically controlled. Controllers and operators shall be supplied by the SUB-CONTRACTORs. The boxes shall be pressure independent. All controllers used for the control of VAV boxes shall be compliant with BACnet/ MODBUS protocol and be freely communicable to third party BACnet/ MODBUS IP controllers.

xiv) VAV Box shall have provision to support from floor/ wall/ ceiling and in vertical/ horizontal condition.

### 12.8.9. Back Draft Dampers

The dampers shall be installed at the outlet of the unit. The damper should be air-tight and should be in a position to prevent back flow. Dampers shall be opposed blade in 18G and 20G blades in G.I construction. Damper shall be operated manually through lever and constructed with suitable links and levers.

### 12.8.10. Testing:

The entire air distribution system shall be balanced to supply the air quantities as required in various zones and rooms to maintain the specified room conditions. The final balancing of air quantities thorough each air outlet shall be recorded and submitted to Consultant/Client for approval.

All ducts will be pressure tested for leakage. The entire ducting shall be tested for leakage with help of soap solution if required. The Contractor shall arrange, on his own, duct leakage system required for pressure testing of duct.

The ducting work shall be completed with inspected chamber as per US standard for taking out samples and inside duct cleaning shall be provided at required length.

Test and Balance report shall be submitted after proper testing and balancing of the system.

### 12.8.11. Installation Practice:

12.8.11.1. Support Hangers:

i. The flexible duct must be installed fully extended to produce optimum results.

ii. The maximum allowable sag, between any two adjacent suspension points, should not exceed 50mm per meter.

iii. The distance between any two adjacent suspension points may vary from 1.50 to 3.00 meter, depending upon the type of flexible duct in use.

iv. Flexible ducts above suspended ceiling should always be independently supported. Ducts mounted in these locations are susceptible to damage whenever ceilings panels need to be periodically interchanged, unless they are separately supported

12.8.11.2. Bending Radius:

All bends should be made as large as possible and should have a radius of not less than the diameter of the duct in use. This reduces un-favorable pressure losses and is particularly important for metal based products which are more susceptible to stress rupturing. Double bends should be avoided, however if un-avoidable, ensure that each radius is not less than R = 2 x D.

12.8.11.3. Straps:

The hanging straps should support the flexible duct with a minimum of half the circumference surface in contact, and without reducing the effective inside diameter of the duct. It is also recommended that the minimum width of material to be used for the hanging straps should be at least 25mm.

12.8.11.4. Flexible Duct To Conventional Duct Connection:

Extra care should be taken when making flexible connection to fix conventional ducts, etc., and ensure that they do not become too stressed. An additional support is recommended to obviate this potential problem.

Metal based flexible duct products are particularly prone to fracturing due to stress caused as a result of sharp connections.

12.8.11.5. Steel Wire Rope Hangers & Supports:

Wire Hangers shall be used to suspend all static HVAC Air Distribution services.

Wire Hangers should consist of a pre-formed wire rope sling with a range of end fixings to fit various substrates and service fixings, these include a ferruled loop, permanently fixed threaded M6 (or M8, M10) stud, permanently fixed nipple end with toggle, at one end or hook or eyelet, cladding hook, barrel, wedge anchor, eyebolt anchor or any other end fixture type or size as per manufacturers recommendation and design. The end fixings and the wire must be of the same manufacturer with several options available. The system should be secured and tensioned with a Hanger self-locking grip (double channel lock)at the other end. Once the grip is locked for safety purpose unlocking should only be done by using a separate setting key and should not be an integral part of the self-locking grip. Only wire and/or supports supplied and/or approved, shall be used with the system.

**a.** Wire Hangers should have been independently tested by Lloyds Register. APAVE, TUV, CSA, Chiltern International fire, ADCAS, Intertek, ECA, and SMACNA, approved by CSA and comply with the requirements of DW/144 and BSRIA – wire Rope Suspension systems. Wire rope should be manufactured to BSEN 12385: 2002

**b.** The contractor shall select the correct specification of wire hanger to use for supporting each particular service from table 1 below. Each size is designated with a maximum safe working load limit (which incorporates a 5:1 safety factor).

The correct specification of wire hanger required is determined using the following formula.

**Weight per meter of object suspended (kg) X distance between suspension points (m) = weight loading per Hanger suspension point (kg).**

Where the installed wire rope is not vertical then the working load limit shall be reduced in accordance with the recommendations give in the manufacturer's handbook.

The contractor shall select the correct length of wire rope required to support the service. Specials can be made, check with manufacturer. No in–line joints should be made in the rope.

The standard range of Hanger Kits should contain galvanized high tensile steel wire rope or stainless steel wire rope as per the application, the minimum specification is as above and should be manufactured to BS 302 (1987), BSEN12385. Comply with manufacturer's load ratings and recommended installation procedures. Note the testing is done to the minimum breaking load of the wire thus giving a minimum safety factor of 5: 1.

12.8.11.6. HVAC Supports – Hanger Supports are suitable for: Rectangular duct, Spiral Duct, Oval Duct, Fabric Duct, Desertification fans, Air Conditioning Units, Plenum Boxes, Fan Coil Units, Diffusers.

Ducting Supports:
All ductwork shall be independently supported from building construction. All horizontal ducts shall be rigidly and securely supported, in an approved manner, with hangers formed of galvanized steel wire ropes and galvanized steel angle/channel or a pair of brackets, connected by galvanized steel wire hangers under ducts, rigid supports may be provided at certain interval if need be. The spacing between supports should be not greater than 2.4 meter. All vertical ductwork shall be supported by structural members on each floor slab. Duct supports may be through galvanized steel insert plates or Toggle end wire fixing left in slab at the time of slab casting. Galvanized steel cleat with a hole for passing the wire rope hanger shall be welded to the plates. Trapeze hanger formed of galvanized steel wire rope shall be hung through these cleats. Wherever use of metal insert plates is not feasible, duct support shall be through dash/anchor fastener driven into the concrete slab by electrically operated gun. Wire rope supports shall hang through the cleats or wire rope threaded studs can be screwed into the anchor fasteners. In case of PEB structure Loop and Catenary system can be used based on the site conditions as per approved suspension system drawings.

All horizontal ducts shall be adequately secured and supported. In an approved manner, with trapeze Hangers formed of galvanized steel wire rope in a cradle support method (refer to typical drawings) under ducts at no greater than 3000mmcentre, for 3001mm-above appropriate size angle along with neoprene pad in between the duct & MS angle should be used with prior approval. All vertical duct work shall be supported by structural members on each floor slab. Duct support shall be through dash / anchor fastener driven into the concrete slab by electrically operated gun. Hanger wires shall then hang around the ducting. Rigid supports shall be used in conjunction with wire rope hangers to assist with alignment of services where recommended for by the manufacturer. Rigid support must also be used in conjunction with wire rope hangers with duct work at each change of direction or connection or as per approved drawings. Support ducting in accordance with Schedule I at the end of this Section. In cases of Spiral ducting the wire can be wrapped directly around the ducting without the need for a spiral ducting clamp for sizes above 1100 a cradle support should be provided, refer to manufacturer's recommendations.

Ducting over furred ceiling shall be supported from the slab above or from beams after obtaining approval of Construction manager/consultant. In no case shall any duct be supported from false ceiling Hangers or be permitted to rest on false ceiling. All metal work in dead or furred down spaces shall be erected in time to occasion no delay to other Contractor's work in the building. All supports of pipe shall be taken from structural slab/wall by means of fastener.

**12.8.12. Measurement for Ducting and Grilles/Diffusers**

12.8.12.1. Unless otherwise specified, measurements for ducting for the project shall be on the basis of centre-line measurements described herewith:

12.8.12.2. Duct Work shall be measured on the basis of external surface area of ducts. Duct measurements shall be taken before application of the insulation. The external surface area shall be calculated by measuring the perimeter comprising overall width and depth, including the corner joints, in the centre of each duct section, multiplying with the overall length from flange face to flange face of each duct section and adding up areas of all duct sections. Plenums shall also be measured in similar manner.

12.8.12.3. For tapered rectangular ducts, the average width and depth shall be considered for perimeter, whereas for tapered circular ducts, the diameter of the section midway between large and small diameter shall be adopted, the length of tapered duct section shall be the centre line distance between the flanges of the duct section.

12.8.12.4. For special pieces like bends, tees, reducers, branches and collars, mode of measurement shall be identical to that described above using the length along the centre line.

12.8.12.5. The quoted unit rate for external surface of ducts shall include all wastage allowances, flanges and gaskets for joints, nuts and bolts, hangers and angles with

double nuts for supports, rubber strip 3 mm thick between duct and support, vibration isolator suspension where specified or required, inspection chamber / access panel, splitter damper with quadrant and lever for position indication, turning vanes, straightening vanes, and all other accessories required to complete the duct installation as per the Specifications. These accessories shall NOT be separately measured nor paid for.

12.8.12.6. Special Items for Air Distribution shall be measured by the cross-section area perpendicular to air flow, as identified herewith:

a) Grilles and registers - width multiplied by height, excluding flanges. Volume control dampers shall form part of the unit rate for registers and shall not be separately accounted.

b) Diffusers - cross section area for air flow at discharge area excluding flanges. Volume control dampers shall form part of unit rate for supply air diffusers and shall not be separately accounted.

c) Linear diffusers - shall be measured by cross-sectional areas and shall exclude flanges for mounting of linear diffusers. The supply air plenum for linear diffusers shall be measured with ducting as described earlier.

d) Flexible connection - shall be measured by their cross sectional area perpendicular to the direction of air flow.

e) Fire Damper-shall be measured by their cross sectional area perpendicular to the direction of air flow and actuators shall be on counting basis.

## 12.9. MECHANICAL VENTILATION SYSTEM

### 12.9.1. Scope

This chapter includes supply air fans, exhaust air fans and fans used in any equipment like AHUs, FCUs etc.

### 12.9.2. Centrifugal Fans

i) Centrifugal fans shall be of double-width, double-inlet construction, with bearing on both sides, complete with access door, squirrel-cage induction motor, V-belt drive, belt guard etc.
ii) Housing shall be of heavy gauge sheet steel in welded construction. It shall be rigidly reinforced and supported by structural angles. Split casing shall be provided on larger sizes of fans. However neoprene/ asbestos packing shall be provided throughout split joints to make it airtight. 1.2 mm galvanized wire mesh inlet guard, of 5cms sleeves shall be provided on both inlets. Housing shall be provided with access door with quick locking tension handles and neoprene gasket. Rotation arrow shall be clearly marked on the housing.
iii) Fan wheel shall be backward curved non-overloading type unless otherwise specified. Fan wheel and housing shall be statically and dynamically balanced. Fan outlet velocity shall not exceed 610 meters per minute.
iv) Shaft shall be constructed of steel, turned, ground and polished.
v) Bearings shall be of the sleeve/ball bearing type mounted directly on the fan housing. Bearing shall be self-aligned, oil grease packed, pillow block type.
vi) Drive to fan shall be provided from 3 phase electric motor through belt with adjustable motor sheave and belt guard. Belt shall be of the oil resistant type. The number of belts shall be not less than two.
vii) The fan motor shall have efficiency class IE-3 or EFF-1, whichever is more efficient.

### 12.9.3. Axial Flow Fans

i) Fan shall be complete with motor, motor mount, belt driven (or direct driven) and vibration isolation type, suspension arrangement as per approved for construction shop drawings.
ii) Casing shall be constructed of heavy gauge sheet steel. Casing shall be provided with hinged door enabling easy replacement of wheel, shaft and bearings. A small inspection door with handle and neoprene gasket shall also be provided. Casing shall have flanged connection on both ends for ducted applications. Support brackets for ceiling suspension shall be welded to the casing for connection to hanger bolts.
Straightening vanes shall be aerodynamically designed for maximum efficiency by converting velocity pressure to static pressure potential and minimizing turbulence. Casing shall be de-rusted, cleaned, primed and finish coated with enamel paint.
iii) Rotor hub and blades shall be of cast aluminum, or cast steel construction. Blades shall be die-formed aero foil shaped for maximum efficiency and shall vary in twist and width from hub to tip to effect equal air distribution along the blade length. Fan blade mounting on the hub shall be statically and dynamically balanced. Extended grease leads for external lubrication shall be provided. The fan pitch control may be manually read just able at site, upon installation, for obtaining actual airflow values, as specified.
iv) Motor shall be of 3 phase squirrel-cage totally enclosed, fan cooled type. Motor and starter shall be in accordance with Part VIII Para 1.9 respectively. The speed of fan shall not exceed 1000 RPM for fans with impeller diameter above 450mm, and 1450RPM for fans with impeller diameter of 450mm and less. The fan motor shall have efficiency class IE-3 or EFF-1, whichever is more efficient.

v) **Drive:**
**For Duct/Wall Mounted Fan:**
For duct/wall mounted fans the impeller shall be mounted directly on the motor. Drive unit and impeller shall be totally enclosed inside the duct.

**For Floor/Ceiling Mounted Fan:**
The fan shall be provided with belt drive and adjustable motor sheave, standard sheet steel belt guard with vented front for heat dissipation. Belt shall be of the oil resistant type.

vi) **Vibration Isolation**

Base shall be provided for each fan. Base for both fan and motor shall be built as an integral part and shall be mounted on a concrete foundation through cushy foot vibration isolators. The concrete foundations shall be at least 15 cm above the finished floor level and shall be further isolated from the structural floor through 5 cm. Thick layers of sand all around, topped with bitumen. In case ceiling hung fan within the ceiling shall be provided Vibration Isolation Suspension (VIS) shall be provided in each of string.

Types of Vibration Isolators:

1. Free Spring Floor Mounted Isolators
   Vibration isolators shall be free standing, un-housed, laterally stable springs wound from high strength spring steel. Springs shall have a lateral stiffness greater than 0.8 times the rated vertical stiffness and shall be designed to provide up to 50% overload capacity. Springs shall be supported either with a neoprene cup or a metal base plate complete with a ribbed neoprene pad, minimum 6 mm (0.25") thick, bonded to the base plate. Springs shall be selected to provide operating static deflections as required. Springs shall be color coded or otherwise identified to indicate load capacity. In capacities up to 5,000 lbs., springs shall be replaceable. In capacities over 5,000 lbs., springs shall be welded to the top and bottom load plate assemblies. Springs shall be assembled between a top and bottom steel load plate. The upper load plate shall be provided with a steel leveling bolt lock nut and washer for attachment to the supported equipment.

2. Restrained Spring Floor Mounted Isolators
   Vibration isolators for equipment which is subject to load variations and large external or torquing forces shall consist of large diameter laterally stable steel springs assembled into formed or welded steel housing assemblies designed to limit vertical movement of the supported equipment. Springs shall be supported either with a neoprene cup of a metal base plate complete with a ribbed neoprene pad, minimum 6 mm (0.25”) thick, bonded to the base plate. Housing assembly shall be formed or fabricated steel members and shall consist of a top-load plate complete with adjusting and leveling bolts, vertical restraints, isolation washers and a bottom plate with non-skid noise stop pads and holes provided for anchoring to supporting structure. Housing shall be hot dipped galvanized.

3. Vibration Modular Restrained Spring Isolator
   Spring isolators shall be comprised of two interfacing but independent elements; a coil spring element and a seismically rated housing. The spring coil element shall be comprised of one or more coil assemblies having all of the characteristics of freestanding coil spring isolators as specified in the vibration isolation portion of the specification. The seismically rated housing shall be sized to meet or exceed the force requirements applicable to the project and have the capability of accepting coils of various sizes, capacities, and deflections as required to meet the desired isolation criteria. All spring forces will be contained within the coil/housing assembly and under no seismic load condition shall the restraint anchoring hardware be exposed to spring - generated forces. The restraint element shall incorporate a steel housing with elastomeric elements at all dynamic contact points. The restraint will allow a maximum of 1/4 in. (25 mm) motion in any direction from the neutral position. All elastomeric elements shall be replaceable. To ensure the optimum anchorage capacity, the restraint will have an overturning factor (the ratio of the effective lateral snubber height to the short axis anchor spacing) of 0.33 or less.

4. Vibration/Seismic Modular Restrained Spring Isolator
   Vibration isolators shall be seismically rated, restrained spring isolators for equipment which is subject to load variations and large external forces. Spring isolators shall be comprised of two interfacing but independent elements; a coil spring element and a seismically rated housing. The spring coil element shall be comprised of two or more coil assemblies having all of the characteristics of freestanding coil spring isolators as

specified in the vibration isolation portion of the specification.. The seismically rated housing shall be sized to meet or exceed the force requirements applicable to the project and have the capability of accepting coils of various sizes, capacities, and deflections as required to meet the desired isolation criteria. The housing shall be hot dipped galvanized for corrosion resistance. All spring forces will be contained within the coil / housing assembly and under no seismic load condition shall the restraint anchoring hardware be exposed to spring generated forces. The single restraint element shall incorporate a steel housing with elastomeric elements at all dynamic contact points. The single restraint will allow 1/4 in. (25mm) motion in any direction from the neutral position. All elastomeric elements shall be replaceable in the field after an event without lifting the unit.

**12.9.4. Cabinet Fans**

The construction of the cabinet fans shall be identical with that of the air washer unit except that the cabinet fans will not have humidifiers and filters only for fresh air fans.

**12.9.5. Propeller Fan**

i) Propeller fan shall be direct-driven, three or four blade type, mounted on a steel mounting plate with orifice ring.
ii) Mounting Plate shall be of steel construction, square with streamlined venturi inlet (reversed for supply applications) coated with baked enamel paint. Mounting plate shall be of standard size, constructed of 12 to 16 gauge sheet steel depending upon the fan size. Orifice ring shall be correctly formed by spinning or stamping to provide easy passage of air without turbulence and to direct the air stream.
iii) Fan Blades shall be constructed of aluminum or steel. Fan hub shall be of heavy welded steel construction with blades bolted to the hub. Fan blades and hub assembly shall be statically and dynamically balanced at the manufacturer's works.
iv) Shaft shall be of steel, accurately ground and shall be of ample size for the load transmitted and shall not pass through first critical speed thru the full range of specified fan speeds.
v) Motor shall be standard (easily replaceable) permanent split capacitor or shaded pole for small sizes, totally enclosed with pre-lubricated sleeve or ball bearings, designed for quiet operation with a maximum speed of 1000 rpm for fans 60 cm dia or larger and 1440 rpm for fans 45 cm dia and smaller. Motors for larger fans shall be suitable for 415±6% volts, 50 cycle's 3 phase power supply rated for IP-55, and for smaller fans shall be suitable for 220±6% volts, 50 cycle's single phase power supply rated for IP-55 to IP-40. Motors shall be suitable for either horizontal or vertical service as indicated on drawings and system design requirements.

vi) Accessories:
The following accessories shall be provided with propeller fans:

a) Wire guard on inlet side and bird screen at the outlet.
b) Fixed or gravity louvers built into an aluminum steel frame at the outlet.
c) Electronic speed controller for controlling fan speed for single phase fan motor and variable speed drives for three phase motors.
d) Single phase preventers for 3 phase fans.

**12.9.6. Inline Fans**

i) SCOPE
The scope of comprises of supply, erection, testing and commissioning of inline fans conforming to these specifications and in accordance with the Schedule of Quantities and drawings.
ii) TYPE
Fans shall be single inlet single width (SISW) type / Double Inlet Double Width (DIDW). Fan shall have directly driven forward curved centrifugal impeller, running in a metal scroll balanced to give quiet and vibration free operation. Fan motor assembly shall be statically and dynamically balanced.

The fan shall be assembled in such a manner that the motor and impeller can be easily removed and reinstalled after servicing.

The air handling capacities, maximum motor H.P., Static pressure shall be as shown on Drawing and in Schedule of Quantities.

iii) MATERIAL
   a) Fans casing shall be manufactured from galvanized steel sheets.
   b) All other metal parts shall be hot dip galvanized.

iv) MOTOR
   a) The fan motor shall be equipped with motor with speed regulator giving volume control from 0 to 100% of output.
   b) Motors shall be with class 'F' insulation wired to an externally mounted weather proofed terminal box.
   c) Motor name plate horsepower shall exceed brake horsepower by minimum of 10%. Motor shall be designed especially for quiet operation and motor speed shall not exceed 1500 RPM.

v) INSTALLATION
   a) Fan shall have rigid supports and fitted to both ends of the casing.
   b) Wherever the fans are to be suspended from ceiling or mounted on the wall, the contractor shall include supply and fixing of all the material that may be required to complete the installation in all respect.
   c) Fan inlet and outlet connections shall be by means of flexible canvas connections.

vi) TESTING

Fan after installation shall be tested for capacities, power consumption, noise level and vibration and results shall confirm to the approved data furnished by the contractor.

vii) ELECTRIC POWER CONSUMPTION
Single phase, 220 V, 50 Hz power supply point within 2 meter from the fan shall be available. All further wiring shall be in the scope of the HVAC contractor.

**12.9.7. Roof Mounted Fans**

i) Roof mounted fans shall be propeller type or centrifugal fans, direct driven or belt driven complete with motor drive and housing with weather proof cowl.

ii) Housing shall be constructed of heavy gauge steel sheet. The housing shall have adjustable flange installation and shall be especially adapted to receive fan motor and drive. The housing shall have a low silhouette. For belt driven units, motor shall be installed in ventilated water proof housing outside the air stream. The discharge cowl shall be hinged along one edge for easy access to motor and drive for inspection and maintenance. The entire assembly shall be weatherproof and raised from the roof terrace sufficiently to prevent down flow of rain water accumulated on the terrace. Galvanized steel mesh bird screen shall be provided on all discharge cowls around the outlet areas.

iii) Fans shall be backwardly inclined centrifugal wheel or propeller type as required, designed for maximum efficiency, minimum turbulence and quiet operation. Shall be statically and dynamically balanced.

iv) Single phase motor shall be shaded pole with permanently lubricated sleeve bearing, or split capacitor type with permanently lubricated sleeve or ball bearing, designed for quiet operation. Bearing shall be designed for vertical/ horizontal mounting. Motor name plate horsepower shall be such that the motor shall not be overloaded in the entire range of rated speed. Motor and fan assembly shall be easily removable. Motor's power supply characteristic and maximum speed shall be as specified for propeller fans.

v) Fan bearing shall be heavy duty, self-aligning sleeve/ball bearing designed for thrust load and sealed for grease retention.

vi) Backdraft damper shall be provided where specified, Roof mounted fan shall be equipped with rattle- free backdraft damper to prevent air from re-entering the fan when fan is not in operation, thus sealing completely in closed position. Damper shall be shatterproof.

**12.9.8. Painting**

All equipment shall be supplied with the manufacturer's standard finished painting.

## 12.10. CENTRAL HEATING SYSTEM

### 12.10.1. Electrically Operated Hot Water Generator

The scope is to provide and install, test and commissioning of hot water generators that are electrically driven and are for winter space heating application. The capacities, sizes, ratings shall be as per drawings and schedules. The performance shall be strictly as per ASHRAE 90.1 or ECBC standards and not less than 80%.

The hot water generator shall be cylindrical/rectangular in shape, fabricated out of MS sheet of 10 mm thickness in rob list welded construction. It shall be provided with necessary supports for standing on floor, such that the bottom of the shell is 300 mm above the finished floor level. The shell of the HWG shall be suitable for 50 C of water circulation unless specified otherwise.

Shell shall be complete with necessary lifting lugs and provisions for inlet and outlet connections, drain connections, and heating elements.

Shell shall be insulated with non-setting, non-corrosive 100 mm thick glass wool insulation of 32 Kg density blanket. This shall be covered with 2 mm thick aluminium sheet, or 1.25 mm thick MS sheet, painted with heat resistant paint. The surface temperature of the cladding shall not be exceeding 45 deg. C.

Electric heating elements shall be replaceable, immersion type having solid copper facing designed for low heat concentration. It shall be easily removable without disturbing other components. The number as well as KW of the elements shall be clearly indicated in the technical particulars by the contractor so as to guarantee production of hot water at the specified rate.

The elements shall be connected to suitable terminal box with hinged cover and shall be complete with provision for termination of electric supply cables, as required. The elements shall be distributed in 3 phase equally for balanced loading, and shall be brought out in the terminal box for switching in stages as required. The number of stages shall be indicated by the bidder.

Suitably rated contactors shall be housed in the control box mounted on or near the hot water generator for the switching of the heater elements in the desired stages. This shall be complete with necessary interconnecting wiring/cabling between the control box and terminal box.

The hot water generator shall be capable to hold a test pressure of 300 PSI and a working pressure of 230 PSI.

The electrical heater coil in the generator shall be capable of operating in minimum 6 steps and have multiple heaters into it.

The control shall have inbuilt thermostat adjustable and step controller with digital display showing completely inlet/outlet temperature and time delay recycling relays.

Shall be capable to integrate with the BMS.

The HWG efficiency shall be as per ASHRAE 90.1 2010 minimum efficiency requirements.

**12.0.3. Accessories:**

Hot water generator shall be provided with but not restricted to the following accessories.

- Safety valve
- Automatic alarm for low water level
- Alarm for high temperature
- Automatic Air vents
- Drain valve
- Automatic Pressure release valve
- Vent cock

Thermometer
Pressure gauge
Level switch
Thermostats
Electrically operated pressure switch

### 12.10.2. Startup And Operator Training

The services of a factory trained, field service representative will be provided to supervise the final leak testing, charging and the initial startup and conduct concurrent operator instruction.

### 12.10.3. Witness Test

Prior to shipment, HWG shall be subjected to inspection and witness of performance tests and sound test by Consultant and Owner's representative (two person) to verify various performance parameters as confirmed by vendor and all costs associated for visit shall be included in the bid. Performance test shall be carried out as per Standard procedure.

### 12.10.4. Miscellaneous

Each unit shall include, but not be limited to, all the Items listed in the foregoing paragraphs or in the 'Schedule of Equipment' and drawings for this project. In addition all such items, as may be required, shall be included whether specifically mentioned or not, if considered or found necessary to fulfill the intent and meaning for the purpose of maintaining design operations under all extreme weather conditions.

### 12.10.5. Electrical

The unit shall be complete with all associated electrical accessories and control panel. Suitably rated contactors shall be housed in the control box mounted on or near the hot water generator for the switching of the heater elements in the desired stages. This shall be complete with necessary interconnecting wiring/cabling between the control box and terminal box.

### 12.10.6. Execution

a) Examine areas to receive HWG for compliance with requirements for installation tolerances and other conditions affecting equipment performance. Examine proposed route of moving HWG into place and verify that it is free of interferences. Verify piping rough-in locations. Verify branch circuit wiring suitability. Do not proceed with installation until unsatisfactory conditions have been corrected.

b) Final locations of the HWG on the Drawings are approximate, unless dimensioned. Determine exact locations before roughing-in piping and electrical work.

b. Installation

The HWG machine shall be installed over a cement concrete platform and shall be adequately isolated as per manufacturer's recommendations against transmission of vibrations to the building structure.

### 12.10.7. Maintenance And Operation

The water heater is automatic in its operation. It will maintain a full tank of water at the temperature setting of the thermostat. The water heater should not be turned on without first making sure that the tank is full of water and that all air has been released.

a) QUARTERLY INSPECTION

1. Water temperature regulation.
   - Let water heater completely heat to a designated thermostat setting.
   - After thermostat satisfies (i.e., when the thermostat actually clicks off), draw water from heater.
   - Measure the maximum temperature with an accurate thermometer.
   - If the temperature is above the safe limits for your circumstances call a service man to adjust or replace the control.

2. Lift test lever on relief valve and let water run through valve for a period of approximately 10 seconds. This will help flush away any sediment that might build up in water passageways.

3. Inspect element flange for leakage as follows:
   - Shut off Power Supply.
   - Remove element housing cover.
   - Visually inspect heating element for evidence of leaks.
   - Rub finger around heating element and check for any evidence of moisture. If moisture is present or a water drip is observed, follow procedure outlined in Section V.

4. Check for loose electrical connections. Tighten as necessary.

b) ANNUAL INSPECTION

1. Flush tank as follows
   a. Shut off power supply.
   b. Attach a hose to the drain valve installed in the cold water piping.
   c. Close valve on the cold water line to the heater.
   d. Open the drain valve and direct the water to a drain.
   e. Open hot water faucet to admit air into the tank.
   f. Close drain valve and hot water faucet.
   g. Open valve on the cold water line to the heater.
   h. Turn power supply ON.

C) LONG TERM SHUT DOWN

1. If the water heater is to remain idle for an extended period of time, the power and water to the heater should be turned off to conserve energy.
2. The water heater and piping should be drained, if they might be subjected to freezing temperatures.
3. After a long shutdown period, the heater's operations and controls should be checked by qualified service personnel.
4. Make certain the water heater is filled before placing it in operation.

**12.10.8. Painting**

The equipment shall be painted baked enamel siemence grey and per manufacturer standard.

### 12.10.9. Data Sheet:

| Sr. No | Description | Unit | Offered by Tenderer |
|---|---|---|---|
| 1 | MAKE | | |
| 2 | MODEL | | |
| 3 | COUNTRY OF ORIGIN | | |
| 4 | CAPACITY | | |
| 5 | UNIT DIMENSION | | |
| 6 | MATERIAL OF CONSTRUCTION | | |
| 7 | MATERIAL OF INSULATION AND THICKNESS | | |
| 8 | UNIT WEIGHT AND OPERATING WEIGHT | | |
| 9 | HEATER RATING AND QUANTITY | | |
| 10 | HEAT OUTPUT | | |
| 11 | TOTAL HEATING SURFACE | | |
| 12 | TEMPERATURE RISE | | |
| 13 | PRESSURE DROP | | |
| 14 | WATER FLOW RATE | | |
| 15 | WATER TEMPERATURE “IN” | | |
| 16 | WATER TEMPERATURE“OUT” | | |
| 17 | WORKING PRESSURE | | |
| 18 | WEIGHT (OPERATING) | | |
| 19 | WATER CAPACITY | | |
| 20 | MATERIAL & THICKNESS OF HWG Tank | | |
| 21 | TYPE OF HEATERS | | |
| 22 | NO OF STAGES OF HEATING | | |
| 23 | MATERIALS OF HEATERS | | |
| 24 | CONTROLS | | |
| 25 | TEST PRESSURE | | |
| 26 | INSULATION MATERIAL & THICKNESS | | |
| 27 | MATERIAL OF CLADING AND GUAGE | | |
| 28 | EARTHING SIZE | | |
| 29 | INCOMER SWITCHGEAR AMP | | |
| 30 | POWER CABLE SIZE | | |
| 31 | POWER SUPPLY (VOLT/HZ/PH) | | |
| 32 | TOTAL CONNECTED LOAD REQUIRED | | |
| 22 | NOISE LEVEL AT 1 M DISTANCE | | |

## 12.11. CONTROLS

### 12.11.1. Scope

This chapter covers the requirements of equipment safety controls, refrigerant flow controls, system controls, and variable speed drive (VSD). For chilling units all the controls shall be microprocessor based.

### 12.11.2. Equipment Safety Controls

a. Compressor:

1. Compressor shall be provided with the following safety controls:-

   I. High discharge pressure (HP) safety (cut out) to stop the compressor automatically, in case discharge pressure exceeds a preset safe value. This safety shall operate when discharge head pressure exceeds the set point. Only manual resetting shall be provided for this safety.

   II. Low suction pressure (LP) safety (cut-out) to stop the compressor automatically, in case suction pressure falls below a pre-set value. This safety shall operate when the suction pressure falls below the set point. Automatic resetting shall be provided for this safety, with adjustable cut-in and cut-out pressures. This safety shall be used for pumping down the system for shutting off the refrigeration plant.

   III. Oil pressure (O.P) safety (cut-outs) to stop the compressor, in case lubricating oil pressure falls below a safe set value. A time delay mechanism shall also be provided, so as to permit running of the compressor upto a maximum period of 90 seconds, with the oil pressure differential below the set value and allow it to continue normal operation if the pressure differential builds up to the set value within that time, or otherwise shut-down the compressor. Only manual resetting shall be provided for this safety.

   IV. High bearing oil temperature cut-out (for centrifugal compressor only). This shall be provided with a manual reset only.

   V. High lubricating oil temperature cut-out (for centrifugal compressor only). This shall be provided with a manual reset only.

   VI. Time delay mechanism on the starting gear to limit short cycling regardless of malfunctioning of controls.

   The cut-outs (i) to (v) mentioned above shall operate when the respective controlled variable crosses the set point to trip the compressor. Audio visual alarm shall be provided to indicate such operations. A manual reset shall be provided for them.

2. Safeties mentioned above shall operate when the respective controlled variable crosses the set point to trip the compressor.
3. Audio visual alarm shall also be provided to indicate such operations.

b. Condenser

The safety control for a condenser shall comprise a safety pressure relief valve on the shell. This shall operate to relieve the pressure at the set point without prior leakage. For small condensers, a fusible plug may be provided to melt at a predetermined temperature.

c. Chiller

   I. An Antifreeze shall be provided with water chiller, set at a few degrees above the freezing point. This shall operate, when the temperature of water in the chiller falls below the set point to trip the compressor motor. The reset provided for the safety shall be manual.

   II. Flooded type of chiller in addition, shall be provided with safety pressure relief valve.

d. Refrigeration Plant

In addition to the safety controls as above for the individual components of a refrigeration plant, the following safety controls shall also be provided for the plant.

I. Compressor motor over current cut-out.
II. Condenser water flow switch.
III. Chilled water flow switch.
IV. Condenser air flow switch in the condenser fan discharge (in case of air-cooled condensers).
V. Air flow switch in the evaporator fan discharge in case of direct expansion coils

1. The above controls, on operation, shall trip the compressor motor, and these shall be provided with manual reset arrangement.
2. The compressor motor shall also be interlocked electrically with,
   I. Condenser water pump in case of water cooled condenser, and condenser fan with air cooled condensers,
   II. Chilled water pumps in case of chilled water system and evaporator fan in case of direct expansion system, and
   III. Antifreeze thermostat in case of chillers.
3. Indicating lamps shall also be provided on the control panel for indicating operation of the safeties and interlocks.

### 12.11.3. Refrigerant Flow Controls

A refrigeration plant shall be provided with controls, necessary for starting, stopping and modulating the flow of refrigerant in the plant so as to satisfy the load requirements. These comprise solenoid valve, thermostatic expansion valve, float valve, compressor capacity controls etc. and other special controls if specified in a particular work.

a. Solenoid Valve
   I. For screw type compressors liquid line solenoid valve shall be provided in the liquid line of the system, ahead of the expansion valve, to allow or to stop the flow of liquid refrigerant to an evaporator, or a section of sectionalized evaporator. This shall be operated by snap-acting thermostat and it shall also be provided with a test switch to enable manual energizing.
   II. Discharge gas valves shall be provided in the following applications as required:
   III. Hot gas defrosting: normally this solenoid valve shall remain closed, but it shall open up to feed the evaporator with hot gas for defrosting when required, especially in cold storage applications.
   IV. Solenoid valves shall be direct acting in smaller sizes and pilot operated for larger sizes, as required. The size of the valves shall be determined by the desired flow rate of refrigerant through them and the pressure drop across the same (and not by the size of the refrigerant line).

b. Thermostatic Expansion Valve
   Thermostatic expansion valve shall be provided in DX type refrigeration plant to modulate the flow rate of liquid refrigerant entering the evaporator in response to the extent of superheat of refrigerant gas leaving the evaporator, so that only a metered flow is ensured matching the load. The number of expansion valve shall be such that the specified accuracy of temperature control of the system can be achieved and that no valve is expected to operate below 35% of its rated capacity. The sizes shall be selected suitably so as to avoid hunting. Adjustable super heat control and external equalizer port shall be provided for each valve. Each expansion valve shall be easily removable for cleaning and adjusting.

c. Float Valve

Float valve shall be provided in refrigerant plant with flooded type chiller for maintaining the liquid level in chiller under all conditions of load at a rate commensurate with the rate of vaporization. This can be provided either on low pressure side or on high pressure side. When provided as low side float valve, this shall be located as a part of the chiller or accumulator.

d. Compressor Capacity Control

The capacity control arrangement shall be in accordance with 2.2A.7 for centrifugal type compressors and 2.2B.8 for screw compressors.

**12.11.4. System Controls**

i) The requirements for maintaining the inside design conditions as specified in the tender specifications for the work shall be met by appropriate system controls and control elements. The system shall satisfy the requirements of both full load and partial load conditions. Details of complete control elements shall be indicated by the tenderer in the tender.
ii) Control shall be affected by 2 way diverting valve in chilled water coil. For heating using hot water coils, now control through them shall also be achieved by using 2 way valves.
iii) The size of 2 way diverting valves shall be selected so as to match the coil where in the flow is to be regulated. The make and size shall be indicated in the Technical particulars in the tender.
iv) Operation of the modulating proportional motor of 2 way diverting valve shall be controlled by proportional type thermostat.

**12.11.5. Operational Controls and Interlocks**

i) The operation of refrigeration plant shall be either manual or automatic, as specified. The plant shall be started by an ON/OFF switch. Additionally, in the case of an automatic plant, an auto/manual switch shall also be provided.
ii) The automatic operation shall be effected through the monitoring of return chilled water temperature, or the room conditions, as the case may be. In multi-unit installations, one unit shall be arranged to be loaded fully before the next unit is switched on automatically. A similar operation system shall be followed in shutting off of the unit. Change over from one operating unit to another shall be possible through the status switch of the plant to be shut down by change to manual position and thus overriding its anti-cycle timer. It should be possible to introduce the changed unit by running it to speed and changing over the status switch to "auto" position.
iii) Pump down shut down shall be provided through low pressure (LP) safely irrespective of the status switch position, auto/manual.
iv) It should be possible to start the compressor motor only after the cooling tower fan motor, chilled water and condenser water pumps are operated.
v) The blower motor shall be interlocked with strip heaters (where provided) such that power supply to strip heaters will become ON, only after the blower has been started and run to full (designed) speed.
vi) Where only the blower motor and not heaters is connected to standby generating set in any particular application, a timer shall be provided, such that the heaters may get energized, only after a period of time, after the blower is run.
vii) In the event of signal from high limit safety of heaters the power supply to the blower motor and the heater bank shall automatically and instantly be switched off.
viii) The power supply to AHU shall be cut off on receipt of a signal from the Fire Alarm System.

**12.11.6. Requirements of Control Elements**

The system control elements comprise controlling elements such as thermostats, three way valves etc. as required for individual applications.

12.11.6.1. **Thermostats**

Thermostats shall be electric fixed differential type as indicated below, with sensing element located in the return air stream. All thermostats shall be supplied with the standard mounting boxes as recommended by the manufacturer. The profile, mounting arrangement and exact location of the thermostat shall be such as to suit the site.

i) Proportional control thermostats shall be provided for actuating the three way modulating valve at each air handling unit. Thermostat shall provide manual switching (heat-off-cool-in heating-cooling system).
ii) Snap-acting fixed differential type thermostat for actuating the three-way diverting valve at each fan coil unit
iii) Thermostat shall have temperature adjustments WARM-NORMAL-COOL settings and fan switch. Switching off must break fan circuit.
iv) Snap-acting fixed differential heating thermostat for electric winter heating and reheat applications for putting on/off power supply to electric heating or reheat coils in air handling units.
v) Safety thermostat shall be provided for electric winter heating and reheat application for cutting off power supply to strip heaters in case air flow across strip heater is not established.
vi) Air-stat shall be provided within air handling unit containing electric heating or reheat coils to prevent heaters from energizing unless the air flow is established.

12.11.6.2. **Pressure Independent/Balanced/High-Rangeability Control Valves (Picv) – AHU**

The Self balancing flow control valves that are pressure independent, 2-way, modulating to accept Input signals from the control system.

Each Air Handling Unit / Fan Coil Unit shall be provided with a Two Way Pressure Independent Balancing and Control Valve integrated in a single Body. The valve should be a Globe Type. Diaphragm (not cartridge) based delta p controller should ensure 100% valve authority & linear characteristics at all loads and all settings.

Regarding Control - Valve should be equipped with electronic modulating gear type (not thermal/wax) actuator which can accept either “4(0)-20 mA / 2(0)-10V DC signals. Operating voltage for actuator shall be 24V AC.

All Valve actuators should be microprocessor based with self-calibrating feature.
Valve Actuator combination should be able to give logarithmic control characteristics to achieve linear control.

Actuator shall be able to work against pump head or maximum closing pressure. Manual Override Flow Balancing should only be done in Valve, not in actuator and should not involve opening of actuator Body.

Regarding Balancing – Each Valve should have a step less adjustable maximum flow limitation as per the designed flow rate of coils. The balancing should be done only in the valve not in the actuator so that in case of actuator failure the balancing is not lost and easily accessible.

12.11.6.3. **Two-Way Diverting Valves for FCUs**

This shall be provided as 2 position diverting valves in chilled/hot water lines at each fan coil unit and shall be actuated by space thermostat. Space conditions shall be maintained by allowing all of chilled/hot water to either pass through the coil or bypass the coil and mix with the chilled/hot water return. The valves shall revert to fully bypass position when fan is shut off. Pressure drop across the valve shall not exceed 0.14 kg/ sq.cm. Valve shall have the facility to replace motor actuator without removing the valve body.

**12.11.7. Variable Speed Drive (VSD)**

12.11.7.1. Air Quantity Flow Control

The VSD System shall function to supply variable air quantity in the air-conditioned area in response to the load variations including that due to variations in ambient conditions and filter cleanliness conditions, to maintain the inside designed temperature, RH and pressure conditions in conjunction with the humidifier and re-heaters. During the day hours, as per the time interval selected, the VSD System shall regulate the speed of the AHU to maintain the temperature within maximum designed

temperature and positive air pressure inside the air-conditioned area. The positive air pressure shall be maintained by keeping a difference of minimum 15% in the –airflow between the supply and exhaust air. However, under any circumstances during the day hours, the air flow rate will not fall below the 60% of the rated CFM of the AHU or 15 air changes, whichever is higher. During the rest of the night hours, the Programmable timer shall give a signal to the VSD to run the AHU at a pre-determined reduced speed so as to provide only 25% of the normal CFM or the minimum CFM achievable closest to 25% but not below 25% of the normal CFM. Due to the clogging of the air filter if the inside temperature conditions are not achieved even at 100% AHU speed then the VSD will close an N.D. contacts to activate an alarm. The VSD shall have the provision to switch over to the manual mode as and when required. The system shall comprise of dedicated Variable Speed Drives (VSDs) designed for HVAC applications to accept 2 feedback signals (from temperature sensor installed in the AC area and programmable timer controller) and have 2 programmable set points (inside temperature conditions, and 60% of the normal CFM condition as stated above) using HVAC terminology, to regulate the speed of the AHU motors in response to the variations in load and filter cleanliness conditions to maintain temperature and Air flow differential in supply and exhaust conditions. In case, any additional sensor (s) including wiring etc are required to meet the system requirements the cost of that shall be deemed to be included in the cost of the VSD. The VSD control shall have:

a) RFI (Radio frequency interference) filters for EMC (Electromagnetic compatibility) compliance.
b) Voltage Vector Control technology to generate advanced sinusoidal output voltage, 100% true RMS value of the fundamental voltage at rated speed and nominal torque, cause no motor de-ration and keep motor temperature limits within permissible class B limits.
c) Displays in user's friendly Alpha Numeric Characters for all operating parameters, programming parameters and faults.
d) Built in energy meter
e) Built in run time counter
f) Local control panel (key pad)

The system shall also comprise a suitable programmable timer & PLC with required electronic components, to allow 2 feedback signals (Temperature &Minimum CFM) to be passed on to the VSD during the day hours. In the night hours only one signal from the programmable timer shall go to the VSD to run it at pre-determined reduced speed. The room l space air temperature and air flow shall be sensed by a temperature and air flow transmitters, which shall generate suitable DC signal to provide feedback to the VSD, which in turn shall regulate the speed of the AHU fan to maintain the designed conditions as described above.
VSD shall be designed, with built-in PID controller, control panel (keypads &display), IP 54/55 enclosure for use on standard centrifugal fans. The VSDs should not cause any de-ration of the connected motors and must ensure that class B temperature levels of the connected motors are never exceeded, The display should be in alpha-numeric characters and programming facility should be in user-friendly HVAC terminology. The VSDs should be able to accept up to 2 feedback signal from temperature &air flow transmitter simultaneously and to program 2 set points in it. It shall have IP 54/55.

The system shall also have following features incorporated

a) Heat sink over temperature protection
b) Under voltage protection
c) Over voltage protection
d) Alpha-numeric display facilities
e) On indication Trip indication
f) Selectable display of various parameters line voltage, frequency, speed, power, torque, motor temperature percentage, VSD temperature percentage, KWH.
g) Raise and lower speed push button in local mode
h) Frequency range variation from 0 to 50 Hz.

i) Remote start and stop facility including indications thereof with necessary hardware and terminal blocks, including toggle switch etc. to override remote start & stop at the time of maintenance/repairs.
j) Off delay facility through timer or PLC with 30 sec to 120 sec. time delay, to be connected to air flow switch.
k) Safeguard facility against single phasing.
l) Tripping of AHU blower motors in response to the fire alarm Signal from AFAS.
m) Inter locking of Exhaust and AHU blowers such that power supply gets fed to exhaust blower only when the supply air flow is there.

Note: All starters and VSDs shall have inbuilt MCCB/ MPCBs in accordance with Type 2 Coordination

12.11.7.2. **Chilled** Water Flow Control

Variable Speed Drive (VSDs) for controlling the chilled water flow rate in the secondary circuit may be provided when AHUs operation is for 24 hours and where the secondary chilled water system has been provided. Requirement and Specifications of VSD system shall be as follows:

The VSD System shall function to supply variable chilled water flow in the secondary circuit of air-conditioning system in response to the load variations including that due to variations in ambient conditions to maintain the inside designed temperature conditions. However, under any circumstances, the secondary chilled water pump speed shall not fall below the 30% of the nominal speed or any other suitable minimum speed as per the system requirement. The VSD shall have the provision to switch over to the manual mode as and when required and facility for the manual speed variation from VSD itself. The system shall comprise of dedicated Variable Speed Drives (VSDs) designed for HVAC applications to accept two feedback signals (from differential pressure transmitters installed across the two farthest, most significant AHUs of the zone to select either maximum of the two or average of the two (as selected by the user) feedback signals using HVAC terminology, to regulate the speed of the secondary chilled water pump motors in response to the load variations. In case, any additional sensor (s) including wiring etc. if required to meet the system requirements the' cost of that shall be deemed to be included in the cost of the VSD. The VSD shall have:

a) The VSD system and controller shall be in such a way that the master controller can work with all other VFDs in case of problem even in master VFD.
b) RFI (Radio frequency interference) filters for EMC (Electromagnetic compatibility) compliance.
c) Voltage Vector Control technology to generate advanced sinusoidal output voltage, 100% true RMS value of the fundamental voltage at rated speed and nominal torque, cause no motor de-ration, and keep motor temperature limits within permissible class B limits.
d) The VSDs shall have D.C. link reactors/ harmonic filters integrated to minimize power line Harmonics. There shall be reactors in both the positive and negative rails.
e) An automatic energy optimization feature shall be provided as standard in the frequency converter. This feature shall reduce output voltage, further to quadratic V/f characteristics, when the motor is lightly loaded and minimize the motor losses.
f) The VSD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 160% torque for upto 5seconds (for high inertia and high friction load).
g) The VSD shall include Automatic Motor Adaptation (AMA) to optimize motor performance, improve start capabilities and compensate for motor cable variances. The AMA shall be carried out at motor stand still with no need for detaching the pump from motor.
h) Unlimited output power circuit switching must be possible without the need for central circuit interlocking and without causing damage to the VSD.
i) Auto-derating of maximum drive current shall be incorporated in VSD to allow continued operation at reduced speed in case of VSD over temperature phase loss or mains imbalance without damaging the VSD.
j) Displays in user's friendly Alpha Numeric Characters for all operating parameters, programming parameters, faults, built in energy meter.

k) In run time counter.
l) Local control panel (key pad)

The system shall also comprise a suitable PLC if required, with electronic components.

VSD shall be designed, with built-in PID controller, control panel (keypads &display), IP 20 enclosure for use on standard centrifugal pumps. The VSDs should not cause any de-ration of the connected motors and must ensure that class B temperature levels of the connected motors are never exceeded. The display should be in alpha-numeric characters and programming facility should be in user-friendly HVAC terminology. The VSDs shall be able to accept up to two feedback signals from differential Pressure transmitters simultaneously and to program set points in it. The system shall have following features incorporated:

a) Heat sink over temperature protection
b) Under voltage protection
c) Over voltage protection
d) Protections against input transients, loss of A.C. line phase, short circuit, ground fault, frequency converter over temperature.
e) Alpha-numeric display facilities
f) On indication
g) Trip indication
h) Selectable display of various parameters like output line voltage, output frequency, speed, power, motor temperature percentage, heat sink temperature, VSD temperature percentage, KWH, hours run, differential pressure.
i) Raise and lower speed push button in local mode.
j) Frequency range variation from 0to 50 Hz.
k) Remote start and stop facility including indications thereof with necessary hardware and terminal blocks, including toggle switch etc. for over ride of remote start & stop of at the time of maintenance/repairs.
l) Safeguard facility against single phasing.

12.11.7.3. **Where** building management system and air quantity flow control/ chilled water flow control through VFD are provided for same application, control panel for sequencing of VFD shall not be required.

**12.11.8. VRF Centralized Control System**

Centralized control of the system shall be achieved via 3 user friendly compact controls: centralized remote control, unified on/off control and schedule timer. These controls may be used independently or in combination where 1 group = several (up to 16) indoor units in combination and 1 zone = several groups in combination.
A centralized remote control is for use in guest House buildings subject to random occupation, enabling indoor units to be classified in groups per space (zoning).
The schedule timer programs the schedule and operation conditions for each tenant and the control can easily be reset according to varying requirements.

Centralized Control system shall do the below mentioned things:

a) Providing individual control of 64 groups (zones) of indoor units.
b) A maximum of 64 groups (128 indoor units, max. 10outdoor units) can be controlled.
c) A maximum of 128 groups (128 indoor units, max. 10 outdoor units) can be controlled via 2 central remote controls in separate locations.
d) Zone control.
e) Group control.
f) Malfunction code display.
g) Expanded timer function.

**12.11.9. Basement Ventilation Fan Control**

a) All the Vane axial/Tube axial fan, located in the basement, for normal operation shall be actuated as per the below given details:
   i) Firstly, CO sensor based operation.

ii) Time clock (if required and adjusted).
iii) Manual, just in case of any control system failure.

b) Time setting for fans shall be done as per the operation and usage of the building. Minimum operational hour of ventilation fan for normal mode shall be 6 hours/day.
c) All the Vane axial/ Tube axial fans installed for fire mode shall be integrated with sprinkler flow switch and fire control panel. In case of fire detection, fire panel shall command the fire fans to operate continuously.
d) In case of fire, sprinkler burst and pressure in the firefighting pipe drop which in turn actuate the nearby fire panel to maintain the certain minimum pressure.
e) Tapping from that fire panel outgoing feeder connected to the ventilation fan panel actuate the fan instantly.

## 12.12. WATER PLUMBING WORK

### 12.12.1. Scope

This chapter covers the requirements of plumbing work in chilled water, hot water, water in condenser circuit, **Refrigerant Plumbing and drains**, to be executed as part of heating, ventilating and air conditioning.

### 12.12.2. Plumbing Design

Pipe sizes shown in tender documents are purely for sub-contractor's guidance. The sub-contractor shall be responsible for selection of sizes as per detailed engineering to be done by him. Plumbing design to be done by the Air-conditioning contractor shall conform to the following:

i) Water velocity in pipes shall not exceed 2.5 m/sec.
ii) Butterfly/Ball valves shall be provided at
   a. Suction and delivery sides of pumps
   b. Inlet and outlet of each condenser, chiller, cooling tower, hot water generator
   c. All drain connections from equipments
   d. Inlet & outlet of every heat exchanger coil, namely for AHU's, FCU's, convector etc.
iii) Non return (Check) valve shall be provided at the delivery of each pump. This shall be of swing type.
iv) Balancing valve shall be provided at the outlet side of chiller, condenser, heating and cooling coils to regulate the maximum flow rate up to value preset as desired.
v) Balancing valves shall be provided, where specified, for AHU's to regulate the maximum flow rate upto a value preset as desired. A mercury manometer shall be supplied with every 10 nos. or part thereof of balancing valves, whether or not specifically indicated in the tender specifications.
vi) Air vent valves shall be provided at all high points in the piping system for venting with a size of 25 mm for pipes up to 100 mm and 40 mm for larger pipes.
vii) Plumbing drawings showing the sizes of valves, layout and other details shall be prepared and shall be got approved from the Engineer-in-Charge before the execution of the plumbing work.

### 12.12.3. Pipe Materials

Pipes shall be of the following materials.

i) Mild steel medium class (Black steel) tube conforming to IS: 1239 for sizes upto 150 mm.
ii) Welded black steel pipe, class 2, conforming to IS: 3589, for sizes greater than 150mm. These pipes shall be factory rolled & fabricated from minimum 6mm thick M.S. Sheet for pipes upto 350mm dia. & from minimum 7mm thick M.S. sheet for pipes of 400mm dia. & above.
iii) For buried piping in the external of the building shall follow below specs:

- The core pipe shall be MS, ERW heavy duty class to IS: 1239 & IS: 3589. All pipes shall be with beveled ends for welded joint.
- All underground hydronic piping shall be insulated with polyurethane foam (PUF) with maximum thermal conductivity of 0.021 W/m k at 24° C, when tested in accordance with IS: 12436 complete with HDPE jacket.
- All above ground hydronic piping shall be insulated with polyurethane foam (PUF) with maximum thermal conductivity of 0.021 W/m k at 24° C, when tested in accordance with IS: 12436.
- The insulation shall be rigid cellular polyurethane foam, injected between the core pipe and the outer casing/jacket, having a density of 40 kg/m3 (2.5 lbs/ft3) nominal and thermal conductivity coefficient of 0.021W/m°K (max) at a mean temperature of 24°C (75°F). The insulation shall meet IS: 12436 specifications with typical operating temperature between -30°C to +100°C.
- Chilled water piping insulation thickness shall be 25 mm thick for 40 mm pipe and smaller, 40 mm thick for 50 mm to 150 mm pipe and 75 mm thick for pipe greater than 150 mm.

- The outer casing/jacket shall be made of extruded high-density polyethylene (HDPE) pipe having a density of 900 to 960 kg/m3. HDPE wall thickness shall be 4mm thick for pipe of 60.3 mm dia and above. For small bore pipes (below 60.3mm) available HDPE pipes shall be used, where thickness can be lower than 4mm as per standard for HDPE pipes. Material shall be UV resistant.
- Pre-insulation process shall be by high pressure foaming machine. Due care shall be taken to avoid air gaps.
- All ends of straight pipes and fittings shall be sealed with polyolefin end seal, applied to the exposed ends of the insulation for protection against moisture ingress.
- The field joint insulation shall consist of polyurethane foam chemical poured into a 4mm thick HDPE sheet roll-up around the joint. Contractor shall provide methodology for approval of consultant before proceeding with work at site.
- The service pipe shall be hydrostatically pressure tested at a minimum of 150 % of the design pressure in accordance with ASME B31.1. Hydro testing shall be performed prior to applying the insulation and jacket at the field joint. A heat shrinkable or weld able HDPE casing which is pressure testable shall be installed over the field joint area and pressure tested in accordance with the manufacturer's instruction prior to insulating the field joint area.
- The system shall be non-corrosive, non-metallic, structurally strong completely water proof and entirely resistance to attack by salts, water and all ground chemicals normally encountered.
- All straight sections fittings, anchors end seals and other accessories shall be factory prefabricated to the project dimensions. The same may be allowed at site if OWNER permits.
- Pipe movement due to thermal expansion shall be accommodated with expansion loops or elbows.
- A warning sign board per CPWD signs board specifications showing clearly “BURIED CHILLED WATER PIPE” shall be marked on the ground at every 100 m interval.

**12.12.4. Pipe Joints**

Joints in black steel pipes shall be of any of the following types.

i) Screwed joints and union joints screwed to pipes, upto 25 mm size.
ii) Butt welded joints for pipe sizes above 25mm. electric welding shall be used for sizes 100mm and above.
iii) Flanges joints with flanges as per IS: 6392 for all sizes. Flanges may be steel welded neck type or slip on type welded to pipe, or alternatively screwed type.

**12.12.5. Valves**

i) The material of butterfly valves shall be as under:
   Body - Cast iron
   Disc - Cast Bronze or Stainless Steel
   Seat - Either integral or Nitrile rubber
   O-ring – Nitrile/Silicon

ii) Balancing valve shall be of cast iron flanged construction with Ethylene propylene diene monomer(EPDM)/ Spheroidal Graphite(SG) iron with epoxy coated disc with built in pressure drop measuring facility (pressure test cocks) to compute flow rate across the valve. The test cocks shall be long enough to protrude out of pipe insulation.

iii) Non return valves shall be of gun metal construction upto 65 mm, the metal conforming to class 2 of IS: 778. For 75 mm and above, the valve shall be of bronze or gun metal, body being of cast iron. While screwed or flanged ends may be provided upto 65 mm, flanged ends shall be provided for larger sizes.

iv) Air vent valves shall be of gunmetal body.

**12.12.6. Strainers**

i) Strainers shall be of 'Y" type or pot type as specified. 'Y' strainers shall be provided on the inlet side of each air-handling unit and pump in chilled water and condenser water circuit. Pot strainers, where specified, shall be provided in return water headers, for chilled water and condenser water if enough floor area is available in the refrigeration plant room, as an alternate to individual Y type strainers with pumps. The strainers shall be designed to the test pressure specified for the gate valves. Filtration area of Y-strainer shall be minimum our times the connecting pipe size.

ii) They shall be provided with equal size isolating gate valves on either side so that the strainers may be cleaned without draining the system.

iii) Pot strainer shall be fabricated out of MS sheet and the sizes shall be as under:

| Pipe sizes (mm) | Pot dia (mm) | Pot Height (mm) | Basket dia (mm) | Basket Height (mm) |
|---|---|---|---|---|
| 50 | 300 | 400 | 200 | 240 |
| 80 | 350 | 450 | 250 | 250 |
| 100 | 450 | 500 | 300 | 280 |
| 125 | 500 | 600 | 330 | 340 |
| 150 | 540 | 700 | 360 | 390 |
| 200 | 610 | 815 | 400 | 470 |
| 250 | 800 | 955 | 550 | 510 |
| 300 | 1000 | 1105 | 750 | 580 |
| 350 | 1190 | 1300 | 895 | 678 |
| 400 | 1350 | 1500 | 1020 | 785 |
| 450 | 1518 | 1700 | 1060 | 890 |
| 500 | 1690 | 1800 | 1100 | 900 |

Strainers shall have a removable bronze/stainless steel minimum 1mm thick screen with 3 mm perforations and permanent magnet. Strainers shall be provided with flanges or threaded sockets as required. They shall be designed so as to enable blowing out accumulated dirt and facilitate removal and replacement of screen without disconnection of the main pipe.

**12.12.7. Instruments**

a) Pressure gauge of appropriate range and 150 mm. dial size shall be provided at the following locations.
   i. Supply and return of all heat exchange equipments.
   ii. Suction and discharge of all pump sets.

b) The pressure gauge shall be duly calibrated before installation and shall be complete with shut off cocks.

c) Direct reading industrial type thermometer of appropriate range shall be provided at the inlet and outlet of all heat exchange equipments. The thermometers shall be installed in separate wells.

d) Flow meter of orifice type shall be provided for measuring the flow through each condenser and chiller.

**12.12.8. Expansion Tanks and Air Separator**

Expansion tanks for chilled water and hot water shall be of M.S. construction and of adequate capacity, to contain 200% of the maximum expansion likely to take place in the system.

Expansion tanks shall be having full acceptance factor and shall be ASME rated/European standard code 97/23/EC, pre-charged bladder-type pressure vessels. The tank shall be designed to absorb the expansion forces of heating / cooling system water maintaining proper system pressurization under varying operating conditions. The heavy duty bladder should contain system water thereby eliminating tank corrosion and water logging problems.

MATERIALS OF CONSTRUCTION

- System connection: forged steel

- Shell: carbon steel
- Bladder: Heavy Duty Butyl Rubber
- Designed and Constructed per ASME section VII, Division 1

**Air Separator**

Furnish and install, as shown on plans, a centrifugal type air separator. The unit shall inlet and outlet connections tangential to the vessel shell. The unit shall have an internal stainless steel collector tube with 5/32 ” (4mm) diameter perforations and 63% open area designed to direct accumulated air to the compression tank on an air control system or an air vent on an air elimination via an NPT vent connection at top of the unit.

A blow down connection shall be provided to facilitate routine cleaning of the separator. Manufacturer to furnish data sheet specifying air collection efficiency and pressure drop at rated flow.

Vessel shell diameter is to be three times the nominal inlet/outlet pipe diameter, with a minimum vessel volume for sufficient velocity reduction. The air separator must be designed, constructed and stamped for 125 psig@350°F(862 kPa @177°C) in accordance with section VIII, division I of the ASME Boiler and pressure vessel inspectors. The air separator(s) shall be painted with one shop coat of light gray air dry enamel.

A manufacturer’s data report for pressure vessels, Form U-1 as required by the provisions of the ASME boiler and pressure vessel code, shall be furnished for each air separator upon request.

**12.12.9. De-Scaling Equipment in Condensor Pipe:**

Each condenser water pipe from the cooling tower to the condenser side of the chiller shall be provided with the de scaling plug of the following specification:

- Material of construction: MS/SS
- Length of Equipment: 750 mm to 1000mm
- Diameter of the equipment: Same as inlet cooling water line
- Flanges: Same as outer shell , MS/SS
- Water parameters:
    a. Ph: 7.0 to 8.5
    b. Total Hardness: Upto 10000 ppm
    c. TDS: Upto 50000 ppm
    d. Flow rate: To meet the design requirements

Refer typical details for installation.

**12.12.10. Condensate Drain Piping:**

All pipes to be used for condensate drain shall be Insulated medium class GI pipe & all joints should be Gluing or solvent cementing as per manufacturer recommendation.

**12.12.11. Flexible Connections**

i) The Flexible connections shall be flanged type expansion joint. Flanges shall be non-compressible and mechanically strong type and the Neoprene rubber shall be provided in between the flange ends.
ii) The connections shall work for a temperature range of minus 10°C to 70°C.
iii) The length and working pressure of bellows shall be as follows:

| Nominal Bore (mm) | Length (mm) | Pressure (Bars) |
|---|---|---|
| 20-25 | 125 | 15 |
| 32-200 | 150 | 15 |
| 250-350 | 200 | 10 |

iv) Connections shall be provided with control roads to control the excessive elongation or compression of piping systems.
v) It shall have torsional movement upto 3° without damage.

vi) The drain piping shall be medium class galvanized steel as per relevant latest IS code.
vii) The fittings shall be of 'R' brand or equal forged with screwed connections.
vii) The gate valves shall be of gun metal as described earlier.
ix) Pipe crosses shall be provided at bends, to permit easy cleaning of drain line or plugged tees.
x) The drain line shall be provided upto the nearest drain trap and pitched towards the trap.
xi) Drain lines shall be provided at all the lowest points in the system, as well as at equipment, or to remove condensate and water from pump glands.

**12.12.12. Installation**

i) The installation work shall be carried out in accordance with the detailed drawings prepared by the sub-Contractor and approved by the Engineer-in-charge.
ii) Sub-contractor shall utilize the structural provisions for Air-conditioning services wherever provided by the lead contractor in the building and make his own arrangements for additional changes.
iii) Expansion loops or joints shall be provided to take care of expansion or contraction of pipes due to temperature changes.
iv) Tee-off connections shall be through equal or reducing tees, otherwise ferrules welded to the main pipe shall be used. Drilling and tapping of the walls of the main pipe shall not be resorted to.
v) Wherever reducers are to be made in horizontal runs, eccentric reducers shall be used if the piping is to drain freely, in other locations, concentric reducers may be used.
vi) Open ends of piping shall be blocked as soon as the pipe is installed to avoid entrance of foreign matter.
vii) All pipes using screwed fittings shall be accurately cut to the required size and threaded in accordance with IS: 554 and burs removed before laying.
viii) Piping installation shall be supported on or suspended from structure adequately. The sub-contractor shall design all brackets, saddles, clamps, hangers etc. and shall be responsible for their structure integrity.
ix) Pipe supports, preferably floor mounted shall be of steel, adjustable for height and prime coated with zinc chromate paint and finish-coated gray. Spacing of pipe supports shall not be more than that specified below:

| Nominal Pipe size (mm) | Spacing (Meters) |
|---|---|
| 12 and 15 | 1.25 |
| 20 and 25 | 2.00 |
| 32, 40, 50 and 65 | 2.50 |
| 80, 100 and 125 | 2.50 |
| 150 and above | 3.00 |

x) Extra supports shall be provided at the bends and at heavy fittings like valves to avoid undue stress on the pipes. Pipe hangers shall be fixed on walls and ceiling by means of metallic or rawl plugs or approved shear fasteners.
xi) Insulated piping shall be supported in such a manner as not to put undue pressure on the insulation.
xii) Anti-vibration pads, springs or liners of resilient and non-deteriorating, material shall be provided at each support, so as to prevent transmission of vibration through the supports.
xiii) Pipe sleeves of diameter larger than the pipe by least 50 mm shall be provided wherever pipes pass through walls and the annular spaces shall be filled with felt and finished with retaining rings.
    a. Vertical risers shall be parallel to walls and column lines and shall be straight and plumb. Risers passing from floor to floor shall be supported at each floor by clamps or collars attached to pipe with a 12 mm thick rubber pad or any other resilient material as approved by the Engineer-in-charge.
    b. The space in the floor cut outs around the pipe work (after insulation work where applicable) shall be closed using cement concrete (1:2:4 mix) or steel sheet, from the fire safety considerations, taking care to see that a small annular space is left around the pipes to prevent transmission of vibration to the structure.

c. Riser shall have suitable supports at the lowest point.

xiv) Where pipes are to be buried under ground, the top of the pipes shall be not less than 75cms from the ground level. Where this is not practicable, permission of the Engineer-in-charge shall be obtained for burying the pipes at lesser depth. The pipes shall be surrounded on all sides by sand cushion of not less than 15cms. After the pipes have been laid and top sand cushion provided, the trench shall be refilled with the excavated soil and any extra soil shall be removed from the site of work by the sub-contractors.

xv) All pipes and their steel supports shall be thoroughly cleaned and given one primer coat of Zinc chromate before being installed.

xvi) After all the water piping has been installed, pressure tested in accordance with clause 8.13, all exposed piping in the plant room shall be given two finish coats of paint, approved by the Engineer-in-Charge. Similar painting work shall be done over insulated pipe work, valves etc. The direction of flow of fluid in the pipes shall be indicated with identifying arrows.

xvii) 3mm gasket shall be used for flanged joints.

xviii) Cut-outs in floor slabs shall be sealed with cement concrete or steel plate after the plumbing work is done, from the fire safety point of view.

**12.12.13. Refrigerant Plumbing**

12.12.13.1. **DESIGN** ASPECTS OF REFRIGERANT PLUMBING

12.12.13.2. **Refrigerant** piping shall be designed and installed so as to:

i) Ensure circulation of adequate refrigerant at all loads.
ii) Ensure oil return to crank case of compressor positively and continuously.
iii) Keep pressure losses within limits, especially in suction lines.
iv) Prevent oil/liquid refrigerant from entering the compressor when the compressor is working as well as when it has stopped.
v) Prevent trapping of oil in evaporator or suction lines, which may return to the compressor in the form of slug.

12.12.13.3. Hot gas **lines**: Oil shall be entrained and carried by hot gas under all load conditions likely to be encountered in normal operation.

12.12.13.4. Liquid Lines:

i) Liquid lines shall be designed to ensure that flashing of liquid refrigerant does not occur by minimizing the pressure drop suitably, by avoiding long vertical risers, and appropriate sub cooling.
ii) Each liquid line shall be provided with a permanently installed refrigerant drier of throw away or rechargeable type. The drier shall be installed in a valved line.
iii) Flow indicator (moisture indicating type) shall be installed on all liquid lines.

12.12.13.5. **Suction** Lines:

i) Oil shall be entrained and carried by the suction gas under all conditions of load likely to be encountered in normal operation.
ii) Piping shall be designed for a suitable velocity of refrigerant (similar to hot gas line) to ensure that oil will not separate from the gas and drain to the compressor in slugs.
iii) The refrigeration system shall be equipped with controls for pump down system so that the evaporator and suction line are emptied before the compressor shuts off, thus preventing liquid refrigerant and oil from entering the compressor when restarted.
iv) Refrigerant lines shall be sized to limit pressure drop between evaporator and condensing unit to less than 0.2 kg. per sq.cm. (3 psi).

12.12.13.6. Isolating valve shall be provided to enable isolation of each compressor in case of multiple compressor units (as built in valves), strainer, drier and any other components as may be required for proper operation and maintenance.

12.12.13.7. **Thermostatic** expansion valve/float valve shall be provided in refrigerant circuit.

12.12.13.8. **Material**

i) Refrigerant plumbing for chilling machine shall be of mild steel or wrought iron/copper to manufacturer's standards.
ii) Fittings like bends, tees, sockets etc. shall be of wrought copper or forged brass and shall be suitable for the duty involved. Flare type compression fittings of forged brass shall be allowed upto 15 mm piping size. Tubes upto and including 15mm size may be bent to form 90 degree bends with inside radius not less than 3tube dia. For bigger sizes, bend fittings as mentioned above must be used.
iii) Where specified in the tender specification, mild steel may be provided for refrigeration piping, with seamless MS tubes and fittings of heavy class conforming to IS: 1239. All liquid lines and instruments lines shall however be of copper only.
iv) Valves shall be of the packed, back-seating type for both copper and MS refrigerant plumbing work, and these shall be of forged or cast brass construction.

**12.12.14. Pressure Testing**

i) All piping shall be tested to hydrostatic test pressure of at least one and a half times the maximum operating pressure, but not less than 10 kg/sqcm for a period not less than 24 hours. All leaks and defects in joints revealed during the testing shall be rectified to the satisfaction of the Engineer-in-charge.
ii) Piping repaired subsequent to the above pressure test shall be re-tested in the same manner.
iii) System may be tested in sections and such sections shall be securely capped.
iv) It shall be made sure that proper noiseless circulation is achieved through all the coils and other heat exchange equipments in the system. If proper circulation is not achieved due to air-bound connections the contractor shall rectify the defective connections. He shall bear all the expenses for carrying out the above rectification including the tearing up and refinishing of floors, walls etc. as required. Insulation shall be applied to piping only after the completion of the pressure testing to the satisfaction of the Engineer-in-charge.
v) Pressure gauges may be capped off during pressure testing of the installation.
vi) The contractor shall provide all materials, tools, equipments, Instruments, services and labor required to perform the tests and to remove water resulting from cleaning after testing.

**12.12.15. Balancing**

i) After completion of the installation, all water system shall be adjusted and balanced to deliver the water quantities as specified, quoted, or as directed.
ii) Automatic control valves and three way diverting valves shall be set for full flow condition during balancing procedure. Water circuit shall be adjusted by balancing cocks provided for balancing. These shall be permanently marked after the balancing is completed so that they can be restored to their correct positions, if disturbed.
iii) Testing and Balance report shall be submitted in coordination with the design documents.

**12.12.16. Measurements Of Piping, Fittings, Valves, Fabricated Items:**

12.12.16.1. **Pipes**:

Including water piping, steam piping and all other piping required to be executed at site for completion of the work:

i) All pipes shall be measured in linear meter (to the nearest cm) along the axis of the pipes and rates shall be inclusive of all fittings and branches e.g. tees, bends, reducers, elbows etc. deduction shall be made for valves in the line.

ii) Exposing reinforcement in wall and ceiling and floors of possible and making good the same or installing anchor fasteners and inclusive of all items as specified in specifications and Schedule of Quantities.

iii) Rates quoted shall be inclusive of providing and fixing vibration pads and wooden pieces, wherever specified or required by Project Coordinator.

iv) Flexible connections, wherever required or specified shall be measured as part of straight length of same diameter, with no additional allowance being made for providing the same.

v) The length of the pipe for the purpose of payment will be taken through the centerline of the pipe and all fittings (e.g. tees, bends, reducers, elbows, etc.) as through the fittings are also presumed to be pipe lengths. Nothing extra whatsoever will be paid for over and above for the fittings for valves and flanges.

12.0.3.1. Valves and Flanges

i) All the extra cast iron and cast metal flanged valves shall be measured according to the nominal size in mm and shall be measured by number. Such valves shall not be counted as part of pipe length will be made wherever valves occur.

ii) All gun metal (gate & globe) valves shall include two numbers flanges and two numbers 150 mm long M.S. nipples, with one side threaded matching one of the valves, and other welded to the M.S. Slip-on-flange. Rate shall also include the necessary number of bolts, nuts and washers, 3 mm thick insertion gasket of required temp. Grade and all items specified in the specifications.

iii) The rates quoted shall be inclusive of making connections to the equipment, tanks, pumps etc. and the connection made with an installed pipe line shall be included in the rates as per the Schedule of Quantities.

12.0.3.2. Structural Supports

Structural supports including supports fabricated from pipe lengths for pipes shall be measured as part of pipe line and hence no separate payment will be made. Rates shall be inclusive of hoisting, cutting, jointing, welding, cutting of holes and chases in walls, slabs or floors, painting supports and other items as described in specifications, drawings and schedule of quantities or as required at site by Project Coordinator.

**12.12.17. Insulation**

The insulation of pipes carrying hot or chilled water shall be carried out as per Part XI.

**12.12.18. Expansion or Contraction:**

The contractor shall provide for expansion and contraction of all piping installed by the use of swing connections and expansion loops.

**12.12.19. Arrangement And Alignment Of Piping (To Be Coordinated With Other Trades):**

i) All piping shall be arranged and aligned in accordance with the drawings as specified. Where special conditions are encountered in the field, the arrangement and alignment of piping shall be as directed by the Project Manager/Engineer-in-charge/Consultants.

ii) The piping shall be installed in a uniform manner, parallel to or perpendicular to walls or ceilings, and all changes in directions shall be made with fittings. The horizontal piping shall be run at right angles and shall not run diagonally across rooms or other piping. Wherever possible all piping shall be arranged to provide maximum head room.

iii) All piping shall be installed as directly as possible between connecting points in so far as the work of other trades permits. Where interference occurs with another trade whose work is more difficult to route, this contractor shall reroute his pipes as required to avoid interference, at the discretion of the Project Manager/Engineer-in-charge/ Consultants.

iv) All piping shall be carefully installed to provide for proper alignment, slope and expansion.

v) The stresses in pipe lines shall be guided and pipes shall be supported in such a manner that pipe lines shall not creep, sag or buckle.

vi) Anchors and supports shall be provided wherever necessary to prevent any misalignment of piping.

vii) Small tubing gauges, controls or other equipment installed on any apparatus, shall not be coiled nor excessive in length, but shall be installed neatly, carefully bent at all changes in direction, secured in place and properly fastened to equipment at intervals to prevent sagging.

viii) The piping shall be grouped wherever practical and shall be installed uniformly in straight parallel lines in either vertical or horizontal positions.

ix) The piping connection to all dynamic equipment e.g., pumps, Induced draft evaporative fluid cooler etc. shall be of flanged type. This item shall be treated as a part of piping and shall not be charged separately

**12.12.20. Testing:**

i) In general, tests shall be applied to piping before connection of equipment and appliances. In no case shall the piping, equipment or appliances be subjected to pressures exceeding their test ratings.

ii) The tests shall be completed and approved before any insulation is applied. Testing of segments of pipe work will be permitted, provided all open ends are first closed, by blank-offs or flanges.

iii) After tests have been completed the system shall be drained and flushed 3 to 4 times and cleaned of all dust and foreign matter. All strainers, valves and fittings shall be cleaned of all dirt, fillings and debris.

iv) All piping shall be tested to hydraulic test pressure of at least one and half times the maximum operating pressure but not less than 10 kg/Sq.cm for a period of not less than 12 hours. All leaks and defects in the joints revealed during the testing shall be rectified to the satisfaction of the Project Manager/Engineer-in-charge/Consultants, without any extra cost.

v) All the piping systems shall be tested in the presence of Owner/Project Manager/Consultants or their authorized representative. Advance notice of test dates shall be given and all equipment, labor, materials required for inspection, and repairs during the test shall be provided by the contractor. A test shall be repeated till the entire systems are found to be satisfactory to the above authority. The tests shall be carried out for a part of work if required by Owner/Project Manager/Consultants in order to avoid hindrance in the work of the insulation contractor.

vi) All steam pipes shall be tested and proven tight under hydrostatic pressure of 20 kg/Sq.cm, unless otherwise stated, for a minimum period of 4 hours without drop in pressure.

vii) The contractor shall make sure that proper noiseless circulation is achieved through all piping systems. If due to poor bond, proper circulation is not achieved, the contractor shall bear all expenses for carrying out the rectification work including finishing of floors, walls and ceiling damaged in the process of rectification.

viii) The contractor shall provide all labour and materials to make provision for removing water and to the proper place, during the testing or/and after the testing to avoid damages to employer or other contractors properties. Any damages caused by the contractor to the employer or other contractors properties, shall be borne by the contractor.

## 12.13. INSULATION WORK

### 12.13.1. Scope

This chapter covers the requirements of thermal insulation for chilled water & hot water piping, pumps and tanks, duct work and acoustic lining in duct work and weather maker rooms. This does not cover exposed roof insulation and under deck insulation work.

### 12.13.2. Material Types

i) T.F. Quality expanded polystyrene insulation material shall be used for insulation of water piping, pumps and tanks. The pipe insulation should be in rigid sections in two halves and preformed to fit snugly on to pipes (up to pipe sizes for which the preformed sections are manufactured by the manufacturer of insulation). For higher pipe sizes insulation slabs shall be used. Insulation however, shall be applied in two layers.

ii) For Insulation of duct work Thermal insulation material for Duct insulation shall be anti-microbial closed cell cross linked polyethylene foam. Thermal conductivity of the insulation material shall not exceed 0.032 W/m K at an average temperature of 25 C. Density of the material shall be 25-30 Kg/m3. The product shall have temperature range of –40 C to 105 C.

The insulation material shall be fire rated for Class 1 as per BS 476 Part 7, 1987 for surface spread of flame test. Water vapor permeability as per DIN 52615 shall not exceed 0.15ng/Pa.Sec.m.

Thermal conductivity of the material shall not be affected by ageing, as per DIN 52616. The material must be tested for ageing effect in an accredited laboratory for a minimum period of five years to satisfy the ageing criteria.

The smoke density of the material as per AS-1530.3 shall not exceed 1. There shall be no toxicity in the emitted smoke, both under flaming and non-flaming conditions, as per AITM 3.000 (1993).

The insulation shall comprise of a single layer upto 18 mm thickness.

* All the piping and ductwork in the mechanical rooms, AHU rooms or spaces which are not air conditioned shall have cladding over the insulation to protect piping/ductwork from condensation and temperature loss.

iii) For acoustic lining of Ducting and AHU rooms : -Resin bonded glass wool.
iv) For suction line and Chiller insulation : -Nitrile rubber insulation
v) For double skin AHUs :-Polyurethane foam (PUF Insulation)

### 12.13.3. Material Specifications

The insulation material shall satisfy the following requirements:

i) For thermal application on Chilled/ Hot water pipes.

| Material | Min. Density (Kg/cu.m) | Max. Thermal conductivity(K.callhr) (°C/m at 10 deg C mean temp.) |
|---|---|---|
| Expanded Polystyrene (TF) | 20 | 0.035 |

Note: Thermal conductivity max 0.038 W/m K at an average temp of 30 C.

ii) For acoustic lining:

| Application | Material | Minimum Density (Kg./Cu.M) |
|---|---|---|
| Duct | Resin bonded glass wool | 32 |
| AHU room | Resin bonded glass wool | 32 |

iii) The specification for resin bonded glass wool insulation & resin bonded mineral wool insulation shall conform to IS 8183 as amended upto date. The specification for expanded polystyrene shall conform to IS-4671 as amended upto date

iv) Expansion tank Insulation: Expanded polystyrene insulation of density not less than 20kg per cum. shall be used.

**12.13.4. Insulation Thickness**

The thickness of insulation shall be as indicated below unless specified otherwise in the tender specifications.

i) For Chilled water pipe insulation

| Pipe Size (mm) | Insulation |
|---|---|
| 150 & above | 75 mm thick |
| Below 150 | 50 mm thick |

ii) For Condensate water pipe insulation

| Pipe Size (mm) | Nitrile rubber (mm) |
|---|---|
| All sizes | 19 |

iii) For Duct insulation

| Application | Insulation |
|---|---|
| Thermal Insulation | 19 mm thick |
| Acoustic | 25 mm thick |

iv) For room acoustic lining
Resin bonded glass wool 50 mm

v) For pumps
Expanded polystyrene TF quality 50mm

vi) Chiller Insulation
Thickness of polyvinyl rubber insulation used for chiller insulation shall not be less than 25mm.

vii) Expansion tank
Thickness of expanded polystyrene (TF quality) insulation used shall not be less than 50mm.

**12.13.5. Application of Insulation On Pipes (Including Suction Line Insulation)**

i) The surface to be insulated shall be first cleaned and a coat of zinc chromate 'primer shah be given. The insulation shall be fixed tightly to the surface with hot bitumen/ cold setting adhesive CPRX compound as recommended by the insulation manufacturer. All joints shall be staggered and sealed. The second layer of insulation shall be similarly applied over the first layer.

ii) The insulation shall be finished as under:

a. For pipes laid inside the building, the insulation over the pipe work shall be finished with 0.63mm thick aluminum sheet cladding over a vapor barrier of 120gm/sqm polythene sheet with 50mm overlap and tied down with lacing wire and complete with type 3, grade-1 roofing felt strip (as per IS 1322 as amended upto date) at the joints..
b. For pipes outside the building laid above ground the finishing over the pipe insulation shall be finished with 0.63 mm G S sheet cladding over a vapor barrier of 120gm/sqm polythene sheet with 50mm overlap and tied down with lacing wire and complete with type 3 grade-1 roofing felt strip applied by means of hot bitumen.
c. For pipes outside the building laid underground the insulation shall be covered with Superfoam rigid cellular polyurethane foam, injected between the core pipe and the outer casing/jacket, having a density of 40 kg/m3 (2.5 lbs/ft3) nominal and thermal conductivity coefficient of 0.021W/m°K maximum at a mean temperature of 24°C (75°F) and Insulation thickness shall be 65 mm for 150 dia, 75 mm thick upto 200 mm dia. and above as per specifications. The insulation shall meet IS 12436 specifications with typical operating temperature between -30°C to 100°C. Insulation thickness shall be as per technical specification.

iii) All valves, fittings, strainers etc. shall be insulated to the same thickness and in the same manner as for the respective piping, taking care to allow operation of valves without damaging the insulation.

**12.13.6. Application of Insulation On Pumps**

Expanded polystyrene (TF quality) 50mm thicknesses shall be sandwiched between two aluminum sheets of 0.5mm thickness and properly clamped to pump in two semicircular sections.

**12.13.7. Application of Insulation On Expansion Tank**

Insulation of expansion tank shall be expanded polystyrene (T.F. Quality) of thickness not less than 50mm. It shall be applied as under

i) Surface shall be thoroughly cleaned with wire brush and rendered free from all dust & grease.
ii) The two layers of hot bitumen shall be applied.
iii) The insulation slabs will then be fixed in one layer and joints shall be sealed with hot bitumen.
iv) The insulation slab then shall be covered with 0.63 mm x 19mm G.I. wire mesh netting which shall be fixed to insulation with brass / G.I. nails.
v) The insulation shall then finally be finished with aluminum cladding of thickness not less than 0.5mm.

**12.13.8. Application Of Insulation (Thermal) On Duct**

i) Surface of duct on which the external thermal insulation is to be provided shall be thoroughly cleaned with wire brush and rendered free from all dust and grease.
ii) Measure the surface dimension properly to cut the XLPE (Chemically cross linked polyethylene) sheet to size using correct tools (scissors or Hacksaw-blade shall not be allowed) with sufficient allowance in dimension.
iii) Apply a thin coat of adhesive (SR-998) on the duct surface and XLPE sheet and leave it for 2-3 min for drying.
iv) Once the adhesive is dry but tacky to touch, place the insulation sheet in the required position and press firmly to achieve a good bond. Stretching and sagging is not allowed.
v) Join the seams after insulation is in place by separating the cut edges and brushing a thin coat of adhesive on both surfaces.
vi) Apply the self-adhesive 3mm thick and 50mm width XLPE tape on both the longitudinal and transverse joints so that the joints are sealed properly.
vii) Seams / flange joints can be insulated with strips of insulation sheet of same thickness.

**12.13.9. Application Of Duct Lining (Acoustic Insulation)**

Where specified in the tender specifications, ducts shall be lined internally with acoustic insulation as detailed below:

i) The Inside surface of duct on which the acoustic lining is to be provided shall be thoroughly cleaned with wire brush and rendered free from all dust and grease.

ii) Then 25 x 25 sq.mm section of minimum 1.25 mm thick G.I. sheet shall be fixed on both ends of the duct piece.
iii) The insulation slabs shall then be fixed between these section of ducts using CPRX adhesive compound and stickpins.
iv) The insulation shall then be covered with Reinforced plastic/ fiber glass tissue, sealing all joints so that no fiber is visible.
v) The insulation shall finally be covered with minimum 0.5 mm thick perforated aluminum sheet having perforations between 20-40%.

**12.13.10. Application Of Acoustic Lining In Ahu Rooms**

i) The wall/ roof surface should be thoroughly cleaned with wire brush.
ii) A 610 x 610 mm frame work of 25mm x 5 0mm x 50mm x 50mm x 25mm shape channel made of 0.6mm thick G.S.S. shall be fixed to walls leaving 610mm from floor by means of raw plugs in walls and dash fasteners in ceiling. Similar frame work shall also be fixed on ceiling by means of dash fasteners.
iii) Resin bonded glass wool/ mineral wool as specified cut to size will be friction fitted in the frame work and covered with tissue paper.
iv) Aluminum perforated sheet having perforation between 20-40%of thickness not less than 0.8mm shall be fixed over the entire surface neatly without causing sag/ depression in between and held with screws. Sheet joints should overlap minimum 10mm.
v) Aluminum beading of 25mm wide and thickness not less than 1.00 mm shall be fixed on all horizontal/vertical joints by means of screws.

**12.13.11. Measurement Of Insulation**

The measurement for vessels, piping and ducts shall be made over the bare un-insulated surface area of the metal.

i) PIPES AND DUCTS:

The measurements for insulation of piping shall be made in linear meters through all valves, flanges, and fittings. Pipes/bends shall be measured along the centerline radius between tangent points. If the outer radius is R1 and the inner radius is R2 the center line radius shall be measured as (R1+R2)/2. Measurement of all valves, flanges and fittings shall be measured with the running meter of pipe line as if they are also pipe length. Nothing extra over the above shall be payable for insulation over valves, flanges and fittings in pipe line/routings. Fittings that connect two or more different sizes of pipe shall be measured.

ii) DUCT:

Measurements for insulation of ducts shall be made in actual net square meters of bare un-insulated duct surface through all dampers, flanges and fittings. In case of bends the area shall be worked out by taking an average of inner and outer lengths of the bends. Measurements for the dampers, flanges, fittings shall be for the surface dimension for the connecting duct, nothing extra over the above shall be payable for insulation over dampers, flanges and fittings in duct routing.

iii) ACCESSORIES INSULATION

The unit of measurement for accessories such as expansion tank, pumps etc. shall be un-insulated area in square meters. In case of curved or irregular surfaces, measurements shall be taken along the curves.
The unit insulation price shall include all necessary adhesives, vapor proofing and finishing materials as well as additional labor and material required for fixing the insulation.

iv) ACOUSTIC DUCT LINING

In case of acoustic lining of air ducts, measurements of the bare inside duct surface in square meters shall be final for billing purposes. The insulation/acoustic panels shall include cost of

battens, supports, adhesives, vapor proofing, finished tiles/boards/sheets as well as additional labor and materials required for completing the work.

## 12.14. ELECTRICAL WORK

### 12.14.1. Scope

This chapter covers the requirements for the electrical works associated with heating, air conditioning, ventilation and cold room applications, namely, switch boards, power cabling, control wiring, earthing, P.F capacitors and remote control-cum-indicating panels. Electric motors are not covered here, as these are covered as part of the respective equipment specifications.

### 12.14.2. General

i) Unless otherwise specified in the tender specifications, all equipments and materials for electrical works shall be suitable for continuous operations on 415V/240V ± 10% (3phase/ single phase), 50 Hz. AC system. Where the use of high voltage equipments is specified in particular works, all the respective equipments shall be suitable for continuous operation on such specified high voltage.
ii) All electrical works shall be carried out complying with the Indian Electricity Rules, 1956 as amended to date.
iii) All parts of electrical works shall be carried out as per appropriate CPWD General specifications for Electrical works, namely, Part I (Internal) 1994, Part II (External) 1994 work, and Part IV (Sub-station), 1982 all as amended to date.
iv) All materials and components used shall conform to the relevant IS specifications amended to date.

### 12.14.3. Distribution Boards

**A. Scope**

The scope of this section comprises the supply, delivery, erection, testing and commissioning of following :

1. Distribution boards considered for all internal and common areas. This also includes items for switchgears used inside the distribution boards and its accessories.
2. All internal wirings including neutral and earthing connections inside DB. This should however not include the earth connection from DB to earth pit.
3. Complete Installation of distribution board in recess / surface as required.
4. Dressing of Distribution board.
5. Testing and commissioning of distribution board in accordance with relevant IS standards.
6. Tagging of each distribution board.

**B. Specification of Items:**

1. Distribution Board (DB):

As a general practice only prewired MCB/HRC type DBs shall be used, on account of their superior technical features, compared to conventional DBs, which don't allow for proper wiring space and wiring termination. Re wirable fuse type DBs shall not be used. Prewired DBs shall have following features:

1. Recess/ Surface type with integral loose wire box.
2. Phase/ neutral/ earth terminal blocks for termination of incoming & outgoing wires.
3. Din Channel for mounting MCBs.
4. Arrangement for mounting incomer MCB/ RCCB/ RCBO/ MCCB as required.
5. Copper Bus bar.
6. Earthing terminals.
7. Wiring from MCBs to phase terminal block.
8. Interconnection between terminal block/ incoming switch/ bus bar/ neutral terminal block/ earth terminal connector with specified size of FRLS pre insulated copper conductor cable duly fitted with copper lugs/ thimbles.
9. Terminal blocks should be suitable for termination of conductor/ cable of required size but minimum rated cross section of the terminal blocks should be 6 sq. mm.
10. Terminal block shall be made of flame retardant polymide material.

Colour terminal blocks and FRLS wires for easy identification of RYB Phases, Neutral and Earth.
11. Prewired DB shall be provided with a detachable cassette for safe removal of MCBs, RCCBs.
12. Terminal connectors from the DB without loosening the internal cable connections of phase and neutral circuits. (This is an optional feature.)
13. The prewired DB shall have peelable poly layer on the cover for protection from cement, plaster, paints etc. during the construction period.
14. Detachable plate with Knock out holes shall be provided at the top/ bottom of board.
15. Complete board shall be factory fabricated and pre-wired in factory ready for installation at site. The box and cover shall be fabricated from 1.6mm sheet steel, properly pre-treated, phosphatized with powder coated finish.
16. Where specified it shall be of double door construction provided with hinged cover in the front.

Note: Prewired DB will be factory manufactured by reputed manufacturer of MCB DBs.

2. Miniature Circuit Breaker (MCB) / Residual Current Circuit Breaker (RCCB)

MCB should be trip free, quick make and quick break type. MCB should be suitable for interchangeable line/ load connections. The MCB, RCCB, RCBO shall have minimum 10 KA breaking capacity and shall have ISI mark as per IS8828-1996 (IEC60898).The MCB shall be suitable for temperature up to 50 deg C without de-rating. The RCCB shall have sensitivities of 30mA and 100mA as specified in the design drawing or SLD or BOQ. The RCCB shall comprise of a core balance current transformer built in to calibrate the differential current between any phase and neutral. All outgoing feeder MCB shall be provided with clip on type auxiliary contact to interface. Terminal of MCB shall be provided with insulated separators between the phases and also on both end. The size and design of the terminal should be adequate to accommodate Aluminum cable required for the rated current of the MCB. It should confirm to current limiting principle class –3 to ensure extremely low let through energy ($I^2t$) under fault conditions. It should have 'two position' DIN clip ensuring easy mounting and removal. It should confirm C.E. Marking (confirmation to European standards) Based upon the tripping characteristics the MCB shall be described as B, C or D curves and the same must be mentioned in bold upon the MCB. All MCB shall have a mention of Full load current, short circuit current, utility voltage, frequency, tripping characteristics (B, C, and D), and basic 3 line diagram. RCCB in addition shall have a mention of its sensitivities engraved upon it.

### 12.14.4. Earthing

**A. Scope**

This chapter covers the essential requirements of earthing system components and their installation. This shall be read with relevant standards, which lays down criteria for their design. For details not covered in these specifications IS code of Practice on Earthing (IS 3043 : 1987) shall be referred to.

**B. Specification Of Items**

1. The earthing conductor (protective conductor from earth electrode up to the main earthing terminal/earth bus, as the case may be) shall be of the same material as the electrode, viz. GI or copper, and in the form of wire or strip as specified.

2. The size of earthing conductor shall be specified, but this shall not be less than the following :
(a) 4 mm dia. (8 SWG) copper wire,
(b) 25 mm x 4 mm in the case of GI strip, or
(c) 20 mm x 3 mm in the case of copper strip.

3. Earthing conductor larger than the following sectional areas need not be used, unless otherwise specified.
(a) 150 sq.mm. in case of GI, or
(b) 100 sq.mm. in case of copper.

4. Earth Continuity / Loop Earthing Conductor & Sizes
The material and size of protective conductors shall be as specified below:

| **Size of phase conductor** | **Size of protective conductor of the same material as phase conductor** |
|---|---|
| Up to 4 sq.mm. | Same size as that of phase conductor |
| Above 4 sq.mm. up to 16 sq.mm. | Same size as that of phase conductor |
| Above 16 sq.mm. up to 35 sq.mm. | 16 sq.mm. |
| Above 35 sq.mm. | Half of the phase conductor |

5. In the case of plate earth electrode, the earthing conductor shall be securely terminated on to the plate with two bolts, nuts, check nuts and washers.
6. In the case of pipe earth electrode, wire type earthing conductor shall be secured using a through bolt, nuts and washers and terminating socket.
7. A double C-clamp arrangement shall be provided for terminating tape type earthing conductor with GI watering pipe coupled to the pipe earth electrode. Galvanized "C" shaped strips, bolts, washers, nuts and check nuts of adequate size shall be used for the purpose.
8. The earthing conductor from the electrode up to the building shall be protected from mechanical injury by a medium class, 15 mm dia. GI pipe in the case of wire, and by 40 mm dia, medium class GI pipe in the case of strip. The protection pipe in ground shall be buried at least 30 cm deep (to be increased to 60 cm in case of road crossing and pavements). The portion within the building shall be recessed in walls and floors to adequate depth in due co-ordination with the building work.
9.The earthing conductor shall be securely connected at the other end to the earth stud/earth bar provided on the switch board by:

(a)Soldered or preferably crimped lug, bolt, nut and washer in the case of wire, and
(b) Bolt, nut and washer in case of strip conductor.

### 12.14.5. Cables & End Termination

**A. Scope**

The scope of this section comprises of supply, delivery, store at site, laying of L.T. cables, fixing of Cable glands, cable dressing and termination in proper position.

**B. Codes and Standards**

The design, manufacture, testing and supply of the cables under this specification shall comply with the latest revisions including amendments of the following standards.

IS : 7098-II XLPE insulated heavy duty cables for working voltages above 1000 V
IS : 3961-II Recommended current ratings for cables.
IS : 8130 Conductors for insulated cables.
IS : 5831 XLPE Insulation and outer sheath of electric cables.
IS : 7098-I Test Procedures for cables.
IS : 10418 Specification for drums for electric cables.
IS : 39751 Mild steel wire, strips, and tapes for armoring of cables.
IS : 1554 PVC insulated.

**C. Specification of Items**

1. Stranded Aluminum/Copper conductor in case of 10 sq. mm and above and solid conductor in case of 10 Sq. mm. and below. All Aluminum/Copper XLPE cables insulation shall be of high grade Cross- linked Polyethylene for insulation for extrusion process. Cores laid up. The inner sheath should be bonded over with thermoplastic material for protection against mechanical and electrical damage. Armoring should be provided over the inner sheath to guard against mechanical damage. Armoring should be Galvanized steel wires or galvanized steel wires or galvanized steel strips. In single core cables used in A.C. wires/strips, round steel wires should be used; where diameter over the inner sheath does not exceed 13 mm, flat steel armor should be used. Round wire of different sizes should be provided against specific request. Insulation shall be of XLPE type as per latest IS general-purpose insulation for maximum rated conductor temp 90 degree C. The XLPE insulated cables shall conform to latest revision IS read along with these specifications. The Conductor shall be stranded Aluminum/Copper circular/sector shaped and compacted. In multi core cables the core shall be identified by red, yellow, blue and black coloring of insulation. The XLPE insulated 1100Volts grade power cables shall conform to latest IS and shall be suitable for a steady conductor temperature of 70 degree centigrade. The conductor shall be stranded Aluminum/Copper as called for in the schedule of quantities. The outer sheath shall be as per the requirement of type ST-2 of IS: 5831 of 1984.Conductor shall be of electrolytic Aluminum/Copper conforming to IS: 8130 and are compact circular or compact shaped. In Inner sheath laid up cores shall be bonded over with thermo-plastic material for protection against mechanical and electrical damage. Insulation, inner sheath and outer sheath shall be applied by extrusion and lapping up process only. Armoring shall be of galvanized steel wire/flat. Repaired cables shall not be used. Current ratings of the cables shall be as per IS: 3961.The cables shall be suitable for laying in racks, ducts, trenches, conduits and underground buried installations with uncontrolled back fill and chances of flooding by water. Progressive automatic in line sequential marking of the length of cables in meters at every one meter shall be provided on the outer sheath of all cables. Both ends of the cables shall be properly sealed with PVC/Rubber caps so as to eliminate ingress of water during transportation, storage and erection.

2. Cables shall be subjected to type tests, acceptance tests and routine tests as per 7098 Part - I. The owner reserves the right to witness any or all the tests for which at least 20 days advance notice shall be given by the contractor. Six (6) copies of all test reports shall be submitted for approval by owner before dispatch of the materials from works. The Contractor shall also submit the excise duty gate pass or excise documents for all the cables along with the dispatch.

3. The Contractor shall furnish technical particulars of cables, types, make and catalogue for the approval by Owner. The product should be coded as per IS: 7098 Part - I and the codes should be as follows:

| | |
|---|---|
| Aluminum Conductor | A |
| XLPE Insulation | 2X |
| Steel round wire armor | W |
| Steel strip armor | F |
| Steel Double round wire armor | WW |
| Steel Double strip armor | FF |
| Non-magnetic (A1.) round wire armor | Wa |
| Non-magnetic (A1.) strip armor | Fa |
| PVC outer sheath | Y |

4. 1.1 KV Grade cables shall be PVC insulated PVC sheathed, Al or Copper conductor Armour confirming to IS 1554 with latest amendments.

5. Cables should be stored in a dry covered place to prevent exposure to climate conditions and wear and tear of wooden drums and it should be preferably concrete surface. All drums should be stored in such a manner as to leave sufficient space between them for air circulation. It is desirable for drums to stand on battens directly placed under the flange. In no case should the drums be

stored "on the flat" i.e. flange horizontal. Both ends of the cables shall be properly sealed with PVC/Rubber caps so as to prevent ingress of water, miniaturization of cores and armors during transportation, storage and erection. On receipt of cable drums visual inspection of drums should be carried out for any damages to these cables. While unloading the cables certain precautions are to be taken to ensure the safety of cables. The cable end to be opened on one side and tested for its insulation and continuity. The cable drums should not be dropped or thrown from the trucks/railway wagons etc. during unloading operations as shock may cause serious damage to cable layers. A crane may be used for unloading cable drums. While lifting the cable drums with crane, it is recommended that the lagging should be left in place to prevent the flanges from crushing on the cables. If crane is not available a ramp should be prepared with approximate inclination of 1: 3 or 1: 4. The cable drums should be rolled over the ramp by means of ropes and winches. Additionally a sand bed at the foot of the ramp may be prepared to brake the rolling of the cable drum. Cable should not be dragged along the earth surface. Drums should be rolled in the direction of arrow only. For laying of cables special care is to be taken to prevent sharp bending, kinking, twisting. Cable should be unwound from drum by proper mounting the cable drum on a cable wheel making sure the spindle is strong enough to carry the weight without bending and that it is lying horizontally in the bearings, so as to prevent the drum creeping to one side or the other, while it is rotating. The maximum safe pulling force (when pulled by pulling eye) proper and safe method of pulling of cable should be used depending upon the site conditions to avoid any kind of damage to the cables. Following pulling forces to be noted.

Aluminum Conductor cables : 3.0 Kg/mm2
Copper conductor cables : 5 Kg/mm2

Special care is to be taken while laying cable at bends. Following are the recommended bending radius for power and control cables.

| Sr. No. | Voltage rating in KV | PVC/XLPE Cables | |
|---|---|---|---|
| | | Multi Core | Single Core |
| 1. | Up to 1.1 | 12 D | 15 D |
| 2. | Above 1.1 to 33 KV | 15 D | 15 D |
| D = D is over all diameter of cable. | | | |

6. If the cables are to be buried directly in the ground IS: 1255 is to be followed for code of practice. Generally cables shall be laid 1200 mm below finished ground level at any point of cable run. After the cable trench has been properly excavated and straightened, it shall be covered with 100 mm thick layer of sand, the cable is then lifted and placed over the sand cushion. Again the cable shall be covered with a sand layer of 100 mm thick. Over this sand layer a layer of RCC tiles (450 x 230 x 65-50 mm) shall be laid. RCC tiles shall be as per IS-5820 and with marking of the Client and the rating of the cable. Cable trenches shall then be back filled with earth, concrete of suitable grade. Direction of run of the cables shall be installed at 25 meters intervals and marking must be done in all bends. In loose soil or at all road crossings, concrete pillar or Hume pipes shall be provided.

7. For laying cables, power cables to be placed at the bottom most layer and control cables at the top most layer. In case of multi core power cables, cables shall be laid side by side with spacing not less than one cable diameter. Multi-core cables shall be clamped by means of mild steel galvanized saddles. All cables below 1.1 KV single core cables if any should be clamped by means of non-magnetic saddles. The saddles / clamps shall not be placed at the intervals more than 1500 mm for horizontal and 1200 mm for vertical runs.

Multi core control cables can be laid touching each other in cable racks and wherever required may be taken in two layers. These cables should be clamped by means of PVC straps for horizontal and vertical runs. Fabricated aluminum clamps may be used at regular intervals. All the cable shall be properly identified at regular intervals. All the cable shall be meggar tested with 1000 volts meggar after being laid and shall be repeated again after the termination.

Cables shall be laid by skilled and experienced workmen using adequate rollers to minimize stretching of the cable. The cable drums shall be placed on jacks before unwinding the cable. Great care shall be exercised in laying cables to avoid forming kinks. The relative position of the cables,

laid on the cable tray shall be preserved and the cables shall not cross each other. At all changes in direction in horizontal and vertical planes, the cable shall be bent smooth with a radius as recommended by the manufacturers. All cables shall be laid with minimum one diameter gap and shall be clamped at every meter to the cable tray and shall be tagged for identification with aluminum tag and clamped properly. Tags shall be provided at both ends and all changes in directions both sides of wall and floor crossings. All cable shall be identified by embossing on the tag the size of the cable, place of origin and termination.

### 12.14.6. LT Panels, Starters, Switchgears, Meters

**A. Scope**

The scope of work comprises of Designing, Obtaining Approval of the Consultants and Fabricating as per Approved Drawings, Testing at works, Packing and Forwarding, supplying, Storing at Site, Checking at site. Touching Up all damaged portions, Erection and testing and commissioning at site.

The equipment shall be designed for operation in highest of ambient temperature 50°C and high humidity tropical atmospheric conditions. Means shall be provided to facilitate ease of inspection, cleaning and repairs in the installations where continuity of operation is of prime importance.

**B. Standards**

The equipment shall be designed to conform to the following requirements and to the latest amendments in the codes or relevant BS applicable standards & CPRI approved:

IS 8623 - Factory Builds Assemblies of switchgear and control gear.
IS 4237 - General requirements for switchgears are control gear for voltage not exceeding 1000 Volts.
IS 2147 - Degrees of protection provided and enclosures for low voltage switchgear and control gear.
IS 375 - Marking and arrangement of bus bars.

Individual equipment housed in the HT / LT panels shall conform to the following IS specifications

| | |
|---|---|
| IS 13947-2 | Air Circuit Breaker & MCCB |
| IS 13947-2 | Fuse Switch & Switch Fuse Unit |
| IS 13703-1993 | HRC Fuse Links |
| IS 2705 | Current Transformer |
| IS 3231 | Relay |
| IS 1248 | Indicating Instruments |
| IS 722 | Integrating Instruments |
| IS 6875 | Control Switches & Push Buttons |
| IS 8828 | Miniature Circuit Breaker |
| IS12640 | ELCB |
| IS2804 | Shunt Capacitor for Power System |

**C. Design Parameters**

The 415V system shall be suitable for the following parameters

| | |
|---|---|
| Rated Voltage: | 415 V, 3 Phase & Neutral. |
| Rated Frequency: | 50Hz. |
| Fault Level: | As per specify in SLD. |
| Enclosure: | IP 52. |

Maximum Allowable Bus Bar Temperature: 55°C for silver plated joints and 40°C Temperature rise for other joints above 50°C Ambient temperature.
Operation Duty: Continuous

**D. Material and Construction**

The main Power distribution panel & distribution boards shall be used to provide power to all sort 415 V/ 230 V equipment /systems. The main Power distribution panel & distribution boards shall be suitable for 415 V +/- 10 %, 3 Phase, 4 wire 50 Hz +/- 5% supply. The equipment shall be kept in a hot, humid and tropical atmosphere and shall be made dust and vermin proof. The Main Power distribution panel shall conform to the latest edition of applicable IS.

**E. Construction**

The main Power distribution panel shall be self-free standing, compartmentalized shall be made out of CRCA M.S. Sheet of thickness not less than 1.6 mm. Thickness of all load bearing members should not be less than 2 mm. The enclosure shall confirm to IP55 protection for outdoor panels and IP52 for indoor panels. The main Power distribution panel & distribution boards shall be designed of the requisite vertical sections, which when coupled together shall form continuous switchboards. It should be readily extensible on both sides by addition of vertical sections after removal of the end covers or as otherwise called for the in the bill of quantities. The main Power distribution panel & distribution boards shall be constructed only of materials capable of with-standing the mechanical, electrical and thermal stresses as well as the effects of humidity, which are likely to be encountered in normal service.

The gland plate shall be of minimum 3 mm thick sheet. The gland plates shall have knock able type holes of suitable diameter of cable glands. Minimum 30% extra knock able holes shall be provided on each gland plate. Non-magnetic gland plates shall be used where single core cables are used for three-phase supply. The terminal blocks shall be provided at convenient location for cable termination. The distance between the terminal strip and gland plate shall be kept in such a way that the cables can be properly dressed & no cable tension is transferred on the terminal strip / or equipment. A main horizontal aluminum grounding bus, rated to carry maximum fault current, extending along the entire of the panel shall be provided. The ground bus shall be provided with two-bolt drilling with GI bolts and nuts at each end to receive the main Earthing grid. The front framed structure shall be designed to house the components contributing to major weight of the panel, such as circuit breaker cassettes, fuse switch units, changeover switches, main horizontal bus-bars, vertical risers and other front mounted accessories. The structure shall be mounted on a rigid base frame fabricated using ISMC channel of minimum 75 mm height. The design shall ensure that weight of the components is adequately supported without deformation or loss of alignment during transit or during operation. The design shall ensure generous availability of space for ease of installation and maintenance of cabling, and adequate safety for working in one vertical section without coming into accidental contact with live parts in an adjacent suction.

Front and rear doors should be fitted with synthetic rubber or neoprene gaskets with fasteners designed to ensure proper compression of gaskets. When covers are provided in place of doors, generous overlap shall be assured between sheet steel surfaces with closely spaced fasteners to preclude the entry of dust. The height of the panel should not be more than 2400 mm. The total depth of the panel should be adequate to cater for proper cabling space and should not be less than 1300 mm for ACB sections and 450 mm for Switch Fuse unit and MCCB sections or should be appropriate.

Doors and compartment partitions shall be fabricated using 14 Gauge thick sheet steel. Sheet steel shrouds and partitions shall be minimum 14 Gauge thickness. All sheet steel work forming the exterior of switch boards shall be smoothly finished. Leveled and free from flaws. The corners should be rounded. All the boards/panels should be fabricated using 14 gauge CRCA MS sheets only. The apparatus and circuits in the panels shall be so arranged as to facilitate their operation and maintenance and at the same time to ensure the necessary degree of safety. Apparatus forming part of the panels shall have the following recommended minimum clearances for non-insulated bus bars or should be as per relevant IS Codes.

| **Distance between** | **minimum Clearance in mm** |
|---|---|
| Phase to Phase | 30mm |
| Phase to Neutral | 25mm |
| Phase to Body | 30mm |

When, for any reason, the above clearances are not available, suitable insulation shall be provided. Clearances shall be maintained during normal service conditions. Creep age distances shall comply with those specified in relevant standards.

All insulating material used in the construction of the equipment shall be of non-hygroscopic material, duly treated to withstand the effects of high humidity, high temperature tropical ambient service conditions. Functional units such as circuit breakers and fuse switches shall be arranged in multi-tier formation. All the Incoming Air Circuit Breakers shall be housed in a single tier formation only. Air circuit breaker for outgoing feeders can be of two-tier formation. Metallic/insulated barriers shall be provided within vertical sections and between adjacent sections to ensure prevention of accidental contact with main bus bars and vertical risers during operation, inspection or maintenance of functional units and front mounted accessories. All doors/covers providing access to live power equipment circuits shall be provided with tool operated fasteners to prevent unauthorized access. Cable entries and terminals shall be provided in the switchboard to suit the number, type and size of aluminum conductor power cables and copper conductor control cable specified in the detailed specifications. Provision shall be made for top or bottom entry of cables as required. Generous size of cabling chambers shall be provided, with the position of cable gland and terminals such that cables can be easily and safely terminated. The minimum depth of the panel shall be restricted to suit for this purpose. Barriers or shrouds shall be provided to permit safe working at the terminals of one circuit without accidentally touching that of another live circuit. Cable risers shall be adequately supported to withstand the effects of rated short circuit without accidentally touching that of another live circuit.

As per indications in the SLD, Sandwiched type Compact Bus Trunkings are to be terminated on Incoming and Outgoing circuits at the top of the panels. Necessary connecting bus-bar pieces with bends, offsets and drilled holes with necessary cadmium plated nuts, bolts & washers shall be provided. The details of the flange and bus configuration shall be obtained from the Bus Trunkings supplier.

## F. Painting

All sheet steel work used in construction of panels shall be given for proper shot blasting/surface finish to make it free from all rusts/impurities/deposits. It shall be then provided with two primer coat and then/powder coated (electro-statically) with final paint shade RAL7032 as per IS – 5.

It shall be the process of Powder Coating with suitable primer and having total coating thickness of 60 micron. The M.S Sheet Steel shall be given for proper shot blasting / surface finish to make it

free from all impurities. All sheet steel work used in construction of panels should have undergone a rigorous metal treatment 7 tank process as mentioned below.

All sheet steel work shall be phosphate in accordance with the procedure mentioned below and in accordance with relevant standards for phosphating iron and steel.

Oil, grease and dirt shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying. A recognized phosphate process to facilitate durable coating of the paint on the metal surface and also to prevent the speared of rustling in the event of the paint film being mechanically damaged. This again, shall be followed by hot water rinsing to remove traces of phosphate solution. After phosphating through rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying. Passivating in de-oxalite solution to retain and augment the effects of phosphating.

## G. Bus Bars

The selection, design and construction of bus bars shall conform to IS specifications and the latest amendments. The bus bars shall be air insulated and made of high conductivity, high strength Aluminum Bus bars. Bus bars shall be located in air-insulated enclosures and segregated from all other compartments of the cubicle. Direct access or accidental contact with bus bars and primary connections shall not be possible. Bus bars shall be rated in accordance with service conditions and the rated for continuous and short time current ratings specified in SLD / data sheets. Maximum temperature of the bus bar and bus bar connections, under operating conditions, while carrying rated normal current at rated frequency shall not exceed 85 degree C. Bus bars shall be adequately supported on SMC insulators to with stand dynamic stresses due to short circuit currents specified in SLD / BOQ /Data sheets. Bus bar support insulators shall be of non-hygroscopic material and shall confirm to relevant IS standards. The size of bus-stars should be indicated in the contractor and shall be subject to the purchaser's approval.

The current density of the bus bars shall not be less than 1 Amp / sq mm. The size of the bus bar shall be chosen on the basis of temperature rise limit of bus-bar for continuous rated current at rated frequency and also on the basis of temperature rise limit at rated short circuit current for 1 sec and mechanical stress capacity at rated peak short circuit current. The neutral as well as the earth bar should also be capable of withstanding the electrical & mechanical stresses equivalent to phase bus bars.

Appropriate clearances and creep age distance shall be provided for the bus bars system to minimize the possibility of a fault.

Connections from the main bus bars to functional circuits shall be arranged and supported so as to withstand without any damage or deformations the thermal and dynamic stresses due to short circuits currents.

Bus bars should be color coded for easy identification of individual phases and neutral.

All the bus bars should be provided with colour coded heat shrink sleeves. The size of the Earth shall be same as the size of the neutral bus bar in any case it should not be less than 50 x 6 mm.

## H. Performance Characteristics

All switchgears and panels shall be capable of satisfactory operation for the application, duty and other requirements as specified in these specifications, enclosed data sheets/drawings. Air circuit breakers, molded case circuit breakers and switches shall be suitable for switching duty of motors, capacitors and other devices shown on drawing.

**I. Safety Features**

The safety shutter shall be provided in breaker panels, which shall prevent in advertent contact with isolating contacts when breaker is withdrawn from the Cradle. It shall be possible to interchange two breakers of two different rating.

There shall be provision of positive earth connection between fixed and moving portion of the ACB either through connector plug or sliding solid earth mechanism. Earthing bolts shall be provided on the cradle or body of fixed ACB. Arc chute covers shall be provided wherever necessary.

It shall be possible to bolt the draw-out frame not only in connected position but also in TEST and DISCONNECTED position to prevent dislocation due to vibration.

All live parts of MCCB and switches when doors are opened after switching them OFF shall be shrouded with insulators of adequate size and strength so that to prevent accidental contacts of the live parts.

**J. MCCB**

MCCB should be provided with door operating mechanism having interlock, defeat and padlocking facility. The Molded Case Circuit Breaker (MCCB) shall conform to IEC 947 – 2.The MCCB shall be suitable for temperature up to 50 deg C without de-rating. The MCCB should trip free, quick make and quick break type and should be equipped with a current limiting feature. MCCB are having spreader links and terminal shroud as a feature for safety and proper heat dissipation. The MCCB shall indicate its suitability for isolation and this should appear clearly with the symbol as specified in IS 13947.

MCCB's for distribution feeders shall have a minimum service breaking capacity (Ics) of suitable up to 400 A. For the entire range, Service Breaking capacity (Ics) shall be equal to Ultimate Breaking capacity (Icu), ( Icu = Ics =100% ).

All Distribution Panel incomer and subsequent feeder MCCB's shall be with thermo-magnetic over-current release with an adjustable overload setting range of 40% to 100% of rated current. Magnetic setting shall also be adjustable from 5 to 10 times the rated current.

All Main panels outgoing feeder MCCB's shall be with microprocessor over-current release with time delay setting for fault discrimination. The settings should be as follows:

Overload setting L 40-100% In
Short circuit setting (with time delay) S 150 –1000% Ir
Time delay (td) 0-500 m sec
Short circuit setting (Instantaneous) (I) 1100% In
Where In = nominal current of MCCB & Ir = rated current to which it is set.

All MCCB's shall have the accessories such as, shunt release, auxiliary and alarm switches, Front door operating mechanism with door interlock defeat facility.

All protection releases has:

In built thermal memory
In built true RMS sensing
Sensitive to heating effects of harmonics.

Frame sizes of MCCB's shall be of following standard sizes.

| MCCB Rating | Frame Size |
|---|---|
| 100 amps & below 100 amps. | 100 amps. |
| More than 100 amps up to 160 amps | 160 amps. |
| More than 160 amps up to 250 amps | 250 amps. |

| | |
|---|---|
| More than 250 amps up to 400 amps. | 400 amps. |
| More than 400 amps up to 630 amps. | 630 amps. |
| More than 630 amps up to 800 amps. | 800 amps. |

The breaking capacities of MCCB's are mentioned panel wise. MCCB's shall be of following standard ratings.

| MCCB Rating | Frame Size |
|---|---|
| 25 KA & above. | 25 KA |
| Above 25 KA up to 35 KA. | 35 KA |
| Above 35 KA up to 50 KA | 50 KA |
| Above 50 KA up to 70 KA | 70 KA. |

All MCCB shall be provided in the thermal magnetic releases up to 250 amps rating unless otherwise asked for differently in the BOQ.

**K. Contactors**

All contactors and bi-metal relays should conform to IS - 13947 - 4/IEC - 947-4 standards. Contactors should be suitable for requisite duty and the contactor shall be designed to operate even in severe operating conditions.

The Contactors shall be suitable for switching and controlling squirrel cage and slipping motors as well as other AC loads such as solenoids, capacitors, lighting loads, heating loads and transformer loads.

The contactors shall be suitable for operation in service temperature up to 50° C without de-rating The contactors and bimetal relays shall have been tested for type-2 co-ordination at 50 KA, 415 V 50 Hz as per IS 13947 for both fuse protected as well as fuse-less motor feeders. The Contactor shall have coil of 220/240 V AC or as may be specifically asked for. The design of the current carrying parts, contact system and the magnet system should be such that it should increase reliability of electrical and mechanical endurance. Auxiliary contact should have double break parallel bridge contact mechanism. For operator safety the contactors above 45 Amp. should have arc-chamber. The construction of the arc chamber should be such that there is no emission of arc by-products on the surrounding equipment.

The contactor shall have funnel shaped cable entries, cable end stops and predetermined insertion depths. Contactor below 63 Amp shall have captive screws preventing the screws from falling. Main contacts should be of silver alloy to have long contact life; it should withstand to keep the contact bounce to minimum and should be shrouded with an arc chute. Both moving and fix contacts should be accessible for inspection or replacement without disturbing terminal wiring.

The magnet system should have laminated, construction to minimize the losses. Coils should withstand high temperature and ensure low power consumption. Coil should be resin cast/encapsulated. It should have inter layer insulation. Contactor should have facility to mount add-on auxiliary contact block. Mechanical interlocks should be provided for sequential operations if required. Contactor should be comfortably mounted in any position on a vertical plane. Contactor should be capable of handling high transient currents, which occurs at a high time of switching of capacitors.

It's Insulation voltage level should be – 1000 v. Contactor shall be designed to have Mechanical endurance of the order of minimum 15 million operations or better.

Contactor should operate without deration from - 30° C to +50°C

**L. Current Transformer**

Current transformers shall comply with the requirements of IS. 2705. They shall have ratios, outputs as specified in SLD. The current transformers shall be core type with cast resin/encapsulated secondary winding. CTs shall withstand stresses originated from short circuit. These shall be mounted on the switchboard stationary part.

The secondary CT leads from all panels should be terminated on the front of the board on easily accessible shorting type terminal connectors so that operation and maintenance can be carried out when the panels are in service.

CT's shall be given heat run test.

CT's shall be of class 1 accuracy unless otherwise specified.

**M. Indicating Instrument**

All indicating instruments shall be digital of flush mounting industrial patterns, conforming to the requirements of I.S.

The instruments shall have non-reflecting bezels, clearly divided and indelibly marked scales and shall be provided with zero adjusting devices in the front.

Integrating instruments shall be of flush mounting switchboard pattern, complying with the requirements of I.S.

**N. Protection Relay**

The protection relay should be microprocessor based & have 12 mm, 8 values, Set values, Trip data and Trip History for analysis and troubleshooting.

All Protection Relays should be conforming to following IS/IEC standards:

| | |
|---|---|
| IEC 61000-4-8 | Power Frequency Magnetic Test |
| IEC 61000-4-11 | Voltage Dips and Interruption Test |
| IEC 61000-4-12 | Ring Wave Test |
| IEC 61000-4-5 | Surge Immunity |
| IEC 61000-4-3 | Radiated Electromagnetic Field Test |
| IEC 61000-4-4 | Electrical Fast Transient test |
| IEC 61000-4-2 | Electrostatic Discharge Test |
| IS 8686/IEC 60255-22-1 | High Frequency Disturbance Test |
| IS 8686/IEC 60255-5 | Impulse Test |
| IS 3231/IEC 60255-5 | Dielectric Test |

The Protection relay should have built in Self Supervision and Self Testing Feature & Self diagnostic to ensure continuous reliability. The protection relay should have separate indication for Power On, Programming Mode and Relay fault.

The protection relay shall have RS 485 port/MOD BUS for Communication with BMS system. The Hardware/Software Protocol for the same shall be given without any additional cost The protection Relay shall have minimum 4 No of user programmable output relays. The protection relay should have a test feature for maintenance and checking purpose. The protection relay shall have 3 phase characteristics, which shall be adjustable over wide range to provide discrimination between a multiplicity of devices.

**O. Control Switches**

Control Switches shall be of the heavy-duty rotary type with escutcheon plates clearly marked to show the operating position. They shall be semi-flush mounting with only the front plate and operating handle projecting.

Circuit breaker control switches shall be of the spring return to neutral type, while instrument selector switches shall be of the stay-put type.

**P. Push Button**

Push buttons should be of the momentary contact, push to actuate type.
Push Buttons should be panel mounted, flush type having 22.5 mm Ø.
Push Buttons should be spring returns type.
Lock and key head with Push turn facility.
Modular blocks should content NO-NC contact.
It should be snap-fit type for easy assembly.
Double break self-cleaning contacts for prolong life.
NO-NC contact block should be colour coded for easy identification.
Push Buttons should have transparent shroud and rubber shroud to enhance protection against ingress as per IP- 67.
It should withstand operating voltage as well as frequent operation.
It should have finger proof shrouded terminals.

**Q. Control Wiring**

All Control wiring shall be carried out with 1100 Volts grade single core PVC cable conforming to IS694 having stranded copper conductors of minimum 1.5 sq mm for potential circuits and 2.5 sq. mm. section for current transformer circuit.
Wiring shall be neatly bunched, adequately supported and properly routed to allow for easy access and maintenance.
Wires shall be identified by numbered ferrules at each end. The ferrules shall be of the ring type and of non-deteriorating material. They shall be firmly located on each wire so as to prevent free movement.
All control circuits fuses shall be mounted in front of the panel and shall be easily accessible.

**R. Terminal Blocks**

Terminal blocks shall be of Elmex /connect well make of the suitable type. Insulating barriers shall be provided between adjacent terminals. CT Terminal blocks shall be shorting type.
Terminal blocks shall have a minimum current rating of 10 Amps & 650 volt grade rating complete with insulated barriers. Provisions shall be made for label inscriptions.
It should have snap fit action.
It should have captive-screws and self-lifting washers.
Withstand temp range from –30° C to 100° C.
Terminal Connectors should have flame retardant property confirming to UL-94, V-2.
Terminal Block should be suitable for commonly used DIN Rail – 35 X7.5 mm and mounting channel ‘C’ shaped Std.32 mm.
Terminal Block should be suitable for commonly used DIN Rail – 35 X7.5 mm and mounting channel ‘C’ shaped Std.32 mm.
The construction material should be of high quality like polyamide 6/6 and contacts of Nickel plated brass. Labels shall be of anodized aluminum, with white engraving on black background. They shall be properly secured with fasteners.

**S. Digital Energy Meter**

The energy meters shall be digital counter type with LCD/LED display. It shall be flush mounted on panel. The size shall be at least 96 mm x 96 mm at the front side. The Class of accuracy of the

meters shall be 1. The meters shall be calibrated as per CT secondary current and directly from the LT voltage, self-powered and suitable for 3 phases, 4 wire system.

Digital Energy Meter should be confirming to following IS/IEC standards.

- IEC 61000-4-8 Power Frequency Magnetic Test
- IEC 61000-4-11 Voltage Dips and Interruption Test
- IEC 61000-4-12 Ring Wave Test
- IEC 61000-4-5 Surge Immunity
- IEC 61000-4-3 Radiated Electromagnetic Field Test
- IEC 61000-4-4 Electrical Fast Transient test
- IEC 61000-4-2 Electrostatic Discharge Test
- IEC 1036 Accuracy
- IS 8686/IEC 60255-22-1 High Frequency Disturbance Test
- IS 8686/IEC 60255-5 Impulse Test
- IS 3231/IEC 60255-5 Dielectric Test
- IS13779 Operating Temperature
- IS 722 3 Phase Watt -Hour Meter with Maximum Demand Indicator

Digital KW Meter shall have 2 Alarm set Points. This should have multi-function facilities to measure Voltage, Current, Power factor, KW.

This unit should give True RMS Measurements.

This unit should have four quadrant operations.

The unit should have 2 No. of relay type outputs for alarm or control action.

The unit should have wide CT ratio selection range to suit site requirements.

The unit shall have large and clear display with backlit facility.

The unit shall have necessary arrangements communication port RS 485 for energy metering.

## T. Isolators

All isolators and switches shall be two position type (ON/OFF) heavy duty, load break, quick make and break type and suitable for front of board operation and shall conform to I.S. 4064.The isolators for motor feeders shall be of “Motor Duty” type adequate for interruption of locked rotor current of motors (excepting for motors rated 50 Kilowatts and above).Switches and isolators provided in the switch boards shall be interlocked with door to prevent opening and closing of the door in the closed (ON) position of the isolators. All live terminals on the isolating / switches shall be adequately shrouded to prevent accidental contact and danger to the personnel. Properly rated co-coordinating fuses (HRC type) shall be provided for every outgoing feeder unless otherwise indicated. The fuse shall be non-deteriorating high rupturing capacity link type mounted in suitable fuse carrier / fuse base and conform to I.S. 3106.

## U. Dual Source Meter

The dual source meter shall Suitable for 3 phase 4 wire network with two separate registers for mains and alternate power i.e. Stirling generator consumption. The meter shall have flashing indication on display to indicate the source in use. The meter shall have Class- 1.0 accuracy with RS – 485 protocol. The meter shall be flush mounted with sealing facility provided and must also give current reversal indication. Following features shall also be provided:

**Enclosure:**

Dimensions: 96 x 96 x 96 mm

Weight: 300 gms

**Front panel:**
Display: Backlit LCD display
Digit Height: 8 mm x 4.8 mm
Protection index: IP 54

**Inputs :**
Current :
Via transformer with primary 50-200 Amp
Insulated secondary 5A
Current circuit burden < 0.1 VA
Overload 7A
Voltage :
Measurement Range 120V AC to 300V AC from phase to neutral
voltage circuit burden 0.1 VA

**Auxillary supply :**
230 V AC +/- 30%, 50 Hz with burden < 2.5VA
**Accuracy :**
Class-1.0
**Pulse Output:**
1 pulse = 1 kWH with a minimum pulse duration of 100ms.

**V. Load Manager**

The load manager shall be micro-controller based unit capable to measures a host of electrical parameters and display them on a 128 x 64 backlit LCD, It shall have load management feature and shall have six numbers of output relay contacts apart from CT/PT contacts. These outputs shall be individually field programmable for both the parameter on which to generate alarm as well as the values on which to activate alarm and deactivate it. In addition to this flexibility in terms of load management, the load manager shall also have RS485 port. RS485 supports MODBUS RTU protocol for connections to EMS/SCADA. The unit shall be made for three phase four wire system. The installation type, CT ratios and PT ratios shall be site selectable. The Load Manager with its six relay contacts shall be capable to be used as a Demand Controller. The method of Demand calculation i.e. sliding window, fixed window shall be selected at site. The device shall have all the features needed to implement a robust electrical load management system. It shall be programmable / configurable to suit most control and communication needs. The load manager shall be capable to measure following parameters:

1. Voltage (Volts L-N & L-L) VL-N Accuracy: 0.5% of Reading VL-L Accuracy: 1.0% of Reading.
2. Current (Amps IR, IY, IB) Accuracy: 0.25% of Reading.
3. Line Frequency 45 to 55 Hz, Accuracy: 0.3% of Reading.
4. Active Power (P) Accuracy: 0.5% of Reading (For IPFI>0.5).
5. Reactive Power (Q) Accuracy: 1.5% of Reading (Between 0.5 Lag to 0.8 Lead).
6. Apparent Power (S) Accuracy: 0.5% of Reading.
7. Power Factor For Individual phases and System. Accuracy: 0.5% of Reading (IPFI≥0.5) Range of Reading: 0.05 to 1.000 Lag/Lead.
8. Total Active Energy (KWh) Range of Reading: 0 to 9999999.9 KWh Accuracy: Class 0.5 as per IS14697.

9. Total Apparent Energy (KVAh) Range of Reading: 0 to 9999999.9 KVAh Accuracy: Class 0.5 as per IS14697.
10. Total Reactive Energy (KVARh) Range of Reading: 0 to 9999999.9 KVARh Accuracy: Class 1.0
11. 3 rd to 15 th Harmonics(Odd) for all Voltages with THD.
12. 3 rd to 15 th Harmonics(Odd) for all Currents with THD.
13. Active Power (KW) Demand - Sliding & Fixed, Selectable.
14. Apparent Power (KVA) Demand - Sliding & Fixed, Selectable

The device shall also have following features:

1. Display 128 X 64 Graphical LCD with Operating temp 10°C to 50°C.
2. Data Logging Buffer 2 MB, Non-volatile memory, capable of holding 19691 records Logging Duration Site selectable.
3. RS485 Modbus-RTU protocol
4. Communication USB 8.0 Pendrive For downloading logged data

### 12.14.7. Drawing and Documents

The Data Sheets attached duly filled up shall be submitted along with the Tender and after the order/ LOI is placed, the contractor/vendor shall submit within 30 days three sets of following drawings for approval. General Arrangement drawing of panel with plan elevation and side view and bus-duct termination flange cable entry and gland plates, earthing arrangement etc.

Mounting arrangement of circuit breakers and other components in different chambers, bus bar, bar details, earth bars door gasketing details etc.

Foundation details.

Single line diagram

Schematic wiring diagram with interlock (both mechanical and electrical), protection and operation scheme.

Bill of materials complete with rating/range, make, type, model number, size, materials, quantity etc.

Nameplate and inscription plate detail.

The drawing shall be preferably of A-3 or A-4 size only.

The contractor/vendor shall also submit all pamphlets/literatures etc. in triplicate for all bought out items for approval.

One print of each drawing/document will be returned to Contractor/vendor after marking all necessary comments, corrections, changes and required clarifications. Contractor/vendor shall revise the drawing accordingly and resubmit the revised drawings within seven days after receipt of the commented drawings/documents.

### 12.14.8. Quality Assurance

Contractor/vendor shall submit Three copies of the Quality Assurance Plan before commencement of work for approval.

The approved Quality Assurance Plan shall form the basis of Quality Assurance and manufacturer shall follow the same to ensure total conformity to owner's requirement.

### 12.14.9. Test and report

**1. Type Test**

Type test shall be conducted on one unit of each type of panel with rated bus-bar and circuit breaker mounted with the unit in accordance with relevant IS and shall be as mentioned below:

Verification of Temperature rise limit.

Verification of dielectric properties
Verification of the short circuit withstand strength.
Verification of the effectiveness of the protective circuit.
Verification of clearance and creepage distances.
Verification of mechanical operation
Verification of degree of protection.
Type 2 co-ordination test
Breaker - Duty cycle
Mechanical endurance
Electrical endurance
Routine tests shall be conducted on all panels and Distribution boards in accordance with relevant IS codes and shall be as mentioned below:
Insulation resistance test (IR value) by 1000V megger before HV test.
Dielectric test by applying 2.2 KV for 1 min and noting leakage reactance.
Insulation resistance test by 1000 V megger after H.V test.
Functional controls check for panels.
Logic simulation test.
Current injection test.
Bus-bar purity test

Test reports for all such tests shall be prepared by contractor for submission along with Inspection offer.

2. **Inspection**

Inspection of the panels shall include inspection of wiring and electrical operational tests where necessary, Dimensional & Visual verification.
Checking of Protective Measures and electrical continuity of the protective circuits.
Primary and Secondary Injection Test for Checking of all Meters and Relays
Checking of control Circuit by simulating the conditions. Any such simulator in case required shall be arranged by contractor / manufacturer / sub-contractor etc.

**3. Acceptance Test**

All the tests carried out in the routine test shall be asked for acceptance test and test shall be carried out in similar way except the dielectric test which shall be carried out at 75% of the routine test voltage.

### 12.14.10. Star Delta Starter

Star-delta starters shall be suitable for motors of air handling units, ventilation fans, Tertiary Pumps and any other motor load pertaining to HVAC equipment. The starter shall comprise of all necessary power and control equipment including, Indication lamps, Push buttons for start/stop, selector switch for Auto / manual operation, Star contactor, delta contactor , timer relay contactor, electronic timer, potential free NO/NC contacts and necessary control wirings properly connected in fully usable state. Minimum utilization category for all contactors shall be AC3 and contactor shall be capable to withstand the steady state (full load) and starting inrush current. The starter shall have necessary protection device (MPCB +EOCR) whose settings and ratings shall be as per the type-2 co-ordination chart. The starter shall have inbuilt protection
against over current, short circuit and single phasing. All these starters shall be equipped with discharge resistors suitable for making the starter run under the closed transition state. All

starters shall be BMS compatible and additional contacts and wiring required for BMS integration shall be provided.

**12.14.11. Direct online starter**

Direct online starters shall be suitable for motors of air handling units/ Heat recovery wheel/Ventilation fans, Tertiary Pumps and any other motor load pertaining to HVAC equipment. The starter shall comprise of all necessary power and control equipment including, Auto / manual selector switch, start / stop push button, LED indication, line contactor, Overload relays, Potential free NO/NC contact for control wiring, 415V actuated relay coil, necessary control wirings properly connected in fully usable state. Minimum utilization category for all contactors shall be AC3 and contactor shall be capable to withstand the steady state (full load) and starting inrush current. The starter shall have necessary protection device (MPCB +EOCR) whose settings and ratings shall be as per the type-2 co-ordination chart. The starter shall have inbuilt protection against over current, short circuit and single phasing. All below mentioned starters shall be BMS compatible and additional contacts and wiring required for BMS integration shall be provided.

**12.14.12. Air circuit breaker :**

1. The ACBs shall have following features :

   a. 230 V A.C closing and shunt trip coil continuous rated.
   b. Drawout type with “service”, “test”, “isolated” and “maintenance” position.
   c. Safety shutter of Fibre glass / polycarbonate sheet of 2mm thickness shall be provided
   d. Mechanically trip free plus antipumping feature is to be provided.
   e. Electrical trip free plus anti pumping shall be provided with relay ONLY and not by contactors.
   f. Electrical/Mechanical operation counter shall be provided.
   g. Door interlock with defeat features to be provided.
   h. ACB shall be lockable in isolation position.
   i. ACB should comply with IEC 60947 and IS 13947 part -2.
   j. Mechanical life should be minimum 12500 operation (maintenance).
   k. Electrical life should be minimum 6500 operation (maintenance).

2. Release:
   a. Static release shall be direct acting type, tripping ACB mechanically.
   b. Short circuit, overload and earth fault protection shall be provided.
   c. Vendor to suggest release type for feeders of supply range characteristic and accuracy.
   d. Release should have separate fault indications like O/L, S/L, E/F alongwith ACB ‘ON’ indication.

3. ACB Performance:
   a. ACB performance inside panels at ambient 50 Degree.
   b. Symmetrical breaking, 50KA
   c. Making capacity peak 105 KA
   d. Short time rating , for 1sec. 50 KA

4. FUSE :

   Fuses shall be of high rupturing capacity (HRC) fuse links and shall be in accordance with IS : 2000-1962 and having high rupturing capacity of not less than 15 KA at 415 V. The back-up fuse rating for each motor / equipment shall be so chosen that the fuse does not operate on starting of motors / equipment. HRC fuses shall be of the make as specified in Make of Material.

## 12.15. INSPECTION, TESTING AND COMMISSIONING

### 12.15.1. Scope

This chapter covers initial inspection and testing of compressor, condenser, chiller & AHUs at manufacturer's works, initial inspection of other equipments/ materials on receipt at site, final inspection testing & commissioning of all equipment at site &description of testing requirements & procedure.

### 12.15.2. Initial Inspection At Manufacturer's Works

a. Centrifugal Compressor

- Salient features such as model capacity control, type of lubrication etc. shall be verified against the requirements visually without opening the compressors.
- Manufacturer's internal test certificates shall be scrutinized to check compliance with the requirements as specified in the contract.
- Free running test shall be carried out at the speed for which the motor is available with manufacturer but the speed shall not be than that specified in contract. This test shall be carried out for minutes in open space. During this running test following operations are to be noted:
  - Manual operation of capacity control
  - Lubrication oil pressure
- Pneumatic test pressure test at 21 Kgf/sq.cm for casing of compressor
- Vacuum test for the compressor for 0.5mm

b. Condensers

- Salient features like number of tubes, inside diameter of tubes (from which the gauge of the tube can be verified), no. of passes, material of fins, length of condenser, provision of fittings like safety valve, water, gas connection shall be verified during stage inspection. The tube thickness shall be checked.
- Manufacturer's internal test certificates shall be furnished and it shall be verified against contract requirements.
- Pneumatic pressure test at twice the normal condensing pressure for gas side of condenser shall be carried out.
- Hydraulic test at 10Kgf/ sqcm for water side of the condenser shall be carried out.

c. Chiller

- Salient features like type of chiller, number and inside diameter of tubes (from which gauge of the tubes can be verified), material of tubes, type, material and the number of fins, wherever applicable, diameter and length of chiller and provision of fittings be verified against requirements specified in the contract during stage inspection. Tube thickness shall be checked.
- Manufacturer's internal test certificate shall be furnished and same shall be checked as per contract requirements.
- Pneumatic pressure test at twice the normal condensing pressure for gas side of condenser shall be carried out.
- Hydraulic test at 10Kgf/sqcm for the water side of chiller shall be carried out.

d. Chilling Unit (Water Cooled Only)

Full load test shall be carried out to verify the capacity and IKW/ Ton. Note: In case of imported centrifugal chilling machine, initial inspection shall be carried out at site before installation in respect of items needing physical inspection and verification. No tests shall be done at manufacturer's works. The test certificates for all the specified tests shall be produced which shall be accepted if found in order.

e Air Handling Units

i) Salient features such as model, size, physical dimensions, and other details of various sections, fan motor details, fan dia, static pressure etc. shall be verified against the contract requirements.

ii) Manufacturer's internal test certificates for the motor and air handling unit shall be furnished and scrutinized as per contract requirements.
iii) Test certificate for static and dynamic balancing of the fan/ blower should be furnished. Fan balancing may be witnessed by Engineer-in-Charge or his authorized representative.
iv) Salient features like type, material, no. and gauge of fins and tubes and no. of rows of cooling coil shall be furnished and verified with reference to contract requirements during stage inspection.
v) Hydraulic pressure to the extent of 10 Kgf/sq.cm or pneumatic pressure of 21kgf/ sq.cm shall be applied to cooling coil and this pressure should be maintained for 1 hour and no drop should be observed indicating any leaks.

f VRV/Energy recovery ventilator/Evaporative coolers/PUMPS ETC.:

i) Identification of materials in accordance with test certificates.

ii) Inspection of various laboratory test certificates for physical properties and technical composition conducted on test samples of materials to be used for fabrication, forgings etc. for all important components of various equipment.

iii) Hydraulic test for various components and assembled equipment at 1.5 times design pressure or double the operating pressure whichever is higher.

iv) Pneumatic leak test after assemblies at design pressure.

v) Static and dynamic balancing on electronic precision machine for rotating parts, links, impeller/crank shaft assemblies etc.

vi) Inspection of assemblies and dis-assemblies of various parts of equipment and complete equipment themselves as desired by Architect.
vii) Noise level test for various rotating/reciprocating equipment.

viii) Pressure drop test for condenser and evaporator.

ix) Inspection of manufacturer's test certificates shall be supplied for all electrical motors.

x) Inspection of welding including welders qualifications as desired by Architect.

### 12.15.3. Initial Inspection At Site

12.15.3.1. For Associated Works At Site:

i) Inspection of raw materials to be used for fabrication and assembly and inspection of Manufacturer's Certificates.

ii) Inspection of welding including welders qualification as desired by inspection Engineers. Inspection of fabricated items.

iii) Pressure testing of pipe fittings used for the refrigerant and water services.

iv) Pressure testing, leak testing of complete piping network for chilled water and condenser water.

v) Vacuum missing and gas/oil charging for refrigeration system.

vi) Checking of electrical circuits (power & controls) and checking functioning of controls of refrigerant systems and other circuits of air conditioning plant.

vii) Checking of calibration of controls and instrumentation

viii) Performances testing of complete

ix) The above inspection procedure is given for general guidance and information of vendors and inspection of Purchaser/Consultant is strictly not limited to these and Inspection Engineer of Purchaser/Consultant will have full right to have detailed inspection at any stage right from placement of order to completion of project as desired by Inspection Engineer, Co-ordination of Inspection Agency of Purchaser/Consultant with his Factory/Sub-vendor's Factory/Erection Site will be the sole responsibility of successful vendor after placement of order for complete

12.15.3.2. Ducting

i) The sheet used for ducting shall be checked for physical test at site. The physical test should include the sheet thickness and bend test as per relevant IS specifications.
ii) Zinc coating of GSS sheet as mentioned in the tender documents may be got tested from a laboratory to verify that same meets the contract requirements.

12.15.3.3. Pumps

i) Salient features such as model and make shall be checked as per contract requirements.
ii) The manufacturer's test certificates with Sr. No., head, discharge will be furnished and verified against contract requirements.

12.15.3.4. Switch Gear, Control Gear, And Measuring Instruments

These should be of specified make. For air circuit breaker manufacturers test certificate shall be furnished by contractor and the same shall be verified as per contract requirements.

12.15.3.5. Electric Motors Electric motors should be of specified make, manufacturer's test certificate for electric motor shall be furnished.

12.15.3.6. Pipes and Valves

i) It should be checked that the same is as per makes specified in contract
ii) Dimensions including weight shall be checked for pipes against the requirements contract.

12.15.3.7. Insulation and Acoustic Lining

i) Physical verification for thickness and make should be made as per contract before application of insulation.
ii) Manufacturer's test certificate for density should be furnished. Note: Accuracy of testing instruments shall be as mentioned in the final inspection procedure.

12.15.3.8. Cooling Tower

- Salient features such as make, model, dimensions, materials used, constructional details, number and size of nozzles, headers, size of tank, etc. should be verified against the requirements. Inspection of cooling tower in knocked down condition would be carried out at the site.
- Manufacturer's test certificate certifying the capacity of cooling tower and static balancing of fan should be furnished.

**12.15.4. Final Inspection**

i) After completion of the entire installation as per specification in all respects, the AC contractor shall demonstrate trouble free running of the AC equipments and installation for a period of minimum 120 hours of running.
ii) After the trial run, the AC contractor shall offer the plant for the seasonal test, namely test for summer or monsoon season whichever occurs earlier.
iii) The equipment capacity computations shall be carried out.
iv) All instruments for testing shall be provided by the AC contractor. The accuracy of the instruments shall be as follows:
   a) Temperature: Liquid in glass thermometer having accuracy ±1deg. C as per IS: 4825.
   b) Wet bulb Temperature: Sling psychomotor conforming to IS:6017,
   c) Scale Error: For less than 0 deg.-C.0.3°C ±0.2 deg. C. For over 0°C 0.2°C±0.1 deg.

d) Pressure Gauge: With the accuracy of ±1% for maximum scale value from 10 to 90%, and +1.9% for maximum scale value for rest of the scale conforming to IS: 3695.
e) Water flow meter: Water flow shall be measured using the arrangement installed as per schedule of work,

In case the tendering firms do not have testing instruments of the accuracy mentioned above, they should specify the accuracy of the instrument available with them for testing at the tender stage.

### 12.15.5. Testing Requirements And Procedures

12.15.5.1. Balancing of all air and water systems and all tests as called for in the specification shall be earned out by the HVAC contractor in accordance with the specifications and relevant local codes if any. Performance tests of individual equipment and control shall be carried out as per manufacturer's recommendation. All tests and balancing shall be carried out in the presence of Engineer-in-charge or his authorized representative.

The whole system balancing shall be tested with microprocessor based hi-tech instruments with an accuracy ±. 0.5%. The instrument shall be capable of storing data and then down loading into a P.C. The HVAC contractor shall provide a minimum but not limited to the following instruments:

a) Microprocessor based calculation meter to measure DB and WB temperature, RH and Dew point
b) Velo meter to measure air volume and air velocity
c) Pitot tube -Electronic rotary vane Anemometer
d) Accubalance flow measuring hood

The contractor shall be responsible to provide necessary sockets and connections for fixing of the testing instruments, probes etc.

12.15.5.2. <u>Air Systems</u>

Systems are to be balanced by first adjusting the total flow at the fan, then by adjusting main dampers and branch dampers. Only final minor adjustments are to be made with register and diffuser dampers. Balancing of the air system shall be accomplished without causing objectionable air noise. Baffles and orifice plates required for proper air balance shall be furnished and installed by the contractor. Basically the following tests and adjustments are required.

i) Test and balance all fan systems to provide proper cfm/ cmh.
ii) Adjust fresh air return air and exhaust dampers to provide proper air quantities in all modes of control.
iii) Test and record fresh air, return air and mixed air temperature at all air handling units. Test and record data at all coils after air and hydronic systems are balanced. Measure wet and dry bulb temperature on cooling coils.
iv) Make point tube transverse at all main supply and return ducts to set proper air quantities. Adjust all zone and branch dampers to proper cfm/cmh.
v) Test and adjust each register, grills, diffuser or other terminals equipment to within 5% of design air quantity. Each opening shall be defined on the test report by size manufacturer's model, room location, design cfm and actual cfm. Outlets shall be adjusted to minimize objectionable drafts.
vi) Test and record static pressure drop across all filters and major coils.
vii) High velocity duct systems shall be tested for leakages. If excessive or audible leakage is detected, the defect shall be repaired by the contractor. Sufficient static pressure readings shall be taken from the air handling units to the terminal units to establish system static pressure.
viii) Test and balance VAV boxes per design document to meet minimum and maximum airflows.

12.15.5.3. <u>Water System</u>

Systems are to be balanced by opening all valves, closing all by-pass and setting all mixing valves to full coil flow. Water systems shall be cleared of Verify that the system has been properly cleaned, flushed and treated before testing. Basically, the following tests and adjustments are required.

i) Test and adjust all pumps to deliver the proper rpm. Record rpm, motor amperage, discharge and suction pressure. Pumps shall operate without objectionable noise or cavitation. Plot actual pump and system performance points on manufacturers pump curves.
ii) Check all expansion tanks for proper filling pressurization. Verify operation of automatic fill and relief valves.

iii) Check the operation of all automatic valves.
iv) Test and adjust correct water flow through chiller, major items of equipment and main water circuits. The balancing valves, provided on the equipment shall be used for adjustment.
v) Check capacity output of chillers and set water flow rate for proper data.
vi) Check and adjust each coil to provide proper rpm. Record water and air temperature changes and water pressure drop.
vii) Set pressure drops across coil by-pass to match coil full-flow pressure drop.

12.15.5.4. Unit capacity in Tons Refrigeration shall be computed from the temperature readings, pressure readings and water/ brine flow measurements. Flow measurements shall be preferably through flow meters. Pumps shall be tested for the discharge head, flow and BHP. Where it is not possible to measure the flow, at least the discharge head and BHP (on the input side) shall be field tested.

12.15.5.5. Balancing Tolerance: Systems shall be balanced within the following tolerances

| | |
|---|---|
| 1. Duct leakage Rates (at operating pressures) | |
| Low pressure ducts (0 to 0.5kPa) | 5% of full flow |
| Medium Pressure Ducts (0.5 to 3kPa) | 1% of full flow |
| High Pressure Ducts (Greater than 3kPa) | 1% of full flow |
| 2. Air flow rates | |
| Under 70 L/S | 10% of flow |
| Over/ at 70 L/S | 5% of flow |
| 3. Water flow rates | |
| Chilled Water | 2% of flow |
| Other | 5% of flow |
| 4. Heat flow rates | |
| Heat exchangers | 5% of design capacity |

Procedure:
i) Review all pertinent plans, specifications, shop drawings and other documentation to become fully familiar with the systems and their specified and intended performance.
ii) Furnish equipment and instruct sheet metal trade on proper use for conducting duct leakage tests. Conduct first test as a way of instructing the above trades in the presence of the Departments representative.
iii) Test relative barometric pressures in various building area, as deemed necessary by the Department's representative and at least in an areas served by different systems.
iv) Test performance and continuously record on a 24 hour basis, temperature and humidity levels where control equipment is provided for that purpose in certain critical areas.
v) Before commissioning of the equipment, the entire electrical installation shall be tested in accordance with relevant BIS codes and test report shall be furnished by a qualified and authorized person.

12.15.5.6. Reports

Provide 3copies of the complete balancing and testing reports to the department. Report shall be neatly typed and bound suitable for a permanent record. Report forms shall contain complete test data and equipment data as specified and safety measures provided.

12.15.5.7. Final Documentation

i) The contractor shall leave the system operating in complete balance with water and air quantities as shown on drawings. Set stops on all balancing valves and lock all damper quadrants in proper position. Secure all automatic damper and valve linkages in proper positions to provide correct operating ranges. Proper damper positions shall be marked on ducts with permanent indication. Notify the department of any areas marginal or unacceptable system performance.
ii) The above tests and procedures are mentioned herein, for general guidance and information only, but not by way of lamination to the provisions of conditions of contract and design/ performance criteria.

iii) Upon commissioning and final handover of the installation, the HVAC contractor shall submit (within 4 weeks) to the engineer-in-charge! department 6 (six) portfolios of the following indexed and bound together in hard cover ring binder (300 x 450 mm) in addition to the completion drawings.
   a) Comprehensive operation and maintenance manual
   b) Test certificates, consolidated control diagram and technical literature on all controls.
   c) Equipment warranties from manufacturers.
   d) Commissioning and testing reports
   e) Rating charts for all equipment
   f) Log books as per equipment manufacturers standard format
   g) List of recommended spares and consumables
   h) Any special tools required for the operation or the maintenance of the plant shall be supplied free with the plant.

iv) At the close of the work and before issue of final certificate of completion by the Engineer-in--charge, the contractor shall furnish a written guarantee indemnifying the department against defective materials and workmanship for the Defects liability period. The contractor shall hold himself fully responsible for reinstallation or replace free of cost to the department.
   a) Any defective material or equipment supplied by the contractor
   b) Any material or equipment supplied by the department which is proved to be damaged or destroyed as a result of defective workmanship by the contractor.

**12.15.6. Submittals:**

12.15.6.1. <u>Submittals Shall Be Submitted For The Following Equipment:</u>

i) Centrifugal water cooled Chiller
ii) Pumps
iii) Hot water generators
iv) Cooling Towers
v) Air Separators
vi) Expansion Tanks
vii) Air cooled VRV
viii) Fan coil units
ix) Air Handling Units
x) Precision Air Conditioning Units
xi) Fans
xii) Pre-Insulated HDPE Pipe
xiii) VAV Boxes
xiv) Motorized Dampers
xv) Control valves
xvi) Controls
xvii) Valves
xviii) Panels

12.15.6.2. <u>Required Submittal Should Contain The Following Information Also.</u>

i) System summary sheet
ii) Sequence of operation
iii) Shop drawing indicating dimensions, required clearances and location and size of each field connection
iv) Power and control wiring diagrams
v) System profile analysis including variable speed pump curves and system curve. The analysis shall also include pump, motor and AFD efficiencies, job specific load profile, staging points, horsepower and kilowatt/hour consumption.
vi) Equipment data sheets

### 12.15.7. Miscellaneous:

i) The above tests are mentioned herein for general guidance and information only but not by way of limitation to the provisions of conditions of Contract and Specification.
ii) The date of commencement of all tests listed above shall be subject to the approval of the Architect, and in accordance with the requirements of this specification.
iii) The contractor shall supply the Commissioning Engineer and all necessary instruments and carry out any test of any kind on a piece of equipment, apparatus, part of system or on a complete system if the architect requests such a test for determining specified or guaranteed data as given in the Specification or on the Drawings.
iv) Any damage resulting from the tests shall be repaired and/or damaged material replaced to the satisfaction of the architect.
v) In the event of any repair or any adjustment having to be made, other than normal running adjustment, the tests shall be void and shall be recommended after the adjustment or repairs have been completed.
vi) The Contractor must inform the architect when such tests are to be made, giving sufficient notice, in order that the architect or his nominated representative may be present.
vii) Complete records of all tests must be kept and 3 copies of these and location drawings must be furnished to the Architect.
viii) The Contractor may be required to repeat the test as required, should the ambient conditions at the time not given, in the opinion of the Architect, sufficient and suitable indication of the effect and performance of the installation as a whole or of any part, as required.

# 12.16 ANNEXURE I – TERMINOLOGY

## 12.16. ANNEXURE I - TERMINOLOGY

I) Air Conditioning
The process of treating air so as to control simultaneously its temperature, humidity, purity, distribution and air movement and pressure to meet the requirements of the conditioned space.

II) Dry-Bulb Temperature
The temperature of air as registered by an ordinary thermometer.

III) Wet-Bulb Temperature
The temperature registered by a thermometer whose bulb is covered by a wetted wick and exposed to a current of rapidly moving air.

IV) Dew Point Temperature
The temperature at which condensation of moisture begins when the air is cooled at same pressure.

V) Humidity
It is the amount of water vapour present in a certain volume of air.

VI) Relative Humidity
Ratio of the actual water vapor in the air as compared to the maximum amount of water that may be contained at its dry bulb temperature. When the air is saturated, dry bulb, wet bulb and dewpoint temperatures are all equal.

VII) Enthalpy
A thermal property indicating the quantity of heat in the air above an arbitrary datum in kilo joules per kg of dry air (or in Btu per pound of dry air).

VIII) Psychrometry
Psychrometry is the science involving thermo dynamic properties of moist air and the effect of atmospheric moisture on materials and human comfort. It also includes methods of controlling thermal properties of moist air.

IX) Psychrometric Chart
A Psychometric chart graphically represents the thermodynamic properties of moist air. If two properties are known, all the other properties can be determined with the help of psychometric chart.

X) Evaporative Air Cooling
The evaporative air-cooling application is the simultaneous removal of sensible heat and the addition of moisture to the air. The water temperature remains essentially constant at the wet-bulb temperature of the air. This is a process in which heat is not added or removed from the air.

XI) Positive Ventilation
The supply of outside air by means of a mechanical device, such as a fan.

XII) Atmospheric Pressure
The pressure of air exerted on the surface of earth by the atmospheric column is called atmospheric pressure. At sea level, the atmospheric or barometric pressure is 760mm column of mercury (29.92 in Hg/406.8 inch water column/101.325 Kpa).

Generally atmospheric pressure is used as a datum for indicating the system pressures inair-conditioning and accordingly, pressures are mentioned above the atmospheric pressure or below the atmospheric pressure considering the atmospheric pressure to be zero. A 'U' tube manometer will indicate zero pressure when atmospheric pressure is measured.

XIII) Indoor Air Quality (Iaq)

Indoor air quality refers to the nature of conditioned air that circulates throughout the space/ area where one works or lives, i.e. the air we breath when we are indoor. IAQ refers not only to comfort which is affected by temperature, humidity and odours but also to harmful biological contaminants and chemicals present in the conditioned space.

Bad Indoor Air Quality can be a serious health hazard. Carbon dioxide (C02) has been recognized by ASHRAE as the surrogate ventilation index or the only measurable variable for the indoor air contaminants.

XIIIA) Buildings Related Illnesses (BRI)

BRI are attributed directly to the specific air-borne building contaminants like the outbreak of the legionnaire's disease after a convention and sensitivity pneumonitis with prolonged exposure to the indoor environment of the building.

XIV) Sick Building Syndrome (SBS)

SBS is a term, which is used to describe the presence of acute non-specific symptoms in the majority of people caused by working in buildings with an adverse indoor environment It could be a cluster of complex irritative symptoms like irritation of the eyes, blackened nose and throat, headaches, dizziness, lethargy, fatigue irritation, wheezing, sinus, congestion, skin rash, sensory discomfort from odours, nausea, etc. These symptoms are usually short-termed and experienced immediately after exposure, and may disappear when one leaves the building.

XV) Hydronic Systems

Water systems that convey heat to or from a conditioned space or process with hot or chilled water are frequently called hydronic systems. The water flows through piping that connects a chiller or the water heater to suitable terminal heat transfer units located at the space or process.

XVI) Water Conditioning

Water circulating in a hydronic system may require to be treated to make it suitable forair-conditioning system due to effect on the economics of air-conditioning plant. Unconditioned water used in air-conditioning system may create problems with equipments such as scale formation, corrosion and organic growth.

XVII) Water Hardness

Hardness in water is represented by the sum of calcium and magnesium in water and may also include aluminium, iron, manganese, zinc, etc. A chemical analysis of water sample should provide number of total dissolved solids (TDS) in a water sample in parts per million (ppm) as also composition of each of the salts in parts per million.

Temporary hardness is attributed to carbonates and bi-carbonates of calcium and/or magnesium expressed in parts per million (ppm) as CaC03. The remainder of the hardness is known as permanent hardness, which is due to sulfates, chloride, nitrites of calcium and/or magnesium expressed in ppm as CaC03.

Temporary hardness is primarily responsible for scale formation, which results in poor heat transfer resulting in increased cost of energy for refrigeration and air-conditioning. Permanent hardness (non-carbonate) is not a serious a factor in water conditioning because it has a solubility which is approximately 70 times greater than the carbonate hardness. In many cases, water may contain as much as 1200 ppm of non-carbonate hardness and not deposit a calcium sulfate scale.

The treated water where hardness as ppm of CaC03 is reduced to 50 ppm or below, is recommended for air-conditioning applications.

XVIII) Thermal Transmittance
Thermal transmission through unit area of the given building unit divided by the temperature difference between the air or some other fluid on either side of the building unit in 'steady state' conditions.

XIX) Thermal Energy Storage
Storage of 'Cold Energy' sensible, latent or combination for use in central system for air-conditioning or refrigeration is called thermal energy storage. It uses a primary source of refrigeration for cooling and storing 'Cold Energy' for reuse at peak demand or for backup as planned.

XX) Shade Factor
The ratio of instantaneous heat gain through the shading device to that through a plain glass sheet of 3mm thickness.

XXI) Sensible Heat Factor (SHF)
Sensible heat factor is the ratio of sensible heat to total heat, where total heat is the sum of sensible and latent heat.

XXII) Supply Air
The air that has been passed through the conditioning apparatus and taken through the duct system and distributed in the conditioned space is termed as supply air.

XXIII) Return Air
The air that is collected from the conditioned space and returned to the conditioning equipment is termed as return air.

XXIV) Re-Circulated Air
The return air that has been passed through the conditioning apparatus before being re-supplied to the space is called re-circulated air.

XXV) Duct System
A continuous passageway for the transmission of air which in addition to the ducts may include duct fittings, dampers, plenums and grilles &diffusers.

XXVI) Plenum
An air compartment or chamber to which one or more ducts are connected and which forms part of an distribution system.

XXVII) Supply And Return Air Grilles &Diffusers
Grilles and diffusers are the devices fixed in the air-conditioned space for distribution of conditioned supply air and return of air collected from the conditioned space for recirculation.

XXVIII) Fire Damper
A closure which consists of a normally held open damper installed in an air distribution system or in a wall or floor assembly and designed to close automatically in the event of a fire in order to maintain the integrity of the fire separation.

XXIX) Smoke Damper
A smoke damper is similar to fire damper. However, it closes automatically on sensing presence of smoke in air distribution system or in conditioned space.

XXX) Fire Separation Wall
The wall provides complete separation of one building from another or part of a building from another part of the same building to prevent any communication of fire of any access or heat transmission to wall itself which may cause or assist in the combustion of materials of the side opposite to that portion which may be on fire.

XXXI) Refrigerant

The fluid used for heat transfer in a refrigerating system, which absorbs heat at a low temperature and low pressure of the fluid and rejects heat at a higher temperature and higher pressure of the fluid, usually involving changes of state of the fluid.

XXXII) Global Warming Potential (GWP)

Global Warming can make our planet and its climate less hospitable and more hostile to human life. It is, therefore, necessary to reduce emission of green house gases such as Co2, Sox, Nox and refrigerants. The potential of are refrigerant to contribute to Global Warming is called its GWP. Long atmospheric life time of refrigerants results in Global Warming unless the emissions are controlled.

XXXIII) Ozone Depletion Potential (ODP)

The potential of refrigerant or gasses to deplete the Ozone in the atmosphere is called ODP. The ODP values for various refrigerants are as under:-

| | |
|---|---|
| R-11 | 1.000 |
| R-12 | 0.820 |
| R-22 | 0.034 |
| R·123 | 0.012 |
| R-134a | Nil |

Due to high OPD of 1, R-22 &R-123 their use in the air conditioning and refrigeration is being phased-out.

# 12.17. ANNEXURE II - SCHEDULE OF TECHNICAL DATA

## 12.17. ANNEXURE II - SCHEDULE OF TECHNICAL DATA

Contractor should furnish technical data as mentioned below, of the equipment and accessories offered by him as per scheme given in schedule of equipment and Bill of Quantities.

**(A) centrifugal pumps:**
(Give separate particulars for each application)

1. Manufacturer
2. Type
3. Model
4. Overall dimensions
5. Operating Weight (Kg)
6. Size of foundations *(mm)*
7. Material:
   - (i) Pump casing
   - (ii) Impeller
   - (iii) Shaft
   - (Iv) Shaft sleeve
   - (v) Base plate
8. Type of bearings
9. Type &material of seal
10. Speed (rpm)
11. Discharge (LPM)
12. Head (Mtr.)
13. Efficiency
14. Performance curves (whether enclosed with the tender)
15. Class of insulation
16. Full Load Current (Amps)
17. Starting Current
18. Locked rotor current on full Load.
19. Vibration isolator.
20. Noise Level at 1 m distance:

**(B) Water Piping:**

1. Material for pipes
2. Material for fittings
3. Pipe wall thickness
4. Material for valves
5. Pressure gauges:
   - (i) Make
   - (ii) Range
   - (iii) Dial
6. Flow meter type and make
7. Size of flow meter

**(C) Electrical**

1. Motors (Give separate particulars for each application)
   - (i) Manufacturer
   - (ii) Type and frame reference
   - (iii) Rated output (KW)
   - (iv) Range of working voltage (V)
   - (v) No. of phases
   - (vi) Rated frequency
   - (vii) Rated speed (RPM)
   - (viii) Full load current (amps)

(ix) Class of insulation
(x) Efficiency and power factor at the following loadings 100%, 75%, 50% 25% of Rated full load.
(xi) Type of bearings
(xii) Noise Level at 1 m distance:

2. Motor starters (Give separate particulars for each application):
   (i) Manufacturer
   (ii) Type
   (iii) Rating
   (iv) Whether the following protections are provided
      (a) Over load
      (b) Under voltage
      (c) Single phase prevention (for 3phase motor starters)

3. Switch board
   (i) Manufacturer
   (ii) Type

4. Circuit Breaker
   (i) Manufacturer
   (ii) Type
   (iii) Rated normal current (amps)
   (iv) Short circuit ratting (MVA)
   (v) Whether following are provided
      (a) *OIL* trip
      (b) EIF trip
      (c) Under voltage trip

5. Measuring Instruments:
   (i) Manufacturer
   (ii) Range
   (iii) Dial size
   (iv) Glass Index

6. Iron clad switch gears:
   (i) Manufacturer
   (ii) Make of HRC fuse provided

**(D) Controls**

1. Make and type of thermostats
2. Make and type of humidistats
3. Make and type of damper motor
4. Make and type of other control components

**(E) Insulation (For each application)**

1. Manufacturer
2. Material and density
3. ‘K' value at 10 deg C mean temperature
4. Thickness.

**(F) Fans(For each Type and application)**

1. Manufacturer

2. Type
3. CFM
4. Static Pressure MM WG
5. Motor H.P.
6. Insulation Class
7. Outlet Vel. FPM
8. R.P.M
9. Type of Drive
10. Noise Level DB

**(G) M.S. Pipe:**

1. Make
2. Class
3. Wall Thickness of Pipes

**(H) Valves & Gauges:**

1. Butterfly Valve Make
2. Balancing Valve Make
3. Check Valve Make
4. Y-strainer Make
5. Pressure Gauge Make
6. Flow Switch Make
7. Thermometer Make

**I) Grilles/Diffusers/Dampers:**
**make, materials and gauge**

1. Fire Dampers - UL Listed
2. Grilles
3. Louvers
4. Diffusers
5. Duct Dampers

**J) Duct Insulation Material**

1. Thermal Conductivity
2. Duct Insulation

**K) Air Handling Units/ Fan Coil Units:**

| | | |
|---|---|---|
| 1.0 | Make | |
| 1.1 | Casing | |
| 1.2 | Coil | |
| 2.0 | Type: | horizontal/ vertical |
| 3.0 | Dimension | MxMxH (M) |
| 4.0 | Cooling coil | |
| 4.1 | Coil area | Sq.M |
| 4.2 | No. of rows | Nos. |
| 4.3 | No. of fins/cm | |
| 4.4 | Tube dia (Outer dia) | mm |
| 4.5 | Thickness of tube | mm |
| 5.0 | Material of casing: | CRCA/GI |
| 6.0 | Air quantity at max. Speed And 1 m long duct collar | CMH |
| 7.0 | Air quantity at min. Speed And 1.0 m. Long duct collar | CMH |

8.0 Whether auxiliary drain pan Provided: Yes/No.

9.0 Make & model of room thermostat.
10.0 Water valves.
10.1 Type 2 way/ 3 way
10.2 Motorized/solenoid.
10.3 Make/dia.
11.0 Type of shut off valves
12.0 Whether acoustic lined duct collar included in Unit price.
13.0 Does FCU/ AHU have return air plenum. Yes/No.
14.0 Noise Level at 1 m distance:

**L) VRF/ Split Air Conditioning System:**

**Indoor**

1.0 Make
2.0 Casing
3.0 Type: Ductable/ Cassete/ High wall
4.0 Dimension MxMxH (M)
50 Cooling Capacity
6.0 Air quantity at max. Speed And 1 m long duct collar CMH
7.0 Air quantity at min. Speed And 1.0 m. Long duct collar CMH
8.0 Whether auxiliary drain pan Provided: Yes/No.
9.0 Make & model of room thermostat.
10.0 Whether acoustic lined duct collar included in Unit price.
11.0 Does Indoor Unit have return air plenum. Yes/No.
12.0 Noise Level at 1 m distance:

**Outdoor**

1. Manufacturer
2. Type
3. Model
4. Overall dimensions (mm)
5. Operating Weight (kg.)
6. No. of fans
7. CMH per fan
8. Outlet velocity (Mts. Per min)
9. Tip speed (Mts per min)
10. Compressor Type
11. Vibration isolator
12. Noise Level at 1 m distance:

**M) COOLING TOWER:**

1. Manufacturer with country of origin of cooling tower
2. Type
3. Model
4. Overall dimensions (mm)
5. Weight with water (kg.)
6. No. of fans
7. CMH per fan

8. Outlet velocity (Mts. Per min)
9. Tip speed (Mts per min)
10. Drift loss (LPH)
11. Total water loss (LPH)
12. Wet bulb temp(deg C)
13. Approach to the design wet bulb (deg C)

**N) Heat Recovery Unit**

1. General
   (i) Manufacturer
   (ii) Type of unit
   (iii) Overall dimensions (mm)
   (iv) Operating weight (including wt. Of water/ refrigerant in circulation (kg)
   (v) Noise level

2. Material and thickness of drain pan
3. Supply & Exhaust Fan Section:
   (i) Manufacturer
   (ii) Type of fan
   (iii) Fan speed (RPM)
   (iv) No. of fans
   (v) Fan wheel diameter (rnm)

4. Drive arrangement
5. No. of belts in case of belt drive
6. Material and thickness of fan wheel and blades
7. Material and of housing
8. Fan outlet area (sq.m.)
9. Outlet velocity (MPM)
10. Total air quantity (CuM./ Min.)
11. Static pressure at outlet (mm of water)
12. Whether statically and dynamically balanced
13. Type of bearings.
14. HEAT RECOVERY WHEEL
    Manufacturer
    Make
    Recovery Efficiency Total
    Sensible
    Latent
    Substrate type
    Desiccant
    Desiccant type
    Seals
    Vertical run /m of Dia mm
    Radial run /m of Dia mm
    Supply Air flow to conditioned space - cfm
    Return air flow from conditioned space - cfm
    Face Velocity-fpm
    Certified as per DIN EN ISO 846 YES/NO
    NFPA certification for 0% flame spread YES/NO
    Pressure drop per 100 FPM face velocity or part thereof
    At minimum recoveries specified :

15. Air filters:
    (i) Manufacturer
    (ii) Type of medium
    (iii) Filter medium

(iv) Material of frame work and its thickness (mm)
(v) Face area (Sq.m)
(vi) Face velocity across filters (MPS)
(vii) Pressure drop across filters (mm. of water)

**O) Water Chilling Unit (Centrifugal Type)**

1.1 Country of Origin

1.2 Refrigerant quantity kg.

1.3 Incomer Switchgear size Amp

1.4 Power cable size (XLPE) Sq.mm

1.5 Earthing size mm

1.6 Lubricant oil used Name

1.7 Quantity of lubricant oil kg.

1.8 Noise level at 1m distance NC
(Noise spectrum to be submitted)

1.9 Capacity at Design (Tons)

2.0 Chilled Water Flow GPM

2.1 Chilled Water IN Temp. º F

2.2 Chilled Water OUT Temp º F

2.3 Evaporating Temp º F

2.4 Condenser Water Flow GPM

2.5 Condenser Water IN Temp º F

2.6 Condenser Water OUT Temp º F

2.7 Condensing Temp º F

2.8 Max Input Power Requirement (Max.)
at Design Conditions IKW/TR

2.9 Max NPLV IkW/TR

3.0 Min C.O.P at ARI Conditions 6.3 including VFD Losses

3.1 Part Load data

| Load | IkW/TR at tender design conditions & with ARI relief | IkW/TR at ARI 550/590 conditions | IkW/TR at tender design conditions & constant condenser water entering temp |
|---|---|---|---|
| 100% | | | |
| 75% | | | |

| | | | |
|---|---|---|---|
| 50% | | | |
| 25% | | | |
| IPLV/NPLV | | | |

3.2 Performance sheet at tender conditions and part load with ARI relief on ECWT (100% - 25%)
Yes/ No

3.3 Performance sheet at ARI conditions and part load with ARI relief on ECWT (100% - 25%)
Yes/ No

3.4 Performance sheet at tender conditions and constant ECWT (100% - 25%)
Yes/ No

**2.0 Compressor**

2.1 Make

2.2 Model

2.3 Compressor Type

2.4 Speed (Operating) RPM

2.5 Speed (Maximum) RPM

2.6 Unloading at constant condenser Entering Water temp %

2.7 Design Suction Temp $^{O}$ F

2.8 Design Discharge Temp $^{O}$ F

2.9 Capacity at Design Temperature Tons

2.10 KW Consumed at Design Temperature KW

2.11 Refrigerant Used R

2.12 Type and Make of Capacity Control

**3.0 Condenser:** Unit

3.1Manufacturer Name

3.2 Length of Tubes m

3.3 Material of Tubes

3.4 Dia of Tubes Inch

3.5 No. of Integral Fins/cm Nos.

3.6 Water Velocity M/S

3.7 Pressure Drop Ft.

3.8 Quantity Nos.

| | |
|---|---|
| 3.9 Fouling Factor | (FPS) |
| 3.10 Marine type water box provided (Y or N) | |
| **4.0 Evaporator:** | Unit |
| 4.1Manufacturer | Name |
| 4.2 Length of Tubes | m |
| 4.3 Material of Tubes | |
| 4.4 Dia of Tubes | Inch |
| 4.5 Water Velocity | M/S |
| 4.6 Pressure Drop | Ft. |
| 4.7 Quantity | Nos. |
| 4.8 Fouling Factor | (FPS) |
| 4.9 Marine type water box provided (Y or N) | |
| **5.0 Compressor Motor:** | |
| 5.1 Manufacturer | Name |
| 5.2 Type of Motor | Type |
| 5.3 Rated Output | KW |
| 5.4 Current Characteristics | |
| **6.0 Starter Panel** | |
| 6.1 VFD | Yes/ No |
| 6.2 VFD – Factory fitted / calibrated(Y or N) | Yes/ No |
| 6.3 VFD – as per global catalogue on website (Y or N) | Yes/ No |
| 6..4.1 Phase rotation | Yes/ No |
| 6.4.2 Single phase protection | Yes/ No |
| 6.4.3 VFD parameters in Common microprocessor panel (Y or N) | Yes/ No |
| 6.4.4 kW Meter | Yes/ No |
| 6.4.5 Ammeter | Yes/ No |
| 6.4.6 Voltmeter | Yes/ No |
| 6.4.7 Display of all VSD parameters in main chiller panel | Yes/ No |

# 12.18. ANNEXURE III - TESTING AND MEASUREMENT NOTES

## 12.18. ANNEXURE III - TESTING AND MEASUREMENT NOTES

**A. Test Instruments**

1. All instruments for testing shall be provided by the air conditioning contractor.
2. Thermometers used for measurement of temperature of *water /* refrigerant shall have graduation of 0.1 deg C and shall be got calibrated from N.P.L. or any recognized test house beforehand.
3. Thermometers used in the psychrometers shall have graduations of 0.2 deg C and shall be calibrated as at (2) above.
4. Pressure gauges shall also be got calibrated beforehand from a recognized test house.
5. Orifice type of flow meters shall be used for measuring flow rate through the condensers and chillers.

**B. Capacity Computations**

1. Air handling unit (chilled water type):
   The capacity shall be computed from the water temperature and water flow measurement A tolerance of + 5% from the tender documents value shall be acceptable in the capacity so computed. Air quantity shall be measured in the supply duct and checked with the quantity specified in the tender documents. a tolerance of ±10% in the air quantity shall be acceptable. The enthalpy difference of air entering and leaving the coil shall be computed from air temperature and recorded.

2. Air handling unit (Dx type):
   The capacity shall be computed from the air quantity measured in the supply air duct and the enthalpy difference between the air entering leaving coil. Air quantity measured shall be checked with that recorded in the tender documents. A tolerance of ±10% from tender documents value shall be acceptable.

3. For the purpose of system capacity, the refrigeration tonnage obtained from the main refrigeration plant will be accepted.

4. If due to any reason, internal load mentioned in the tender specifications is not available psychometric computations for actual load conditions will, be done and the plant, if found satisfactory will be accepted.

# 12.19. ANNEXURE IV- MAINTENANCE

## 12.19. ANNEXURE IV- MAINTENANCE

This section covers the maintenance schedule during 2 year free warranty period and 3 year paid subsequent warranty period.

The maintenance provided during the warranty period shall be fully comprehensive and shall include but not limited to all equipments, labour part and emergency calls providing and site response within 24 hours. However during the maintenance period after the warranty is over, the materials shall be arranged by the department if any replacement is warranted. However consumable materials shall be arranged by the department during 5 yrs period including that of warranty period.

The maintenance shall also include a minimum of 24month preventive maintenance visits by qualified personnel who are thoroughly familiar with the type of equipment and system provided for this project.

| | | |
|---|---|---|
| Centrifugal Chillers | MONTHLY /ANNUAL INSPECTION | 1) Inspect all Chillers Periodically, and before the cooling season, to check the chiller starter and controls.<br>2) Ensure there's no litter, dirt, or debris in the panels.<br>3) Ensure all the linkages move freely.<br>4) Ensure the overloads are set correctly and that they work<br>5) Ensure all wiring connections are tight<br>6) Check all contacts for pitting and corrosion.<br>7) Verify that the safeties and controls all work.<br>8) Check Operating Pressure and temperatures and evaluate if chiller has the full refrigerant charge<br>9)Eddy current tube testing every two years<br>10) All manufacturer's recommendation to follow and performed at required interval |
| Cooling Towers | MONTHLY / ANNUAL INSPECTI | 1) Check the overall condition of the unit and listen for any uncommon noises to establish a baseline of any potential issues.<br>2) Before beginning any hands-on work, be sure to follow proper lock-out procedures and disconnect motor switches to ensure your safety.<br>3). Inspect and clean debris from strainers to keep the system free of excess materials.<br>4). Inspect the water distribution system and check for dry areas over the fill coil section to avoid scale buildup and increase system capacity. If the surface is not fully wetted, check the nozzles for cracks and clogs.<br>5) Flush dirt and debris from the cold water basin through the tower drain or sump strainer to maintain water filtration and keep dirt from collecting. Installing basin sweeper piping in addition to a filtration system will function as automatic maintenance.<br>6) Check the makeup water supply for the appropriate predetermined water level to conserve water and reduce air entrainment.<br>7) Adjust the bleed rate accordingly per your local water quality and evaporation rate regulations, preventing accumulation of solids in recirculating water. |

| | | |
|---|---|---|
| | | 8) Fix any tension problems on the belt to ensure optimal belt-drive system performance.<br>9) Routinely check oil level, oil quality, and shaft alignment for a gear-drive system following the manufacturer's recommendations to assure reliable service.<br>10) Lubricate fan shaft bearings every three months, at a minimum, to maintain proper operation. Installing automatic bearing greasers is easy and can eliminate monthly bearing maintenance.<br>11) Follow all manufacturer recommendations for operation and maintenance. |
| Hot Water Generator - Electric | Monthly /Annual inspection | 1) Follow steps and procedure mentioned in the specification of HWG<br>2)Follow all manufacturer recommendations for operation and maintenance. |
| WATER PUMPS | ANNUAL INSPECTION PRIOR TO EXPIRY OF WARRANTY PERIOD | 1) Perform all functions for monthly check.<br>2) Check motor earthing, megger motor and connection wiring on each leg.<br>3) Tighten motor terminals.<br>4) Check starter contacts.<br>5) Test and calibrate over-load settings. |
| AIR HANDLING UNITS AND FAN COIL UNITS | MONTHLY INSPECTION | 1) Inspect all air handling and fan coil units.<br>2) Check all air filters and clean or change filters as necessary.<br>3) Check all water coils, seals and pipelines for leaks and rectify as necessary.<br>4) Check and re-calibrate modulating valves and control. Adjust and rectify as necessary to ensure compliance with the original specifications.<br>5) Purge air from all water coils.<br>6) Check all fan bearings and lubricate with grease as necessary.<br>7) Check the tension of belt drives and adjust as necessary.<br>8) Check and clean all condensate pans, trays and drains.<br>9) Check, measure and recalibrate all sensors if necessary.<br>10) Check, clean and service all smoke detectors. Carry out a system test to ensure that the smoke detector will trip the AHU's.<br>11) Check all spring vibration isolators for abnormal vibration. Rectify as necessary.<br>12) Coil to be cleaned by<br>a) Spray of high press clean water(not exceeding 30 psi)<br>b) With chemical spray ,if necessary. |
| AIR HANDLING UNITS AND FAN COIL UNITS | ANNUAL INSPECTION PRIOR TO | 1) Perform all functions for monthly check.<br>2) Tighten motor terminals.<br>3) Check starter contacts. |

| | | |
|---|---|---|
| | EXPIRY OF WARRANTY PERIOD | 4) Test and calibrate over-load settings. |
| AIR COOLED PACKAGED UNITS AND PRECISION COMPUTER AIR CONDITION EQUIPMENTS | MONTHLY CHECK | 1) Check condenser fan motor load ampere.<br>2) Check fan and motor mounting brackets.<br>3) Check shafts and bearings. Lubricate with grease if necessary.<br>4) Check the tension of all belt drives adjust if necessary.<br>5) Check refrigerant leak with electronic leak detector.<br>6) Check electrical terminals and contactors operations and connections for tightness.<br>7) Check compressor motor current.<br>8) Check refrigerant line driers and moisture indicators. |
| AIR COOLED PACKAGED UNITS AND PRECISION COMPUTER AIR CONDITION EQUIPMENTS | ANNUAL INSPECTION PRIOR TO EXPIRY OF WARRANTY PERIOD | Perform all functions listed in the monthly check. |
| AIR DISTRIBUTION SYSTEM | MONTHLY AND ANNUAL INSPECTION PRIOR TO EXPIRY OF WARRANTY PERIOD | 1) Check operations of all modulating and fixed dampers controlling air flow through unit. Lubricate all damper bearing and linkages as necessary.<br>2) Carry out space temperature checks on air conditioned areas with thermo hydrographs. Balance air flow as necessary to compliance with requirement of original specifications. These checks include the calibration of sensors, thermostat, etc.<br>3) Check noise level of discharged air from diffusers. |
| VENTILATION | MONTHLY CHECK AND ANNUAL INSPECTION PRIOR TO EXPIRY OF WARRANTY PERIOD | 1) Check, adjust as necessary the air flow of all fans are in compliance with the original specification.<br>2) Check the tension of all belt drives and adjust as necessary.<br>3) Check and lubricate all fan bearings.<br>4) Tighten motor terminals.<br>5) Check starter contacts.<br>6) Test and calibrate over-load settings.<br>7) A system check shall be carried out for all mechanical ventilation (MV), pressurization and exhaust system to verify the performance of the system. |
| SWITCH BOARD | SIX-MONTHLY AND ANNUAL INSPECTION PRIOR TO EXPIRY OF WARRANTY | 1) Clean and adjust all switch gear, contactors, relays and associated electrical equipments at intervals not exceeding six months.<br>2) Check and prove operation of thermal over-load and protection devices.<br>3) Check and ensure tightness of all equipment |

| | | |
|---|---|---|
| | PERIOD | fastenings and cable terminations within switch boards.<br>4) Vacuum clean all switch board cubicles. |
| PIPINGSYSTEM | MONTHLY AND ANNUAL INSPECTION PRIOR TO EXPIRY OF WARRANTY PERIOD | 1) Check all piping system for leaks and repairs these where they have occurred.<br>2) Check for damages and deterioration of insulation or sheathings. Rectify as necessary. |
| | CONSUMABLE MATERIALS | CONSUMABLE MATERIALS The department shall supply the following consumable materials as and when required:-<br>1) The oils and grease required for lubrication of compressors, fan bearings, motors bearings, pivots and other moving parts.<br>2) All refrigerant required for topping up. Refrigerant loss if due to manufacturing defect or due to negligence shall be made good by the contractor.<br>3) All consumable filter elements/rolls.<br>4) All chemical for the correct chemical treatment of the cooling tower and chilled water system.<br>5) All carbon brushes required to replace worn brushes in electric motors.<br>6) All electric contact points required to replace worn electric contact points in switchgears, motor starter gears, electronic control gears and electric relays.<br>7) All electric fuses required to replace blown fuses.<br><br>Just before the expiry of the warranty of the contact, the contractor shall carry out a complete system operability test on all the system or sub systems as called for in the contract.<br>The purpose of the test is to verify that the performance of all the systems or sub-systems in the contract is in accordance to the specifications. All test shall be carried out in the presence of the Engineer-in-charge or his representative.<br>The warranty period is deemed to be over if the department or his representative is completely satisfied with the system performance during the test. |

# 12.20 ANNEXURE V - DDR FOR AD1 - ADMINISTRATION BUILDING

## 12.20: ANNEXURE V - DDR for AD1- ADMINISTRATION BUILDING

### A. Introduction:

Administration is part of academic block in South Asian University. This building includes General administration, Cafeteria, Meeting Room, Admin office, Conference Room, Examination Department, Director Room, Discussion Room, Examination Hall, Facilitation centre, Exhibition Hall, Cabins, Finance, Engineering & Maintenance, Fire control room, security room, Kitchen etc.

Building consists of a Basement + Ground + 5 Floors and a total built-up area of 13622sq.mtr.

#### 1. Air Conditioning Objective:

Objective of air conditioning is to provide thermal comfort to all areas for administration building in an efficient and cost-effective manner round the year. Temperatures and Indoor Air Quality shall be maintained in accordance with parameters as specified in the following sections of Basis of Design.

Administration building is served by Central chilled water system. The chilled water flowing through the M.S Pipe with HDPE Jacketing buried underground is connected to branch piping to serve all risers which are connected to all AHU's and FCU's.

#### 2. Ventilation Objective:

Objective of Mechanical Ventilation is to provide fresh air and vent out exhaust air to maintain indoor air quality and to have an escape route in case of fire. Mechanical ventilation system is being considered for Basements, Kitchen/pantry, toilets and other similar areas using combination of centrifugal fans, axial flow fans, propeller fans and inline fans.

### B. General Building HVAC Design Criteria and Assumptions

This section of the report documents specific numbers used in the design of the administration building. These assumptions are an essential part of making the transition from the project intent to installed equipment. Also the codes and guidelines for the designer and contractor which are to be followed during the different stages of project are outlined.

#### 1. CODES & STANDARDS:

The applicable Standards/Codes are:

(a) American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE).
- a.1 ASHRAE - 55
- a.2 ASHRAE - 90.1
- a.3 ASHRAE - 62.1
- a.4 ASHRAE - Fundamentals
- a.5 ASHRAE - HVAC Application
- a.6 ASHRAE - HVAC System & Equipment
- a.7 ASHRAE – Refrigeration

(b) Energy Conservation Building Code (ECBC)
(c) Duct construction standards as per relevant BIS Codes & SMACNA standards
(d) National Buildings Code-2005
(e) Air Filter as per ASHRAE-52.1 and 52.2
(f) National Electric code
(g) National Fire Protection code
(h) ISHRAE Standards
(i) GRIHA Manual
(j) IMC-2009

The following IS codes shall be applicable:

| S. No. | Material/item of Work | Standard/Code |
|---|---|---|
| 1. | Ducting Fabrication | IS: 655 |
| 2. | Galvanized Sheets/Wires | IS: 277 |
| 3. | Aluminum Sheets/Wires | IS: 737 |
| 4. | Horizontal Centrifugal Pumps | IS: 6595 |
| 5. | Mild Steel, ERW Pipes | IS: 1239, IS: 3589 |
| 6. | Pipe Fittings | IS: 1239 |
| 7. | Steel Pipe Flanges | IS: 6392 |
| 8. | Gate, Globe & Check Valves | |
| | • Up to 40 mm Gun metal | IS:778 |
| | • Butterfly valve of 50 mm and Above (Cast Iron) | IS:2906 |
| | • Balancing valve | IS:778 |
| | • Non Return valve | IS:5312 |
| 9. | Color Code for Identifications of pipes | IS: 2379 |
| 10. | 3 Phase induction motors | IS: 325 |
| 11. | Pressure and vacuum gauges | IS: 3624 |
| 12. | PVC insulated electric cables | IS: 1554 |
| 13. | Starters sheets/wires | IS: 8555 |
| 14. | Glossary of terms used in refrigeration and Air-conditioning | IS: 3615 |
| 15. | Hot die zinc coated steel pipes | IS: 4736-1968 |
| 16. | Expanded Polystyrene | IS: 4671 |

**Safety codes**

The following safety codes as laid down by ISI shall be followed:

| | | |
|---|---|---|
| 1. | Safety code for mechanical refrigeration | IS : 660 |
| 2. | Safety code for air-conditioning | IS : 659 |
| 3. | Safety code for scaffolding and ladders | IS : 3696 |
| 4. | Code for practice for safety and health Requirements in electrical and gas Welding & cutting operations | IS: 818 |
| 5. | Recommendations of safety procedures and Practices In electrical works | IS: 5216 |

NOTE: - All the codes and standards are applicable only with the latest amendments only.

**<u>Green building/GRIHA Features:</u>**

a) SouthAsian campus is targeting to be a GRIHA five star rated campus.
b) High efficient equipment will be used for HVAC system. Selection of High efficient fans for AHU and Ventilation system.
c) The overall potable water requirement will be reduced substantially by using treated water. Energy saving of 30% or higher will be achieved in overall project.
d) Heat rejection through the water bodies available at site level will be explored and adopted to achieve energy saving.
e) Variable speed drive shall be used on selected AHU and large ventilation fans.
f) Variable air volume system shall be used for selected areas as per the application.
g) Car parking exhaust system shall be equipped with CO sensors so that exhaust fans are operated as per permitted CO concentration levels.
h) Heat recovery wheels for pre-cooling OA by using the waste exhaust air wherever possible to lower down the fresh air load. This ensures reduced energy consumption despite higher fresh air intake.

2. Cooling tower selection for minimum drift and noise level; energy efficient motors, VFD for motor speed control.

3. **Location:**
   - Site Location : New Delhi
   - Geographic Location : 28.38°N, 77.13°E
   - Altitude : 216 m above mean sea level

a) **Design Conditions and Assumptions:**
The summer design condition is based on ISHRAE weather data and statistics of the most recent data of 10 year period, published by the India Metrological Department and *.epw* weather data files from the *DOE*.
The year round temperatures and climatic conditions is as below and system is evaluated for 8760 hours.

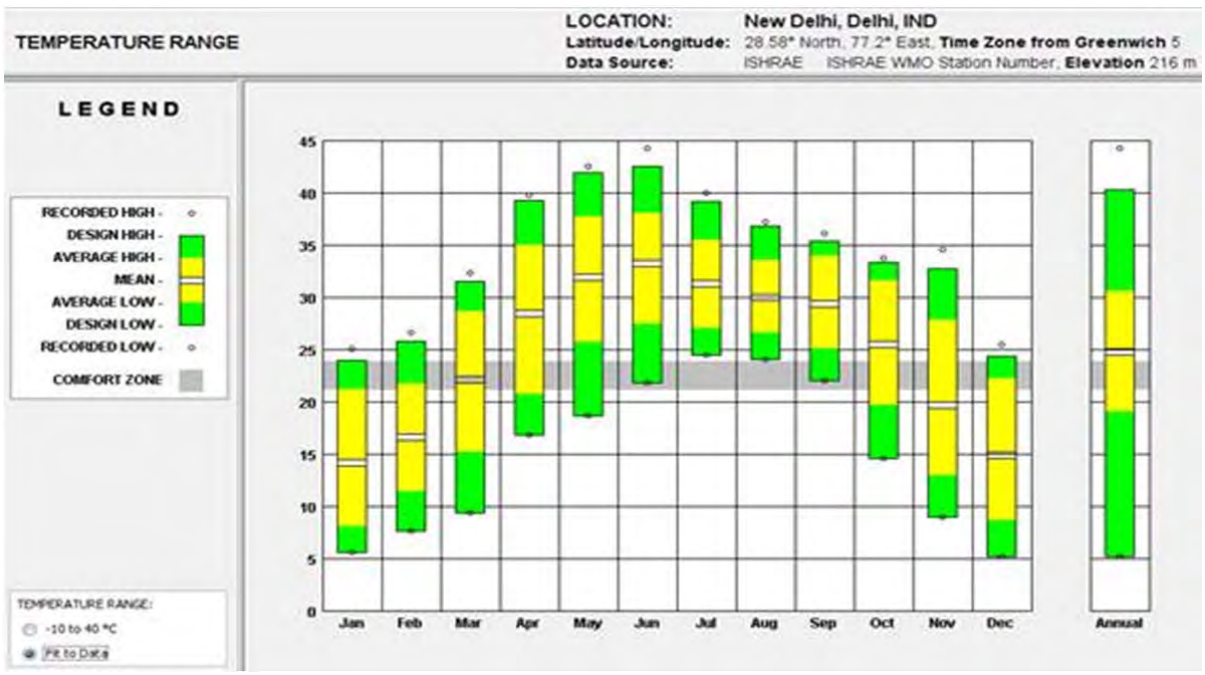



**Table-1 Design Assumptions**

| Description | Value (units) |
|---|---|
| Latitude/Longitude | 28.38°N, 77.13°E |
| Sea level | 216 m |
| Clearness number | 0.95 |
| Summer outdoor air DB/WB temperature | 43.3°C (109.94 °F) /23.89 (75.02 °F) |
| Winter outdoor air DB/WB temperature | 7.2°C (44.96 °F) / 5.0°C(41.0°F) |
| Monsoon outdoor air DB/WB temperature | 35°C (95.0°F)/ 28.3°C (83°F) |
| Ground reflectance | 0.20 |
| Roof U-value | 0.0793 Btu/h. ft².°F |
| Overall Wall U-value | 0.105 Btu/h. ft².°F |

| | |
|---|---|
| Glass U-value (summer/winter) | 0.317 Btu/h. ft².°F |
| Glass shading coefficient | 0.58 |
| Infiltration /Ex-filtration | As per ASHRAE 90.1 |
| Building system peak cooling load (day/month) | 15 / 7 |
| Cooling load design calculation program | CLTD, Trane Trace 700 |
| Winter Heat load design calculation program | UATD, Trane Trace 700 |
| Ductwork sizing program | Trane Ductulator |
| Cooling Safety factor/Heating Safety Factor | 10% |
| Fan heat gain safety factor | 5% |
| Diversity | 80% Overall on chiller plant |
| Typical Hours of Operation | As directed by SAU |

**b) Inside Design Conditions:**

Table below shows Room Ambient Temperature and Humidity Design Criteria for administration buildings. The set points are considered on the basis of ASHRAE -55, Clause 5&Thermal Comfort charts .

**Table-2- Inside Set Points conditions:**

| | **Inside conditions** | | | |
|---|---|---|---|---|
| | **Summer** | | **Winter** | |
| **Spaces** | **Temp.** | **Humidity** | **Temp.** | **Humidity** |
| CONFERENCE | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| CAFETERIA | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| FACILITATION CENTER | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| CABINS | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| EXAMINATION HALL | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| BANK | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| HEAD ROOM | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| MEETING ROOM | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| ENGG & MAINTENANCE | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| WAITING ROOM | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| ADMISSION DEPTT. | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| DIRECTOR ROOM | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| OFFICE | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| ROOMS | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| EXAMINATION DEPTT | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| ATM | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| SERVER ROOM | 22 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| OFFICE | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| DISCUSSION ROOM | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| GENERAL ADMINISTRATION | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| REGISTRAR SUITE | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| MEETING ROOM | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| LOBBY | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| PROCTOR | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| DEAN STUDENT OFFICE | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| SECRETARY | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |

| | | | | |
|---|---|---|---|---|
| VICE PRESIDENT SUITE | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| SR VP SUITE | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| DOCUMENTATION ROOM | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| DINING AREA | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| PRESIDENT SUITE | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| LOUNGE | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| CONFERENCE ROOM | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |

4. **Acoustic Criteria:**
   Air-conditioning systems will be designed to maintain the following noise criteria (NC) level in various spaces as per NBC - 2005 - PART 8 Building Services Section 4, Acoustics, Sound Insulation and Noise Control.

   - Meeting/Conference Room : NC 35-40
   - Cabins/Suite : NC 35-40
   - Office Space : NC 35-40
   - Cafeteria : NC 50-55
   - Admission/Examination Dept.: NC 40-45
   - Data Centre/Server Room : NC 35-40
   - Exhibition Hall : NC 40-45
   - BMS control Room : NC 40-45
   - Cafeteria : NC 50-55

5. **Fresh Air:**
   Adequate fresh air quantity shall be provided to air-conditioned spaces to maintain indoor air quality (IAQ) generally as per ASHRAE standard 62.1-2007.
   - 5 CFM /person + 0.12 CFM/Sq.ft. for Cabins/Suite
   - 5 CFM /person + 0.06 CFM/Sq.ft. for Office
   - 7.5 CFM/Person + 0.18 CFM/Sq.ft for Cafeteria
   - 5 CFM/Person + 0.06 CFM/Sq.ft for Faculty rooms
   - 5 CFM/Person + 0.06 CFM/Sq.ft for conference room
   - 5 CFM/Person + 0.06 CFM/Sq.ft for Meeting Room
   - 5 CFM/Person + 0.06 CFM/Sq.ft for Admission/Examination dept.
   - 5 CFM/Person + 0.06 CFM/Sq.ft for general Admin
   - 0 CFM/Person + 0.06 CFM/Sq.ft for Data Centre/Server room
   - 5 CFM/Person + 0.06 CFM/Sq.ft for Exhibition Hall
   - 0 CFM/Person + 0.06 CFM/Sq.ft for BMS control room

6. **Lighting Load:**
   Following is the assumptions made for the purpose of considering lighting load and will be according to the electrical lighting design. ASHRAE 90.1-2007 will be used for any assumptions.

   - 1.1 W/Sq.ft for Office Space.
   - 1.1 W/Sq.ft for Cabins.
   - 1.4 W/Sq.ft for Meeting Room.
   - 1.1 W/Sq.ft for lobby.
   - 1.5 W/Sq.ft for Bank.
   - 1.4 W/Sq.ft for Server Room
   - 1.4 W/Sq.ft for Cafeteria
   - 1.4 W/Sq.ft for Conference room
   - 1.1 W/Sq.ft for Server room

**7. Equipment Loads**

Following is the assumptions made for the purpose of considering Equipment load and will be according to the ASHRAE Fundamentals-2005, chapter 30 & electrical design/equipment used.

- 40 W/Sq.ft for Server room

**8. Occupancy**

Occupancy as per furniture layout of rooms as mentioned on the architectural plans.
For areas where capacity is not mentioned, it is assumed as per NBC-Part-8, Building Services, and Section-3, Table 4 or ASHRAE 62.1-2007 table 6-1.

**9. Mechanical Ventilation System:**

The following areas shall be provided with dedicated ventilation system with the number of air changes per hour for each space as identified herewith:

| | | | |
|---|---|---|---|
| a) | Toilets | : | 10 ACPH |
| b) | Car Parking/Basement ACPH Exhaust & ACPH Fresh Air | : | 6 (Normal Mode)/ 12 (Fire Mode)<br>6(Normal Mode)/12(Fire Mode) |
| c) | Kitchen | : | 20 ACPH |
| d) | Electrical Room | : | 20 ACPH |

**10. Relative Pressure:**

| | | |
|---|---|---|
| • Toilet Rooms | : | Negative inside pressure |
| • Garbage Room | : | Negative inside pressure |
| • Lift well | : | 50 Pa Positive Pressure |
| • Closed Staircase | : | 50 Pa Positive Pressure |
| • Lift lobby Pressurization | : | 30 Pa Positive Pressure |
| • All other areas | : | As per codes and standards |

## C. Mechanical System Design Parameters & Philosophy:

This section describes the assumptions, parameters considered for sizing and designing of various Mechanical equipments and its components. Below is the detailed description.

- Administration building shall be served by the central chilled water plant & hot water generator located in utility building.
- Chilled water network buried shall supply required chilled water to the building.

**1. Air Handling Units:**

- Unit shall be provided with filter, cooling coil & fan to serve the specific premises.
- During summer season, supply & return temperature of chilled water is considered are 44° F & 56° F.
- During winter season, supply & return temperature of water considered are 130° F & 110° F.
- Air Distribution to the rooms shall be provided with supply air duct with suitable terminals and return air through return air duct or plenum, as applicable.
- All duct subjected to temperature below dew point shall be insulted with XLPE with thermal conductivity of 0.037 W/m-k at 20°C mean temperature.

- Fan motor shall be Class A type with class F insulation. The fan motor shall have efficiency class IE-3.

**2. Piping:**

- Hydronic Piping material for chilled/Heating water supply and return shall be of Heavy class Black steel (MS- Class C) Pipes. Piping up to and including 150 mm diameter shall be of heavy class black steel confirming to IS:1239 and piping greater than 150 mm shall be minimum 6 mm thick black steel confirming to IS:3589.
- Hydronic piping shall be insulated with closed cell elastomer with maximum thermal conductivity of 0.038 W/m-k at 38° C, when tested in accordance with EN- ISO 8947.
- Chilled water piping insulation thickness shall be 25 mm thick for 40 mm pipe and smaller, 40 mm thick for 50 mm to 150 mm pipe and 75 mm thick for pipe greater than 150 mm.
- Drain from the all the air-conditioning equipment shall be collected by GI drain pipe insulated with 9 mm thick closed cell elastomer material and connected to nearest drain point.

All chilled water pipes shall be mild steel Class 'C' (heavy duty) conforming to relevant BIS codes. All jointing in the pipe system shall be by welding. Various types of valves such as butterfly valves, balancing valves and non return valves shall be provided in water lines.

Condensate drain piping would be GI 'B' Class conforming to relevant BIS codes.

**PIPING SHALL BE SIZED FOR THE FOLLOWING DESIGN PARAMETERS**

Pipes shall be sized to provide maximum water velocities as follows:

| **Pipe Sizes** | **Maximum Velocity** |
|---|---|
| Up to 50mm | 0.6 m/sec |
| 65 to 100mm | 0.8 m/sec |
| 125 to 200mm | 1.5 m/sec |
| 250 to 300mm | 2.5 m/sec |
| 355mm and up | 3.0m/sec |

**3. Filtration:**

Re-circulated air (mixed outdoor & return air) atAir handling unit: Washable synthetic type air filter Having 90% efficiency down to 10 Micron MERV 8 and filter having 99% efficiency down to 3 microns MERV 13)

Re-circulated air (mixed outdoor & return air) at Ventilation units : Washable synthetic type air filter Having 90% efficiency down to 10 Microns (MERV)

**4.**

**5. Duct Design Criteria:**

The following maximum duct design velocities will be used in the design of ductwork systems. Where a range is indicated, it is intended to represent velocities over a range of flow volume.

**Table-3**

| | **Meters/Second** |
|---|---|
| Low Pressure Systems | |
| - Main Duct | 7.5 |
| - Primary Branch | 5.0 |

| | Meters/Second |
|---|---|
| - Secondary Branch | 2.0-3.5 |
| Plenum | 5.0-6.0 |
| Medium Pressure Systems | 12.0 |
| Cooling Coils | 2.5 |
| Heating Coil | 4.0 |
| Filters | 2.5 |

The following maximum friction losses are to be used in conjunction with the velocities noted above.

| | Pascal's/meter |
|---|---|
| Low pressure systems | 1.0 |
| Medium pressure systems | 3.3 |

**6. Ventilation Fan Design Criteria:**

- Maximum fan outlet velocity for fan upto 450 mm Dia : 9.14m/s(1800 FPM)
- Maximum fan outlet velocity for fan above 450 mm Dia : 12m/s (2400 FPM)
- Maximum fan speed for fan upto 450 mm : 1440 RPM
- Maximum fan speed for fan above 450 mm : 1100 RPM

Note: Ventilation fans can be either axial type or centrifugal type.

**7. Diffuser and Grill Design Criteria:**

- All air outlets and intakes shall be made of extruded aluminum sections &shall present a neat appearance and shall be rigid with mechanical joints.
- Square and rectangular wall outlets shall have a flanged frame with the outside edges returned or curved 5 to 7 mm and fitted with a suitable flexible gasket between the concealed face of the flanges and the finished wall face. The core of supply air register shall have adjustable front louvers parallel to the longer side to give upto 22.5 degrees vertical deflection and adjustable back louvers parallel to the shorter side to achieve a horizontal spread air pattern to at least 45 degrees. Return air grilles shall have only front louvers. The outer framework of the grilles shall be made of not less than 1.6 mm thick aluminum sheet. The louvers shall be of aero foil design of extruded aluminum section with minimum thickness of 0.8mm at front and shall be made of 0.8mm thick aluminum sheet. Louvers may be spaced 18 mm apart.
- Square and rectangular ceiling outlets/intakes shall have a flange flush with the ceiling into which it is fitted or shall be of anti-smudge type. The outlets shall comprise an outer shell with duct collar and removable diffusing assembly. These shall be suitable for discharge in one or more directions as required. The outer shell shall not be less than 1.6 mm thick extruded section aluminum sheet. The diffuser assembly shall not be less than 0.80 mm thick extruded aluminum section.
- Circular ceiling outlets/intakes shall have either flush or anti smudge outer cone as specified in the tender specifications. Flush outer cones shall have the lower edge of the cone not more than 5 mm below the underside of the finished ceiling into which it is fitted. Anti-smudge cones shall have the outer cone profile designed to reduce dirt deposit on the ceiling adjacent to the air outlet. The metal sheet used for construction of these shall be minimum 1.6 mm thick extruded aluminum sheet.
- Linear diffusers shall have a flanged frame with the outside edges returned 3.5 mm and shall have one to four slots as required. The air quantity through each slot shall be

adjustable. The metal sheet used for the construction of these shall be minimum 1.6 mm thick extruded aluminum sheet.

- Grilles and diffusers constructed of extruded aluminum sections shall have grille bars set straight, or deflected as required. These shall be assembled by mechanical interlocking of components to prevent distortion. These grilles and diffusers shall have a rear set of adjustable blades, perpendicular to the face blades for deflection purposes.
- All supply air outlets shall be fitted with a VOLUME CONTROL DEVICE, made of extruded aluminum gate section. The blades of the device shall be mill finish/ block shade pivoted on nylon brushes to avoid rusting & rattling noise, which shall be located immediately behind the outlet and shall be fully adjustable from within the occupied space without removing any access panel. The volume control device for circular cutlets shall be opposed blade radial/shutter type dampers, or two or more butterfly dampers in conjunction with equalizing grid. Opposed blade dampers shall be used for square and rectangular ceiling/ wall outlets and intakes.

**D. Building Cooling and Heating Requirements:**

This section of the report describes the Cooling (TR) and Heating (MBH) requirement for the various spaces of the buildings. Table below shows the building wise preliminary requirements:

**Table-4 Building Heating and cooling Requirements:**

| Sr.no | Floor | Area Description | Floor area (Sqft) | No.of Person | Dehumified (CFM) | Cooling ( TR) | Heating (MBH) |
|---|---|---|---|---|---|---|---|
| 1 | GROUND | CONFERENCE 1 | 1281 | 30 | 1930 | 6.7 | 17.5 |
| 2 | | CONFERENCE 2 | 659 | 12 | 935 | 3.2 | 8.7 |
| 3 | | CAFETERIA | 2199 | 92 | 3358 | 15.0 | 28.6 |
| 4 | | FACILIATION CENTER | 592 | 8 | 1170 | 3.3 | 10.1 |
| 5 | | CABIN 1 | 109 | 3 | 334 | 0.9 | 2.7 |
| 6 | | CABIN 2 | 109 | 3 | 86 | 0.4 | 0.6 |
| 7 | | CABIN 3 | 109 | 3 | 86 | 0.4 | 0.6 |
| 8 | | CABIN 4 | 109 | 3 | 329 | 0.9 | 2.7 |
| 11 | | EXHIBITION HALL | 2219 | 4 | 4536 | 12.9 | 40.5 |
| 12 | | BANK+ TELLER | 1121 | 26 | 1512 | 5.3 | 12.1 |
| 13 | | LOBBY+PREFUNCTION + LOUNGE+CORRIDOR | 4797 | 10 | 1803 | 10.9 | 32.2 |
| | | | | | | | |
| 14 | FIRST | CABIN 1 | 139 | 3 | 332 | 1.0 | 3.2 |
| 15 | | CABIN 2 | 119 | 3 | 140 | 0.5 | 1.4 |
| 16 | | CABIN 3 | 119 | 3 | 140 | 0.5 | 1.4 |
| 17 | | CABIN 4 | 119 | 3 | 140 | 0.5 | 1.4 |
| 18 | | HEAD ROOM | 370 | 7 | 305 | 1.3 | 2.9 |
| 19 | | BMS CONTROL ROOM | 616 | 11 | 1171 | 3.0 | 8.6 |
| 20 | | MEETING ROOM | 189 | 8 | 393 | 1.3 | 3.2 |
| 21 | | HEAD ROOM 2 | 255 | 7 | 718 | 2.0 | 6.4 |
| 22 | | CABIN 1 | 104 | 3 | 269 | 0.8 | 2.1 |
| 23 | | CABIN 2 | 104 | 3 | 219 | 0.7 | 1.8 |
| 24 | | CABIN 3 | 104 | 3 | 212 | 0.7 | 2.0 |
| 25 | | STORE & PURCHASE | 924 | 12 | 650 | 2.75 | 5.0 |
| 26 | | CORRIDOR | 3155 | 16 | 1001 | 5.6 | 11.1 |
| 27 | | MEETING ROOM | 397 | 14 | 427 | 1.8 | 3.3 |
| 28 | | ENGG & MAINTAINANCE | 1528 | 31 | 2563 | 7.9 | 21.3 |
| 29 | | CABIN 3 | 98 | 3 | 252 | 0.7 | 2.0 |
| 30 | | CABIN 2 | 98 | 3 | 214 | 0.7 | 1.7 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 31 | | CABIN 1 | 98 | 3 | 256 | 0.8 | 2.0 |
| 32 | | MEETING ROOM | 171 | 8 | 417 | 1.4 | 3.3 |
| 33 | | HEAD ROOM | 259 | 7 | 909 | 2.4 | 7.4 |
| 34 | | SERVICES & HOUSE KEEPING | 967 | 12 | 661 | 2.8 | 5.1 |
| 35 | | WAITING ROOM | 476 | 10 | 950 | 2.6 | 7.3 |
| 36 | | ADMISSION DEPT 1 & 2 | 1896 | 22 | 2519 | 7.9 | 22.0 |
| 37 | | HEAD ROOM | 364 | 8 | 324 | 1.3 | 3.0 |
| 38 | | CABIN 1 | 139 | 3 | 334 | 1.0 | 3.2 |
| 39 | | CABIN 2 | 119 | 3 | 174 | 0.6 | 1.5 |
| 40 | | CABIN 3 | 119 | 3 | 173 | 0.6 | 1.5 |
| 41 | | CABIN 4 | 119 | 3 | 176 | 0.6 | 1.5 |
| | | | | | | | |
| 42 | SECOND | CABIN 1 | 92 | 3 | 469 | 1.2 | 3.9 |
| 43 | | CABIN 2 | 109 | 3 | 220 | 0.7 | 1.8 |
| 44 | | CABIN 3 | 109 | 3 | 220 | 0.7 | 1.8 |
| 45 | | CABIN 4 | 109 | 3 | 220 | 0.7 | 1.8 |
| 46 | | CABIN 5 | 109 | 3 | 220 | 0.7 | 1.9 |
| 47 | | CABIN 6 | 109 | 3 | 220 | 0.7 | 1.9 |
| 48 | | FINANCE | 2122 | 32 | 3537 | 10.8 | 28.1 |
| 49 | | DIRECTOR ROOM | 470 | 14 | 913 | 2.9 | 7.4 |
| 50 | | OFFICE | 139 | 4 | 220 | 0.5 | 0.8 |
| 51 | | MEETING ROOM | 599 | 18 | 1319 | 4.1 | 11.2 |
| 52 | | CABIN 5 | 127 | 3 | 250 | 0.8 | 2.1 |
| 53 | | CABIN 4 | 109 | 3 | 237 | 0.7 | 1.9 |
| 54 | | CABIN 3 | 109 | 3 | 275 | 0.8 | 2.2 |
| 55 | | LOBBY | 3464 | 5 | 940 | 5.2 | 11.4 |
| 56 | | CABIN 2 | 109 | 3 | 270 | 0.8 | 2.1 |
| 57 | | CABIN 1 | 109 | 3 | 270 | 0.8 | 2.1 |
| 58 | | CABIN 1 | 110 | 3 | 260 | 0.8 | 2.1 |
| 59 | | CABIN 2 | 110 | 3 | 269 | 0.80 | 2.1 |
| 60 | | CABIN 3 | 110 | 3 | 266 | 0.78 | 2.1 |
| 61 | | CABIN 4 | 331 | 9 | 797 | 2.35 | 6.3 |
| 62 | | EXAMINATION DEPT | 1732 | 24 | 1456 | 5.74 | 10.5 |
| 63 | | EXAM ROOM | 1902 | 28 | 3406 | 10.08 | 27.4 |
| 64 | | FINANCE 2 | 1732 | 24 | 1285 | 5.43 | 9.9 |
| 65 | | OFFICE | 140 | 4 | 320 | 0.52 | 0.8 |
| 66 | | DIRECTOR ROOM | 468 | 14 | 948 | 2.78 | 7.2 |
| 67 | | CABIN 1 | 92 | 3 | 516 | 1.32 | 4.1 |
| 68 | | CABIN 2 & 3 | 219 | 6 | 628 | 1.82 | 4.7 |
| 69 | | CABIN 4 | 109 | 3 | 242 | 0.69 | 1.9 |
| 70 | | MEETING ROOM | 625 | 18 | 1338 | 4.22 | 11.6 |
| 71 | | STRONG ROOM | 425 | 5 | 513 | 1.63 | 4.4 |
| | | | | | | | |
| 72 | | SERVER ROOM 1 | 7718 | 0 | 52930 | 123.00 | 291.8 |
| 73 | | SERVER ROOM 2 | 7718 | 0 | 52830 | 123.34 | 291.4 |
| | | | | | | | |
| | | | | | | | |
| 75 | FOURTH | CABIN 1 | 92 | 3 | 498 | 1.3 | 4.2 |
| 76 | | CABIN 2 | 109 | 3 | 237 | 0.7 | 2.2 |
| 77 | | CABIN 3 | 109 | 3 | 237 | 0.7 | 2.2 |
| 78 | | CABIN 4 | 109 | 3 | 212 | 0.7 | 1.8 |
| 79 | | CABIN 5 & 6 | 219 | 3 | 368 | 1.1 | 3.4 |
| 80 | | GENERAL ADMINISTRATION | 2122 | 32 | 3839 | 11.5 | 31.8 |
| 81 | | GENERAL ADMINISTRATION | 1099 | 20 | 692 | 3.3 | 5.5 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 82 | | REGISTRAR SUITE | 503 | 14 | 769 | 2.6 | 6.4 |
| 83 | | SECRETARY | 138 | 4 | 119 | 0.6 | 0.9 |
| 84 | | MEETING ROOM | 587 | 18 | 1355 | 4.1 | 12.7 |
| 85 | | CABIN 2 | 130 | 3 | 299 | 0.9 | 2.6 |
| 86 | | CABIN 1 | 109 | 3 | 286 | 0.8 | 2.4 |
| 87 | | LOBBY+WAITING LOUNGE | 4023 | 12 | 1208 | 6.6 | 13.8 |
| 88 | | PROCTOR | 452 | 9 | 589 | 2.0 | 4.9 |
| 89 | | OFFICE | 192 | 7 | 512 | 1.5 | 4.2 |
| 90 | | DEAN STUDENT OFFICE | 487 | 13 | 638 | 2.3 | 5.2 |
| 91 | | OFFICE | 192 | 3 | 460 | 1.3 | 4.0 |
| 92 | | DEPT OF IT | 1902 | 32 | 4532 | 12.8 | 33.9 |
| 93 | | DEPT OF IT | 1345 | 18 | 1475 | 5.1 | 12.1 |
| 94 | | CABIN 1 | 92 | 3 | 549 | 1.40 | 4.5 |
| 95 | | CABIN 2 | 109 | 3 | 324 | 0.87 | 2.6 |
| 96 | | CABIN 3 | 109 | 3 | 316 | 0.86 | 2.6 |
| 97 | | CABIN 4 | 109 | 3 | 302 | 0.81 | 2.3 |
| 98 | | CABIN 5 & 6 | 219 | 6 | 1058 | 2.60 | 8.0 |
| 99 | | SECRETARY | 140 | 4 | 120 | 0.56 | 0.9 |
| 100 | | VICE PRESIDENT SUITE | 470 | 14 | 1256 | 3.40 | 9.1 |
| 101 | | MEETING ROOM | 587 | 18 | 1302 | 4.09 | 11.9 |
| | | | | | | | |
| 102 | FIFTH | MEETING ROOM | 174 | 8 | 776 | 2.2 | 6.4 |
| 103 | | SECRETARY | 115 | 3 | 367 | 1.0 | 2.9 |
| 104 | | SR VICE PRESIDENT SUITE | 363 | 10 | 608 | 2.0 | 5.5 |
| 105 | | SECRETARY | 140 | 4 | 158 | 0.6 | 1.4 |
| 106 | | VICE PRESIDENT SUITE | 467 | 14 | 880 | 2.9 | 7.9 |
| 107 | | CORRIDOR | 687 | 4 | 777 | 2.5 | 7.4 |
| 108 | | DOCUMENTATION ROOM | 272 | 3 | 231 | 0.9 | 2.2 |
| 109 | | OFFICE | 508 | 8 | 1096 | 2.7 | 9.4 |
| 110 | | MEETING ROOM | 239 | 10 | 946 | 3.1 | 7.7 |
| 111 | | DINING AREA | 528 | 12 | 923 | 3.2 | 8.6 |
| 112 | | PRESIDENT SUITE | 670 | 15 | 1364 | 4.1 | 8.1 |
| 113 | | SECRETARY | 485 | 11 | 686 | 2.3 | 11.6 |
| 114 | | MEETING ROOM | 256 | 10 | 666 | 2.05 | 6.0 |
| 115 | | CORRIDOR/LOBBY | 1126 | 8 | 810 | 3.1 | 5.5 |
| 116 | | LOUNGE | 1922 | 16 | 2065 | 6.7 | 20.3 |
| 117 | | COMMITTEE ROOM | 1293 | 30 | 3591 | 10.4 | 29.2 |
| 118 | | SECRETARY | 140 | 4 | 189 | 0.7 | 1.5 |
| 119 | | VICE PRESIDENT SUIT | 426 | 14 | 1070 | 3.2 | 8.8 |
| | | | | | | | |
| TOTAL | | | 68140 | | 94921 | 559 | 1413 |

**Total HVAC Load for Administration Building on chiller- 559TR**
**Admin Load on Central Plant (@80 % diversity) - 448TR**

**Note:** Server Rooms is air conditioned Using Specialized dual fluid Precision ACs as per the server requirements . During day time PAC unit will take chilled water from chiller and during night time DX type system will work and provide cooling in server room /Data centre, In this way sever room 24 X 7 working can be achieved energy efficient and economically. Also conditioned areas in the respective floor i.e. ATM, ELV and UPS room are also based on DX type air conditioned.

**Assumptions:**

Since complete server room will not be installed at a time and it is assumed that 50 % server will be installed. So we have designed server room airconditioning at 100 % but**we have considered 50% PAC unit configuration in our BOQ for this phase.**

**Table-5 DX Type Load:**

| Sr.no | Floor | Area Description | Floor area (Sqft) | No.of Person | Dehumified (CFM) | Cooling ( TR) | Heating (MBH) |
|---|---|---|---|---|---|---|---|
| 1 | GROUND | ATM | 194 | 3 | 659 | 1.7 | 4.8 |
| 2 | | DISPATCH ROOM | 294 | 2 | 412 | 1.3 | 3.2 |
| 3 | | FIRE CONTROL ROOM | 325 | 2 | 422 | 1.3 | 3.3 |
| 4 | | LV ROOM | 171 | 2 | 386 | 1.1 | 2.8 |
| 5 | FIRST | LV ROOM | 171 | 2 | 386 | 1.1 | 2.8 |
| 6 | SECOND | LV ROOM | 171 | 2 | 386 | 1.1 | 2.8 |
| 7 | THIRD | OFFICE 1 | 217 | 3 | 113 | 0.56 | 1.0 |
| 8 | | OFFICE 2 | 217 | 3 | 113 | 0.56 | 1.0 |
| 11 | | SERVER ROOM 1 | 7718 | 0 | 52930 | 123.00 | 291.8 |
| 12 | | SERVER ROOM 2 | 7718 | 0 | 52830 | 123.34 | 291.4 |
| 13 | | LV ROOM | 171 | 2 | 386 | 1.08 | 2.8 |
| 14 | FOURTH | LV ROOM | 171 | 2 | 386 | 1.08 | 2.8 |
| 15 | FIFTH | LV ROOM | 171 | 2 | 386 | 1.08 | 2.8 |
| | | | | | | | |
| TOTAL | | | 17708 | | 109795 | 258 | 613 |

AHU Zoning of the building is as shown in the drawings and are based on best possible &efficient option and area application.

- Server room on third floor is air conditioned with the use of PAC (Precision air conditioning system) System. Air will be supplied from unit below the false floor and return is taken from top of the unit. So for doing this system we will require false floor of minimum 600 mm clear height.
- Cafeteria to have its own independent AHUs.
- We are proposing VAV boxes for the supply of dehumidified air to the respective zone. This will be used in conjunction with the VFD (Variable frequency drive motor)of AHU forsaving energy and make a building energy efficient.
- We are proposing of HRW (Heat Recovery Energy) unit for saving energy andmake building energy efficient. Please see the below mention detailed offresh air requirement in whole building, zone wise according to drawings.

| **SR.NO** | **ZONE 1** | | **ZONE -2** | | **ZONE -3** | | **ZONE -4** | |
|---|---|---|---|---|---|---|---|---|
| **FLOOR** | **EQUIP. TAG** | **FRESH AIR CFM** | **EQUIP. TAG** | **FRESH AIR CFM** | **EQUIP. TAG** | **FRESH AIR CFM** | **EQUIP. TAG** | **FRESH AIR CFM** |
| GROUND | AHU-01-01 | 327 | AHU-01-02 | 320 | AHU-01-03 | 319 | AHU-01-04 | 1090 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| FIRST | AHU-02-01 | 465 | AHU-02-02 | 466 | AHU-02-03 | 394 | AHU-02-04 | 355 |
| SECOND | AHU-03-01 | 562 | AHU-03-02 | 508 | AHU-03-03 | 491 | AHU-03-04 | 482 |
| FOURTH | AHU-05-01 | 520 | AHU-05-02 | 485 | AHU-05-03 | 430 | AHU-05-04 | 473 |
| FIRFTH | AHU-06-01 | 485 | AHU-06-02 | ----- | AHU-06-03 | 561 | AHU-06-04 | 433 |
| TOTAL | Fresh air | 2359 | Fresh Air | 1779 | Fresh Air | 2195 | Fresh Air | 2833 |
| **Grand Total of Fresh Air of All Zones:- 9166 CFM** | | | | | | | | |

**HRW (Heat Recovery wheel):**

Heat recovery wheel is used to reduce the cooling load of outside fresh air .The amount of outside air which is required for maintaining the indoor air quality is first passed through a rotating wheel in which enthalpy of dry air is stored. Return air of room(will pass through toilets and pantry through door transfer grille and will be collected in exhaust duct from respective floor) passes through heat recovery wheel where exchange of enthalpy (Hot & cool) takes place and the fresh air supply to indoor unit contains much lower temperature than the outside air. Since outside air supplied to indoor unit is having less amount of enthalpy, so the net cooling load required to bring the outside air temperature to room air temperature is very less. In this way we can save energy consumption and maintain good indoor air quality. Saving of cooling load calculation is as follow:

**Table: Heat recovery energy calculation:**

| | PEAK WINTER | PEAK SUMMER |
|---|---|---|
| **OUTSIDE CONDITION** | | |
| DBT($^0$C) | 12 | 43.3 |
| DBT($^0$F) | 53.6 | 109.9 |
| WBT($^0$C) | 9.5 | 24 |
| WBT($^0$F) | 49.2 | 75.2 |
| RH (%) | 74 | 19.6 |
| Total Enthalpy(H1) | 19.8 | 38.3 |
| Fresh Air (CFM) | 9165 | 9165 |
| **ROOM CONDITION** | | |
| DBT($^0$C) | 21 | 24 |
| DBT($^0$F) | 69.8 | 75.2 |
| WBT($^0$C) | 14.5 | 17.1 |
| WBT($^0$F) | 58.1 | 62.8 |
| RH (%) | 50 | 50 |
| Total Enthalpy(H2) | 25.2 | 28.2 |
| **RETURN AIR CONDITION** | | |
| DBT($^0$C) | 24 | 26 |
| DBT($^0$F) | 75.2 | 78.8 |
| WBT($^0$C) | 17 | 18.7 |
| WBT($^0$F) | 62.6 | 65.7 |
| RH (%) | 50 | 50 |
| Total Enthalpy(H3) | 28.2 | 30.4 |
| **CONDITION OF FRESH AIR AFTER HRWs** | | |
| DBT($^0$C) | 18 | 34.7 |
| DBT($^0$F) | 64.4 | 94.4 |

| | | |
|---|---|---|
| WBT($^0$C) | 13.3 | 21.4 |
| WBT($^0$F) | 55.9 | 70.4 |
| RH (%) | 62 | 34.8 |
| Total Enthalpy(H4) | 24 | 34.4 |
| **Total cooling load required to bring down outside air to room condition** | | |
| **Cooling Load (TR)** | - | 34.22 |
| **Total cooling load required to bring down outside air to room condition with the use of Heat recovery wheel** | | |
| **Cooling Load (TR)** | - | 21 |
| **Total Saving in cooling load with the use of HRW unit** | | |
| **Cooling Load (TR)** | - | 13.21 |
| **Saving percentage** | **-** | **38%** |

**Saving in one day operation of building during Summer(considering 9 hours operation in a day) = 13.21 x 9 x 0.65 = 77.27 kwh/day**

**Saving in one year operation of building during Summer (considering 250 operational days in a year) = 77.27 x 250 = 19319.6 kwh/year**

**E. Air Distribution Systems**

Various Options will be explored, evaluated and opted for air distribution and low side system.

- Variable volume air distribution
- Constant volume air distribution system
- Under floor Air Distribution System

Individual spaces will be evaluated for suitability for the above systems. Based on a detailed energy analysis and nature/application of each space, all above systems will be evaluated and the best options based will be applied. For example, Lecture hall to go with under floor Air distribution system, Classrooms, office will have VAV and so on.
Faculty of Law & Humanities building shall be served through central chilled water Plant located at utility building through pump & piping network.

- **Tertiary Pump:**
  Tertiary pump will be provided at later stages of design into the building basement to accommodate the pressure requirements at each AHU. This will be after the Calculation of the pump head for the pumps of central plant.
  There shall be provision of 2 tertiary pumps (1 working+ 1 standby). This ensures And maintains the required pressure and Flow of chilled water to meet the Building Cooling load.

- **BTU Metering System**
  Metered chilled water will be provided through each AHU in the complex where in BTU meter will be provided for measuring the AHU chilled water use. This will help to keep a

check on energy usage at each space.

- **Under floor air distribution:**
  Under floor Air distribution will be adopted in administration server room at third floor of administration building. Under floor air distribution systems (UAFD) deliver air flow at a higher temperature than a conventional system and can be very effective in maintaining a constant temperature without fail. A duct network is not required under the floor and floor grille is used to serve the space& maintain desired condition inside the room. This gives the uniform distribution of air throughout the space and provides a good cooling.

  1. Reduced energy consumption due to stratification.
  2. Reduced ductwork due to floor plenums. The system does add to architectural costs as a raised floor system installation in the space is required.
  3. Increased number of economizer operation hours to utilize free cooling.

**Details of DX-Type PAC Unit for Data Centre/Server room:-**

| SR.no | BTUH | TOTAL TR | POWER CONSUMPTION(KW) | FILTER | HUMIDIFIER | ELECTRIC HEATER |
|---|---|---|---|---|---|---|
| 1 | 300000 | 25.00 | 48.1 | G4 | Humidifier 8 kg/h | YES |
| 2 | 300000 | 25.00 | 48.1 | G4 | Humidifier 8 kg/h | YES |
| 3 | 300000 | 25.00 | 48.1 | G4 | Humidifier 8 kg/h | YES |
| 4 | 300000 | 25.00 | 48.1 | G5 | Humidifier 8 kg/h | YES |
| 5 | 300000 | 25.00 | 48.1 | G6 | Humidifier 8 kg/h | YES |
| 6 | 300000 | 25.00 | 48.1 | G7 | Humidifier 8 kg/h | YES |
| 7 | 300000 | 25.00 | 48.1 | G8 | Humidifier 8 kg/h | YES |
| 8 | 300000 | 25.00 | 48.1 | G9 | Humidifier 8 kg/h | YES |
| 9 | 300000 | 25.00 | 48.1 | G10 | Humidifier 8 kg/h | YES |
| 10 | 300000 | 25.00 | 48.1 | G11 | Humidifier 8 kg/h | YES |
| 11 | 300000 | 25.00 | 48.1 | G12 | Humidifier 8 kg/h | YES |
| 12 | 300000 | 25.00 | 48.1 | G13 | Humidifier 8 kg/h | YES |

- **Duct Construction and Fire Safety**
  All ducts shall be fabricated out of galvanized sheet steel (GSS) as per SMACNA standard for long life and as per fire norms. Motorized smoke dampers shall be installed within supply air ducts and return air ducts at AHU room wall crossings, to prevent spread of smoke / fire to the adjoining areas. Air handling unit fan motor shall also be tripped when smoke is sensed in the conditioned area served by the air handling unit.

- **Fresh Air requirement**
  Fresh air requirement for various spaces shall be either mechanically forced or infiltrated.
  For labs areas, fresh air dampers are located on AHU room for supplying required fresh air.

**F. MECHANICAL VENTILATION AND SMOKE EVACUATION SYSTEM:**

Mechanical ventilation system is being considered for Utility rooms, Basements, Kitchen/pantry, toilets and other similar areas using combination of centrifugal fans, axial flow fans, propeller

fans and inline fans.

1. **Car Parking Extract and Supply:**
   Mechanical Ventilation for car parking in basement shall be ducted ventilation as per draft amendment to NBC-2005 designed to permit 6 ACPH for normal ventilation, and 12 ACPH in case of fire. During Normal operation, Exhaust air @ 6 ACPH shall be exhausted through fans in the basement and the fresh air requirement shall be met through the Ramp openings available. To cater to additional 6 ACPH (total 12 ACPH) in case of fire, another set of Tube-axial fans connected with exhaust air riser shall get actuated. During this period, additional supply air fans @6 ACPH shall also supply the fresh air into the basement car parking area (wherever openings are not sufficient for the fresh air).
   Basement ventilation fans for normal operation shall be provided with variable frequency drive controlled through CO concentration level within parking area for energy conservation.
   As per revised NBC-2005, there are only one zone considered for parking ventilation in administration building. Area detail & air quantity required are given
   in table below.

**Table-6 – Parking Ventilation**

| Space | Area Sq.ft | Height (ft) | ACPH for Exhaust air | ACPH for Fire Mode | Exhaust CFM in Normal mode | Exhaust CFM Fire Mode | Exhaust Air Fan | Fresh Air Fan |
|---|---|---|---|---|---|---|---|---|
| Car Parking /Basement | 22058 | 13.448 | 6 | 6 | 29664 | 29664 | 01#30000 CFM (N) & 01#30000 CFM (F) | 01#36000 CFM FAN & 40% through Ramp opening |

All the basement parking ventilation fans shall be fire rated for a minimum of 250 Deg C for a minimum of 2 Hrs applications. Fan motor shall be Class H type with class O insulation. The fan motor shall have efficiency class IE-3.

2. **Bath, Toilet, Services and Lab Exhaust:**
   Bath exhaust fans will be provided in buildings as required removing foul air and maintaining air quality. Toilets, Service room electrical room etc will also have exhaust system installed. Toilet doors shall have an undercut (or an air transfer grill) so that some air from the surrounding spaces shall pass through this undercut /air transfer grill and exhausted out, using duct mounted fans. Toilets are ventilated through the ducting arrangement.

   Propeller, axial and duct mounted inline fan of required CFM and relative pressure serve the space. Approx. CFM for the different areas for various building in Stage-I is as shown in table:

**Table-7 –Ventilation Summary:**

| Sr. No | Floor | Room Description | Area(Sqm) | ACPH | Ventilation (CFM) |
|---|---|---|---|---|---|
| 1 | BASEMENT | ELECTRICAL ROOM | 52 | 20 | 2508 |
| 2 | | UPS ROOM | 30.4 | 15 | 1100 |
| 3 | GROUND | HAND TOILET | 4.7 | 10 | 114 |
| 4 | | J STORE | 5.7 | 12 | 165 |
| 5 | | FEMALE TOILET | 11.8 | 10 | 285 |
| 6 | | MALE TOILET | 13.5 | 10 | 326 |
| 7 | | ELECTRICAL ROOM | 15.48 | 20 | 747 |
| 8 | | STORE | 8.16 | 12 | 236 |
| 9 | | PANTRY | 5.05 | 10 | 122 |

| | | | | | |
|---|---|---|---|---|---|
| 10 | | JANITOR ROOM | 2.8 | 10 | 68 |
| 11 | | LADIES TOILET | 11.83 | 10 | 285 |
| 12 | | GENTS TOILET | 13.52 | 10 | 326 |
| 13 | | KITCHEN | 24 | 20 | 1158 |
| 14 | | STORE | 12.96 | 12 | 375 |
| 15 | FIRST | HAND TOILET | 5 | 10 | 110 |
| 16 | | J STORE | 5.71 | 12 | 159.7 |
| 17 | | FEMALE TOILET | 11.8 | 10 | 275 |
| 18 | | MALE TOILET | 13.5 | 10 | 315 |
| 19 | | ELECTRICAL ROOM | 15.48 | 20 | 722 |
| 20 | | PANTRY | 5.05 | 10 | 118 |
| 21 | | JANITOR ROOM | 2.8 | 12 | 78 |
| 22 | | LADIES TOILET | 11.83 | 10 | 276 |
| 23 | | GENTS TOILET | 13.52 | 10 | 315 |
| 24 | SECOND | HAND TOILET | 5 | 10 | 110 |
| 25 | | J STORE | 5.71 | 12 | 160 |
| 26 | | FEMALE TOILET | 11.8 | 10 | 275 |
| 27 | | MALE TOILET | 13.5 | 10 | 315 |
| 28 | | ELECTRICAL ROOM | 15.48 | 20 | 722 |
| 29 | | PANTRY | 5.05 | 10 | 118 |
| 30 | | JANITOR ROOM | 2.8 | 12 | 78 |
| 31 | | LADIES TOILET | 11.83 | 10 | 276 |
| 32 | | GENTS TOILET | 13.52 | 10 | 315 |
| 33 | THIRD | STORE | 65.61 | 12 | 1836 |
| 34 | | ELECTRICAL | 15.48 | 20 | 722 |
| 35 | | STORE 1 | 12.76 | 12 | 357 |
| 36 | | STORE 2 | 12.76 | 12 | 357 |
| 37 | | STORE 3 | 65.61 | 12 | 1836 |
| 38 | FOURTH | HAND TOILET | 5 | 10 | 110 |
| 39 | | J STORE | 5.71 | 12 | 160 |
| 40 | | FEMALE TOILET | 11.8 | 10 | 275 |
| 41 | | MALE TOILET | 5.95 | 12 | 166 |
| 42 | | TOILET | 4.08 | 10 | 95 |
| 43 | | ELECTRICAL ROOM | 15.48 | 20 | 722 |
| 44 | | PANTRY | 5.05 | 10 | 118 |
| 45 | | JANITOR ROOM | 2.8 | 12 | 78 |
| 46 | | LADIES TOILET | 11.83 | 10 | 276 |
| 47 | | GENTS TOILET | 13.52 | 10 | 315 |
| 48 | | TOILET | 4.07 | 10 | 95 |
| 49 | FIFTH | HAND TOILET | 5 | 10 | 110 |
| 50 | | J STORE | 5.71 | 12 | 160 |
| 51 | | FEMALE TOILET | 11.8 | 10 | 275 |
| 52 | | MALE TOILET | 5.955 | 10 | 139 |
| 53 | | TOILET | 4.08 | 10 | 95 |
| 54 | | ELECTRICAL ROOM | 15.48 | 20 | 722 |
| 55 | | TOILET | 6.873 | 10 | 160 |
| 56 | | WASH/PANTRY | 5.394 | 10 | 126 |
| 57 | | DRESS | 5.394 | 10 | 126 |

| | | | | | |
|---|---|---|---|---|---|
| 58 | | PANTRY | 5.05 | 10 | 118 |
| 59 | | JANITOR ROOM | 2.8 | 12 | 78 |
| 60 | | LADIES TOILET | 11.83 | 10 | 276 |
| 61 | | GENTS TOILET | 13.52 | 10 | 315 |
| 62 | | TOILET | 4.07 | 10 | 95 |

**3. Lift Well / Lift Lobby / Staircase Pressurization:**

Fire escape staircases shall be provided with 50 Pa of Positive Pressurization and Lift well and lift lobby shall be provided with 50/30 Pa of Positive Pressurization arrangement, consisting of supply air fans installed on roof top. The fans shall connect to supply air ducts installed in vertical risers and inject air at each staircase landing, for achieving effective pressurization. Fans shall be sized to maintain minimum positive pressure of 50 Pa across the door. Make up air fans serving stairwell shall be provided with motorized damper at fan discharge to prevent humid fresh air entering into staircase well. These dampers shall be interlocked with fan motor and shall open upon getting signal from the smoke sensor. Lift wells shall also be similarly pressurized by supplying the air through fans installed on roof top.

***Refer to Annexure-A, B and C for Staircase pressurization, Lift lobby and Lift Well**

## G. BRIEF DESCRIPTION OF HVAC EQUIPMENTS:

### 1. AIR HANDLING UNITS

The air handling units shall be double skin construction, draw through type comprising of various sections such as mixing box, (the return air and fresh air are ducted), pre-filter section, cooling & heating coil sections, fan section, filters section, Double skinned panels shall be (60mm thick for units for AHUs made of galvanized steel, pressure injected with foam insulation (density 40 KG/ M3 .The entire framework shall be mounted on an aluminum alloy channel base. Panels shall be sealed to framework by heavy duty “O” ring gaskets held captive in the framed extrusion. All panels shall be detachable or hinged. Hinges shall made of die cast aluminum with stainless steel pivots, handles shall be made of hard nylon and be operational from both inside and outside of the unit. Thermal breaks shall be provided in the unit framework to prevent condensation at the panel joints during humid outside conditions. Units shall have hinged, quick opening access door in fan and filter section. Access doors shall be double skin type. Condensate drain pan shall be fabricated from 18 gauge stainless steel sheet with all corners welded. It shall be isolated from bottom floor panel through 25 MM heavy duty urethane foam.

Centrifugal Fans shall be forward/ backward inclined blade type. Fan casing shall be made of galvanized steel sheet. Fan wheels shall be of galvanized steel. Fan wheels and pulleys shall be individually tested and precision balanced dynamically. Fans shall be imported.
Both fan and motor assemblies shall be mounted on a deep section aluminum alloy or galvanized steel base frame. The fan motor shall have efficiency class IE-3 .

### 2. Axial Fans

The fan casing and Motor mounting plates should be manufactured from mild steel. The fan casing and flanges should have a minimum thickness of 3.0mm for fans up to and including 1000mm diameter, with thickness of 5mm for larger diameters. Flanges should be integral with casing and should be provided with bolt holes for connection. The casing assembly, complete with flanges, should be hot dip /spray galvanized after manufacture.
An external terminal box should be provided, as standard, on long case fans. Short case fans will have a terminal box on the motor only.
The pitch angle of the fan should be individually adjustable. The fan should be of the variable pitch angle or controllable pitch angle design. The supplier should be able to provide evidence that the impeller has been adequately stressed for running at the highest speed. The impeller should be balanced to G3.6 or better as defined in ISO 1940/1:1986 (6.3 mm/s peak to peak or 4.5mm/s rms).
The aerodynamic design of the fan should be such that the maximum power required by the fan occurs within the normal working ranges, i.e., it has a non-overloading characteristic.

The fan should be suitable for frequent starting applications and for continuous operation in ambient temperatures ranging from -43°C up to +63°C.

Fan motors should be at the totally enclosed, squirrel cage induction, continuous duty, and variable torque type. Fan motor shall be Class A type with class Fclass insulation. The fan motor shall have efficiency class IE-3 or EFF-1, whichever is more efficient.

**3. Centrifugal Fans:**

Centrifugal fans shall be of double-width, double-inlet construction, with bearing on both sides, complete with access door, squirrel-cage induction motor, V-belt drive, belt guard etc.

Housing shall be of heavy gauge sheet steel in welded construction. It shall be rigidly reinforced and supported by structural angles. Split casing shall be provided on larger sizes of fans. However neoprene/ asbestos packing shall be provided throughout split joints to make it airtight. 1.2 mm galvanized wire mesh inlet guard, of 5cms sleeves shall be provided on both inlets. Housing shall be provided with access door with quick locking tension handles and neoprene gasket. Rotation arrow shall be clearly marked on the housing.

Fan wheel shall be backward curved non-overloading type unless otherwise specified. Fan wheel and housing shall be statically and dynamically balanced. Fan outlet velocity shall not exceed 610 meters per minute.

Shaft shall be constructed of steel, turned, ground and polished.

Bearings shall be of the sleeve/ball bearing type mounted directly on the fan housing. Bearing shall be self-aligned, oil grease packed, pillow block type.

Drive to fan shall be provided from 3 phase electric motor through belt with adjustable motor sheave and belt guard. Belt shall be of the oil resistant type. The number of belts shall be not less than two.Fan motor shall be Class A type with class F class insulation. The fan motor shall have efficiency class IE-3.

**4. Variable Speed Drives:**

Variable speed drive shall be factory installed on the Electrical panel. It will vary the fan motor speed by controlling the frequency and voltage of the electrical power to the motor. The capacity control logic shall automatically adjust motor speed and capacity control mechanism for maximum real world efficiency by analyzing information fed to it by sensors located either in return air path or potential difference sensors located across the duct.Unit must have less than 5% Total Demand Distortion (TDD) at equipment level.

Field power wiring shall be a single point connection and electrical plugs for incoming power wiring will be provided. All VSD components are designed to last the life of the AHU.

**5. Fire Dampers:**

Motorized fire damper shall be installed with supply & return duct at AHU room wall to prevent spread of smoke fire at adjoining areas dampers shall be robust constructions and tightly fitted. The design, method of handling and control, shall be suitable for the location and service required. Dampers and their operation devices shall be made robust, easily operable, and accessible through suitable access doors in the ducts. Every damper shall have an indicating device clearly showing the damper position at all times.

Fire dampers shall be motorized smoke & fire dampers type. It shall be supplied with spring loaded UL stamped fusible link to close fire damper in the event of rise in duct temperature. Fire damper shall also close on receipt of fire alarm signal to cut off air supply instantaneously. An electric limit switch shall also be operated by the closing of fire damper, which in turn shall switch off power supply to AHU blower motor as well as strip heaters(If installed).

**6. Dampers**

Dampers shall be opposed blade type. Blades shall be made of double skinned aerofoil aluminum/ GI section with integral gasket and assembled within a rigid extruded aluminum alloy frame. All linkages and supporting spindles shall be made of aluminum/GI or nylon, turning in Teflon bushes. Manual dampers shall be provided with a Bakelite knob for locking damper blades in position

**7. Grilles and Diffusers:**

Supply air grilles shall be provided with vertical and horizontal adjustable bars and volume control multi-louver damper which shall be key operated from the front of the grille. All linear diffusers shall be powder coated extruded aluminum. All linear grilles shall be of extruded aluminum.

**8. Insulation:**

Thermal insulation shall be applied to air distribution ductwork and to components within distribution systems such as fans, and cooler casings which convey conditioned air within AHU rooms and to ductwork (including recirculation air ductwork) conveying warmed or chilled air through unconditioned spaces or the open air. Unless otherwise indicated, distribution systems conveying conditioned, warmed or chilled air through conditioned spaces shall not be insulated. Distribution system conveying fresh air. Thermal insulation shall be applied to chilled water pipe work distribution systems and to components within distribution systems such as valves. Where thermal insulation is applied to the outside of piped and ducted services. The vapor barrier shall be applied such that it is continuous and given protection to the whole surface of the insulation which it protects. It shall not be pierced or otherwise damaged by supports or by the application of external cladding. At points of support means of load distribution shall be provided as necessary.

| Space | Insulation Thickness |
|---|---|
| Duct in conditioned Space | 19.00 mm (XLPE Insulation) |
| Duct in unconditioned space | 25.0 mm (XLPE Insulation) |

**9. Acoustic lining of AHU Rooms:**

Acoustic insulation on walls and ceiling of Air handling unit's rooms with 50mm thick resin bonded fiber glass slabs fixed in frame work and finished with vapor barrier and perforated aluminum sheet two walls and ceiling of air conditioning plant room and air handling unit rooms may be provided with acoustic lining of resin bonded fiber glass. The surface shall be cleaned and frame work of 22 gage GI fabricated Channels 25 mm x 50 mm screwed back to back at 60 cm centre's shall be provided vertically and horizontally so that 60 x 60 cm squares are formed. The gaps between frames shall be filled with 50 mm thick about 60 cm x 60 cm cut panels of resin bonded fiberglass slabs. The entire surface shall then be covered with fiberglass tissue and 26 gage perforated aluminum sheet, 60 cm or 120 cm wide having at least 15 percent perforations, fixed with sheet metal screws. Over-lapping of sheets shall be covered with Aluminum beading. Acoustic lining of walls shall be terminated approximately 15 cm above the finished floor to prevent damage to insulation due to accidental water-logging in plant/AHU rooms.

**10. Acoustic lining over ducts:**

Ducts shall be lined internally with acoustic insulation as detailed below:

- The Inside surface of duct on which the acoustic lining is to be provided shall be clean free from all dust and grease.
- Then 25 x 25 sq.mm section of minimum 1.25 mm thick G.I. sheet shall be fixed on both ends of the duct piece.
- The insulation slabs shall then be fixed between these section of ducts using CPRX adhesive compound and stickpins.
- The insulation shall then be covered with Reinforced plastic/ fiber glass tissue, sealing all joints so that no fiber is visible.
- The insulation shall finally be covered with minimum 0.5 mm thick perforated aluminum sheet having perforations between 20-40%

**11. Filters:**

**i. Pre-filters (fabric type)**

Synthetic fiber Pre-filters shall be in light weight aluminum framed with non woven synthetic fiber replaceable media. The filter shall have an efficiency of 90 percent down to 10 microns particles size when tested as per B.S.2831 standards. The filter frame shall be of aluminum and shall be suitable for mounting in Air handling units or ducts as required at site. The velocity across the face of the filter shall not exceed 500 FPM and the pressure drop across the filter shall not exceed 4mm.

**ii. Microvee filters (fine filters):**

Microvee filters shall be of dry type. Filters media shall be made from washable nonwoven synthetic fiber replaceable media reinforced with HDPE cloth & Aluminum mesh, specially treated with antifungal and bactericidal agents to prevent growth of micro organisms. The filter media shall be treated to permit washing with water several times before discharged. The media shall be properly supported and spaced so that air flow through the filter is uniform. The filter shall be housed in aluminium frame work. Filters shall be designed to remove particle down to 5 micron size and with efficiently of 98.0 percent tested as per BS 2831 using Test Dust II. The filters shall be installed in the air handling units after the chilled water coils. They shall be capable of being replaced or removed for servicing without the use of special tools.

## H. BUILDING MANAGEMENT SYSTEM:

Building automation and control systems would control and monitor system such as air handling units, Tertiary Pumps, Fans in Parking area, Lift and miscellaneous electrical and plumbing points.
A totally direct digital control (DDC) system with electric Actuation control Valve and Damper would be considered.
There would be preference to systems, which support open protocol, i.e., BACNET.

**MONITORING/ CONTROLLING POINTS FOR BMS:**

| S. No. | Description |
|---|---|
| | **HVAC SYSTEM**<br>**AIR CONDITIONING SYSTEM** |
| | |
| **A** | **OUTSIDE AIR** |
| | Outside Air Temperature and RH |
| | |
| **B** | **AIR HANDLING UNITS (with RH & Temp Control) (Common areas)** |
| | AHU Blower Status |
| | AHU Manual Operation Status |
| | AHU FAN ON/OFF Status |
| | AHU Motor trip Status |
| | AHU Run Status |
| | AHU Filter Status |
| | AHU Return Air Temperature & RH |
| | AHU modulate Chilled Water Valve |
| | VAV/ VFD |
| | Fresh air Damper control |
| | Fresh air damper Feedback |
| | Supply/Return Fire Damper status |
| | |
| **C** | **VENTILATION FANS/TOILET FANS** |
| **D** | **LIFTS MONITORING** |
| **E** | **ELECTRICAL ENERGY** |
| **F** | **BASEMENT FANS** |
| **G** | **TERTIARY CHILLED WATER PUMP** |
| **H** | **HEAT RECOVERY WHEEL** |

# ANNEXURE A, B and C
# FOR
# ADMINISTRATION BUILDING PRESSURIZATION CALCULATION

**Annexure – A**

**Pressurization of Staircase(Basement)-Typical all staircase of basement which is in periphery of building**
**Architectural Drawing - AD1-AC-2.0**

**1. Leakage path from pressurized staircase are as follows**

a) Door at each mid landing
b) Door on the basement floor

**2. Staircase Description**

a) Total No. of Doors = 1 Nos.
b) Door size = 1.5 m x 2.1 m
c) Area of each door = 3.15 $mt^2$ or 33.9 $ft^2$.

**3. Calculation of air quantity leakage through open staircase door as follows;**

= Area of staircase door ($mt^2$) x Exhaust air velocity of air assumed (m/second) x Nos. of Doors open.

= 3.15 x 1 x 1 = 3.15 $m^3/s$

= (3.15 x 3600) / 1.7

= 6670 CFM

Accounting for 10 % duct losses = (6670) x 1.10

= 7337.6 CFM

**Say 7500 CFM @ 25 mm static pressure of free inflow of air for each Lift Well. Typical for same dimension staircase.**

**Pressurization of Staircase(Ground+ 5 Floor) - Central staircase**
**Architectural Drawing - AD1-AC-2.0**

**1. Leakage path from pressurized staircase are as follows**

a) Door at each mid landing
b) Door on the basement floor

**2. Staircase Description**

a) Total No. of Doors = 6 Nos.
b) Door size = 1.5 m x 2.1 m
c) Area of each door = 3.15 $mt^2$ or 33.9 $ft^2$.

**3. Calculation of air quantity leakage through open staircase door as follows;**

= Area of staircase door ($mt^2$) x Exhaust air velocity of air assumed (m/second) x Nos. of Doors open.

= 3.15 x 1 x 2 = $m^3/s$

= (6.3 x 3600) / 1.7

= 13341 CFM

**4. Calculation of air quantity leakage through staircase doors and cracks on other floors**

Perimeter of door = 7.2 m

Assume Gap = 2.0 mm =0.002 m

Total No. of leakage door = 6 Nos.

Total leakage area = Perimeter of Door x Gap x No. of Leakage Door

= 7.2 x 0.002 x 6

= 0.0864 $mt^2$

Now, Assume Pressure Difference = 50 Pascal

Now, Air leakage through Staircase door and cracks = 0.827 x leakage area x √PD

= 0.827 x 0.0864 x √50

= 0.505 $m^3/s$

= (0.505 x 3600) / 1.7 CFM

= 1077 CFM

Total CFM = (13341 + 1077)

= 14418 CFM

**Say 14,500 CFM @ 30 mm static pressure of free inflow of air for Each Staircase Pressurization.**

**Annexure – B:**

**Pressurization of each Lift Lobby (Basement + Ground +5th Floor)**
**Architectural Drawing - AD1-AC-2.0**

**1. Leakage path from pressurized lift lobby are as follows**

a) Door at each mid landing

**2. Lift Lobby Description**

a) Total No. of Doors = 7 Nos.
b) Door size = 1.5 x 2.1 mt.
c) Area of each door = 3.15 $mt^2$ or 33.89 $ft^2$.

**3. Calculation of air quantity leakage through open lift lobby door be as follows;**

= Area of lift lobby door ($mt^2$) x Exhaust air velocity of air assumed (m/second) x Nos. of Doors open.

= 3.15 x 1 x 1 = 3.15 $m^3/s$

= (3.15 x 3600) / 1.7

= 6670 CFM

**4. Calculation of air quantity leakage through lift lobby doors and cracks on other floors**

Perimeter of door = 7.2 m

Assume Gap = 2.0 mm = 0.002 m

Total No. of leakage door = 7 Nos.

Total leakage area = Perimeter of Door x Gap x No of Leakage Door

= 7.2 x 0.002 x 7

= 0.1008 $mt^2$

Now, Assume Pressure Difference = 30 Pascal

Now, Air leakage through lift Lobby door and cracks = 0.827 x leakage area x √PD

= 0.827 x 0.1008 x √30

= 0.4565 $m^3/s$

=(0.4565 x 3600) / 1.7 CFM

**= 966.89 CFM**

Total CFM = (6670 + 966)

= 8017 CFM

**Say 8000 CFM @ 25 mm static pressure of free inflow of air for each Lift Lobby.**

**Annexure – C:**

**Pressurization of each Lift Well (Basement + Ground +5th Floor)**

**Architectural Drawing - AD1-AC-2.0**

**1. Leakage path from pressurized lift well are as follows**

a) Door at each mid landing

**2. Lift Description**

a) Total No. of Doors = 5 Nos.
b) Door size = 0.8 m x 2.1 m
c) Area of each door = 1.68 $mt^2$ or 18.08 ft2

**3. Calculation of air quantity leakage through open lift well door be as follows;**

= **Area of lift lobby door ($mt^2$) x Exhaust air velocity of air assumed (m/second) x Nos. of Doors open.**

= 1.68 x 1 x 1 = 1.68 $m^3/s$

= (1.68 x 3600) / 1.7

= **3558 CFM**

**4. Calculation of air quantity leakage through lift well doors and cracks on other floors**

Perimeter of door = 5.8 m

Assume Gap = 2.0 mm =0.002 m

Total No. of leakage door = 7 Nos.

Total leakage area = Perimeter of Door x Gap x No. of Leakage Door

= 5.8 x 0.002 x 7

= 0.0812 $mt^2$

Now, Assume Pressure Difference = 50 Pascal

Now, Air leakage through lift Well door and cracks = 0.827 x leakage area x √PD

=0.827 x 0.0812 x √50

= 0.4748 $m^3/s$

=(0.4748 x 3600) / 1.7 CFM

= **1012 CFM**

Accounting for 5 % duct losses = (3558 + 1012) x 1.05

= 4798.9 CFM

No. of lift well = 2 Nos.

**Say 10000 CFM @ 50 mm static pressure of free inflow of air for each Lift Well.Typical for same dimension staircase.**

# 12.21. ANNEXURE VI - DDR for L1- LIBRARY BUILDING

## 12.21 : ANNEXURE VI - DDR for L1- LIBRARY BUILDING

### A. Introduction:

Library Building is part of South Asian University. This building includes Library, Exhibition Area, Reference Section, Information counter, Library Admin, Meeting Room, Server Room, Cyber Library, Seminar Room, Book Stack PhD workstation etc.

Building consists of a basement + Ground + 5 Floors and a total built-up area of 10540 sq.mtr.

#### 1. Air Conditioning Objective:

Objective of air conditioning is to provide thermal comfort to all areas for Library building in an efficient and cost-effective manner round the year. Temperatures and Indoor Air Quality shall be maintained in accordance with parameters as specified in the following sections of Basis of Design.

Library building is served by Central chilled water system. The chilled water flowing through the "MS" pipe with HDPE Jacketing buried underground is connected to branch piping to serve all risers which are connected to all AHU's and FCU's.

#### 2. Ventilation Objective :

Objective of Mechanical Ventilation is to provide fresh air and vent out exhaust air to maintain indoor air quality and to have an escape route in case of fire. Mechanical ventilation system is being considered for Utility rooms, Basements, Kitchen/pantry, toilets and other similar areas using combination of centrifugal fans, axial flow fans, propeller fans and inline fans.

### B. General Building HVAC Design Criteria and Assumptions

This section of the report documents specific numbers used in the design of the Library building. These assumptions are an essential part of making the transition from the project intent to installed equipment. Also the codes and guidelines for the designer and contractor which are to be followed during the different stages of project are outlined.

#### 1. CODES & STANDARDS:

The applicable Standards/Codes are:

(a) American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE).
- a.1 ASHRAE - 55
- a.2 ASHRAE - 90.1
- a.3 ASHRAE - 62.1
- a.4 ASHRAE - Fundamentals
- a.5 ASHRAE - HVAC Application
- a.6 ASHRAE - HVAC System & Equipment
- a.7 ASHRAE - Refrigeration

(b) Energy Conservation Building Code (ECBC)
(c) Duct construction standards as per relevant BIS Codes & SMACNA standards
(d) National Buildings Code-2005
(e) Air Filter as per ASHRAE-52.1 and 52.2
(f) National Electric code
(g) National Fire Protection code
(h) ISHRAE Standards
(i) GRIHA Manual
(j) IMC-2009

The following IS codes shall be applicable:

| S. No. | Material/item of Work | Standard/Code |
|---|---|---|
| 1. | Ducting Fabrication | IS: 655 |
| 2. | Galvanized Sheets/Wires | IS: 277 |
| 3. | Aluminum Sheets/Wires | IS: 737 |
| 4. | Horizontal Centrifugal Pumps | IS: 6595 |
| 5. | Mild Steel, ERW Pipes | IS: 1239, IS: 3589 |
| 6. | Pipe Fittings | IS: 1239 |
| 7. | Steel Pipe Flanges | IS: 6392 |
| 8. | Gate, Globe & Check Valves | |
| | • Up to 40 mm Gun metal | IS:778 |
| | • Butterfly valve of 50 mm and Above (Cast Iron) | IS:2906 |
| | • Balancing valve | IS:778 |
| | • Non Return valve | IS:5312 |
| 9. | Color Code for Identifications of pipes | IS: 2379 |
| 10. | 3 Phase induction motors | IS: 325 |
| 11. | Pressure and vacuum gauges | IS: 3624 |
| 12. | PVC insulated electric cables | IS: 1554 |
| 13. | Starters sheets/wires | IS: 8555 |
| 14. | Glossary of terms used in refrigeration and Air-conditioning | IS: 3615 |
| 15. | Hot die zinc coated steel pipes | IS: 4736-1968 |
| 16. | Expanded Polystyrene | IS: 4671 |

**Safety codes**

The following safety codes as laid down by ISI shall be followed:

| | | |
|---|---|---|
| 1. | Safety code for mechanical refrigeration | IS : 660 |
| 2. | Safety code for air-conditioning | IS : 659 |
| 3. | Safety code for scaffolding and ladders | IS : 3696 |
| 4. | Code for practice for safety and health Requirements in electrical and gas Welding & cutting operations | IS: 818 |
| 5. | Recommendations of safety procedures and practices In electrical works | IS: 5216 |

NOTE:- All the codes and standards are applicable only with the latest amendments only.

**<u>Green building/GRIHA features :</u>**

a) South Asian campus is targeting to be a GRIHA five star rated campus.
b) High efficient equipment will be used for HVAC system. Selection of High efficient fans for AHU and Ventilation system.
c) Variable speed drive shall be used on selected AHU and large ventilation fans.
d) Variable air volume system shall be used for selected areas as per the application.
e) Car parking exhaust system shall be equipped with CO sensors so that exhaust fans are operated as per permitted CO concentration levels.
f) Heat recovery wheels for pre-cooling OA by using the waster exhaust air wherever possible to lower down the fresh air load. This ensures reduced energy consumption despite higher fresh air intake.
g) Cooling tower selection for minimum drift and noise level; energy efficient motors, VFD for motor speed control.

## 2. LOCATION:

- Site Location : New Delhi
- Geographic Location : 28.38°N, 77.13°E
- Altitude : 216 m above mean sea level

### a) Design Conditions and Assumptions:

The summer design condition is based on ISHRAE weather data and statistics of the most recent data of 10 year period, published by the India Metrological Department and *.epw* weather data files from the *DOE*.

The year round temperatures and climatic conditions is as below and system is evaluated for 8760 hours.

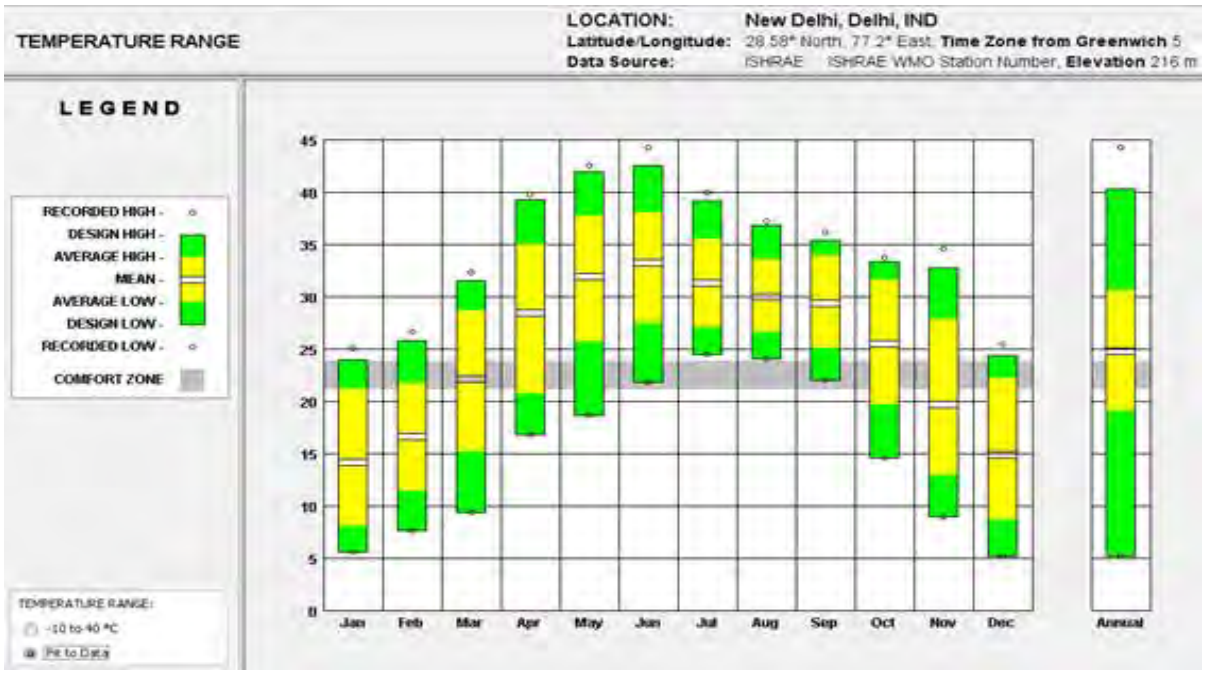



**Table-1 Design Assumptions**

| Description | Value (units) |
|---|---|
| Latitude/Longitude | 28.38°N, 77.13°E |
| Sea level | 216 m |
| Clearness number | 0.95 |
| Summer outdoor air DB/WB temperature | 43.3°C (109.94 °F) /23.89 (75.02 °F) |
| Winter outdoor air DB/WB temperature | 7.2°C (44.96 °F) / 5.0°C(41.0°F) |
| Monsoon outdoor air DB/WB temperature | 35°C (95.0°F)/ 28.3°C (83°F) |
| Ground reflectance | 0.20 |
| Roof U-value | 0.079 Btu/h. ft².°F |
| Overall Wall U-value | 0.1179 Btu/h. ft².°F |
| Glass U-value (summer/winter) | 0.31 Btu/h. ft².°F |
| Glass shading coefficient | 0.58 |
| Infiltration /Ex-filtration | As per ASHRAE 90.1 |

| | |
|---|---|
| Building system peak cooling load (day/month) | 15 / 7 |
| Cooling load design calculation program | CLTD, Trane Trace 700 |
| Winter Heat load design calculation program | UATD, Trane Trace 700 |
| Ductwork sizing program | Trane Ductulator |
| Cooling Safety factor/Heating Safety Factor | 10% |
| Fan heat gain safety factor | 5% |
| Diversity | 75% Overall on chiller plant |
| Typical Hours of Operation | As directed by SAU |

**b) Inside Design Conditions:**

Table below shows Room Ambient Temperature and Humidity Design Criteria for Library building. The set points are considered on the basis of ASHRAE -55 Clause 5, Thermal Comfort charts and after discussion with SAU.

**Table-2- Inside Set Points conditions:**

| | **Inside conditions** | | | |
|---|---|---|---|---|
| | **Summer** | | **Winter** | |
| **Spaces** | **Temp.** | **Humidity** | **Temp.** | **Humidity** |
| SEMINAR ROOM | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| ADMIN OFFICE | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| OFFICE | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| MEETING ROOM | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| SEMINAR ROOM WITH VIDEO CONFERENCE | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| LIBRARY | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| BOOK STACK | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| CYBER LIBRARY | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| AUDIO VISUAL ROOM | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| PHD WORKSTATION | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| LIBRARY ADMINISTRATION | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| EXHIBITION AREA | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| REFERENCE SECTION | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| LIBRARY FOR VISUALLY IMPAIRED | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| ENTRANCE FOYER | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| CAFETERIA | 25 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| SIT OUT | 25 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| LIBRARY OFF HOUR | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| INFORMATION COUNTER | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| GENERAL READING | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |

**3. Acoustic Criteria:**

Air-conditioning systems will be designed to maintain the following noise criteria (NC) level in various spaces as per NBC - 2005 - PART 8 Building Services Section 4, Acoustics, Sound Insulation And Noise Control.

- Lecture Hall : NC 40-45
- Classrooms : NC 40-45
- Office Space : NC 35-40
- Cafeteria : NC 50-55
- Computer rooms : NC 45-50

- Laboratories : NC 40-45
- Library : NC 35-40
- Entrance Foyer : NC 45-50

4. **Fresh Air:**
   Adequate fresh air quantity shall be provided to air-conditioned spaces to maintain indoor air quality (IAQ) generally as per ASHRAE standard 62.1-2007.
   - 5.0 CFM/person + 0.06 CFM/Sq.ft. for Library
   - 5 CFM/person + 0.06 CFM/Sq.ft. for Stack Room
   - 5 CFM/person + 0.06 CFM/Sq.ft. for Meeting Room
   - 5 CFM/person + 0.06 CFM/Sq.ft. for Cyber Library
   - 5 CFM/person + 0.06 CFM/Sq.ft. for Seminar Room
   - 5 CFM /person + 0.06 CFM/Sq.ft. for Archives
   - 5 CFM /person + 0.06 CFM/Sq.ft. for Information Counter
   - 5 CFM/Person + 0.06 CFM/sq.ft for Office
   - 5 CFM/Person + 0.06 CFM/sq.ft for Library Administration
   - 5 CFM/Person + 0.06 CFM/sq.ft for PhD workstation.

5. **Lighting Load:**
   Following is the assumptions made for the purpose of considering lighting load and will be according to the electrical lighting design. ASHRAE 90.1-2007 will be used for any assumptions.

   - 1.4 W/Sq.ft for Office Library
   - 1.1 W/Sq.ft for Stack Room
   - 1.1 W/Sq.ft for Meeting Room
   - 1.4 W/Sq.ft for Cyber Library
   - 1.1 W/Sq.ft for Seminar Room
   - 1.1 W/Sq.ft for Archives
   - 1.1 W/Sq.ft for Information Counter
   - 1.3 W/sq.ft for Office
   - 1.3 W/sq.ft for Library Administration
   - 1.3 W/sq.ft for PhD workstation

6. **Equipment Loads**
   Following is the assumptions made for the purpose of considering Equipment load and will be according to the ASHRAE Fundamentals-2005, chapter 30 & electrical design/equipment used.

   - 0.25 W/Sq.ft for Library
   - 0.25 W/Sq.ft for Stack Room
   - 1.0 W/Sq.ft for Meeting Room
   - 5.0 W/Sq.ft for Cyber Library
   - 1.0 W/Sq.ft for Seminar Room
   - 0.1 W/Sq.ft for Archives
   - 0.1 W/Sq.ft for Information Counter
   - 1.0 W/sq.ft for Office
   - 0.5 W/sq.ft for Library Administration
   - 0.1 W/sq.ft for PhD workstation

7. **Occupancy**
   Occupancy as per furniture layout of rooms as mentioned on the architectural plans.
   For areas where capacity is not mentioned, it is assumed as per NBC-Part-8, Building

Services, and Section-3, Table 4 or ASHRAE 62.1-2007 table 6-1.

8. **Mechanical Ventilation System:**
   The following areas shall be provided with dedicated ventilation system with the number of air changes per hour for each space as identified here with:

| | | | |
|---|---|---|---|
| a) | Toilets | : | 10 ACPH |
| b) | Car Parking | : | 6 (Normal Mode)/ 12 (Fire Mode) ACPH Exhaust & 6 (Normal Mode)/12 (Fire Mode) ACPH Fresh Air |
| c) | Kitchen | : | 20 ACPH |
| d) | Electrical Room | : | 20 ACPH |

9. **Relative Pressure:**
   - Library, Admin, Office, Stack : Positive Inside pressure
   - Toilet : Negative inside pressure
   - Lift well : 50 Pa Positive Pressure
   - Closed Staircase : 50 Pa Positive Pressure
   - Lift lobby Pressurization : 30 Pa Positive Pressure
   - All other areas : As per codes and standards

**C. Mechanical System Design Parameters & Philosophy:**

This section describes the assumptions, parameters considered for sizing and designing of various Mechanical equipments and its components. Below is the detailed description.

- Library building shall be served by the central chilled water plant & hot water generator located in utility building.
- Chilled water network buried shall supply required chilled water to the building.

1. **Air Handling Units:**
   - Unit shall be provided with filter, cooling coil & fan to serve the specific premises.
   - During summer season, supply & return temperature of chilled water is considered are 44° F & 56° F.
   - During winter season, supply & return temperature of water considered are 130° F & 110° F.
   - Air Distribution to the rooms shall be provided with supply air duct with suitable terminals and return air through return air duct or plenum, as applicable.
   - All duct subjected to temperature below dew point shall be insulted with XLPE insulation with thermal conductivity of 0.037 W/m-k at 20°C mean temperature.
   - Fan motor shall be Class A type with class F insulation. The fan motor shall have efficiency class IE-3 or EFF-1, whichever is more efficient.
2. **Piping:**
   - Hydronic Piping material for chilled/Heating water supply and return shall be of Heavy class Black steel (MS- Class C) Pipes. Piping up to and including 150 mm diameter shall be of heavy class black steel confirming to IS:1239 and piping greater than 150 mm shall be minimum 6 mm thick black steel confirming to IS:3589.
   - Hydronic piping shall be insulated with closed cell elastomer with maximum thermal conductivity of 0.038 W/m-k at 38° C, when tested in accordance with EN- ISO 8947.
   - Chilled water piping insulation thickness shall be 25 mm thick for 40 mm pipe and smaller, 40 mm thick for 50 mm to 150 mm pipe and 75 mm thick for pipe greater than 150 mm.

- Drain from the all the air-conditioning equipment shall be collected by GI drain pipe insulated with 9 mm thick closed cell elastomer material and connected to nearest drain point.

All chilled water pipes shall be mild steel Class 'C' (heavy duty) conforming to relevant BIS codes. All jointing in the pipe system shall be by welding. Various type of valves such as butterfly valves, balancing valves and non return valves shall be provided in water lines.

Condensate drain piping would be GI 'B' Class conforming to relevant BIS codes.

**PIPING SHALL BE SIZED FOR THE FOLLOWING DESIGN PARAMETERS**

Pipes shall be sized to provide maximum water velocities as follows:

| **Pipe Sizes** | **Maximum Velocity** |
|---|---|
| Up to 50mm | 0.6 m/sec |
| 65 to 100mm | 0.8 m/sec |
| 125 to 200mm | 1.5 m/sec |
| 250 to 300mm | 2.5 m/sec |
| 355mm and up | 3.0m/sec |

**3. Filtration:**

Re-circulated air (mixed outdoor & return air) at Air handling unit : Washable synthetic type air filter having 90% efficiency down to 10 micron MERV 8 and filter having 99% efficiency down to 3 microns MERV 13)

Re-circulated air (mixed outdoor & return air) at Ventilation units : Washable synthetic type air filter having 90% efficiency down to 10 microns (MERV)

**4. Duct Design Criteria:**

The following maximum duct design velocities will be used in the design of ductwork systems. Where a range is indicated, it is intended to represent velocities over a range of flow volume.

**Table-3**

| | **Meters/Second** |
|---|---|
| Low Pressure Systems | |
| - Main Duct | 7.5 |
| - Primary Branch | 5.0 |
| - Secondary Branch | 2.0-3.5 |
| Plenum | 5.0-6.0 |
| Medium Pressure Systems | 12.0 |
| Cooling Coils | 2.5 |
| Heating Coil | 4.0 |
| Filters | 2.5 |

The following maximum friction losses are to be used in conjunction with the velocities noted above.

| | **Pascal's/meter** |
|---|---|
| Low pressure systems | 1.0 |
| Medium pressure systems | 3.3 |

**5. Ventilation Fan Design Criteria:**

- Maximum fan outlet velocity for fan upto 450 mm dia : 9.14m/s(1800 FPM)
- Maximum fan outlet velocity for fan above 450 mm dia : 12m/s (2400 FPM)
- Maximum fan speed for fan upto 450 mm : 1440 RPM
- Maximum fan speed for fan above 450 mm : 1100 RPM

Note: Ventilation fans can be either axial type or centrifugal type.

**6. Diffuser and Grill Design Criteria:**

- All air outlets and intakes shall be made of extruded aluminum sections &shall present a neat appearance and shall be rigid with mechanical joints.
- Square and rectangular wall outlets shall have a flanged frame with the outside edges returned or curved 5 to 7 mm and fitted with a suitable flexible gasket between the concealed face of the flanges and the finished wall face. The core of supply air register shall have adjustable front louvers parallel to the longer side to give up to 22.5 degrees vertical deflection and adjustable back louvers parallel to the shorter side to achieve a horizontal spread air pattern to at least 45 degrees. Return air grilles shall have only front louvers. The outer framework of the grilles shall be made of not less than 1.6 mm thick aluminum sheet. The louvers shall be of aero foil design of extruded aluminum section with minimum thickness of 0.8mm at front and shall be made of 0.8mm thick aluminum sheet. Louvers may be spaced 18 mm apart.
- Square and rectangular ceiling outlets/intakes shall have a flange flush with the ceiling into which it is fitted or shall be of anti-smudge type. The outlets shall comprise an outer shell with duct collar and removable diffusing assembly. These shall be suitable for discharge in one or more directions as required. The outer shell shall not be less than 1.6 mm thick extruded section aluminum sheet. The diffuser assembly shall not be less than 0.80 mm thick extruded aluminum section.
- Circular ceiling outlets/intakes shall have either flush or anti smudge outer cone as specified in the tender specifications. Flush outer cones shall have the lower edge of the cone not more than 5 mm below the underside of the finished ceiling into which it is fitted. Anti-smudge cones shall have the outer cone profile designed to reduce dirt deposit on the ceiling adjacent to the air outlet. The metal sheet used for construction of these shall be minimum 1.6 mm thick extruded aluminum sheet.
- Linear diffusers shall have a flanged frame with the outside edges returned 3.5 mm and shall have one to four slots as required. The air quantity through each slot shall be adjustable. The metal sheet used for the construction of these shall be minimum 1.6 mm thick extruded aluminum sheet.
- Grilles and diffusers constructed of extruded aluminum sections shall have grille bars set straight, or deflected as required. These shall be assembled by mechanical interlocking of components to prevent distortion. These grilles and diffusers shall have a rear set of adjustable blades, perpendicular to the face blades for deflection purposes.
- All supply air outlets shall be fitted with a VOLUME CONTROL DEVICE, made of extruded aluminum gate section. The blades of the device shall be mill finish/ block shade pivoted on nylon brushes to avoid rusting & rattling noise, which shall be located immediately behind the outlet and shall be fully adjustable from within the occupied

space without removing any access panel. The volume control device for circular cutlets shall be opposed blade radial/shutter type dampers, or two or more butterfly dampers in conjunction with equalizing grid. Opposed blade dampers shall be used for square and rectangular ceiling/ wall outlets and intakes.

**D. Building Cooling and Heating Requirements:**

This section of the report describes the Cooling (TR) and Heating (MBH) requirement for the various spaces of the buildings. Table below shows the building wise preliminary requirements:

**Table-4 Building Heating and cooling Requirements:**

| S.No | Floor | Area Description | Floor area (Sqft) | No.of Person | Dehumified CFM | Cooling TR | Heating MBH |
|---|---|---|---|---|---|---|---|
| 1 | GROUND | CAFETERIA | 2379 | 80 | 5305 | 16.7 | 43.8 |
| 2 | | OFF HOUR READING AREA | 2619 | 35 | 1787 | 8.8 | 21.2 |
| 3 | | EXIBITION AREA | 2903 | 36 | 1695 | 7.2 | 15.8 |
| 4 | | LIBRARY FOR VISUALLY IMPAIRED | 2288 | 24 | 1890 | 7.7 | 21.5 |
| | | | | | | | |
| 5 | FIRST | A REFERENCE SECTION | 2748 | 20 | 2417 | 9.7 | 24.8 |
| 6 | | B REFERENCE SECTION | 2748 | 20 | 2341 | 9.5 | 24.4 |
| 7 | | REFERENCE SECTION | 2831 | 60 | 4971 | 18.3 | 49.8 |
| 8 | | BOOK STACK ATRIUM (SECOND ) | 2097 | 2 | 1227 | 5.4 | 17.5 |
| 9 | | BOOK STACK ATRIUM (THIRD ) | 2158 | 2 | 1243 | 5.5 | 17.8 |
| 10 | | INFORMATION COUNTER | 2797 | 30 | 3790 | 12.5 | 34.9 |
| 11 | | ENTRANCE FOYER | 878 | 2 | 804 | 2.5 | 6.7 |
| 12 | | ENTRANCE FOYER | 878 | 2 | 1265 | 3.4 | 11.2 |
| | | | | | | | |
| 13 | SECOND | GENERAL READING | 1074 | 16 | 1957 | 5.6 | 16.0 |
| 14 | | BOOK STACK | 7747 | 40 | 3961 | 19.9 | 48.7 |
| 15 | | GENERAL READING | 1218 | 48 | 1044 | 5.4 | 9.1 |
| 16 | | GENERAL READING | 1074 | 16 | 1876 | 5.4 | 15.6 |
| 17 | | GENERAL READING | 1218 | 48 | 1044 | 5.4 | 9.1 |
| 18 | | ARCHIVE | 973 | 10 | 1614 | 4.6 | 12.5 |
| 19 | | MEETING ROOM | 192 | 8 | 471 | 1.4 | 3.6 |
| 20 | | LIBRARY ADMINISTRATION | 2556 | 44 | 4720 | 13.3 | 38.0 |
| 21 | | OFFICE | 185 | 2 | 439 | 1.1 | 2.2 |
| 22 | | OFFICE | 185 | 2 | 439 | 1.1 | 2.2 |
| 23 | | OFFICE | 185 | 2 | 439 | 1.1 | 2.2 |
| 24 | | OFFICE | 185 | 2 | 439 | 1.1 | 2.2 |
| 25 | | OFFICE | 193 | 2 | 385 | 1.0 | 1.9 |
| | | | | | | | |
| 26 | THIRD | GENERAL READING | 1063 | 16 | 1658 | 5.4 | 15.5 |
| 27 | | BOOK STACK | 8295 | 40 | 3949 | 21.1 | 50.7 |
| 28 | | GENERAL READING | 1190 | 48 | 1007 | 5.4 | 9.0 |
| 29 | | GENERAL READING | 1063 | 16 | 1582 | 5.2 | 15.1 |
| 30 | | GENERAL READING | 1190 | 48 | 1007 | 5.4 | 9.0 |
| 31 | | AUDIO VISUAL ROOM | 506 | 30 | 1181 | 4.4 | 8.3 |
| 32 | | CYBER LIBRARY | 1600 | 50 | 3396 | 11.2 | 20.5 |
| 33 | | MEETING ROOM 1 | 463 | 16 | 978 | 3.0 | 7.5 |
| 34 | | MEETING ROOM 2 | 235 | 8 | 468 | 1.4 | 3.5 |
| 35 | | MEETING ROOM 3 | 235 | 8 | 468 | 1.4 | 3.5 |
| 36 | | MEETING ROOM 4 | 241 | 8 | 478 | 1.5 | 3.6 |
| 37 | | MEETING ROOM 5 | 241 | 8 | 478 | 1.5 | 3.6 |
| 38 | | MEETING ROOM 6 | 469 | 16 | 958 | 2.9 | 7.2 |
| | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 39 | FOURTH | GENERAL READING | 531 | 16 | 993 | 3.3 | 8.8 |
| 40 | | BOOK STACK | 8094 | 40 | 3,872 | 20.7 | 49.6 |
| 41 | | GENERAL READING | 531 | 16 | 917 | 3.1 | 8.4 |
| 42 | | GENERAL READING | 1137 | 20 | 677 | 3.7 | 7.1 |
| 43 | | GENERAL READING | 1137 | 20 | 677 | 3.7 | 7.1 |
| 44 | | MEETING ROOM NEAR SEMINAR | 482 | 16 | 927 | 2.9 | 6.1 |
| 45 | | SEMINAR ROOM WITH VIDEO CONFERENCE | 513 | 30 | 1,167 | 4.0 | 7.3 |
| 46 | | CYBER LIBRARY | 1593 | 50 | 3,345 | 11.1 | 20.2 |
| 47 | | MEETING ROOM7 | 465 | 16 | 1,030 | 3.1 | 7.9 |
| 48 | | MEETING ROOM8 | 231 | 8 | 467 | 1.4 | 3.5 |
| 49 | | MEETING ROOM9 | 237 | 12 | 514 | 1.7 | 3.8 |
| 50 | | MEETING ROOM10 | 241 | 8 | 469 | 1.5 | 3.6 |
| 51 | | MEETING ROOM11 | 239 | 8 | 469 | 1.4 | 3.5 |
| 52 | | MEETING ROOM12 | 463 | 16 | 994 | 3.0 | 7.6 |
| | | | | | | | |
| 53 | | BOOK STACK | 5600 | 28 | 4,808 | 18.8 | 57.7 |
| 54 | FIFTH | A PHD WORKSTATION | 681 | 16 | 1,200 | 4.0 | 11.6 |
| 55 | | B PHD WORKSTATION | 681 | 16 | 1,128 | 3.8 | 11.3 |
| 56 | | C PHD WORKSTATION | 2518 | 44 | 3,214 | 11.9 | 32.7 |
| 57 | | D PHD WORKSTATION | 1447 | 16 | 1,287 | 5.2 | 14.2 |
| 58 | | PHD WORKSTATION | 5264 | 62 | 7,754 | 26.2 | 80.7 |
| | | | | | | | |
| | | **TOTAL** | **93185** | | **101080** | **378** | **963** |

**Total HVAC Load for Library Building - 378 TR**

**Library Load on Central Plant (@75 % diversity) - 283.5 TR**

**Note :** Server Room is based on DX type air conditioned.

**Table-5 DX Type Load**

| AREA | Sq. ft. | TR |
|---|---|---|
| Server Room | 513 | 3 |

AHU Zoning of the building is as shown in the drawings and also tabulated below.

- Reference Section to have its own independent AHU's
- We are proposing of HRW (Heat Recovery Wheel) unit for saving energy and make the building energy efficient. Please see the below mention detailed of fresh air requirement in whole building, zone wise according to drawings.

| FLOOR NAME | ZONE-1 | | ZONE -2 | | ZONE-3 | |
|---|---|---|---|---|---|---|
| | EQUIP. TAG | FRESH AIR (CFM) | EQUIP. TAG | FRESH AIR (CFM) | EQUIP. TAG | FRESH AIR (CFM) |
| GROUND | AHU-01-01 | 725 | AHU-01-02 | 420 | AHU-01-03 | 670 |
| FIRST | AHU-02-01 | 760 | AHU-02-02 | 670 | AHU-02-03 | 760 |
| SECOND | AHU-03-01 | 1200 | AHU-03-02 | 640 | AHU-03-03 | 1100 |
| THIRD | AHU-04-01 | 1500 | AHU-04-02 | 1150 | AHU-04-03 | 1200 |
| FOURTH | AHU-05-01 | 1240 | AHU-05-02 | 1170 | AHU-05-03 | 960 |
| FIFTH | AHU-06-01 | 650 | AHU-06-02 | 1300 | AHU-06-03 | 1300 |
| | **Total** | **6075** | **Total** | **5350** | **Total** | **5990** |

**Grand Total Fresh Air :- 17415 cfm**

**HRW (Heat Recovery wheel):**

Heat recovery wheel is used to reduce the cooling load of outside fresh air .The amount of outside air which is required for maintaining the indoor air quality is first passed through a rotating wheel in which enthalpy of dry air is stored. Return air of room(will pass through toilets and pantry through door transfer grille and will be collected in exhaust duct from respective floor) passes through heat recovery wheel where exchange of enthalpy (Hot & cool) takes place and the fresh air supply to indoor unit contains much lower temperature than the outside air. Since outside air supplied to indoor unit is having less amount of enthalpy, so the net cooling load required to bring the outside air temperature to room air temperature is very less. In this way we can save energy consumption and maintain good indoor air quality. Saving of cooling load calculation is as follow:

**Table: Heat recovery energy calculation:**

| | PEAK WINTER | PEAK SUMMER |
|---|---|---|
| **OUTSIDE CONDITION** | | |
| DBT($^0$C) | 12.0 | 43.3 |
| DBT($^0$F) | 53.6 | 109.9 |
| WBT($^0$C) | 9.5 | 24.0 |
| WBT($^0$F) | 49.2 | 75.2 |
| RH (%) | 74 | 19.6 |
| Total Enthalpy(H1) | 19.8 | 38.3 |
| Fresh Air (CFM) | 17500 | 17500 |
| **ROOM CONDITION** | | |
| DBT($^0$C) | 21.0 | 24.0 |
| DBT($^0$F) | 69.8 | 75.2 |
| WBT($^0$C) | 14.5 | 17.1 |
| WBT($^0$F) | 58.1 | 62.8 |
| RH (%) | 50.0 | 50.0 |
| Total Enthalpy(H2) | 25.2 | 28.2 |
| **RETURN AIR CONDITION** | | |
| DBT($^0$C) | 24.0 | 26.0 |
| DBT($^0$F) | 75.2 | 78.8 |
| WBT($^0$C) | 17.0 | 18.7 |
| WBT($^0$F) | 62.6 | 65.7 |
| RH (%) | 50.0 | 50.0 |
| Total Enthalpy(H3) | 28.2 | 30.4 |
| **CONDITION OF FRESH AIR AFTER HRWs** | | |
| DBT($^0$C) | 18.0 | 34.7 |
| DBT($^0$F) | 64.4 | 94.4 |
| WBT($^0$C) | 13.3 | 21.4 |
| WBT($^0$F) | 55.9 | 70.4 |
| RH (%) | 62.0 | 34.8 |
| Total Enthalpy(H4) | 24.0 | 34.4 |
| | | |

| | | |
|---|---|---|
| **Case 1 :Total cooling load required to bring down outside air to room condition** | | |
| **Cooling Load (TR)** | 36.5 | 68.2 |
| **Equivalent heating (MBH)** | 437.4 | - |
| | | |
| **Case 2 :Total cooling load required to bring down outside air to room condition with the use of Heat recovery wheel** | | |
| **Cooling Load (TR)** | 28.4 | 26.7 |
| **Equivalent heating (MBH)** | 340.2 | - |
| | | |
| **Total Saving in cooling load with the use of HRW unit** | | |
| **Cooling Load (TR)** | 8.1 | 41.5 |
| **Heating load (MBH)** | 97.2 | - |
| **Saving percentage** | **22%** | **61%** |
| | | |

**Saving in one day operation of building during Summer = 41.5 x 10 x 0.65 = 270 kwh**

**Saving in one year operation of building during Summer = 270 x 280 = 75600 kwh**

**E. Air Distribution Systems**

Various Options will be explored, evaluated and opted for air distribution and low side system.

- Variable volume air distribution
- Constant volume air distribution system
- Under floor Air Distribution System

Individual spaces will be evaluated for suitability for the above systems. Based on a detailed energy analysis and nature/application of each space, all above systems will be evaluated and the best options based will be applied. For example, Lecture hall to go with under floor Air distribution system, Classrooms, office will have VAV and so on.
Library building shall be served through central chilled water Plant located at utility building through pump & piping network.

- **Tertiary Pump:**
  Tertiary pump will be provided at later stages of design into the building basement to accommodate the pressure requirements at each AHU. This will be after the calculation of the pump head for the pumps of central plant.
  There shall be provision of 2 tertiary pumps (1 working+ 1 standby). This ensures And maintains the required pressure and Flow of chilled water to meet the Building Cooling load.

- **BTU Metering System**
  Metered chilled water will be provided through each AHU in the complex where in BTU meter will be provided for measuring the AHU chilled water use. This will help to keep a check on energy usage at each space.

- **Duct Construction and Fire Safety**

All ducts shall be fabricated out of galvanized sheet steel (GSS) as per SMACNA standard for long life and as per fire norms. Motorized smoke dampers shall be installed within supply air ducts and return air ducts at AHU room wall crossings, to prevent spread of smoke / fire to the adjoining areas. Air handling unit fan motor shall also be tripped when smoke is sensed in the conditioned area served by the air handling unit.

- **Fresh Air requirement**
  Fresh air requirement for various spaces shall be either mechanically forced or infiltrated.

**F. MECHANICAL VENTILATION AND SMOKE EVACUATION SYSTEM:**

Mechanical ventilation system is being considered for Electrical Room, Basement, Kitchen/pantry, toilets and other similar areas using combination of centrifugal fans, axial flow fans, propeller fans and inline fans.

1. **Car Parking Extract and Supply:**
   Mechanical Ventilation for car parking in basement shall be ducted ventilation as per Revised NBC-2005 designed to permit 6 ACPH for normal ventilation, and 12 ACPH in case of fire. During Normal operation, Exhaust air @ 6 ACPH shall be exhausted through fans in the basement and the fresh air requirement shall be met through the Ramp openings available. To cater to additional 6 ACPH (total 12 ACPH) in case of fire, another set of Tube-axial fans connected with exhaust air riser shall get actuated. During this period, additional supply air fans @6 ACPH shall also supply the fresh air into the basement car parking area (wherever openings are not sufficient for the fresh air).
   Basement ventilation fans for normal operation shall be provided with variable frequency drive controlled through CO concentration level within parking area for energy conservation.
   As per revised NBC-2005, there is one zone considered for parking ventilation in Library building. Area detail & air quantity required are given in table below.

**Table-6 – Parking Ventilation**

| Space | Area (sqft) | Height (ft) | ACPH for Exhaust air | ACPH for Fire Mode | Exhaust air CFM in Normal mode | Exhaust CFM Fire Mode | Exhaust Air Fan | Fresh Air Fan |
|---|---|---|---|---|---|---|---|---|
| Car Parking Zone 1 | 19368 | 12.3 | 6 | 6 | 23822 | 23822 | 01#25000 CFM (N) & 01#25000 CFM (F) | 40 % Through Ramp and 1 No. 25000 CFM fan |

All the basement parking ventilation fans should be fire rated for a minimum of 250 Deg C for a minimum of 2 Hrs. application. Fan motor shall be Class H type with class O insulation. The fan motor shall have efficiency class IE-3.

2. **Electrical Room & Toilet Exhaust:**
   Toilet exhaust fans will be provided in buildings as required for removing foul air and maintaining air quality. Toilets, Electrical room etc will also have exhaust system installed. Toilet doors shall have an undercut (or an air transfer grill) so that some air from the surrounding spaces shall pass through this undercut /air transfer grill and exhausted out, using duct mounted fans. Toilets are ventilated through the ducting arrangement.

   Propeller, axial and duct mounted inline fan of required CFM and relative pressure serve the space. Approx. CFM for the different areas for various building in Stage-I is as shown in table.

**Table-7 –Ventilation Summary:**

| Room Name | Area (SQFT) | ACPH | CFM |
|---|---|---|---|
| ELECTRICAL ROOM-1 | 200 | 20 | 600 |
| ELECTRICAL ROOM-2 | 200 | 20 | 600 |
| ELECTRICAL ROOM-3 | 200 | 20 | 600 |
| ELECTRICAL ROOM-4 | 200 | 20 | 600 |
| ELECTRICAL ROOM-5 | 200 | 20 | 600 |
| ELECTRICAL ROOM-6 | 200 | 20 | 600 |
| MALE TOILET-GF | 142 | 10 | 400 |
| FEMALE TOILET-GF | 120 | 10 | 300 |
| HAND. TOILET-GF | 54 | 10 | 100 |
| MALE TOILET-1F | 142 | 10 | 400 |
| FEMALE TOILET-1F | 120 | 10 | 300 |
| HAND. TOILET-1F | 54 | 10 | 100 |
| MALE TOILET-2F | 142 | 10 | 400 |
| FEMALE TOILET-2F | 120 | 10 | 300 |
| HAND. TOILET-2F | 54 | 10 | 100 |
| MALE TOILET-3F | 142 | 10 | 400 |
| FEMALE TOILET-3F | 120 | 10 | 300 |
| HAND. TOILET-3F | 54 | 10 | 100 |
| MALE TOILET-4F | 142 | 10 | 400 |
| FEMALE TOILET-4F | 120 | 10 | 300 |
| HAND. TOILET-4F | 54 | 10 | 100 |
| MALE TOILET-5F | 142 | 10 | 400 |
| FEMALE TOILET-5F | 120 | 10 | 300 |
| HAND. TOILET-5F | 54 | 10 | 100 |
| **Total** | **3096** | | **8400** |

3. **Lift Well / Lift Lobby / Staircase Pressurization:**
   Fire escape staircases shall be provided with 50 Pa of Positive Pressurization and Lift well and lift lobby shall be provided with 50/30 Pa of Positive Pressurization arrangement, consisting of supply air fans installed on roof top. The fans shall connect to supply air ducts installed in vertical risers and inject air at each staircase landing, for achieving effective pressurization. Fans shall be sized to maintain minimum positive pressure of 50 Pa across the door. Make up air fans serving stairwell shall be provided with motorized damper at fan discharge to prevent humid fresh air entering into staircase well. These dampers shall be interlocked with fan motor and shall open upon getting signal from the smoke sensor. Lift wells shall also be similarly pressurized by supplying the air through fans installed on roof top.
   ***Refer to Annexure-A, B and C for Staircase, Liftlobby & Liftwell pressurization**

**G. Brief Description of HVAC Equipments:**

**1. AIR HANDLING UNITS**

The air handling units shall be double skin construction, draw through type comprising of various sections such as mixing box, (the return air and fresh air are ducted), pre-filter section, cooling & heating coil sections, fan section, filters section, Double skinned panels shall be (60mm thick for units for AHUs made of galvanized steel, pressure injected with foam insulation (density 40 KG/M3 .The entire framework shall be mounted on an aluminum alloy channel

base. Panels shall be sealed to framework by heavy duty “O” ring gaskets held captive in the framed extrusion. All panels shall be detachable or hinged. Hinges shall made of die cast aluminum with stainless steel pivots, handles shall be made of hard nylon and be operational from both inside and outside of the unit. Thermal breaks shall be provided in the unit framework to prevent condensation at the panel joints during humid outside conditions. Units shall have hinged, quick opening access door in fan and filter section. Access doors shall be double skin type. Condensate drain pan shall be fabricated from 18 gauge stainless steel sheet with all corners welded. It shall be isolated from bottom floor panel through 25 MM heavy duty urethane foam.

Centrifugal Fans shall be forward/ backward inclined blade type. Fan casing shall be made of galvanized steel sheet. Fan wheels shall be of galvanized steel. Fan wheels and pulleys shall be individually tested and precision balanced dynamically. Fans shall be imported.
Both fan and motor assemblies shall be mounted on a deep section aluminum alloy or galvanized steel base frame. The fan motor shall have efficiency class IE-3

**2. Axial Fans**

The fan casing and Motor mounting plates should be manufactured from mild steel. The fan casing and flanges should have a minimum thickness of 3.0mm for fans up to and including 1000mm diameter, with thickness of 5mm for larger diameters. Flanges should be integral with casing and should be provided with bolt holes for connection. The casing assembly, complete with flanges, should be hot dip /spray galvanized after manufacture.
An external terminal box should be provided, as standard, on long case fans. Short case fans will have a terminal box on the motor only.
The pitch angle of the fan should be individually adjustable. The fan should be of the variable pitch angle or controllable pitch angle design. The supplier should be able to provide evidence that the impeller has been adequately stressed for running at the highest speed. The impeller should be balanced to G3.6 or better as defined in ISO 1940/1:1986 (6.3 mm/s peak to peak or 4.5mm/s rms).
The aerodynamic design of the fan should be such that the maximum power required by the fan occurs within the normal working ranges, i.e., it has a non-overloading characteristic.
The fan should be suitable for frequent starting applications and for continuous operation in ambient temperatures ranging from -43°C up to +63°C.
Fan motors should be at the totally enclosed, squirrel cage induction, continuous duty, and variable torque type. Fan motor shall be Class A type with class F class insulation. The fan motor shall have efficiency class IE-3 or EFF-1, whichever is more efficient.

**3. Centrifugal Fans:**

Centrifugal fans shall be of double-width, double-inlet construction, with bearing on both sides, complete with access door, squirrel-cage induction motor, V-belt drive, belt guard etc.
Housing shall be of heavy gauge sheet steel in welded construction. It shall be rigidly reinforced and supported by structural angles. Split casing shall be provided on larger sizes of fans. However neoprene/ asbestos packing shall be provided throughout split joints to make it airtight. 1.2 mm galvanized wire mesh inlet guard, of 5cms sleeves shall be provided on both inlets. Housing shall be provided with access door with quick locking tension handles and neoprene gasket. Rotation arrow shall be clearly marked on the housing.
Fan wheel shall be backward curved non-overloading type unless otherwise specified. Fan wheel and housing shall be statically and dynamically balanced. Fan outlet velocity shall not exceed 610 meters per minute.
Shaft shall be constructed of steel, turned, ground and polished.
Bearings shall be of the sleeve/ball bearing type mounted directly on the fan housing. Bearing shall be self-aligned, oil grease packed, pillow block type.
Drive to fan shall be provided from 3 phase electric motor through belt with adjustable motor sheave and belt guard. Belt shall be of the oil resistant type. The number of belts shall be not less than two. Fan motor shall be Class A type with class F class insulation. The fan motor shall have efficiency class IE-3.

**4. Variable Speed Drives:**

Variable speed drive shall be factory installed on the Electrical panel. It will vary the fan motor speed by controlling the frequency and voltage of the electrical power to the motor. The capacity control

logic shall automatically adjust motor speed and capacity control mechanism for maximum real world efficiency by analyzing information fed to it by sensors located either in return air path or potential difference sensors located across the duct. Unit must have less than 5% Total Demand Distortion (TDD) at equipment level.

Field power wiring shall be a single point connection and electrical plugs for incoming power wiring will be provided. All VSD components are designed to last the life of the AHU.

**5. Fire Dampers:**

Motorized fire damper shall be installed with supply & return duct at AHU room wall to prevent spread of smoke fire at adjoining areas dampers shall be robust constructions and tightly fitted. The design, method of handling and control, shall be suitable for the location and service required. Dampers and their operation devices shall be made robust, easily operable, and accessible through suitable access doors in the ducts. Every damper shall have an indicating device clearly showing the damper position at all times.

Fire dampers shall be motorized smoke & fire dampers type. It shall be supplied with spring loaded UL stamped fusible link to close fire damper in the event of rise in duct temperature. Fire damper shall also close on receipt of fire alarm signal to cut off air supply instantaneously. An electric limit switch shall also be operated by the closing of fire damper, which in turn shall switch off power supply to AHU blower motor as well as strip heaters(If installed).

**6. Dampers**

Dampers shall be opposed blade type. Blades shall be made of double skinned aerofoil aluminum/ GI section with integral gasket and assembled within a rigid extruded aluminum alloy frame. All linkages and supporting spindles shall be made of aluminum/GI or nylon, turning in Teflon bushes. Manual dampers shall be provided with a Bakelite knob for locking damper blades in position

**7. Grilles and Diffusers:**

Supply air grilles shall be provided with vertical and horizontal adjustable bars and volume control multi-louver damper which shall be key operated from the front of the grille. All linear diffusers shall be powder coated extruded aluminum. All linear grilles shall be of extruded aluminum.

**8. Insulation:**

Thermal insulation shall be applied to air distribution ductwork and to components within distribution systems such as fans, and cooler casings which convey conditioned air within AHU rooms and to ductwork (including recirculation air ductwork) conveying warmed or chilled air through unconditioned spaces or the open air. Unless otherwise indicated, distribution systems conveying conditioned, warmed or chilled air through conditioned spaces shall not be insulated. Distribution system conveying fresh air. Thermal insulation shall be applied to chilled water pipe work distribution systems and to components within distribution systems such as valves. Where thermal insulation is applied to the outside of piped and ducted services. The vapor barrier shall be applied such that it is continuous and given protection to the whole surface of the insulation which it protects. It shall not be pierced or otherwise damaged by supports or by the application of external cladding. At points of support means of load distribution shall be provided as necessary.

| Space | Insulation Thickness |
|---|---|
| Duct in conditioned Space | 19.00 mm (XLPE Insulation ) |
| Duct in unconditioned space | 25.0 mm (XLPE Insulation ) |

**9. Acoustic lining of AHU Rooms:**

Acoustic insulation on walls and ceiling of Air handling unit's rooms with 50mm thick resin bonded fiber glass slabs fixed in frame work and finished with vapor barrier and perforated aluminum sheet two walls and ceiling of air conditioning plant room and air handling unit rooms may be provided with

acoustic lining of resin bonded fibre glass. The surface shall be cleaned and frame work of 22 gage GI fabricated Channels 25 mm x 50 mm screwed back to back at 60 cm centre's shall be provided vertically and horizontally so that 60 x 60 cm squares are formed. The gaps between frames shall be filled with 50 mm thick about 60 cm x 60 cm cut panels of resin bonded fiberglass slabs. The entire surface shall then be covered with fiberglass tissue and 26 gage perforated aluminum sheet, 60 cm or 120 cm wide having at least 15 percent perforations, fixed with sheet metal screws. Over-lapping of sheets shall be covered with Aluminum beading. Acoustic lining of walls shall be terminated approximately 15 cm above the finished floor to prevent damage to insulation due to accidental water-logging in plant/AHU rooms.

**10. Acoustic lining over ducts:**

Ducts shall be lined internally with acoustic insulation as detailed below:

- The Inside surface of duct on which the acoustic lining is to be provided shall be clean free from all dust and grease.
- Then 25 x 25 sq.mm section of minimum 1.25 mm thick G.I. sheet shall be fixed on both ends of the duct piece.
- The insulation slabs shall then be fixed between these section of ducts using CPRX adhesive compound and stickpins.
- The insulation shall then be covered with Reinforced plastic/ fiber glass tissue, sealing all joints so that no fiber is visible.
- The insulation shall finally be covered with minimum 0.5 mm thick perforated aluminum sheet having perforations between 20-40%

**11. Filters:**

**i. Pre-filters (fabric type)**

Synthetic fiber Pre-filters shall be in light weight aluminium framed with non woven synthetic fiber replaceable media. The filter shall have an efficiency of 90 percent down to 10 microns particles size when tested as per B.S.2831 standards. The filter frame shall be of aluminium and shall be suitable for mounting in Air handling units or ducts as required at site. The velocity across the face of the filter shall not exceed 500 FPM and the pressure drop across the filter shall not exceed 4mm.

**ii. Microvee filters (fine filters):**

Microvee filters shall be of dry type. Filters media shall be made from washable nonwoven synthetic fiber replaceable media reinforced with HDPE cloth & Aluminum mesh, specially treated with antifungal and bactericidal agents to prevent growth of micro organisms. The filter media shall be treated to permit washing with water several times before discharged. The media shall be properly supported and spaced so that air flow through the filter is uniform. The filter shall be housed in aluminium frame work. Filters shall be designed to remove particle down to 5 micron size and with efficiently of 98.0 percent tested as per BS 2831 using Test Dust II. The filters shall be installed in the air handling units after the chilled water coils. They shall be capable of being replaced or removed for servicing without the use of special tools.

**H. BUILDING MANAGEMENT SYSTEM:**

Building automation and control systems would control and monitor system such as air handling units, Tertiary Pumps, Fans in Parking area, Lift and miscellaneous electrical and plumbing points.

A totally direct digital control (DDC) system with electric Actuation control Valve and Damper would be considered.

There would be preference to systems, which support open protocol, i.e., BACNET.

**MONITORING/ CONTROLLING POINTS FOR BMS:**

| S. No. | Description |
|---|---|
| | **HVAC SYSTEM**<br>**AIR CONDITIONING SYSTEM** |
| | |
| **A** | **OUTSIDE AIR** |

| | |
|---|---|
| | Outside Air Temperature and RH |
| | |
| **B** | **AIR HANDLING UNITS (with RH & Temp Control) (Common areas)** |
| | AHU Blower Status |
| | AHU Manual Operation Status |
| | AHU FAN ON/OFF Status |
| | AHU Motor trip Status |
| | AHU Run Status |
| | AHU Filter Status |
| | AHU Return Air Temperature & RH |
| | AHU modulate Chilled Water Valve |
| | VAV/ VFD |
| | Fresh air Damper control |
| | Fresh air damper Feedback |
| | Supply/Return Fire Damper status |
| | |
| **C** | **VENTILATION FANS/TOILET FANS** |
| **D** | **LIFTS MONITORING** |
| **E** | **ELECTRICAL ENERGY** |
| **F** | **BASEMENT FANS** |
| **G** | **TERTIARY CHILLED WATER PUMP** |
| **H** | **HEAT RECOVERY WHEEL** |

# ANNEXURE A, B and C
# FOR
# LIBRARY BUILDING PRESSURIZATION CALCULATION

**Annexure – A**

**Pressurization of each Staircase (Basement to 5th floor)**

**1. Leakage path from pressurized staircase are as follows**

a) Door at each mid landing
b) Door on the basement floor

**2. Staircase Description**

a) Total No. of Doors = 6 Nos.
b) Door size = 1.5m x 2.1 m
c) Area of each door = 3.15 $mt^2$ or 33.9 $ft^2$.

**3. Calculation of air quantity leakage through open staircase door as follows;**

= Area of staircase door ($mt^2$) x Exhaust air velocity of air assumed (m/second) x Nos. of Doors open.

= 3.15 x 1 x 1 = 3.15 $m^3/s$

= (3.15 x 3600) / 1.7

= 6670 CFM

**4. Calculation of air quantity leakage through staircase doors and cracks on other floors**

Perimeter of door = 7.2 m

Assume Gap = 2.0 mm =0.002 m

Total No. of leakage door = 2 Nos.

Total leakage area = Perimeter of Door x Gap x No. of Leakage Door

= 7.2 x 0.002 x 2

= 0.0288 $mt^2$

Now, Assume Pressure Difference = 50 Pascal

Now, Air leakage through Staircase door and cracks = 0.827 x leakage area x √PD

= 0.827 x 0.0288 x √50

= 0.1684 $m^3/s$

= (0.1684 x 3600) / 1.7 CFM

= 356 CFM

Accounting for 5 % duct losses = (6670 + 356) x 1.05

= 7377 CFM

**Say 7500 CFM @ 25 mm of WG static pressure of free inflow of air for Each Staircase Pressurization.**

**Annexure – B:**

**Pressurization of each Lift Lobby (Basement to 5th Floor)**

**1. Leakage path from pressurized lift lobby are as follows**

a) Door at each mid landing
a) Door on the ground floor

**2. Staircase Description**

a) Total No. of Doors = 6 Nos.
b) Door size = 1.5 x 2.1 mtr.
c) Area of each door = 3.15 $mt^2$ or 33.9 $ft^2$.

**3. Calculation of air quantity leakage through open lift lobby door be as follows;**

= Area of lift lobby door ($mt^2$) x Exhaust air velocity of air assumed (m/second) x Nos. of Doors open.

= 3.15 x 1 x 2 = 6.3 $m^3/s$

= (6.3 x 3600) / 1.7

= 13341 CFM

**4. Calculation of air quantity leakage through lift lobby doors and cracks on other floors**

Perimeter of door = 7.2 m

Assume Gap = 2.0 mm = 0.002 m

Total No. of leakage door = 6 Nos.

Total leakage area = Perimeter of Door x Gap x No of Leakage Door

= 7.2 x 0.002 x 6

= 0.0864 $mt^2$

Now, Assume Pressure Difference = 30 Pascal

Now, Air leakage through lift Lobby door and cracks = 0.827 x leakage area x √PD

= 0.827 x 0.0864 x √30

= 0.3914 $m^3/s$

=(0.3914 x 3600) / 1.7 CFM

**= 829 CFM**

Accounting for 5 % duct losses = (13341 + 829) x 1.05

= 14878 CFM

**Say 15000 CFM @30 mm of WG static pressure of free inflow of air for each Lift Lobby.**

**Annexure – C:**

**Pressurization of each Lift Well (Basement to 3th Floor)**

**1. Leakage path from pressurized lift well are as follows**

a) Door at each mid landing

**2. Staircase Description**

a) Total No. of Doors = 6 Nos.
b) Door size = 1.2 m x 2.1 m
2.52 $mt^2$ or
c) Area of each door = 27.11$ft^2$.

**3. Calculation of air quantity leakage through open lift well door be as follows;**

= **Area of lift lobby door ($mt^2$) x Exhaust air velocity of air assumed (m/second) x Nos. of Doors open.**

= 2.52 x 1 x 1 = 2.52 $m^3$/s

= (2.52 x 3600) / 1.7

= **5336 CFM**

**4. Calculation of air quantity leakage through lift well doors and cracks on other floors**

Perimeter of door = 6.6 m

Assume Gap = 2.0 mm =0.002 m

Total No. of leakage door = 6 Nos.

Total leakage area = Perimeter of Door x Gap x No. of Leakage Door

= 6.6 x 0.002 x 6

= 0.0792 $mt^2$

Now, Assume Pressure Difference = 50 Pascal

Now, Air leakage through lift Well door and cracks = 0.827 x leakage area x √PD

=0.827 x 0.0792 x √50

= 0.463 $m^3$/s

=(0.463x3600) / 1.7 CFM

= **980 CFM**

Accounting for 5 % duct losses = (5336 + 980) x 1.05

= 6632 CFM

**Say 6700 CFM @ 25 mm of WG static pressure of free inflow of air for each Lift Well.**

# 12.22. ANNEXURE VII - DDR for AC4- FACULTY OF LAW & HUMANITY

## 12.22. ANNEXURE VII - DDR for AC4- FACULTY OF LAW & HUMANITY

### A. Introduction:

Faculty of Law & Humanities Building is part of academic block in South Asian University. This building includes Class Room, Lecture Theatre, Cafeteria, Meeting Room, Admin office, Conference Room, Student Lounge, Library, Moot Court, Faculty Rooms, P.H.D. cubicles, Computer lab, Language Lab, IT Room, Fire control room, security room, Kitchen etc.

Building consists of a basement + Ground + 3 Floors and a total built-up area of 26043.23 sq.mtr.

#### 1. Air Conditioning Objective:

Objective of air conditioning is to provide thermal comfort to all areas for Faculty of Law & Humanities building in an efficient and cost-effective manner round the year. Temperatures and Indoor Air Quality shall be maintained in accordance with parameters as specified in the following sections of Basis of Design.

Faculty of Law & Humanities building is served by Central chilled water system. The chilled water flowing through the M.S Pipe with HDPE Jacketing buried underground is connected to branch piping to serve all risers which are connected to all AHU's and FCU's.

#### 2. Ventilation Objective :

Objective of Mechanical Ventilation is to provide fresh air and vent out exhaust air to maintain indoor air quality and to have an escape route in case of fire. Mechanical ventilation system is being considered for Utility rooms, Basements, Kitchen/pantry, toilets, stores and other similar areas using combination of centrifugal fans, axial flow fans, propeller fans and inline fans.

### B. General Building HVAC Design Criteria and Assumptions

This section of the report documents specific numbers used in the design of the Faculty of Law & Humanities building. These assumptions are an essential part of making the transition from the project intent to installed equipment. Also the codes and guidelines for the designer and contractor which are to be followed during the different stages of project are outlined.

#### 1. CODES & STANDARDS:

The applicable Standards/Codes are:

(a) American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE).
- a.1 ASHRAE - 55
- a.2 ASHRAE - 90.1
- a.3 ASHRAE - 62.1
- a.4 ASHRAE - Fundamentals
- a.5 ASHRAE - HVAC Application
- a.6 ASHRAE - HVAC System & Equipment
- a.7 ASHRAE - Refrigeration

(b) Energy Conservation Building Code (ECBC)
(c) Duct construction standards as per relevant BIS Codes & SMACNA standards
(d) National Buildings Code-2005
(e) Air Filter as per ASHRAE-52.1 and 52.2
(f) National Electric code
(g) National Fire Protection code
(h) ISHRAE Standards
(i) GRIHA Manual
(j) IMC-2009

The following IS codes shall be applicable:

| S. No. | Material/item of Work | Standard/Code |
|---|---|---|
| 1. | Ducting Fabrication | IS: 655 |
| 2. | Galvanized Sheets/Wires | IS: 277 |
| 3. | Aluminum Sheets/Wires | IS: 737 |
| 4. | Horizontal Centrifugal Pumps | IS: 6595 |
| 5. | Mild Steel, ERW Pipes | IS: 1239, IS: 3589 |
| 6. | Pipe Fittings | IS: 1239 |
| 7. | Steel Pipe Flanges | IS: 6392 |
| 8. | Gate, Globe & Check Valves | |
| | • Up to 40 mm Gun metal | IS:778 |
| | • Butterfly valve of 50 mm and Above (Cast Iron) | IS:2906 |
| | • Balancing valve | IS:778 |
| | • Non Return valve | IS:5312 |
| 9. | Color Code for Identifications of pipes | IS: 2379 |
| 10. | 3 Phase induction motors | IS: 325 |
| 11. | Pressure and vacuum gauges | IS: 3624 |
| 12. | PVC insulated electric cables | IS: 1554 |
| 13. | Starters sheets/wires | IS: 8555 |
| 14. | Glossary of terms used in refrigeration and Air-conditioning | IS: 3615 |
| 15. | Hot die zinc coated steel pipes | IS: 4736-1968 |
| 16. | Expanded Polystyrene | IS: 4671 |

**Safety codes**

The following safety codes as laid down by ISI shall be followed:

| | | |
|---|---|---|
| 1. | Safety code for mechanical refrigeration | IS : 660 |
| 2. | Safety code for air-conditioning | IS : 659 |
| 3. | Safety code for scaffolding and ladders | IS : 3696 |
| 4. | Code for practice for safety and health Requirements in electrical and gas Welding & cutting operations | IS: 818 |
| 5. | Recommendations of safety procedures and practices In electrical works | IS: 5216 |

NOTE:- All the codes and standards are applicable only with the latest amendments only.

**<u>Green building/GRIHA features :</u>**

a) South Asian campus is targeting to be a GRIHA five star rated campus.
b) High efficient equipment will be used for HVAC system. Selection of High efficient fans for AHU and Ventilation system.
c) Variable speed drive shall be used on selected AHU and large ventilation fans.
d) Variable air volume system shall be used for selected areas as per the application.
e) Car parking exhaust system shall be equipped with CO sensors so that exhaust fans are operated as per permitted CO concentration levels.
f) Heat recovery wheels for pre-cooling OA by using the waster exhaust air wherever possible to lower down the fresh air load. This ensures reduced energy consumption despite higher fresh air intake.
g) Cooling tower selection for minimum drift and noise level; energy efficient motors, VFD for motor speed control.

**2. LOCATION:**

- Site Location : New Delhi
- Geographic Location : 28.38°N, 77.13°E

- Altitude : 216 m above mean sea level

**a) Design Conditions and Assumptions:**

The summer design condition is based on ISHRAE weather data and statistics of the most recent data of 10 year period, published by the India Metrological Department and *.epw* weather data files from the *DOE*.

The year round temperatures and climatic conditions is as below and system is evaluated for 8760 hours.

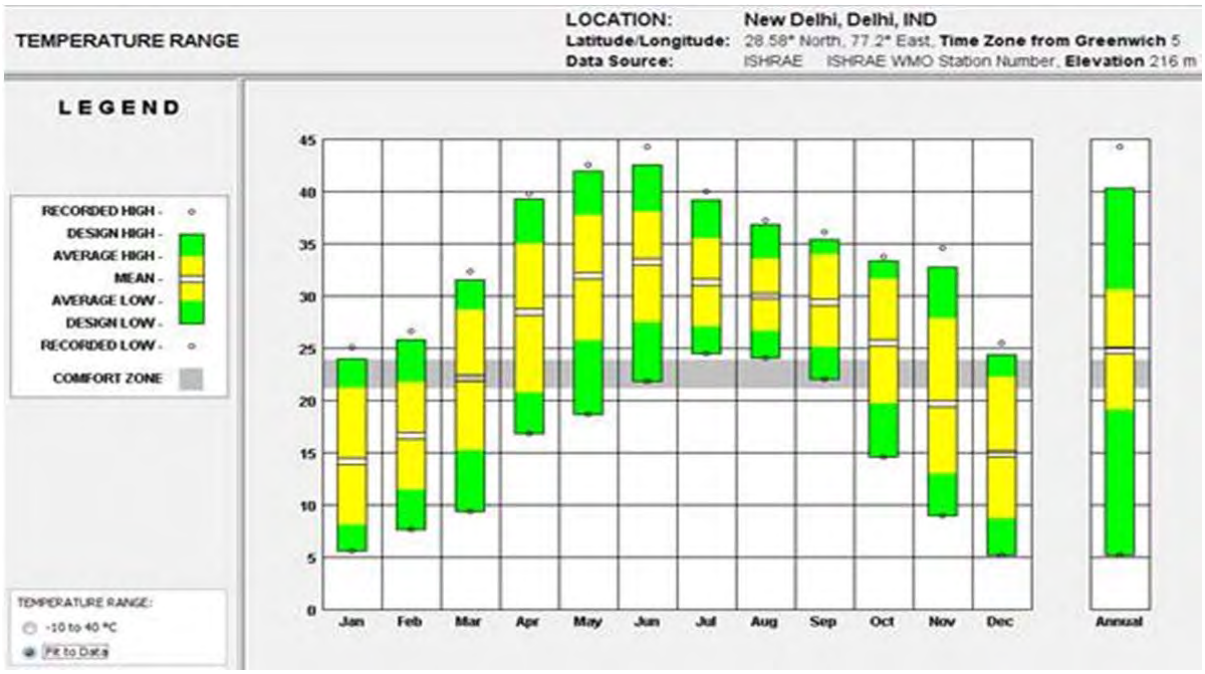



**Table-1 Design Assumptions**

| Description | Value (units) |
|---|---|
| Latitude/Longitude | 28.38°N, 77.13°E |
| Sea level | 216 m |
| Clearness number | 0.95 |
| Summer outdoor air DB/WB temperature | 43.3°C (109.94 °F) /23.89 (75.02 °F) |
| Winter outdoor air DB/WB temperature | 7.2°C (44.96 °F) / 5.0°C(41.0°F) |
| Monsoon outdoor air DB/WB temperature | 35°C (95.0°F)/ 28.3°C (83°F) |
| Ground reflectance | 0.20 |
| Roof U-value | 0.079 Btu/h. ft².°F |
| Overall Wall U-value | 0.1179 Btu/h. ft².°F |
| Glass U-value (summer/winter) | 0.31 Btu/h. ft².°F |
| Glass shading coefficient | 0.58 |
| Infiltration /Ex-filtration | As per ASHRAE 90.1 |
| Building system peak cooling load (day/month) | 15 / 7 |

| | |
|---|---|
| Cooling load design calculation program | CLTD, Trane Trace 700 |
| Winter Heat load design calculation program | UATD, Trane Trace 700 |
| Ductwork sizing program | Trane Ductulator |
| Cooling Safety factor/Heating Safety Factor | 10% |
| Fan heat gain safety factor | 5% |
| Diversity | 75% Overall on chiller plant |
| Typical Hours of Operation | As directed by SAU |

**b) Inside Design Conditions:**

Table below shows Room Ambient Temperature and Humidity Design Criteria for Faculty of Law & Humanity buildings. The set points are considered on the basis of ASHRAE -55 Clause 5, Thermal Comfort charts and after discussion with SAU.

**Table-2- Inside Set Points conditions:**

| | **Inside conditions** | | | |
|---|---|---|---|---|
| | **Summer** | | **Winter** | |
| **Spaces** | **Temp.** | **Humidity** | **Temp.** | **Humidity** |
| CLASS ROOM | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| ADMIN OFFICE | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| LECTURE THEATRE | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| CAFETERIA | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| DEANS OFFICE | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| MEETING ROOM | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| CONFERENCE ROOM | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| LIBRARY | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| LOUNGE | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| MOOT COURT | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| FACULTY ROOM | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| LANGUAGE LAB | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| COMPUTER LAB | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| PHD CUBICLES | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| FACULTY LOUNGE | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| IT ROOM | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| FIRE CONTROL ROOM | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| UPS ROOM | 22 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |

**3. Acoustic Criteria:**

Air-conditioning systems will be designed to maintain the following noise criteria (NC) level in various spaces as per NBC - 2005 - PART 8 Building Services Section 4, Acoustics, Sound Insulation And Noise Control.

- Lecture Hall : NC 40-45
- Classrooms : NC 40-45
- Seminar Room : NC 40-45
- Office Space : NC 35-40
- Faculty Room : NC 35-40
- Cafeteria : NC 50-55
- Computer rooms : NC 45-50
- Language Lab : NC 35-45

- Moot court : NC 40-45
- Library : NC 35-40

**4. Fresh Air:**

Adequate fresh air quantity shall be provided to air-conditioned spaces to maintain indoor air quality (IAQ) generally as per ASHRAE standard 62.1-2007.

- 10.0 CFM/person + 0.12 CFM/Sq.ft. for Classrooms
- 10 CFM/person + 0.12 CFM/Sq.ft. for Lecture theater
- 10 CFM/person + 0.12 CFM/Sq.ft. for Computer Labs
- 10 CFM/person + 0.12 CFM/Sq.ft. for Language Labs
- 5 CFM /person + 0.12 CFM/Sq.ft. for Libraries
- 5 CFM /person + 0.06 CFM/Sq.ft. for Office
- 7.5 CFM/Person + 0.18 CFM/Sq.ft for Cafeteria
- 5 CFM/Person + 0.06 CFM/Sq.ft for Faculty rooms
- 5 CFM/Person + 0.06 CFM/Sq.ft for Conference room
- 5 CFM/Person + 0.06 CFM /Sq.ft. for Moot Court
- 5 CFM/Person + 0.06 CFM/Sq.ft for Lounge

**5. Lighting Load:**

Following is the assumptions made for the purpose of considering lighting load and will be according to the electrical lighting design. ASHRAE 90.1-2007 will be used for any assumptions.

- 1.1 W/Sq.ft for office Space.
- 1.4 W/Sq.ft for classrooms.
- 1.4 W/Sq.ft for Lecture Theater.
- 1.4 W/Sq.ft for computer labs.
- 1.4 W/Sq.ft for Language lab.
- 1.3 W/Sq.ft for library.
- 1.2 W/Sq.ft for Lounge
- 1.3 W/Sq.ft for Cafeteria
- 1.3 W/Sq.ft for Faculty rooms
- 1.3 W/Sq.ft for Conference room
- 1.3 W/Sq.ft for Moot court

**6. Equipment Loads**

Following is the assumptions made for the purpose of considering Equipment load and will be according to the ASHRAE Fundamentals-2005, chapter 30 & electrical design/equipment used.

- 1.2 W/Sq.ft for Admin Office Space.
- 0.25 W/Sq.ft for classrooms.
- 0.25 W/Sq.ft for Lecture theater.
- 5.0 W/Sq.ft for computer labs.
- 5.0 W/Sq.ft for lab areas.
- 0.5 W/Sq.ft for library.
- 0.5 W/Sq.ft for Lounge
- 2.5 W/sq.ft for Cafeteria
- 1.2 W/sq.ft for Faculty rooms
- 0.86 W/sq.ft for Conference room
- 0.5 W/sq.ft for Moot Court

**7. Occupancy**

Occupancy as per furniture layout of rooms as mentioned on the architectural plans.
For areas where capacity is not mentioned, it is assumed as per NBC-Part-8, Building Services, and Section-3, Table 4 or ASHRAE 62.1-2007 table 6-1.

**8. Mechanical Ventilation System:**

The following areas shall be provided with dedicated ventilation system with the number of air changes per hour for each space as identified here with:

| | | | |
|---|---|---|---|
| a) | Toilets | : | 10 ACPH |
| b) | Car Parking | : | 6 (Normal Mode)/ 12 (Fire Mode) ACPH Exhaust & 6 (Normal Mode)/12 (Fire Mode) ACPH Fresh Air |
| c) | Kitchen | : | 20 ACPH |
| d) | Electrical Room | : | 20 ACPH |

**9. Relative Pressure:**

| | | |
|---|---|---|
| • Toilet Rooms | : | Negative inside pressure |
| • Lift well | : | 50 Pa Positive Pressure |
| • Closed Staircase | : | 50 Pa Positive Pressure |
| • Lift lobby Pressurization | : | 30 Pa Positive Pressure |
| • All other areas | : | As per codes and standards |

**C. Mechanical System Design Parameters & Philosophy:**

This section describes the assumptions, parameters considered for sizing and designing of various Mechanical equipments and its components. Below is the detailed description.

- Faculty of Law & Humanities building shall be served by the central chilled water plant & hot water generator located in utility building.
- Chilled water network buried shall supply required chilled water to the building.

**1. Air Handling Units:**

- Unit shall be provided with filter, cooling coil & fan to serve the specific premises.
- During summer season, supply & return temperature of chilled water is considered are 44° F & 56° F.
- During winter season, supply & return temperature of water considered are 130° F & 110° F.
- Air Distribution to the rooms shall be provided with supply air duct with suitable terminals and return air through return air duct or plenum, as applicable.
- All duct subjected to temperature below dew point shall be insulted with XLPE with thermal conductivity of 0.037 W/m-k at 20°C mean temperature.
- Fan motor shall be Class A type with class F insulation. The fan motor shall have efficiency class IE-3.

**2. Piping:**

- Hydronic Piping material for chilled/Heating water supply and return shall be of Heavy class Black steel (MS- Class C) Pipes. Piping up to and including 150 mm diameter shall be of heavy class black steel confirming to IS:1239 and piping greater than 150 mm shall be minimum 6 mm thick black steel confirming to IS:3589.

- Hydronic piping shall be insulated with closed cell elastomer with maximum thermal conductivity of 0.038 W/m-k at 38° C, when tested in accordance with EN- ISO 8947.
- Chilled water piping insulation thickness shall be 25 mm thick for 40 mm pipe and smaller, 40 mm thick for 50 mm to 150 mm pipe and 75 mm thick for pipe greater than 150 mm.
- Drain from the all the air-conditioning equipment shall be collected by GI drain pipe insulated with 9 mm thick closed cell elastomer material and connected to nearest drain point.

All chilled water pipes shall be mild steel Class 'C' (heavy duty) conforming to relevant BIS codes. All jointing in the pipe system shall be by welding. Various type of valves such as butterfly valves, balancing valves and non return valves shall be provided in water lines.

Condensate drain piping would be GI 'B' Class conforming to relevant BIS codes.

**PIPING SHALL BE SIZED FOR THE FOLLOWING DESIGN PARAMETERS**

Pipes shall be sized to provide maximum water velocities as follows:

| **Pipe Sizes** | **Maximum Velocity** |
|---|---|
| Up to 50mm | 0.6 m/sec |
| 65 to 100mm | 0.8 m/sec |
| 125 to 200mm | 1.5 m/sec |
| 250 to 300mm | 2.5 m/sec |
| 355mm and up | 3.0m/sec |

**3. Filtration:**

Re-circulated air
(mixed outdoor & return air)
At Air handling unit : Washable synthetic type air filter having 90% efficiency down to 10 micron MERV 8 and filter having 99% efficiency down to 3 microns MERV 13)

Re-circulated air
(mixed outdoor & return air)
At Ventilation units : Washable synthetic type air filter havig 90% efficiency down to 10 microns (MERV)

**4. Duct Design Criteria:**

The following maximum duct design velocities will be used in the design of ductwork systems. Where a range is indicated, it is intended to represent velocities over a range of flow volume.

**Table-3**

| | **Meters/Second** |
|---|---|
| Low Pressure Systems | |
| - Main Duct | 7.5 |
| - Primary Branch | 5.0 |
| - Secondary Branch | 2.0-3.5 |
| Plenum | 5.0-6.0 |
| Medium Pressure Systems | 12.0 |
| Cooling Coils | 2.5 |
| Heating Coil | 4.0 |
| Filters | 2.5 |

The following maximum friction losses are to be used in conjunction with the velocities noted above.

| | Pascal's/meter |
|---|---|
| Low pressure systems | 1.0 |
| Medium pressure systems | 3.3 |

**5. Ventilation Fan Design Criteria:**

- Maximum fan outlet velocity for fan upto 450 mm dia : 9.14m/s(1800 FPM)
- Maximum fan outlet velocity for fan above 450 mm dia : 12m/s (2400 FPM)
- Maximum fan speed for fan upto 450 mm : 1440 RPM
- Maximum fan speed for fan above 450 mm : 1100 RPM

Note: Ventilation fans can be either axial type or centrifugal type.

**6. Diffuser and Grill Design Criteria:**

- All air outlets and intakes shall be made of extruded aluminum sections &shall present a neat appearance and shall be rigid with mechanical joints.
- Square and rectangular wall outlets shall have a flanged frame with the outside edges returned or curved 5 to 7 mm and fitted with a suitable flexible gasket between the concealed face of the flanges and the finished wall face. The core of supply air register shall have adjustable front louvers parallel to the longer side to give up to 22.5 degrees vertical deflection and adjustable back louvers parallel to the shorter side to achieve a horizontal spread air pattern to at least 45 degrees. Return air grilles shall have only front louvers. The outer framework of the grilles shall be made of not less than 1.6 mm thick aluminum sheet. The louvers shall be of aero foil design of extruded aluminum section with minimum thickness of 0.8mm at front and shall be made of 0.8mm thick aluminum sheet. Louvers may be spaced 18 mm apart.
- Square and rectangular ceiling outlets/intakes shall have a flange flush with the ceiling into which it is fitted or shall be of anti-smudge type. The outlets shall comprise an outer shell with duct collar and removable diffusing assembly. These shall be suitable for discharge in one or more directions as required. The outer shell shall not be less than 1.6 mm thick extruded section aluminum sheet. The diffuser assembly shall not be less than 0.80 mm thick extruded aluminum section.
- Circular ceiling outlets/intakes shall have either flush or anti smudge outer cone as specified in the tender specifications. Flush outer cones shall have the lower edge of the cone not more than 5 mm below the underside of the finished ceiling into which it is fitted. Anti-smudge cones shall have the outer cone profile designed to reduce dirt deposit on the ceiling adjacent to the air outlet. The metal sheet used for construction of these shall be minimum 1.6 mm thick extruded aluminum sheet.
- Linear diffusers shall have a flanged frame with the outside edges returned 3.5 mm and shall have one to four slots as required. The air quantity through each slot shall be adjustable. The metal sheet used for the construction of these shall be minimum 1.6 mm thick extruded aluminum sheet.
- Grilles and diffusers constructed of extruded aluminum sections shall have grille bars set straight, or deflected as required. These shall be assembled by mechanical interlocking of components to prevent distortion. These grilles and diffusers shall have a rear set of adjustable blades, perpendicular to the face blades for deflection purposes.
- All supply air outlets shall be fitted with a VOLUME CONTROL DEVICE, made of extruded aluminum gate section. The blades of the device shall be mill finish/ block shade pivoted on nylon brushes to avoid rusting & rattling noise, which shall be located immediately behind the outlet and shall be fully adjustable from within the occupied space without removing any access panel. The volume control device for circular cutlets

shall be opposed blade radial/shutter type dampers, or two or more butterfly dampers in conjunction with equalizing grid. Opposed blade dampers shall be used for square and rectangular ceiling/ wall outlets and intakes.

**D. Building Cooling and Heating Requirements:**

This section of the report describes the Cooling (TR) and Heating (MBH) requirement for the various spaces of the buildings. Table below shows the building wise preliminary requirements:

**Table-4 Building Heating and cooling Requirements:**

| Sr.no | Floor | Area Description | Floor area (Sqft) | No.Of Person | Dehumified CFM | Cooling TR | Heating MBH |
|---|---|---|---|---|---|---|---|
| 1 | GROUND | CLASS ROOM 1B | 1001 | 70 | 1709 | 8.1 | 26.9 |
| 2 | | CLASS 2 B | 1001 | 70 | 1709 | 8.1 | 26.9 |
| 3 | | CLASS 3 B | 1001 | 70 | 1709 | 8.1 | 26.9 |
| 4 | | LECTURE THEATRE | 3060 | 211 | 4125 | 22.7 | 84.6 |
| 5 | | CAFETERIA | 2150 | 68 | 3267 | 14.1 | 38.4 |
| 6 | | CLASROOM B1 | 1001 | 70 | 1686 | 7.8 | 26.9 |
| 7 | | CLASSROOM B2 | 1001 | 70 | 1686 | 7.8 | 26.9 |
| 8 | | CLASSROOM B3 | 1001 | 70 | 1686 | 7.8 | 26.9 |
| 9 | | MEETING ROOM | 730 | 22 | 1052 | 3.4 | 7.4 |
| 10 | | ADMIN OFFICE | 844 | 16 | 1020 | 3.1 | 7.1 |
| 11 | | DEANS OFFICE | 502 | 15 | 1052 | 2.7 | 6.5 |
| 12 | | CLASSROOM B6 | 1001 | 70 | 1613 | 7.8 | 26.8 |
| 13 | | CLASSROOM B5 | 1001 | 70 | 1709 | 8.1 | 26.9 |
| 14 | | CLASSROOM B4 | 1001 | 70 | 1613 | 7.8 | 26.8 |
| 15 | | CLASSROOM B | 1001 | 70 | 1648 | 7.6 | 26.8 |
| 16 | | CLASSROOM B | 1001 | 70 | 1686 | 7.8 | 26.9 |
| 17 | | CLASSROOM B | 1001 | 70 | 1648 | 7.6 | 26.8 |
| 18 | | DEANS OFFICE | 502 | 15 | 1052 | 2.8 | 6.5 |
| 19 | | ADMIN OFFICE | 844 | 16 | 1020 | 3.1 | 7.1 |
| 20 | | MEETING ROOM | 730 | 35 | 1075 | 4.2 | 9.3 |
| | | | | | | | |
| 21 | FIRST | CONFERENCE/SEMINAR ROOM | 810 | 30 | 1069 | 4.0 | 9.0 |
| 22 | | HOD 4 | 325 | 8 | 563 | 1.8 | 4.4 |
| 23 | | HOD 4 | 325 | 8 | 543 | 1.7 | 4.4 |
| 24 | | HOD 3 | 335 | 8 | 411 | 1.4 | 3.5 |
| 25 | | HOD 2 | 335 | 8 | 411 | 1.4 | 3.5 |
| 26 | | HOD1 | 343 | 8 | 431 | 1.5 | 4.2 |
| 27 | | CLASSROOM A4 | 508 | 40 | 1001 | 4.5 | 15.2 |
| 28 | | CLASSROOM A3 | 506 | 40 | 1000 | 4.5 | 15.2 |
| 29 | | CLASSROOM A2 | 506 | 40 | 1000 | 4.5 | 15.2 |
| 30 | | CLASSROOM A1 | 508 | 40 | 1012 | 4.6 | 16.2 |
| 32 | | CLASSROOM C | 1985 | 110 | 3271 | 14.8 | 45.0 |
| 33 | | CLASSROOM C 1 | 1926 | 120 | 3374 | 15.5 | 47.5 |
| 35 | | CLASSROOM A1 | 508 | 40 | 1046 | 4.7 | 16.2 |
| 36 | | CLASSROOM A2 | 506 | 40 | 1007 | 4.6 | 15.2 |
| 37 | | CLASSROOM A3 | 506 | 40 | 1007 | 4.6 | 15.2 |
| 38 | | CLASSROOM A4 | 508 | 40 | 1009 | 4.6 | 15.2 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 39 | | FR 18 (SINGL W X 6) | 719 | 18 | 1074 | 3.6 | 7.6 |
| 40 | | FR 18 (DBL W X 3 ) | 359 | 9 | 803 | 2.4 | 4.2 |
| 41 | | FR 18 (SINGL W X 6) | 719 | 18 | 1113 | 3.7 | 7.6 |
| 42 | | FR 18 (DBL W X 3 ) | 359 | 9 | 808 | 2.4 | 4.2 |
| 43 | | CLASSROOM A8 | 615 | 40 | 1058 | 4.8 | 15.9 |
| 44 | | CLASSROOM A7 | 653 | 40 | 1176 | 5.1 | 16.3 |
| 45 | | CLASSROOM A6 | 495 | 40 | 1014 | 4.6 | 15.3 |
| 46 | | CLASSROOM A8 | 615 | 40 | 1070 | 4.9 | 15.9 |
| 47 | | CLASSROOM A7 | 653 | 40 | 1182 | 5.3 | 16.3 |
| 48 | | CLASSROOM A6 | 678 | 40 | 1095 | 5.0 | 16.2 |
| 49 | | FR 18 (SINGL W X 6) | 719 | 18 | 1074 | 3.6 | 7.6 |
| 50 | | FR 18 (DBL W X 3 ) | 359 | 9 | 803 | 2.4 | 4.2 |
| 51 | | FR 18 (SINGL W X 6) | 719 | 18 | 1113 | 3.7 | 7.6 |
| 52 | | FR 18 (DBL W X 3 ) | 359 | 9 | 808 | 2.4 | 4.2 |
| 53 | | CONFERENCE/ SEMINAR ROOM | 1017 | 29 | 1093 | 4.2 | 10.1 |
| 54 | | SECRETARY AND ADMIN 1-4 | 1500 | 22 | 979 | 4.1 | 9.1 |
| 55 | | SECURITY AND ADMIN 4 -LHS | 369 | 7 | 610 | 1.3 | 2.8 |
| | | | | | | | |
| 57 | SECOND | CONFERENCE/SEMINAR HALL | 999 | 31 | 1443 | 5.1 | 11.7 |
| 58 | | MEETING ROOM | 494 | 22 | 909 | 3.1 | 6.5 |
| 59 | | MEETING ROOM | 494 | 22 | 547 | 2.4 | 4.9 |
| 60 | | CONFERENCE/SEMINAR | 987 | 31 | 1047 | 4.2 | 9.2 |
| 61 | | LANGUAGE LAB | 1356 | 44 | 2667 | 9.7 | 23.0 |
| 62 | | LANGUAGE LAB | 1356 | 44 | 2274 | 8.8 | 23.6 |
| 63 | | FR 18 (SINGL W X 6) | 719 | 18 | 1113 | 3.7 | 7.6 |
| 64 | | FR 18 (DBL W X 3 ) | 361 | 9 | 811 | 2.4 | 4.3 |
| 65 | | FR 18 (SINGL W X 6) | 719 | 18 | 1074 | 3.6 | 7.6 |
| 66 | | FR 18 (DBL W X 3 ) | 359 | 9 | 802 | 2.4 | 4.3 |
| 67 | | CLASSROOM A12 | 631 | 40 | 999 | 4.7 | 15.9 |
| 68 | | CLASSROOM A 11 | 631 | 44 | 1307 | 5.7 | 17.5 |
| 69 | | CLASSROOM A10 | 631 | 44 | 1172 | 5.3 | 17.3 |
| 70 | | LOUNGE | 623 | 26 | 768 | 3.1 | 7.2 |
| 71 | | CONFERENCE | 1348 | 87 | 2491 | 9.7 | 20.4 |
| 72 | | FR 18 (SINGL W X 6) | 719 | 18 | 1113 | 3.7 | 7.6 |
| 73 | | FR 18 (DBL W X 3 ) | 359 | 9 | 811 | 2.4 | 4.3 |
| 74 | | FR 18 (SINGL W X 6) | 719 | 18 | 1074 | 3.6 | 7.6 |
| 75 | | FR 18 (DBL W X 2 ) | 240 | 6 | 535 | 1.6 | 2.9 |
| 76 | | FR 18 (SINGL W X 6) | 719 | 18 | 1586 | 4.7 | 8.6 |
| 77 | | FR 18 (DBL W X 3 ) | 359 | 9 | 795 | 2.4 | 4.4 |
| 78 | | STUDENT LOUNGE | 628 | 13 | 749 | 2.7 | 6.5 |
| 79 | | MOOT COURT | 3035 | 73 | 2904 | 11.5 | 24.2 |
| 80 | | LIBRARY | 1956 | 48 | 2214 | 8.6 | 20.2 |
| 81 | | COMPUTER LAB | 1963 | 53 | 3812 | 13.5 | 28.4 |
| 82 | | FACULTY ROOM LOBBY | 2422 | 32 | 1101 | 5.3 | 13.0 |
| 85 | | LIBRARY | 1956 | 48 | 4160 | 17.3 | 40.4 |
| | | | | | | | |
| 88 | THIRD | MEETING ROOM | 675 | 35 | 1128 | 4.3 | 10.0 |
| 89 | | MEETING ROOM | 675 | 35 | 1128 | 4.3 | 10.0 |
| 90 | | PHD CUBICLES | 623 | 12 | 816 | 2.7 | 6.4 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 91 | FR 18 (SINGL W X 6) | 719 | 18 | 1280 | 4.1 | 9.1 |
| 92 | FR 18 (DBL W X 3 ) | 359 | 9 | 891 | 2.6 | 5.1 |
| 93 | FR 18 (SINGL W X 6) | 719 | 18 | 1276 | 4.0 | 9.1 |
| 94 | FR 18 (DBL W X 2 ) | 239 | 6 | 587 | 1.7 | 3.4 |
| 95 | FR 18 (SINGL W X 7) | 839 | 21 | 2090 | 6.1 | 11.7 |
| 96 | FR 39 | 359 | 9 | 406 | 1.5 | 3.3 |
| 97 | STUDENT LOUNGE | 629 | 17 | 851 | 3.1 | 8.4 |
| 100 | FR (69-74) | 573 | 15 | 661 | 2.5 | 5.3 |
| 101 | FR 84 | 99 | 3 | 175 | 0.6 | 1.2 |
| 102 | FR 85 | 99 | 3 | 198 | 0.6 | 1.3 |
| 103 | FR 68 | 113 | 3 | 240 | 0.7 | 2.0 |
| 104 | FR 67-58 ( X 10 ) | 1012 | 30 | 2136 | 6.5 | 15.4 |
| 105 | FR 57 | 758 | 21 | 1017 | 3.6 | 9.3 |
| 106 | PHD CUBICLES | 959 | 20 | 1397 | 4.7 | 9.6 |
| 107 | CLASSROOM B*2 | 1985 | 140 | 4176 | 18.8 | 57.6 |
| 108 | LANGUAGE LAB | 2048 | 49 | 2893 | 11.4 | 32.0 |
| 109 | MOOT COURT | 3112 | 162 | 6001 | 22.4 | 45.2 |
| 110 | CLASSROOM B | 1012 | 70 | 1970 | 8.8 | 28.7 |
| | | | | | | |
| | | **87109** | | **140391** | **560** | **1532** |

**Total HVAC Load for L&H - 560 TR**
**L&H Load on Central Plant (@75 % diversity) - 420 TR**

**Note:** IT room, Fire Control room, Server room, UPS room and security room are based on DX type air conditioned.

**Table-5 DX Type Load**

| Sr.no | Floor | Area Description | Floor area (Sqft) | No.of Person | Cooling ( TR) | WORKING |
|---|---|---|---|---|---|---|
| 1 | BASEMENT | UPS 1 | 194 | 0 | 1.5 | 1 WORKING + 1 STANDBY |
| 2 | | UPS 2 | 294 | 0 | 1.5 | 1 WORKING + 1 STANDBY |
| 3 | FIRST | FIRE CONTROL ROOM | 171 | 1 | 2 | 1 WORKING + 1 STANDBY |
| 4 | SECOND | IT OFFICE | 282 | 1 | 2 | 1 WORKING |
| 5 | | SERVER ROOM | 310 | 1 | 1.5 | 2 WORKING + 1 STANDBY |
| 6 | | IT OFFICE | 282 | 1 | 2 | 1 WORKING |
| 7 | | SERVER ROOM | 310 | 1 | 1.5 | 2 WORKING + 1 STANDBY |

AHU Zoning of the building is as per the drawings and based on best possible option, efficient option and area application.

- Lecture Hall having its own AHU and under floor air-distribution shall be followed.
- Cafeteria to have its own independent AHUs.
- We are proposing of HRW (Heat Recovery Energy) unit for saving energy and make a building energy efficient. Please see the below mention detailed of fresh air requirement in whole building, zone wise according to drawings.

**HRW (Heat Recovery wheel):**

Heat recovery wheel is used to reduce the cooling load of outside fresh air .The amount of outside air which is required for maintaining the indoor air quality is first passed through a rotating wheel in which enthalpy of dry air is stored. Return air of room(will pass through toilets and pantry through door transfer grille and will be collected in exhaust duct from respective floor) passes through heat recovery wheel where exchange of enthalpy (Hot & cool) takes place and the fresh air supply to indoor unit contains much lower temperature than the outside air. Since outside air supplied to indoor unit is having less amount of enthalpy, so the net cooling load required to bring the outside air temperature to room air temperature is very less. In this way we can save energy consumption and maintain good indoor air quality. Saving of cooling load calculation is as follow:

**Table: Heat recovery energy calculation:**

| | PEAK WINTER | PEAK SUMMER |
|---|---|---|
| **OUTSIDE CONDITION** | | |
| DBT($^0$C) | 12.0 | 43.3 |
| DBT($^0$F) | 53.6 | 109.9 |
| WBT($^0$C) | 9.5 | 24.0 |
| WBT($^0$F) | 49.2 | 75.2 |
| RH (%) | 74 | 19.6 |
| Total Enthalpy(H1) | 19.8 | 38.3 |
| Fresh Air (CFM) | 41800 | 41800 |
| **ROOM CONDITION** | | |
| DBT($^0$C) | 21.0 | 24.0 |
| DBT($^0$F) | 69.8 | 75.2 |
| WBT($^0$C) | 14.5 | 17.1 |
| WBT($^0$F) | 58.1 | 62.8 |
| RH (%) | 50.0 | 50.0 |
| Total Enthalpy(H2) | 25.2 | 28.2 |
| **RETURN AIR CONDITION** | | |
| DBT($^0$C) | 24.0 | 26.0 |
| DBT($^0$F) | 75.2 | 78.8 |
| WBT($^0$C) | 17.0 | 18.7 |
| WBT($^0$F) | 62.6 | 65.7 |
| RH (%) | 50.0 | 50.0 |
| Total Enthalpy(H3) | 28.2 | 30.4 |
| **CONDITION OF FRESH AIR AFTER HRWs** | | |
| DBT($^0$C) | 18.0 | 34.7 |
| DBT($^0$F) | 64.4 | 94.4 |
| WBT($^0$C) | 13.3 | 21.4 |
| WBT($^0$F) | 55.9 | 70.4 |
| RH (%) | 62.0 | 34.8 |
| Total Enthalpy(H4) | 24.0 | 34.4 |

**Total cooling load required to bring down outside air to room condition**

| | | | |
|---|---|---|---|
| **Cooling Load (TR)** | 89.2 | 166.9 | |

**Total cooling load required to bring down outside air to room condition with the use of Heat recovery wheel**

| | | | |
|---|---|---|---|
| **Cooling Load (TR)** | 69.4 | 65.3 | |

**Total Saving in cooling load with the use of HRW unit**

| | | |
|---|---|---|
| **Cooling Load (TR)** | 19.8 | 101.6 |
| **Saving percentage** | **22%** | **61%** |

**Saving in one day operation of building during Summer(considering 9 hours operation in a day) = 101.6 x 9 x 0.65 = 594.36 kwh**

**Saving in one year operation of building during Summer (considering 250 operational days in a year) = 594.36 x 280 = 148590 kwh**

**E. Air Distribution Systems**

Various Options will be explored, evaluated and opted for air distribution and low side system.

- Variable volume air distribution
- Constant volume air distribution system
- Under floor Air Distribution System

Individual spaces will be evaluated for suitability for the above systems. Based on a detailed energy analysis and nature/application of each space, all above systems will be evaluated and the best options based will be applied. For example, Lecture hall to go with under floor Air distribution system, Classrooms, office will have VAV and so on.
Faculty of Law & Humanities building shall be served through central chilled water Plant located at utility building through pump & piping network.

- **Tertiary Pump:**
  Tertiary pump will be provided at later stages of design into the building basement to accommodate the pressure requirements at each AHU. This will be after the calculation of the pump head for the pumps of central plant.
  There shall be provision of 2 tertiary pumps (1 working+ 1 standby). This ensures and maintains the required pressure and Flow of chilled water to meet the Building Cooling load.

- **BTU Metering System**
  Metered chilled water will be provided through each AHU in the complex where in BTU meter will be provided for measuring the AHU chilled water use. This will help to keep a check on energy usage at each space.

- **Under floor air distribution:**
  Under floor Air distribution will be adopted in lecture theatre room at Basement of Faculty of Law & Humanities building. Under floor air distribution systems (UAFD) deliver air flow at a higher temperature than a conventional system and can be very effective like in case of

Lecture room. A duct network shall be set up under the floor and to serve the space with the diffusers. This gives the uniform distribution of air throughout the space and provides a good comfort level.

1. Reduced energy consumption due to stratification.
2. Reduced ductwork due to floor plenums. The system does add to architectural costs as a raised floor system installation in the space is required.
3. Increased number of economizer operation hours to utilize free cooling.

- **Duct Construction and Fire Safety**

All ducts shall be fabricated out of galvanized sheet steel (GSS) as per SMACNA standard for long life and as per fire norms. Motorized smoke dampers shall be installed within supply air ducts and return air ducts at AHU room wall crossings, to prevent spread of smoke / fire to the adjoining areas. Air handling unit fan motor shall also be tripped when smoke is sensed in the conditioned area served by the air handling unit.

- **Fresh Air requirement**

Fresh air requirement for various spaces shall be either mechanically forced or infiltrated.
For labs areas, fresh air dampers are located on AHU room for supplying required fresh air.

**F. MECHANICAL VENTILATION AND SMOKE EVACUATION SYSTEM:**

Mechanical ventilation system is being considered for Utility rooms, Basements, Kitchen/pantry, toilets and other similar areas using combination of centrifugal fans, axial flow fans, propeller fans and inline fans.

1. **Car Parking Extract and Supply:**

Mechanical Ventilation for car parking in basement shall be ducted ventilation as per Revised NBC-2005 designed to permit 6 ACPH for normal ventilation, and 12 ACPH in case of fire. During Normal operation, Exhaust air @ 6 ACPH shall be exhausted through fans in the basement and the fresh air requirement shall be met through the Ramp openings available. To cater to additional 6 ACPH (total 12 ACPH) in case of fire, another set of Tube-axial fans connected with exhaust air riser shall get actuated. During this period, additional supply air fans @6 ACPH shall also supply the fresh air into the basement car parking area (wherever openings are not sufficient for the fresh air).
Basement ventilation fans for normal operation shall be provided with variable frequency drive controlled through CO concentration level within parking area for energy conservation.
As per revised NBC-2005, there are 2 zone considered for parking ventilation in Faculty of Law & Humanities building. Area detail & air quantity required are given in table below.

**Table-6 – Parking Ventilation**

| Space | Area Sq.FT | Height (ft) | ACPH for Exhaust air | ACPH for Fire Mode | Exhaust air CFM in Normal mode | Exhaust CFM Fire Mode | Exhaust Air Fan | Fresh Air Fan @ 50% through fan during Fire |
|---|---|---|---|---|---|---|---|---|
| Car Parking Zone 1 | 23672 | 11.1 | 6 | 6 | 26205 | 26205 | 01#26500 CFM (N) & | 01#26500 CFM |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | 01#26500 CFM (F) | (F) |
| Car Parking Zone 2 | 22219 | 11.1 | 6 | 6 | 24597 | 24597 | 01#24500 CFM (N) & 01#24500 CFM (F) | 01#24500 CFM (F) |

All the basement parking ventilation fans should be fire rated for a minimum of 250 Deg C for a minimum of 2 Hrs. applications. Fan motor shall be Class H type with class O insulation. The fan motor shall have efficiency class IE-3.

2. **Bath, Toilet and Services Exhaust:**
   Bath exhaust fans will be provided in buildings as required removing foul air and maintaining air quality. Toilets, Service room electrical room etc will also have exhaust system installed. Toilet doors shall have an undercut (or an air transfer grill) so that some air from the surrounding spaces shall pass through this undercut /air transfer grill and exhausted out, using duct mounted fans. Toilets are ventilated through the ducting arrangement.

   Propeller, axial and duct mounted inline fan of required CFM and relative pressure serve the space. Approx. CFM for the different areas for various building in Stage-I is as shown in table:

**Table-7 –Ventilation Summary:**

| S.No. | Room Name | Area (SQFT) | ACPH | CFM |
|---|---|---|---|---|
| | **BASEMENT** | | | |
| 1 | SERVICES & UTILITY | 2050 | 20 | 7523 |
| 2 | KICHEN STORAGE | 940 | 20 | 3250 |
| 3 | ELECTRICAL ROOM-1 | 960 | 20 | 3520 |
| 4 | STORE 1 | 306 | 12 | 670 |
| 5 | ELECTRICAL ROOM-2 | 960 | 20 | 3520 |
| 6 | STORE 1 | 360 | 12 | 670 |
| 7 | STORE 2 | 745 | 12 | 1635 |
| | **GROUND** | | | |
| 8 | MALE TOILET-1 | 172 | 10 | 315 |
| 9 | FEMAIL TOILET-1 | 193 | 10 | 354 |
| 10 | HAND. TOILET-1 | 57 | 10 | 105 |
| 11 | MALE TOILET-2 | 172 | 10 | 315 |
| 12 | FEMAIL TOILET-2 | 193 | 10 | 354 |
| 13 | HAND. TOILET-2 | 57 | 10 | 105 |
| 14 | ELECTRICAL ROOM-1 | 269 | 20 | 1076 |
| 15 | ELECTRICAL ROOM-2 | 269 | 20 | 1076 |
| 16 | TOILET-3 | 36 | 10 | 77 |
| 17 | PANTRY -1 | 32 | 20 | 150 |
| 18 | TOILET-4 | 36 | 10 | 77 |
| 19 | PANTRY -2 | 32 | 20 | 150 |
| | **FIRST** | | | |

| | | | | |
|---|---|---|---|---|
| 20 | MALE TOILET-1 | 172 | 10 | 344 |
| 21 | FEMAIL TOILET-1 | 193 | 10 | 386 |
| 22 | HAND. TOILET-1 | 57 | 10 | 114 |
| 23 | MALE TOILET-2 | 172 | 10 | 344 |
| 24 | FEMAIL TOILET-2 | 193 | 10 | 386 |
| 25 | HAND. TOILET-2 | 57 | 10 | 114 |
| 26 | ELECTRICAL ROOM-1 | 269 | 20 | 1076 |
| 27 | ELECTRICAL ROOM-2 | 269 | 20 | 1076 |
| 28 | TOILET-3 | 36 | 10 | 77 |
| 29 | PANTRY -1 | 32 | 20 | 150 |
| 30 | TOILET-4 | 36 | 10 | 77 |
| 31 | PANTRY -2 | 32 | 20 | 150 |
| | **SECOND** | | | |
| 32 | MALE TOILET-1 | 172 | 10 | 344 |
| 33 | FEMAIL TOILET-1 | 193 | 10 | 386 |
| 34 | HAND. TOILET-1 | 57 | 10 | 114 |
| 35 | MALE TOILET-2 | 172 | 10 | 344 |
| 36 | FEMAIL TOILET-2 | 193 | 10 | 386 |
| 37 | HAND. TOILET-2 | 57 | 10 | 114 |
| 38 | ELECTRICAL ROOM-1 | 269 | 20 | 1076 |
| 39 | ELECTRICAL ROOM-2 | 269 | 20 | 1076 |
| 40 | PANTRY -2 | 322 | 20 | 1100 |
| | **THIRD** | | | |
| 41 | MALE TOILET-1 | 172 | 10 | 344 |
| 42 | FEMAIL TOILET-1 | 193 | 10 | 386 |
| 43 | HAND. TOILET-1 | 57 | 10 | 114 |
| 44 | MALE TOILET-2 | 172 | 10 | 344 |
| 45 | FEMAIL TOILET-2 | 193 | 10 | 386 |
| 46 | HAND. TOILET-2 | 57 | 10 | 114 |
| 47 | ELECTRICAL ROOM-1 | 269 | 20 | 1076 |
| 48 | ELECTRICAL ROOM-2 | 269 | 20 | 1076 |
| | **Total** | | | |

3. **Lift Well / Lift Lobby / Staircase Pressurization:**
   Fire escape staircases shall be provided with 50 Pa of Positive Pressurization and Lift well and lift lobby shall be provided with 50/30 Pa of Positive Pressurization arrangement, consisting of supply air fans installed on roof top. The fans shall connect to supply air ducts installed in vertical risers and inject air at each staircase landing, for achieving effective pressurization. Fans shall be sized to maintain minimum positive pressure of 50 Pa across the door. Make up air fans serving stairwell shall be provided with motorized damper at fan discharge to prevent humid fresh air entering into staircase well. These dampers shall be interlocked with fan motor and shall open upon getting signal from the smoke sensor. Lift wells shall also be similarly pressurized by supplying the air through fans installed on roof top.

   ***Refer to Annexure-A, B and C for Lift well, lift lobby & Staircase pressurization**

**G. Brief Description of HVAC Equipments:**

## 1. AIR HANDLING UNITS

The air handling units shall be double skin construction, draw through type comprising of various sections such as mixing box, (the return air and fresh air are ducted), pre-filter section, cooling & heating coil sections, fan section, filters section, Double skinned panels shall be (60mm thick for units for AHUs made of galvanized steel, pressure injected with foam insulation (density 40 KG/ M3 .The entire framework shall be mounted on an aluminum alloy channel base. Panels shall be sealed to framework by heavy duty “O” ring gaskets held captive in the framed extrusion. All panels shall be detachable or hinged. Hinges shall made of die cast aluminum with stainless steel pivots, handles shall be made of hard nylon and be operational from both inside and outside of the unit. Thermal breaks shall be provided in the unit framework to prevent condensation at the panel joints during humid outside conditions. Units shall have hinged, quick opening access door in fan and filter section. Access doors shall be double skin type. Condensate drain pan shall be fabricated from 18 gauge stainless steel sheet with all corners welded. It shall be isolated from bottom floor panel through 25 MM heavy duty urethane foam.

Centrifugal Fans shall be forward/ backward inclined blade type. Fan casing shall be made of galvanized steel sheet. Fan wheels shall be of galvanized steel. Fan wheels and pulleys shall be individually tested and precision balanced dynamically. Fans shall be imported.
Both fan and motor assemblies shall be mounted on a deep section aluminum alloy or galvanized steel base frame. The fan motor shall have efficiency class IE-3 or EFF-1, whichever is more efficient.

## 2. Axial Fans

The fan casing and Motor mounting plates should be manufactured from mild steel. The fan casing and flanges should have a minimum thickness of 3.0mm for fans up to and including 1000mm diameter, with thickness of 5mm for larger diameters. Flanges should be integral with casing and should be provided with bolt holes for connection. The casing assembly, complete with flanges, should be hot dip /spray galvanized after manufacture.
An external terminal box should be provided, as standard, on long case fans. Short case fans will have a terminal box on the motor only.
The pitch angle of the fan should be individually adjustable. The fan should be of the variable pitch angle or controllable pitch angle design. The supplier should be able to provide evidence that the impeller has been adequately stressed for running at the highest speed. The impeller should be balanced to G3.6 or better as defined in ISO 1940/1:1986 (6.3 mm/s peak to peak or 4.5mm/s rms).
The aerodynamic design of the fan should be such that the maximum power required by the fan occurs within the normal working ranges, i.e., it has a non-overloading characteristic.
The fan should be suitable for frequent starting applications and for continuous operation in ambient temperatures ranging from -43°C up to +63°C.
Fan motors should be at the totally enclosed, squirrel cage induction, continuous duty, and variable torque type. Fan motor shall be Class A type with class F class insulation. The fan motor shall have efficiency class IE-3 .

## 3. Centrifugal Fans:

Centrifugal fans shall be of double-width, double-inlet construction, with bearing on both sides, complete with access door, squirrel-cage induction motor, V-belt drive, belt guard etc.
Housing shall be of heavy gauge sheet steel in welded construction. It shall be rigidly reinforced and supported by structural angles. Split casing shall be provided on larger sizes of fans. However neoprene/ asbestos packing shall be provided throughout split joints to make it airtight. 1.2 mm galvanized wire mesh inlet guard, of 5cms sleeves shall be provided on both inlets. Housing shall be provided with access door with quick locking tension handles and neoprene gasket. Rotation arrow shall be clearly marked on the housing.
Fan wheel shall be backward curved non-overloading type unless otherwise specified. Fan wheel and housing shall be statically and dynamically balanced. Fan outlet velocity shall not exceed 610 meters per minute.
Shaft shall be constructed of steel, turned, ground and polished.

Bearings shall be of the sleeve/ball bearing type mounted directly on the fan housing. Bearing shall be self-aligned, oil grease packed, pillow block type.
Drive to fan shall be provided from 3 phase electric motor through belt with adjustable motor sheave and belt guard. Belt shall be of the oil resistant type. The number of belts shall be not less than two. Fan motor shall be Class A type with class F class insulation. The fan motor shall have efficiency class IE-3.

**4. Variable Speed Drives:**

Variable speed drive shall be factory installed on the Electrical panel. It will vary the fan motor speed by controlling the frequency and voltage of the electrical power to the motor. The capacity control logic shall automatically adjust motor speed and capacity control mechanism for maximum real world efficiency by analyzing information fed to it by sensors located either in return air path or potential difference sensors located across the duct. Unit must have less than 5% Total Demand Distortion (TDD) at equipment level.

Field power wiring shall be a single point connection and electrical plugs for incoming power wiring will be provided. All VSD components are designed to last the life of the AHU.

**5. Fire Dampers:**

Motorized fire damper shall be installed with supply & return duct at AHU room wall to prevent spread of smoke fire at adjoining areas dampers shall be robust constructions and tightly fitted. The design, method of handling and control, shall be suitable for the location and service required. Dampers and their operation devices shall be made robust, easily operable, and accessible through suitable access doors in the ducts. Every damper shall have an indicating device clearly showing the damper position at all times.

Fire dampers shall be motorized smoke & fire dampers type. It shall be supplied with spring loaded UL stamped fusible link to close fire damper in the event of rise in duct temperature. Fire damper shall also close on receipt of fire alarm signal to cut off air supply instantaneously. An electric limit switch shall also be operated by the closing of fire damper, which in turn shall switch off power supply to AHU blower motor as well as strip heaters(If installed).

**6. Dampers**

Dampers shall be opposed blade type. Blades shall be made of double skinned aerofoil aluminum/ GI section with integral gasket and assembled within a rigid extruded aluminum alloy frame. All linkages and supporting spindles shall be made of aluminum/GI or nylon, turning in Teflon bushes. Manual dampers shall be provided with a Bakelite knob for locking damper blades in position

**7. Grilles and Diffusers:**

Supply air grilles shall be provided with vertical and horizontal adjustable bars and volume control multi-louver damper which shall be key operated from the front of the grille. All linear diffusers shall be powder coated extruded aluminum. All linear grilles shall be of extruded aluminum.

**8. Insulation:**

Thermal insulation shall be applied to air distribution ductwork and to components within distribution systems such as fans, and cooler casings which convey conditioned air within AHU rooms and to ductwork (including recirculation air ductwork) conveying warmed or chilled air through unconditioned spaces or the open air. Unless otherwise indicated, distribution systems conveying conditioned, warmed or chilled air through conditioned spaces shall not be insulated. Distribution system conveying fresh air. Thermal insulation shall be applied to chilled water pipe work distribution systems and to components within distribution systems such as valves. Where thermal insulation is applied to the outside of piped and ducted services. The vapor barrier shall be applied such that it is continuous and given protection to the whole surface of the insulation which it protects. It shall not be pierced or otherwise damaged by supports or by the application of external cladding. At points of support means of load distribution shall be provided as necessary.

| Space | Insulation Thickness |
|---|---|
| Duct in conditioned Space | 19.00 mm (XLPE) |
| Duct in unconditioned space | 25.0 mm (XLPE) |

**9. Acoustic lining of AHU Rooms:**

Acoustic insulation on walls and ceiling of Air handling unit's rooms with 50mm thick resin bonded fibre glass slabs fixed in frame work and finished with vapor barrier and perforated aluminum sheet two walls and ceiling of air conditioning plant room and air handling unit rooms may be provided with acoustic lining of resin bonded fibre glass. The surface shall be cleaned and frame work of 22 gage GI fabricated Channels 25 mm x 50 mm screwed back to back at 60 cm centre's shall be provided vertically and horizontally so that 60 x 60 cm squares are formed. The gaps between frames shall be filled with 50 mm thick about 60 cm x 60 cm cut panels of resin bonded fiberglass slabs. The entire surface shall then be covered with fiberglass tissue and 26 gage perforated aluminum sheet, 60 cm or 120 cm wide having at least 15 percent perforations, fixed with sheet metal screws. Over-lapping of sheets shall be covered with Aluminum beading. Acoustic lining of walls shall be terminated approximately 15 cm above the finished floor to prevent damage to insulation due to accidental water-logging in plant/AHU rooms.

**10. Acoustic lining over ducts:**

Ducts shall be lined internally with acoustic insulation as detailed below:

- The Inside surface of duct on which the acoustic lining is to be provided shall be clean free from all dust and grease.
- Then 25 x 25 sq.mm section of minimum 1.25 mm thick G.I. sheet shall be fixed on both ends of the duct piece.
- The insulation slabs shall then be fixed between these section of ducts using CPRX adhesive compound and stickpins.
- The insulation shall then be covered with Reinforced plastic/ fiber glass tissue, sealing all joints so that no fiber is visible.
- The insulation shall finally be covered with minimum 0.5 mm thick perforated aluminum sheet having perforations between 20-40%

**11. Filters:**

**i. Pre-filters (fabric type)**

Synthetic fiber Pre-filters shall be in light weight aluminium framed with non woven synthetic fiber replaceable media. The filter shall have an efficiency of 90 percent down to 10 microns particles size when tested as per B.S.2831 standards. The filter frame shall be of aluminium and shall be suitable for mounting in Air handling units or ducts as required at site. The velocity across the face of the filter shall not exceed 500 FPM and the pressure drop across the filter shall not exceed 4mm.

**ii. Microvee filters (fine filters):**

Microvee filters shall be of dry type. Filters media shall be made from washable nonwoven synthetic fibre replaceable media reinforced with HDPE cloth & Aluminum mesh, specially treated with antifungal and bactericidal agents to prevent growth of micro organisms. The filter media shall be treated to permit washing with water several times before discharged. The media shall be properly supported and spaced so that air flow through the filter is uniform. The filter shall be housed in aluminium frame work. Filters shall be designed to remove particle down to 5 micron size and with efficiently of 98.0 percent tested as per BS 2831 using Test Dust II. The filters shall be installed in the air handling units after the chilled water coils. They shall be capable of being replaced or removed for servicing without the use of special tools.

## H. BUILDING MANAGEMENT SYSTEM:

Building automation and control systems would control and monitor system such as air handling units, Tertiary Pumps, Fans in Parking area, Lift and miscellaneous electrical and plumbing points.
A totally direct digital control (DDC) system with electric Actuation control Valve and Damper would be considered.
There would be preference to systems, which support open protocol, i.e., BACNET.

**MONITORING & CONTROLLING POINTS FOR BMS:**

| S. No. | Description |
|---|---|
| | **HVAC SYSTEM**<br>**AIR CONDITIONING SYSTEM** |
| | |
| **A** | **OUTSIDE AIR** |
| | Outside Air Temperature and RH |
| | |
| **B** | **AIR HANDLING UNITS (with RH & Temp Control) (Common areas)** |
| | AHU Blower Status |
| | AHU Manual Operation Status |
| | AHU FAN ON/OFF Status |
| | AHU Motor trip Status |
| | AHU Run Status |
| | AHU Filter Status |
| | AHU Return Air Temperature & RH |
| | AHU modulate Chilled Water Valve |
| | VAV/ VFD |
| | Fresh air Damper control |
| | Fresh air damper Feedback |
| | Supply/Return Fire Damper status |
| | |
| **C** | **VENTILATION FANS/TOILET FANS** |
| **D** | **LIFTS MONITORING** |
| **E** | **ELECTRICAL ENERGY** |
| **F** | **BASEMENT FANS** |
| **G** | **TERTIARY CHILLED WATER PUMP** |
| **H** | **HEAT RECOVERY WHEEL** |

# ANNEXURE A, B and C
# FOR
# FACULTY OF LAW & HUMANITIES PRESSURIZATION CALCULATION

**Annexure – A**

**Pressurization of each Staircase (Basement)**

**1. Leakage path from pressurized staircase are as follows**

a) Door at each mid landing
b) Door on the basement floor

**2. Staircase Description**

a) Total No. of Doors = 5 Nos.
b) Door size = 1.5 m x 2.1 m
c) Area of each door = 3.15 $mt^2$ or 33.9 $ft^2$.

**3. Calculation of air quantity leakage through open staircase door as follows;**

= Area of staircase door ($mt^2$) x Exhaust air velocity of air assumed (m/second) x Nos. of Doors open.

= 3.15 x 1 x 1 = 3.15 $m^3/s$

= (6.3 x 3600) / 1.7

= 6670.5 CFM

**4. Calculation of air quantity leakage through staircase doors and cracks on other floors**

Perimeter of door = 7.2 m

Assume Gap = 2.0 mm =0.002 m

Total No. of leakage door = 2 Nos.

Total leakage area = Perimeter of Door x Gap x No. of Leakage Door

= 7.2 x 0.002 x 2

= 0.0288 $mt^2$

Now, Assume Pressure Difference = 50 Pascal

Now, Air leakage through Staircase door and cracks = 0.827 x leakage area x √PD

= 0.827 x 0.0288 x √50

= 0.169 $m^3/s$

= (0.169 x 3600) / 1.7 CFM

= 357.8 CFM

Accounting for 5 % duct losses = (6670.5 + 357.8) x 1.05

= 7379.7 CFM

**Say 7,500 CFM of free inflow of air for Each Staircase Pressurization @ 25 mm of WG Static pressure.**

**Annexure – B:**

**Pressurization of each Lift Lobby (Basement to 3th Floor)**

**1. Leakage path from pressurized lift lobby are as follows**

a) Door at each mid landing
a) Door on the ground floor

**2. Staircase Description**

a) Total No. of Doors = 5 Nos.
b) Door size = 1.8 x 2.1 mt.
c) Area of each door = 3.78 $mt^2$ or 40.67 $ft^2$.

**3. Calculation of air quantity leakage through open lift lobby door be as follows;**

= Area of lift lobby door ($mt^2$) x Exhaust air velocity of air assumed (m/second) x Nos. of Doors open.

= 3.78 x 1 x 2 = 7.56 $m^3/s$

= (7.56 x 3600) / 1.7

= 16009.4 CFM

**4. Calculation of air quantity leakage through lift lobby doors and cracks on other floors**

Perimeter of door = 7.8 m

Assume Gap = 2.0 mm = 0.002 m
Total No. of leakage door = 5 Nos.
Total leakage area = Perimeter of Door x Gap x No of Leakage Door

= 7.8 x 0.002 x 5

= 0.078 $mt^2$

Now, Assume Pressure Difference = 30 Pascal
Now, Air leakage through lift Lobby door and cracks = 0.827 x leakage area x √PD

= 0.827 x 0.078 x √30

= 0.353 $m^3/s$

=(0.353 x 3600) / 1.7 CFM

**= 747.5 CFM**

Accounting for 5 % duct losses = (16009.4 + 747.5) x 1.05

= 17594.7 CFM

**Say 17600 CFM of free inflow of air for each Lift Lobby @ 25 mm of WG Static pressure.**

**Annexure – C:**

**Pressurization of each Lift Well (Basement to 3th Floor)**

**1. Leakage path from pressurized lift well are as follows**

a) Door at each mid landing

**2. Staircase Description**

a) Total No. of Doors = 5 Nos.
b) Door size = 0.8 m x 2.1 m
c) Area of each door = 1.68 $mt^2$ or 18.08 $ft^2$.

**3. Calculation of air quantity leakage through open lift well door be as follows;**

= **Area of lift lobby door ($mt^2$) x Exhaust air velocity of air assumed (m/second) x Nos. of Doors open.**

= 1.68 x 1 x 1 = 1.68 $m^3/s$

= (1.68 x 3600) / 1.7

= **3558 CFM**

**4. Calculation of air quantity leakage through lift well doors and cracks on other floors**

Perimeter of door = 5.8 m

Assume Gap = 2.0 mm =0.002 m

Total No. of leakage door = 5 Nos.

Total leakage area = Perimeter of Door x Gap x No. of Leakage Door

= 5.8 x 0.002 x 5

= 0.058 $mt^2$

Now, Assume Pressure Difference = 50 Pascal

Now, Air leakage through lift Well door and cracks = 0.827 x leakage area x √PD

=0.827 x 0.058 x √50

= 0.34 $m^3/s$

=(0.34 x 3600) / 1.7 CFM

= **720 CFM**

Accounting for 5 % duct losses = (3558 + 720) x 1.05

= 4491.9 CFM

**Two Lift Well has been combined and fan is selected of 9000 CFM @ 30 mm static pressure of free inflow of air for each Lift Well.**

# 12.23. APPENDIX-VIII - DDR for AC3- FACULTY OF MATHS, PHYSICS AND CHEMISTRY, IT

## 12.23: APPENDIX-VIII (DDR for AC3- FACULTY OF MATHS, PHYSICS AND CHEMISTRY ,IT)

### A. Introduction:

Faculty of Phy-Chem & Maths Building is part of academic block in South Asian University. This building includes Training Lab, Lecture Theatre, Admin office, Meeting Room, Cafeteria, Computer Lab, Conference Room, Student Lounge, Class Room, Repro Center, Labs, Seminar room, Library, Lecture Theatre, PHD Cubicles etc.

Building consists of a basement + Ground + 4 Floors and a total built-up area of 27886sq.mtr.

#### 1. Air Conditioning Objective:

Objective of air conditioning is to provide thermal comfort to all areas for Faculty of Phy-Chem Maths & IT building in an efficient and cost-effective manner round the year. Temperatures and Indoor Air Quality shall be maintained in accordance with parameters as specified in the following sections of Basis of Design.

Faculty of Phy Chem Maths & IT building is served by Central chilled water system. The chilled water flowing through the “MS” pipe with HDPE Jacketing buried underground is connected to branch piping to serve all risers which are connected to all AHU’s and FCU’s.

#### 2. Ventilation Objective :

Objective of Mechanical Ventilation is to provide fresh air and vent out exhaust air to maintain indoor air quality and to have an escape route in case of fire. Mechanical ventilation system is being considered for Utility rooms, Basements, Kitchen/pantry, toilets and other similar areas using combination of centrifugal fans, axial flow fans, propeller fans and inline fans.

### B. General Building HVAC Design Criteria and Assumptions

This section of the report documents specific numbers used in the design of the Faculty of Phy Chem Maths & IT building. These assumptions are an essential part of making the transition from the project intent to installed equipment. Also the codes and guidelines for the designer and contractor which are to be followed during the different stages of project are outlined.

#### 1. CODES & STANDARDS:

The applicable Standards/Codes are:

(a) American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE).
- a.1 ASHRAE - 55
- a.2 ASHRAE - 90.1
- a.3 ASHRAE - 62.1
- a.4 ASHRAE - Fundamentals
- a.5 ASHRAE - HVAC Application
- a.6 ASHRAE - HVAC System & Equipment
- a.7 ASHRAE - Refrigeration

(b) Energy Conservation Building Code (ECBC)
(c) Duct construction standards as per relevant BIS Codes & SMACNA standards
(d) National Buildings Code-2005
(e) Air Filter as per ASHRAE-52.1 and 52.2
(f) National Electric code
(g) National Fire Protection code
(h) ISHRAE Standards
(i) GRIHA Manual
(j) IMC-2009

The following IS codes shall be applicable:

| S. No. | Material/item of Work | Standard/Code |
|---|---|---|
| 1. | Ducting Fabrication | IS: 655 |
| 2. | Galvanized Sheets/Wires | IS: 277 |
| 3. | Aluminum Sheets/Wires | IS: 737 |
| 4. | Horizontal Centrifugal Pumps | IS: 6595 |
| 5. | Mild Steel, ERW Pipes | IS: 1239, IS: 3589 |
| 6. | Pipe Fittings | IS: 1239 |
| 7. | Steel Pipe Flanges | IS: 6392 |
| 8. | Gate, Globe & Check Valves | |
| | • Up to 40 mm Gun metal | IS:778 |
| | • Butterfly valve of 50 mm and Above (Cast Iron) | IS:2906 |
| | • Balancing valve | IS:778 |
| | • Non Return valve | IS:5312 |
| 9. | Color Code for Identifications of pipes | IS: 2379 |
| 10. | 3 Phase induction motors | IS: 325 |
| 11. | Pressure and vacuum gauges | IS: 3624 |
| 12. | PVC insulated electric cables | IS: 1554 |
| 13. | Starters sheets/wires | IS: 8555 |
| 14. | Glossary of terms used in refrigeration and Air-conditioning | IS: 3615 |
| 15. | Hot die zinc coated steel pipes | IS: 4736-1968 |
| 16. | Expanded Polystyrene | IS: 4671 |

**Safety codes**

The following safety codes as laid down by ISI shall be followed:

| | | |
|---|---|---|
| 1. | Safety code for mechanical refrigeration | IS : 660 |
| 2. | Safety code for air-conditioning | IS : 659 |
| 3. | Safety code for scaffolding and ladders | IS : 3696 |
| 4. | Code for practice for safety and health Requirements in electrical and gas Welding & cutting operations | IS: 818 |
| 5. | Recommendations of safety procedures and Practices In electrical works | IS: 5216 |

NOTE:- All the codes and standards are applicable only with the latest amendments only.

**<u>Green building/GRIHA features :</u>**

a) South Asian campus is targeting to be a GRIHA five star rated campus.
b) High efficient equipment will be used for HVAC system. Selection of High efficient fans for AHU and Ventilation system.
c) Variable speed drive shall be used on selected AHU and large ventilation fans.
d) Variable air volume system shall be used for selected areas as per the application.
e) Car parking exhaust system shall be equipped with CO sensors so that exhaust fans are operated as per permitted CO concentration levels.
f) Heat recovery wheels for pre-cooling OA by using the waster exhaust air wherever possible to lower down the fresh air load. This ensures reduced energy consumption despite higher fresh air intake.
g) Cooling tower selection for minimum drift and noise level; energy efficient motors, VFD for motor speed control.

## 2. LOCATION:

- Site Location : New Delhi
- Geographic Location : 28.38°N, 77.13°E
- Altitude : 216 m above mean sea level

### a) Design Conditions and Assumptions:

The summer design condition is based on ISHRAE weather data and statistics of the most recent data of 10 year period, published by the India Metrological Department and *.epw* weather data files from the *DOE*.

The year round temperatures and climatic conditions is as below and system is evaluated for 8760 hours.

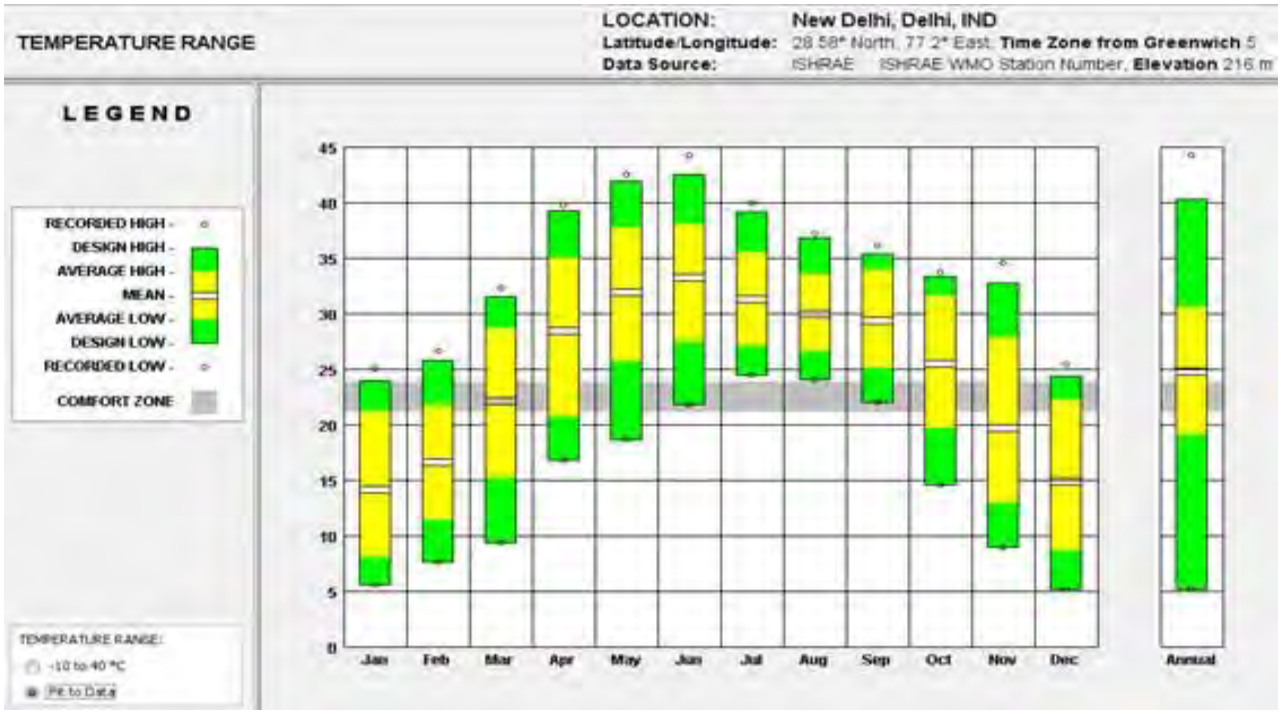



**Table-1 Design Assumptions**

| Description | Value (units) |
|---|---|
| Latitude/Longitude | 28.38°N, 77.13°E |
| Sea level | 216 m |
| Clearness number | 0.95 |
| Summer outdoor air DB/WB temperature | 43.3°C (109.94 °F) /23.89 (75.02 °F) |
| Winter outdoor air DB/WB temperature | 7.2°C (44.96 °F) / 5.0°C(41.0°F) |
| Monsoon outdoor air DB/WB temperature | 35°C (95.0°F)/ 28.3°C (83°F) |
| Ground reflectance | 0.20 |
| Roof U-value | 0.079 Btu/h. ft².°F |
| Overall Wall U-value | 0.1179 Btu/h. ft².°F |
| Glass U-value (summer/winter) | 0.31 Btu/h. ft².°F |
| Glass shading coefficient | 0.58 |
| Infiltration /Ex-filtration | As per ASHRAE 90.1 |

| | |
|---|---|
| Building system peak cooling load (day/month) | 17 / 6 |
| Cooling load design calculation program | CLTD, Trane Trace 700 |
| Winter Heat load design calculation program | UATD, Trane Trace 700 |
| Ductwork sizing program | Trane Ductulator |
| Cooling Safety factor/Heating Safety Factor | 10% |
| Fan heat gain safety factor | 5% |
| Diversity | 75% Overall on chiller plant |
| Typical Hours of Operation | As directed by SAU |

**b) Inside Design Conditions:**

Table below shows Room Ambient Temperature and Humidity Design Criteria for Faculty of Physic &Maths buildings. The set points are considered on the basis of ASHRAE -55 Clause 5, Thermal Comfort charts and after discussion with SAU.

**Table-2- Inside Set Points conditions:**

| | **Inside conditions** | | | |
|---|---|---|---|---|
| | **Summer** | | **Winter** | |
| **Spaces** | **Temp.** | **Humidity** | **Temp.** | **Humidity** |
| CENTRAL INSTRUMATION ROOM | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| CLASS ROOM | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| TRAINING LAB | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| LECTURE THEATRE | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| CAFETERIA | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| DEANS OFFICE | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| MEETING ROOM | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| CONFERENCE ROOM | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| LIBRARY | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| LOUNGE | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| FACULTY ROOM | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| INSTRUMENT ROOM | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| LABS | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| COMPUTER LAB | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| PHD CUBICLES | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| LOUNGE | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| SEMINAR ROOM | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| FR office | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |

**3. Acoustic Criteria:**

Air-conditioning systems will be designed to maintain the following noise criteria (NC) level in various spaces as per NBC - 2005 - PART 8 Building Services Section 4, Acoustics, Sound Insulation and Noise Control.

- Lecture Hall : NC 40-45
- Classrooms : NC 40-45
- Seminar Room : NC 40-45
- Office Space : NC 35-40
- Faculty Room : NC 35-40

- Cafeteria : NC 50-55
- Computer rooms : NC 45-50
- Laboratories : NC 40-45
- Library : NC 35-40.
- Central Instrumentation room : NC 35-40

**4. Fresh Air:**

Adequate fresh air quantity shall be provided to air-conditioned spaces to maintain indoor air quality (IAQ) generally as per ASHRAE standard 62.1-2007.

- 10.0 CFM/person + 0.18 CFM/Sq.ft. for Training Lab
- 7.5 CFM/person + 0.06 CFM/Sq.ft. for Class rooms
- 7.5 CFM/person + 0.06 CFM/Sq.ft. for Lecture theater
- 10 CFM/person + 0.18 CFM/Sq.ft. for Computer Labs
- 10 CFM/person + 0.12 CFM/Sq.ft. for Labs
- 10 CFM /person + 0.12 CFM/Sq.ft. for Central Instrument Room
- 5 CFM /person + 0.06 CFM/Sq.ft. for Admin office
- 7.5 CFM/Person + 0.18 CFM/Sq.ft for Cafeteria
- 5 CFM/Person + 0.06 CFM/Sq.ft for Meeting rooms
- 5 CFM/Person + 0.06 CFM/Sq.ft for conference room
- 5 CFM/Person + 0.12 CFM/Sq.ft for Library

**5. Lighting Load:**

Following is the assumptions made for the purpose of considering lighting load and will be according to the electrical lighting design. ASHRAE 90.1-2007 will be used for any assumptions.

- 1.4 W/Sq.ft for Training Lab.
- 1.4 W/Sq.ft for classrooms.
- 1.4 W/Sq.ft for Lecture Theater.
- 1.4 W/Sq.ft for computer labs.
- 1.4 W/Sq.ft for lab areas.
- 1.4 W/Sq.ft for Central Instrument Room
- 1.1 W/Sq.ft for Admin office
- 1.3 W/Sq.ft for Cafeteria
- 1.4 W/Sq.ft for Meeting rooms
- 1.3 W/Sq.ft for Conference room
- 1.4 W/Sq.ft for Library

**6. Equipment Loads**

Following is the assumptions made for the purpose of considering Equipment load and will be according to the ASHRAE Fundamentals-2005, chapter 30 & electrical design/equipment used.

- 1.0 W/Sq.ft for Training Lab.
- 0.25 W/Sq.ft for classrooms.
- 0.25 W/Sq.ft for Lecture Theater.
- 3.0 W/Sq.ft for computer labs.
- 9 W/Sq.ft for for Central Instrument Room
- 1.1 W/Sq.ft for Admin office
- 0.8 W/Sq.ft for Cafeteria
- 0.6 W/Sq.ft for Meeting rooms
- 0.5 W/Sq.ft for Library

**7. Occupancy**

Occupancy as per furniture layout of rooms as mentioned on the architectural plans.
For areas where capacity is not mentioned, it is assumed as per NBC-Part-8, Building Services, and Section-3, Table 4 or ASHRAE 62.1-2007 table 6-1.

**8. Mechanical Ventilation System:**

The following areas shall be provided with dedicated ventilation system according to NBC-2005 standards, clause No. 5.2.2.1with the number of air changes per hour for each space as identified herewith:

| | | | |
|---|---|---|---|
| a) | Toilets | : | 10 ACPH |
| b) | Car Parking | : | 6 (Normal Mode)/ 12 (Fire Mode) ACPH Exhaust & 6 (Normal Mode)/12 (Fire Mode) ACPH Fresh Air |
| c) | Kitchen | : | 20 ACPH |
| d) | Electrical Room | : | 20 ACPH |

**9. Relative Pressure:**

- Central Instrumentation Lab : Positive Inside pressure
- Toilet Rooms : Negative inside pressure
- Lift well : 50 Pa Positive Pressure
- Closed Staircase : 50 Pa Positive Pressure
- Lift lobby Pressurization : 30 Pa Positive Pressure
- All other areas : As per codes and standards

## C. Mechanical System Design Parameters & Philosophy:

This section describes the assumptions, parameters considered for sizing and designing of various Mechanical equipments and its components. Below is the detailed description.

- Faculty of Phy Chem Maths & IT building shall be served by the central chilled water plant & Boiler located in utility building.
- Chilled water network buried shall supply required chilled water to the building.

**1. Air Handling Units:**

- Unit shall be provided with filter, cooling coil & fan to serve the specific premises.
- During summer season, supply & return temperature of chilled water is considered are 44° F & 56° F.
- During winter season, supply & return temperature of water considered are 130° F & 110° F.
- Air Distribution to the rooms shall be provided with supply air duct with suitable terminals and return air through return air duct or plenum, as applicable.
- All duct subjected to temperature below dew point shall be insulted with XLPE with thermal conductivity of 0.037 W/m-k at 20°C mean temperature.
- Fan motor shall be Class A type with class F insulation. The fan motor shall have efficiency class IE-3.

**2. Piping:**

- Hydronic Piping material for chilled/Heating water supply and return shall be of Heavy class Black steel (MS- Class C) Pipes. Piping up to and including 150 mm diameter shall be of heavy class black steel confirming to IS:1239 and piping greater than 150 mm shall be minimum 6 mm thick black steel confirming to IS:3589.

- Hydronic piping shall be insulated with closed cell elastomer with maximum thermal conductivity of 0.038 W/m-k at 38° C, when tested in accordance with EN- ISO 8947.
- Chilled water piping insulation thickness shall be 25 mm thick for 40 mm pipe and smaller, 40 mm thick for 50 mm to 150 mm pipe and 75 mm thick for pipe greater than 150 mm.
- Drain from the all the air-conditioning equipment shall be collected by GI drain pipe insulated with 9 mm thick closed cell elastomer material and connected to nearest drain point.

All chilled water pipes shall be mild steel Class 'C' (heavy duty) conforming to relevant BIS codes. All jointing in the pipe system shall be by welding. Various type of valves such as butterfly valves, balancing valves and non return valves shall be provided in water lines.

Condensate drain piping would be GI 'B' Class conforming to relevant BIS codes.

**PIPING SHALL BE SIZED FOR THE FOLLOWING DESIGN PARAMETERS**

Pipes shall be sized to provide maximum water velocities as follows:

| **Pipe Sizes** | **Maximum Velocity** |
|---|---|
| Up to 50mm | 0.6 m/sec |
| 65 to 100mm | 0.8 m/sec |
| 125 to 200mm | 1.5 m/sec |
| 250 to 300mm | 2.5 m/sec |
| 355mm and up | 3.0m/sec |

3. **Filtration:**

Re-circulated air (mixed 0utdoor & return air) at Air handling unit : Washable synthetic type air filter having 90% efficiency down to 10 micron MERV 8 and filter having 99% efficiency down to 3 microns MERV 13)

Re-circulated air (mixed Outdoor & return air) at Ventilation units : Washable synthetic type air filter having 90% efficiency down to 10 microns (MERV)

4.
5.
6. **Duct Design Criteria:**

The following maximum duct design velocities will be used in the design of ductwork systems. Where a range is indicated, it is intended to represent velocities over a range of flow volume.

**Table-3**

| | **Meters/Second** |
|---|---|
| Low Pressure Systems | |
| - Main Duct | 7.5 |
| - Primary Branch | 5.0 |
| - Secondary Branch | 2.0-3.5 |
| Plenum | 5.0-6.0 |
| Medium Pressure Systems | 12.0 |
| Cooling Coils | 2.5 |
| Heating Coil | 4.0 |
| Filters | 2.5 |

The following maximum friction losses are to be used in conjunction with the velocities noted above.

| | **Pascal's/meter** |
|---|---|
| Low pressure systems | 1.0 |
| Medium pressure systems | 3.3 |

**7. Ventilation Fan Design Criteria:**

- Maximum fan outlet velocity for fan upto 450 mm dia : 9.14m/s(1800FPM)
- Maximum fan outlet velocity for fan above 450 mm dia : 12m/s (2400 FPM)
- Maximum fan speed for fan upto 450 mm : 1440 RPM
- Maximum fan speed for fan above 450 mm : 1100 RPM

Note: Ventilation fans can be either axial type or centrifugal type.

**8. Diffuser and Grill Design Criteria:**

- All air outlets and intakes shall be made of extruded aluminum sections &shall present a neat appearance and shall be rigid with mechanical joints.
- Square and rectangular wall outlets shall have a flanged frame with the outside edges returned or curved 5 to 7 mm and fitted with a suitable flexible gasket between the concealed face of the flanges and the finished wall face. The core of supply air register shall have adjustable front louvers parallel to the longer side to give upto 22.5 degrees vertical deflection and adjustable back louvers parallel to the shorter side to achieve a horizontal spread air pattern to at least 45 degrees. Return air grilles shall have only front louvers. The outer framework of the grilles shall be made of not less than 1.6 mm thick aluminum sheet. The louvers shall be of aero foil design of extruded aluminum section with minimum thickness of 0.8mm at front and shall be made of 0.8mm thick aluminum sheet. Louvers may be spaced 18 mm apart.
- Square and rectangular ceiling outlets/intakes shall have a flange flush with the ceiling into which it is fitted or shall be of anti-smudge type. The outlets shall comprise an outer shell with duct collar and removable diffusing assembly. These shall be suitable for discharge in one or more directions as required. The outer shell shall not be less than 1.6 mm thick extruded section aluminum sheet. The diffuser assembly shall not be less than 0.80 mm thick extruded aluminum section.
- Circular ceiling outlets/intakes shall have either flush or anti smudge outer cone as specified in the tender specifications. Flush outer cones shall have the lower edge of the cone not more than 5 mm below the underside of the finished ceiling into which it is fitted. Anti-smudge cones shall have the outer cone profile designed to reduce dirt deposit on the ceiling adjacent to the air outlet. The metal sheet used for construction of these shall be minimum 1.6 mm thick extruded aluminum sheet.
- Linear diffusers shall have a flanged frame with the outside edges returned 3.5 mm and shall have one to four slots as required. The air quantity through each slot shall be adjustable. The metal sheet used for the construction of these shall be minimum 1.6 mm thick extruded aluminum sheet.
- Grilles and diffusers constructed of extruded aluminum sections shall have grille bars set straight, or deflected as required. These shall be assembled by mechanical interlocking of components to prevent distortion. These grilles and diffusers shall have a rear set of adjustable blades, perpendicular to the face blades for deflection purposes.
- All supply air outlets shall be fitted with a VOLUME CONTROL DEVICE, made of extruded aluminum gate section. The blades of the device shall be mill finish/ block shade pivoted on nylon brushes to avoid rusting & rattling noise, which shall be located immediately behind the outlet and shall be fully adjustable from within the occupied

space without removing any access panel. The volume control device for circular cutlets shall be opposed blade radial/shutter type dampers, or two or more butterfly dampers in conjunction with equalizing grid. Opposed blade dampers shall be used for square and rectangular ceiling/ wall outlets and intakes.

**D. Building Cooling and Heating Requirements:**

This section of the report describes the Cooling (TR) and Heating (MBH) requirement for the various spaces of the buildings. Table below shows the building wise preliminary requirements with Heat Recovery Wheel advantages:

**Table-4 Building Heating and cooling Requirements:**

| Sr.no | Floor | Area Description | Floor area (Sqft) | No.of Person | Cooling ( TR) | Dehumified (CFM) | Heating (MBH) |
|---|---|---|---|---|---|---|---|
| 1 | | CENTRAL INSTRUMENTATION | 4074 | 40.7 | 27.00 | 6890 | 120.0 |
| | | | | | | | |
| 2 | GROUND | TRAINING LAB X 2 | 3035 | 86 | 21.4 | 4055 | 50.8 |
| 3 | | LECTURE THEATRE | 3034 | 211 | 24.1 | 6679 | 70.8 |
| 4 | | CLASSROOM X 2 | 2024 | 160 | 12.8 | 3131 | 44.4 |
| 5 | | DEAN OFFICE | 502 | 15 | 2.8 | 923 | 6.4 |
| 6 | | ADMIN OFFICEX 2 | 1676 | 32 | 6.3 | 2049 | 14.0 |
| 7 | | MEETING ROOM x 2 | 1427 | 70 | 8.5 | 2739 | 18.4 |
| 8 | | CAFETERIA | 2403 | 76 | 9.6 | 3000 | 46.5 |
| 9 | | COMPUTER LAB | 2024 | 63 | 16.7 | 3401 | 35.3 |
| 10 | | COMPUTER LAB | 1012 | 40 | 10.1 | 2100 | 20.0 |
| 11 | | DEAN OFFICE | 502 | 15 | 2.8 | 933 | 6.4 |
| 12 | | CLASSROOM | 1012 | 80 | 6.7 | 1810 | 22.4 |
| 13 | | CLASSROOM X 2 | 2024 | 160 | 13.1 | 3379 | 44.4 |
| 14 | | CLASSROOM | 1012 | 80 | 6.5 | 1625 | 22.4 |
| | | | | | | | |
| 15 | FIRST | LAB 1& 3 | 2009 | 64 | 13.8 | 2219 | 34.6 |
| 16 | | LAB 2 | 2009 | 64 | 7.1 | 1170 | 34.9 |
| 17 | | SECRETARY & ADMIN OFFICE | 366 | 7 | 1.4 | 431 | 3.2 |
| 18 | | HOD 5 | 328 | 4 | 1.6 | 591 | 3.7 |
| 19 | | CONFERENCE SEMINAR RM | 843 | 34 | 4.6 | 1486 | 9.6 |
| 20 | | CONFERENCE SEMINAR RM | 984 | 32 | 4.5 | 1451 | 10.4 |
| 21 | | CLASSROOM X 2 No. | 3821 | 240 | 25.8 | 7223 | 71.8 |
| 22 | | COMPUTER LAB 1 | 2011 | 63 | 16.4 | 3305 | 34.6 |
| 23 | | COMPUTER LAB 2 | 934 | 32 | 5.2 | 1603 | 11.3 |
| 24 | | FR OFFICE X 9 No. | 974 | 27 | 5.3 | 1748 | 11.4 |
| 25 | | HOD 1 | 352 | 8 | 1.8 | 626 | 4.2 |
| 26 | | HOD2 | 343 | 8 | 1.7 | 592 | 3.5 |
| 27 | | HOD 3 | 343 | 8 | 1.7 | 592 | 3.5 |
| 28 | | HOD 4 | 333 | 8 | 2.0 | 703 | 4.4 |
| 29 | | SEC ADMIN OFFICE | 1488 | 22 | 3.4 | 930 | 8.9 |
| 30 | | TRAINING LAB X 2 No. | 3035 | 86 | 21.2 | 3948 | 50.0 |
| 31 | | CLASSRM A1 X 3 | 1526 | 120 | 10.3 | 2632 | 34.1 |
| 32 | | CLASSRM A1 X 1 | 1526 | 120 | 6.5 | 1002 | 37.0 |
| | | | | | | | |
| 33 | | FR OFFICE27 | 108 | 3 | 0.46 | 150 | 1.1 |
| 34 | | FR OFFICE 28-34 X 7 NO. | 757 | 21 | 6.02 | 1545 | 9.7 |
| 35 | | FACULTY LOBBY 2 | 2266 | 32 | 6.00 | 1681 | 17.5 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 36 | | FR OFFICE 19-26 X 8 NO. | 882 | 24 | 4.67 | 1539 | 10.1 |
| 37 | | LAB B 7 | 934 | 32 | 6.79 | 1165 | 16.9 |
| 38 | | LAB B 8 | 1010 | 33 | 7.49 | 1424 | 18.0 |
| 39 | | LAB B9 | 1776 | 64 | 14.29 | 2643 | 35.4 |
| 40 | | COMPUTER LAB | 918 | 28 | 8.38 | 1874 | 15.9 |
| 41 | | LIBRARY | 1908 | 104 | 11.87 | 3090 | 31.2 |
| 42 | | MEETING ROOM | 1017 | 32 | 4.67 | 1512 | 9.8 |
| 43 | | CLASSROOM RM | 918 | 60 | 6.09 | 1652 | 17.6 |
| 44 | | CONFERANCE/SEMINAR 1 | 949 | 27 | 4.04 | 1228 | 10.2 |
| 45 | | CONFERANCE/SEMINAR 2 | 1009 | 27 | 4.15 | 1346 | 9.0 |
| 46 | | PHD CUBICAL | 1776 | 30 | 10.55 | 2312 | 25.8 |
| 47 | | STUDENT LOUNGE LEFT | 628 | 15 | 2.68 | 949 | 6.7 |
| 48 | | STUDENT LOUNGE RIGHT | 628 | 15 | 2.75 | 916 | 6.7 |
| 49 | | COMPUTER LAB | 1000 | 35 | 9.51 | 2028 | 18.5 |
| 50 | | CLASSROOM | 1908 | 120 | 11.61 | 3076 | 35.3 |
| 51 | | LAB A4 | 1005 | 32 | 6.97 | 1136 | 17.4 |
| 52 | | LAB A5 | 974 | 32 | 7.11 | 1212 | 17.4 |
| 53 | | LAB A6 | 930 | 32 | 6.49 | 988 | 16.4 |
| 54 | | COMPUTER LAB 1 | 2024 | 61 | 16.96 | 3725 | 34.1 |
| 55 | | COMPUTER LAB 2 | 926 | 28 | 7.46 | 1491 | 15.2 |
| 56 | | FR 10-18 X 9 NO. | 958 | 27 | 5.32 | 1992 | 11.2 |
| 57 | | CLASSROOM A1 | 507 | 40 | 3.56 | 924 | 11.4 |
| 58 | | CLASSROOM A1 X 3 NO. | 1406 | 120 | 11.06 | 2942 | 34.3 |
| | | | | | | | |
| 59 | THIRD | COMPUTER LAB | 1959 | 63 | 19.47 | 4496 | 38.8 |
| 60 | | SEMINAR ROOM | 628 | 18 | 3.26 | 1124 | 8.4 |
| 61 | | SEMINAR ROOM | 628 | 18 | 3.38 | 1158 | 8.4 |
| 62 | | FR OFFICE 52 | 108 | 3 | 0.46 | 150 | 1.1 |
| 63 | | FR OFFICE 53-59 X 7 NO. | 757 | 21 | 6.02 | 1450 | 9.7 |
| 64 | | FACULTY LOBBY 2 | 2266 | 32 | 5.55 | 1511 | 17.5 |
| 65 | | FR OFFICE 44-51 X 8 NO. | 882 | 24 | 4.67 | 1539 | 10.1 |
| 66 | | LAB A 13 | 934 | 32 | 6.79 | 1165 | 16.9 |
| 67 | | LAB A 14 | 1010 | 33 | 7.49 | 1424 | 18.0 |
| 68 | | LAB B15 | 1776 | 64 | 14.29 | 2643 | 35.4 |
| 69 | | COMPUTER LAB | 918 | 28 | 9.13 | 2169 | 17.8 |
| 70 | | COMPUTER LAB | 1000 | 35 | 10.21 | 2298 | 20.5 |
| 71 | | LIBRARYX 2 NO. | 3816 | 208 | 26.19 | 7116 | 70.2 |
| 72 | | CONFERANCE/SEMINAR 1 | 949 | 27 | 3.69 | 1158 | 8.5 |
| 73 | | CONFERANCE/SEMINAR 2 | 1009 | 27 | 4.15 | 1346 | 9.0 |
| 74 | | PHD CUBICAL | 1776 | 30 | 10.55 | 2312 | 25.8 |
| 75 | | LAB A10 | 1005 | 32 | 6.97 | 1136 | 17.4 |
| 76 | | LAB A11 | 974 | 32 | 7.11 | 1212 | 17.4 |
| 77 | | LAB A12 | 930 | 56 | 6.28 | 1140 | 24.9 |
| 78 | | COMPUTER LAB 1 | 2024 | 56 | 16.14 | 3575 | 32.7 |
| 79 | | COMPUTER LAB 2 | 926 | 28 | 7.46 | 1491 | 15.2 |
| 80 | | FR 35-43 X 9 NO. | 958 | 27 | 5.32 | 1522 | 11.2 |
| 81 | | CLASSROOM A1 | 507 | 40 | 3.64 | 955 | 11.4 |
| 82 | | CLASSROOM A1 X 3 | 1406 | 120 | 11.06 | 2942 | 34.3 |
| | | | | | | | |
| 83 | FOURTH | FR OFFICE 68 | 108 | 3 | 0.51 | 166 | 1.3 |
| 84 | | FR OFFICE 69-75 X 7 No. | 757 | 21 | 6.18 | 1514 | 11.3 |
| 85 | | FACULTY LOBBY 2 | 2266 | 32 | 7.70 | 2369 | 22.2 |
| 86 | | FR OFFICE 60-67 X 8 NO. | 882 | 24 | 4.93 | 1651 | 11.9 |
| 87 | | LAB A17 | 1005 | 32 | 7.79 | 1424 | 19.5 |
| 88 | | LAB A18 | 974 | 32 | 7.83 | 1470 | 19.4 |
| 89 | | LAB A19 | 930 | 32 | 7.32 | 1282 | 18.3 |
| 90 | | LIBRARY | 2024 | 98 | 13.45 | 3722 | 35.1 |
| 91 | | COMPUTER LAB | 2019 | 43 | 11.34 | 1838 | 26.1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 92 | | LAB A 20 | 934 | 32 | 7.66 | 1455 | 18.8 |
| 93 | | LAB A 21 | 1010 | 33 | 8.40 | 1723 | 20.1 |
| 94 | | LAB B22 | 1776 | 64 | 15.86 | 3196 | 39.1 |
| | | | | | | | |
| TOTAL | | | 121931 | | 788 | 188347 | 2071 |

**Total HVAC Load for FACULTY OF PHY-CHEM & MATHS - 788 TR**
**FACULTY OF PHY CHEM MATHS & IT Load on Central Plant (@75 % diversity) - 591 TR**

**Note:** IT Room, Fire Control Room and Security room are based on DX type air conditioned.

**Table-5 DX Type Load:-**

| SR.NO | DESCRIPTION | AREA (Sq. ft.) | TR | OPERATION |
|---|---|---|---|---|
| 1 | UPS 1 | 347 | 2.00 | 2 WORKING + 1 STANDBY |
| 2 | UPS 2 | 347 | 2.00 | 2 WORKING + 1 STANDBY |
| 3 | IT OFFICE LEFT | 309 | 2.00 | 2 WORKING + 1 STANDBY |
| 4 | IT OFFICE RIGHT | 309 | 2.00 | 2 WORKING + 1 STANDBY |
| 5 | LV ROOM 1 | 46 | 1.00 | 1 WORKING |
| 6 | LV ROOM 2 | 46 | 1.00 | 1 WORKING |
| 7 | IT OFFICE LEFT | 309 | 2.00 | 1 WORKING + 1 STANDBY |
| 8 | IT OFFICE RIGHT | 309 | 2.00 | 1 WORKING + 1 STANDBY |
| 9 | SERVER ROOM LEFT | 296 | 2.00 | 1 WORKING + 1 STANDBY |
| 10 | SERVER ROOM LEFT | 296 | 2.00 | 1 WORKING + 1 STANDBY |
| 11 | LV ROOM 1 | 46 | 1.00 | 1 WORKING |
| 12 | LV ROOM 2 | 46 | 1.00 | 1 WORKING |
| 13 | LV ROOM 1 | 46 | 1.00 | 1 WORKING |
| 14 | LV ROOM 2 | 46 | 1.00 | 1 WORKING |
| 15 | LV ROOM 1 | 46 | 1.00 | 1 WORKING |
| 16 | LV ROOM 2 | 46 | 1.00 | 1 WORKING |
| 17 | FIRE CONTROL ROOM | 312 | 1.5 | 1 WORKING + 1 STANDBY |
| 18 | FIRE CONTROL ROOM | 312 | 1.5 | 1 WORKING + 1 STANDBY |

AHU Zoning of the building is as shown in the drawings and based on best possible option, efficient option and area application.

- Lecture Hall having its own AHU and under floor air-distribution shall be followed.
- Cafeteria to have its own independent AHUs.
- We are proposing of HRW (Heat Recovery Energy) unit for saving energy and make a building energy efficient. Please see the below mention detailedof fresh air requirement in whole building,zone wise according to drawings.

| ZONE -1 | | | ZONE -2 | | ZONE -3 | | ZONE -4 | |
|---|---|---|---|---|---|---|---|---|
| **FLOOR NAME** | **EQUIP. TAG** | **FRESH AIR (CFM)** | **EQUIP. TAG** | **FRESH AIR (CFM)** | **EQUIP. TAG** | **FRESH AIR (CFM)** | **EQUIP. TAG** | **FRESH AIR (CFM)** |
| GROUND | AHU-01-01 | 3720 | AHU-00-02 | 1695 | AHU-01-03 | 2300 | AHU-01-04 | 4110 |
| FIRST | AHU-02-01 | 3410 | AHU-02-02 | 2900 | - | - | AHU-02-03 | 3945 |
| SECOND | AHU-03-01 | 3420 | AHU-03-02 | 2600 | AHU-03-03 | 1800 | AHU-03-04 | 1550 |
| THIRD | AHU-04-01 | 3420 | AHU-04-02 | 1800 | AHU-04-03 | 1800 | AHU-04-04 | 1700 |
| FOURTH | AHU-05-01- | 3660 | - | - | - | - | AHU-05-02 | 1800 |
| Total Fresh Air | | 17630 | Total Fresh Air | 8995 | Total Fresh Air | 3600 | Total Fresh Air | 13105 |
| **Grand Total of Fresh Air of All Zones:- 43330 CFM** | | | | | | | | |

**HRW (Heat Recovery wheel):**

Heat recovery wheel is used to reduce the cooling load of outside fresh air .The amount of outside air which is required for maintaining the indoor air quality is first passed through a rotating wheel in which enthalpy of dry air is stored. Return air of room(will pass through toilets and pantry through door transfer grille and will be collected in exhaust duct from respective floor) passes through heat recovery wheel where exchange of enthalpy (Hot & cool) takes place and the fresh air supply to indoor unit contains much lower temperature than the outside air. Since outside air supplied to indoor unit is having less amount of enthalpy, so the net cooling load required to bring the outside air temperature to room air temperature is very less. In this way we can save energy consumption and maintain good indoor air quality. Saving of cooling load calculation is as follow:

**Table: Heat recovery energy calculation:**

| | PEAK WINTER | PEAK SUMMER |
|---|---|---|
| **OUTSIDE CONDITION** | | |
| DBT($^0$C) | 12.0 | 43.3 |
| DBT($^0$F) | 53.6 | 109.9 |
| WBT($^0$C) | 9.5 | 24.0 |
| WBT($^0$F) | 49.2 | 75.2 |
| RH (%) | 74 | 19.6 |
| Total Enthalpy(H1) | 19.8 | 38.3 |
| Fresh Air (CFM) | 43330 | 43330 |
| **ROOM CONDITION** | | |
| DBT($^0$C) | 21.0 | 24.0 |
| DBT($^0$F) | 69.8 | 75.2 |
| WBT($^0$C) | 14.5 | 17.1 |
| WBT($^0$F) | 58.1 | 62.8 |
| RH (%) | 50.0 | 50.0 |
| Total Enthalpy(H2) | 25.2 | 28.2 |
| **RETURN AIR CONDITION** | | |
| DBT($^0$C) | 24.0 | 26.0 |
| DBT($^0$F) | 75.2 | 78.8 |

| | | |
|---|---|---|
| WBT($^0$C) | 17.0 | 18.7 |
| WBT($^0$F) | 62.6 | 65.7 |
| RH (%) | 50.0 | 50.0 |
| Total Enthalpy(H3) | 28.2 | 30.4 |
| **CONDITION OF FRESH AIR AFTER HRWs** | | |
| DBT($^0$C) | 18.0 | 34.7 |
| DBT($^0$F) | 64.4 | 94.4 |
| WBT($^0$C) | 13.3 | 21.4 |
| WBT($^0$F) | 55.9 | 70.4 |
| RH (%) | 62.0 | 34.8 |
| Total Enthalpy(H4) | 24.0 | 34.4 |
| | | |
| **Case 1 :Total cooling load required to bring down outside air to room condition** | | |
| **Cooling Load (TR)** | 87.7 | 164.1 |
| **Equivalent heating (MBH)** | 1052.9 | - |
| | | |
| **Case 2 :Total cooling load required to bring down outside air to room condition with the use of Heat recovery wheel** | | |
| **Cooling Load (TR)** | 68.2 | 64.2 |
| **Equivalent heating (MBH)** | 818.9 | - |
| | | |
| **Total Saving in cooling load with the use of HRW unit** | | |
| **Cooling Load (TR)** | 19.5 | 99.9 |
| **Heating load (MBH)** | 234.0 | - |
| **Saving percentage** | **22%** | **61%** |
| | | |

**Saving in one day operation of building during Summer = 19.5 x 10 x 0.65 = 1:**
**kwh/day**

**Saving in one year operation of building during Summer = 127 x 280 =**
**35490 kwh/year**

## E. Air Distribution Systems

Various Options will be explored, evaluated and opted for air distribution and low side system.

- Variable volume air distribution
- Constant volume air distribution system
- Under floor Air Distribution System

Individual spaces will be evaluated for suitability for the above systems. Based on a detailed energy analysis and nature/application of each space, all above systems will be evaluated and the best options based will be applied. For example, Lecture hall to go with under floor Air distribution

system, Classrooms, office will have VAV and so on.
Faculty of Phy Chem Maths & IT building shall be served through central chilled water Plant located at utility building through pump & piping network.

- **Tertiary Pump:**
  Tertiary pump will be provided at later stages of design into the building basement to accommodate the pressure requirements at each AHU. This will be after the Calculation of the pump head for the pumps of central plant.
  There shall be provision of 2 tertiary pumps (1 working+ 1 standby). This ensures And maintains the required pressure and Flow of chilled water to meet the Building Cooling load.

- **BTU Metering System**
  Metered chilled water will be provided through each AHU in the complex where in BTU meter will be provided for measuring the AHU chilled water use. This will help to keep a check on energy usage at each space.

- **Under floor air distribution:**
  Under floor Air distribution will be adopted in lecture theatre room at ground floor of Faculty of Phy Chem Maths & IT building. Under floor air distribution systems (UFAD) deliver air flow at a lower temperature than a conventional system and can be very effective like in case of Lecture room. A duct network shall be set up under the floor and to serve the space with the grills. This gives the uniform distribution of air throughout the space and provides a good comfort level.

  1. Reduced energy consumption due to stratification.
  2. Reduced ductwork due to floor plenums. The system does add to architectural costs as a raised floor system installation in the space is required.
  3. Increased number of economizer operation hours to utilize free cooling.

- **Duct Construction and Fire Safety**
  All ducts shall be fabricated out of galvanized sheet steel (GSS) as per SMACNA standard for long life and as per fire norms. Motorized smoke dampers shall be installed within supply air ducts and return air ducts at AHU room wall crossings, to prevent spread of smoke / fire to the adjoining areas. Air handling unit fan motor shall also be tripped when smoke is sensed in the conditioned area served by the air handling unit.

- **Fresh Air requirement**
  Fresh air requirement for various spaces shall be either mechanically forced or infiltrated.
  For labs areas, fresh air dampers are located on AHU room for supplying required fresh air.

## F. MECHANICAL VENTILATION AND SMOKE EVACUATION SYSTEM:

Mechanical ventilation system is being considered for Utility rooms, Basements, Kitchen/pantry, toilets and other similar areas using combination of centrifugal fans, axial flow fans, propeller fans and inline fans.

1. **Car Parking Extract and Supply:**
   Mechanical Ventilation for car parking in basement shall be ducted ventilation as per Revised NBC-2005, clause No. 5.2.2.1 designed to permit 6 ACPH for normal ventilation, and 12 ACPH in case of fire. During Normal operation, Exhaust air @ 6 ACPH shall be exhausted through fans in the basement and the fresh air requirement shall be met through the Ramp openings available. To cater to additional 6 ACPH (total 12 ACPH) in case of fire, another set of Tube-axial fans connected with exhaust air riser shall get actuated. During this period, additional supply air fans @6 ACPH shall also supply the fresh air into the basement car parking area (wherever openings are not sufficient for the fresh air).
   Basement ventilation fans for normal operation shall be provided with variable frequency drive controlled through CO concentration level within parking area for energy conservation.

As per revised NBC-2005, there are 2 zone considered for parking ventilation in Faculty of Phy Chem Maths & IT building. Area detail & air quantity required are given in table below.

**Table-6 – Parking Ventilation**

| Space | Area Sq.ft | Height (ft) | ACPH for Exhaust air | ACPH for Fire Mode | Exhaust air CFM in Normal mode | Exhaust CFM Fire Mode | Exhaust Air Fan | Fresh Air Fan |
|---|---|---|---|---|---|---|---|---|
| Car Parking Zone 1 | 22596 | 12.5 | 6 | 6 | 28164 | 28164 | 01#28000 CFM (N) & 01#28000 CFM (F) | 01#28000 CFM (F) |
| Car Parking Zone 2 | 23349 | 12.5 | 6 | 6 | 29102 | 29102 | 01#29750 CFM (N) & 01#29750 CFM (F) | 01#29000 CFM (F) |

All the basement parking ventilation fans should be fire rated for a minimum of 250 Deg C for a minimum of 2 Hrs. applications. Fan motor shall be “Class H” type with class O insulation. The fan motor shall have efficiency class IE-3.

2. **Bath, Toilet, Services and Lab Exhaust:**
   Bath exhaust fans will be provided in buildings as required removing foul air and maintaining air quality. Toilets, Service room electrical room etc will also have exhaust system installed. Toilet doors shall have an undercut (or an air transfer grill) so that some air from the surrounding spaces shall pass through this undercut /air transfer grill and exhausted out, using duct mounted fans. Toilets are ventilated through the ducting arrangement.

   Propeller, axial and duct mounted inline fan of required CFM and relative pressure serve the space. Approx. CFM for the different areas for various building in Stage-I is as shown in table:

**Table-7 –Ventilation Summary:**

| Room Name | Area (SQFT) | ACPH | CFM |
|---|---|---|---|
| ELECTRICAL ROOM-1 | 622 | 20 | 1080 |
| ELECTRICAL ROOM-2 | 622 | 20 | 1080 |
| STORE | 645 | 12 | 1095 |
| MALE TOILET-1 | 172 | 10 | 315 |
| FEMAIL TOILET-1 | 193 | 10 | 354 |
| HAND. TOILET-1 | 57 | 10 | 105 |
| MALE TOILET-2 | 172 | 10 | 315 |
| FEMAIL TOILET-2 | 193 | 10 | 354 |
| HAND. TOILET-2 | 57 | 10 | 105 |
| MALE TOILET-3 | 172 | 10 | 344 |
| FEMAIL TOILET-3 | 193 | 10 | 386 |
| HAND. TOILET-3 | 57 | 10 | 114 |
| MALE TOILET-4 | 172 | 10 | 344 |
| FEMAIL TOILET-4 | 193 | 10 | 386 |
| HAND. TOILET-4 | 57 | 10 | 114 |

| | | | |
|---|---|---|---|
| MALE TOILET-5 | 172 | 10 | 344 |
| FEMAIL TOILET-5 | 193 | 10 | 386 |
| HAND. TOILET-5 | 57 | 10 | 114 |
| MALE TOILET-6 | 172 | 10 | 344 |
| FEMAIL TOILET-6 | 193 | 10 | 386 |
| HAND. TOILET-6 | 57 | 10 | 114 |
| MALE TOILET-7 | 172 | 10 | 344 |
| FEMAIL TOILET-7 | 193 | 10 | 386 |
| HAND. TOILET-7 | 57 | 10 | 114 |
| MALE TOILET-8 | 172 | 10 | 344 |
| FEMAIL TOILET-8 | 193 | 10 | 386 |
| HAND. TOILET-8 | 57 | 10 | 114 |
| MALE TOILET-9 | 172 | 10 | 344 |
| FEMAIL TOILET-9 | 193 | 10 | 386 |
| HAND. TOILET-9 | 57 | 10 | 114 |
| **Total** | **6487** | | **16369** |
| | | | |

**3. Lift Well / Lift Lobby / Staircase Pressurization:**

Fire escape staircases shall be provided with 50 Pa of Positive Pressurization and Lift well and lift lobby shall be provided with 50/30 Pa of Positive Pressurization arrangement as per NBC-2005 standards clause No. C1.5 (g) for lift well & lift lobby and C1.4 of part 4 for staircase, consisting of supply air fans installed on roof top. The fans shall connect to supply air ducts installed in vertical risers and inject air at each staircase landing, for achieving effective pressurization. Fans shall be sized to maintain minimum positive pressure of 50 Pa across the door. Make up air fans serving stairwell shall be provided with motorized damper at fan discharge to prevent humid fresh air entering into staircase well. These dampers shall be interlocked with fan motor and shall open upon getting signal from the smoke sensor. Lift wells shall also be similarly pressurized by supplying the air through fans installed on roof top.

***Refer to Annexure-A, B and C for Lift well, lift lobby & Staircase pressurization**

**G. Brief Description of HVAC Equipments:**

**1. AIR HANDLING UNITS**

The air handling units shall be double skin construction, draw through type comprising of various sections such as mixing box, (the return air and fresh air are ducted), pre-filter section, cooling & heating coil sections, fan section, filters section, Double skinned panels shall be (60mm thick for units for AHUs made of galvanized steel, pressure injected with foam insulation (density 40 KG/ M3 .The entire framework shall be mounted on an aluminum alloy channel base. Panels shall be sealed to framework by heavy duty “O” ring gaskets held captive in the framed extrusion. All panels shall be detachable or hinged. Hinges shall made of die cast aluminum with stainless steel pivots, handles shall be made of hard nylon and be operational from both inside and outside of the unit. Thermal breaks shall be provided in the unit framework to prevent condensation at the panel joints during humid outside conditions. Units shall have hinged, quick opening access door in fan and filter section. Access doors shall be double skin type. Condensate drain pan shall be fabricated from 18 gauge stainless steel sheet with all corners welded. It shall be isolated from bottom floor panel through 25 MM heavy duty urethane foam.

Centrifugal Fans shall be forward/ backward inclined blade type. Fan casing shall be made of galvanized steel sheet. Fan wheels shall be of galvanized steel. Fan wheels and pulleys shall be individually tested and precision balanced dynamically. Fans shall be imported.

Both fan and motor assemblies shall be mounted on a deep section aluminum alloy or galvanized steel base frame. The fan motor shall have efficiency class IE-3.

**2. Axial Fans**

The fan casing and Motor mounting plates should be manufactured from mild steel. The fan casing and flanges should have a minimum thickness of 3.0mm for fans up to and including 1000mm diameter, with thickness of 5mm for larger diameters. Flanges should be integral with casing and should be provided with bolt holes for connection. The casing assembly, complete with flanges, should be hot dip /spray galvanized after manufacture.

An external terminal box should be provided, as standard, on long case fans. Short case fans will have a terminal box on the motor only.

The pitch angle of the fan should be individually adjustable. The fan should be of the variable pitch angle or controllable pitch angle design. The supplier should be able to provide evidence that the impeller has been adequately stressed for running at the highest speed. The impeller should be balanced to G3.6 or better as defined in ISO 1940/1:1986 (6.3 mm/s peak to peak or 4.5mm/s rms).

The aerodynamic design of the fan should be such that the maximum power required by the fan occurs within the normal working ranges, i.e., it has a non-overloading characteristic.

The fan should be suitable for frequent starting applications and for continuous operation in ambient temperatures ranging from -43°C up to +63°C.

Fan motors should be at the totally enclosed, squirrel cage induction, continuous duty, and variable torque type. Fan motor shall be Class A type with class F class insulation. The fan motor shall have efficiency class IE-3 or EFF-1, whichever is more efficient.

**3. Centrifugal Fans:**

Centrifugal fans shall be of double-width, double-inlet construction, with bearing on both sides, complete with access door, squirrel-cage induction motor, V-belt drive, belt guard etc.

Housing shall be of heavy gauge sheet steel in welded construction. It shall be rigidly reinforced and supported by structural angles. Split casing shall be provided on larger sizes of fans. However neoprene/ asbestos packing shall be provided throughout split joints to make it airtight. 1.2 mm galvanized wire mesh inlet guard, of 5cms sleeves shall be provided on both inlets. Housing shall be provided with access door with quick locking tension handles and neoprene gasket. Rotation arrow shall be clearly marked on the housing.

Fan wheel shall be backward curved non-overloading type unless otherwise specified. Fan wheel and housing shall be statically and dynamically balanced. Fan outlet velocity shall not exceed 610 meters per minute.

Shaft shall be constructed of steel, turned, ground and polished.

Bearings shall be of the sleeve/ball bearing type mounted directly on the fan housing. Bearing shall be self-aligned, oil grease packed, pillow block type.

Drive to fan shall be provided from 3 phase electric motor through belt with adjustable motor sheave and belt guard. Belt shall be of the oil resistant type. The number of belts shall be not less than two.Fan motor shall be Class A type with class F class insulation. The fan motor shall have efficiency class IE-3.

**4. Variable Speed Drives:**

Variable speed drive shall be factory installed on the Electrical panel. It will vary the fan motor speed by controlling the frequency and voltage of the electrical power to the motor. The capacity control logic shall automatically adjust motor speed and capacity control mechanism for maximum real world efficiency by analyzing information fed to it by sensors located either in return air path or potential difference sensors located across the duct.Unit must have less than 5% Total Demand Distortion (TDD) at equipment level.

Field power wiring shall be a single point connection and electrical plugs for incoming power wiring will be provided. All VSD components are designed to last the life of the AHU.

**5. Fire Dampers:**

Motorized fire damper shall be installed with supply & return duct at AHU room wall to prevent spread of smoke fire at adjoining areas dampers shall be robust constructions and tightly fitted. The design, method of handling and control, shall be suitable for the location and service required.

Dampers and their operation devices shall be made robust, easily operable, and accessible through suitable access doors in the ducts. Every damper shall have an indicating device clearly showing the damper position at all times.

Fire dampers shall be motorized smoke & fire dampers type. It shall be supplied with spring loaded UL stamped fusible link to close fire damper in the event of rise in duct temperature. Fire damper shall also close on receipt of fire alarm signal to cut off air supply instantaneously. An electric limit switch shall also be operated by the closing of fire damper, which in turn shall switch off power supply to AHU blower motor as well as strip heaters(If installed).

**6. Dampers**

Dampers shall be opposed blade type. Blades shall be made of double skinned aerofoil aluminum/ GI section with integral gasket and assembled within a rigid extruded aluminum alloy frame. All linkages and supporting spindles shall be made of aluminum/GI or nylon, turning in Teflon bushes. Manual dampers shall be provided with a Bakelite knob for locking damper blades in position.

**7. Grilles and Diffusers:**

Supply air grilles shall be provided with vertical and horizontal adjustable bars and volume control multi-louver damper which shall be key operated from the front of the grille. All linear diffusers shall be powder coated extruded aluminum. All linear grilles shall be of extruded aluminum.

**8. Insulation:**

Thermal insulation shall be applied to air distribution ductwork and to components within distribution systems such as fans, and cooler casings which convey conditioned air within AHU rooms and to ductwork (including recirculation air ductwork) conveying warmed or chilled air through unconditioned spaces or the open air. Unless otherwise indicated, distribution systems conveying conditioned, warmed or chilled air through conditioned spaces shall not be insulated. Distribution system conveying fresh air. Thermal insulation shall be applied to chilled water pipe work distribution systems and to components within distribution systems such as valves. Where thermal insulation is applied to the outside of piped and ducted services. The vapor barrier shall be applied such that it is continuous and given protection to the whole surface of the insulation which it protects. It shall not be pierced or otherwise damaged by supports or by the application of external cladding. At points of support means of load distribution shall be provided as necessary.

| Space | Insulation Thickness |
|---|---|
| Duct in conditioned Space | 19.00 mm (XLPE) |
| Duct in unconditioned space | 25.0 mm (XLPE) |

**9. Acoustic lining of AHU Rooms:**

Acoustic insulation on walls and ceiling of Air handling unit's rooms with 50mm thick resin bonded fibre glass slabs fixed in frame work and finished with vapor barrier and perforated aluminum sheet two walls and ceiling of air conditioning plant room and air handling unit rooms may be provided with acoustic lining of resin bonded fibre glass. The surface shall be cleaned and frame work of 22 gage GI fabricated Channels 25 mm x 50 mm screwed back to back at 60 cm centre's shall be provided vertically and horizontally so that 60 x 60 cm squares are formed. The gaps between frames shall be filled with 50 mm thick about 60 cm x 60 cm cut panels of resin bonded fiberglass slabs. The entire surface shall then be covered with fiberglass tissue and 26 gage perforated aluminum sheet, 60 cm or 120 cm wide having at least 15 percent perforations, fixed with sheet metal screws.

Over-lapping of sheets shall be covered with Aluminum beading. Acoustic lining of walls shall be terminated approximately 15 cm above the finished floor to prevent damage to insulation due to accidental water-logging in plant/AHU rooms.

**10. Acoustic lining over ducts:**

Ducts shall be lined internally with acoustic insulation as detailed below:

- The Inside surface of duct on which the acoustic lining is to be provided shall be clean free from all dust and grease.
- Then 25 x 25 sq.mm section of minimum 1.25 mm thick G.I. sheet shall be fixed on both ends of the duct piece.
- The insulation slabs shall then be fixed between these section of ducts using CPRX adhesive compound and stickpins.
- The insulation shall then be covered with Reinforced plastic/ fiber glass tissue, sealing all joints so that no fiber is visible.
- The insulation shall finally be covered with minimum 0.5 mm thick perforated aluminum sheet having perforations between 20-40%

**11. Filters:**

**i. Pre-filters (fabric type)**

Synthetic fiber Pre-filters shall be in light weight aluminum framed with non woven synthetic fiber replaceable media. The filter shall have an efficiency of 90 percent down to 10 microns particles size when tested as per B.S.2831 standards. The filter frame shall be of aluminum and shall be suitable for mounting in Air handling units or ducts as required at site. The velocity across the face of the filter shall not exceed 500 FPM and the pressure drop across the filter shall not exceed 4mm.

**ii. Microvee filters (fine filters):**

Microvee filters shall be of dry type. Filters media shall be made from washable nonwoven synthetic fiber replaceable media reinforced with HDPE cloth & Aluminum mesh, specially treated with antifungal and bactericidal agents to prevent growth of micro organisms. The filter media shall be treated to permit washing with water several times before discharged. The media shall be properly supported and spaced so that air flow through the filter is uniform. The filter shall be housed in aluminum frame work. Filters shall be designed to remove particle down to 5 micron size and with efficiently of 98.0 percent tested as per BS 2831 using Test Dust II. The filters shall be installed in the air handling units after the chilled water coils. They shall be capable of being replaced or removed for servicing without the use of special tools.

**H. BUILDING MANAGEMENT SYSTEM:**

Building automation and control systems would control and monitor system such as air handling units, Tertiary Pumps, Fans in Parking area, Lift and miscellaneous electrical and plumbing points.
A totally direct digital control (DDC) system with electric Actuation control Valve and Damper would be considered.
There would be preference to systems, which support open protocol, i.e., BACNET.

**MONITORING/ CONTROLLING POINTS FOR BMS:**

| S. No. | Description |
|---|---|
| | **HVAC SYSTEM**<br>**AIR CONDITIONING SYSTEM** |
| | |
| **A** | **OUTSIDE AIR** |
| | Outside Air Temperature and RH |
| | |
| **B** | **AIR HANDLING UNITS (with RH & Temp Control) (Common areas)** |

| | |
|---|---|
| | AHU Blower Status |
| | AHU Manual Operation Status |
| | AHU FAN ON/OFF Status |
| | AHU Motor trip Status |
| | AHU Run Status |
| | AHU Filter Status |
| | AHU Return Air Temperature & RH |
| | AHU modulate Chilled Water Valve |
| | VAV/ VFD |
| | Fresh air Damper control |
| | Fresh air damper Feedback |
| | Supply/Return Fire Damper status |
| | |
| **C** | **VENTILATION FANS/TOILET FANS** |
| **D** | **LIFTS MONITORING** |
| **E** | **ELECTRICAL ENERGY** |
| **F** | **BASEMENT FANS** |
| **G** | **TERTIARY CHILLED WATER PUMP** |
| **H** | **HEAT RECOVERY WHEEL** |

# ANNEXURE A, B and C
# FOR
# FACULTY OF PHY CHEM MATHS & IT PRESSURIZATION CALCULATION

## Annexure – A

**Pressurization of each Staircase (Basement)**

**1. Leakage path from pressurized staircase are as follows**

a) Door at each mid landing
b) Door on the basement floor

**2. Staircase Description**

a) Total No. of Doors = 2 Nos.
b) Door size = 1.5 m x 2.1 m

c) Area of each door = 3.15 $mt^2$ or 33.9 $ft^2$.

**3. Calculation of air quantity leakage through open staircase door as follows;**

= Area of staircase door ($mt^2$) x Exhaust air velocity of air assumed (m/second) x Nos. of Doors open.

= 3.15 x 1 x 1 = 3.15 $m^3/s$

= (6.3 x 3600) / 1.7

= 6670.5 CFM

**4. Calculation of air quantity leakage through staircase doors and cracks on other floors**

Perimeter of door = 7.2 m

Assume Gap = 2.0 mm =0.002 m

Total No. of leakage door = 2 Nos.

Total leakage area = Perimeter of Door x Gap x No. of Leakage Door

= 7.2 x 0.002 x 2

= 0.0288 $mt^2$

Now, Assume Pressure Difference = 50 Pascal

Now, Air leakage through Staircase door and cracks = 0.827 x leakage area x √PD

= 0.827 x 0.0288 x √50

= 0.169$m^3/s$

= (0.169 x 3600) / 1.7 CFM

= 357.8 CFM

Accounting for 5 % duct losses = (6670.5 + 357.8) x 1.05

= 7379.7 CFM

**Say 7,500 CFM @ 20 mm total static pressure of free inflow of air for each Staircase Pressurization.**

**Annexure – B:**

**Pressurization of each Lift Lobby (Basement to 4th Floor)**

**1. Leakage path from pressurized lift lobby are as follows**

a) Door at each mid landing
a) Door on the ground floor

**2. Lift lobby Description**

a) Total No. of Doors = 6 Nos.
b) Door size = 1.8 x 2.1 mt.
c) Area of each door = 3.78 $mt^2$ or 40.67 $ft^2$.

**3. Calculation of air quantity leakage through open lift lobby door be as follows;**

= Area of lift lobby door ($mt^2$) x Exhaust air velocity of air assumed (m/second) x Nos. of Doors open.

= 3.78 x 1 x 2 = 7.56 $m^3/s$

= (7.56 x 3600) / 1.7

= 16009.4 CFM

**4. Calculation of air quantity leakage through lift lobby doors and cracks on other floors**

Perimeter of door = 7.8 m

Assume Gap =2.0 mm = 0.002 m

Total No. of leakage door =6 Nos.

Total leakage area = Perimeter of Door x Gap x No of Leakage Door

= 7.8 x 0.002 x 6

= 0.0936 $mt^2$

Now, Assume Pressure Difference = 30 Pascal

Now, Air leakage through lift Lobby door and cracks = 0.827 x leakage area x √PD

= 0.827 x 0.0936 x √30

= 0.424$m^3/s$

=(0.424 x 3600) / 1.7 CFM

**= 897.5 CFM**

Accounting for 5 % duct losses = (16009.4 + 897.5) x 1.05

= 17752.7 CFM

**Say 17600 CFM @ 30 mm total static pressure of free inflow of air for each Lift Lobby.**

**Annexure – C:**

**Pressurization of each Lift Well (Basement to 4th Floor)**

**1. Leakage path from pressurized lift well are as follows**

a) Door at each mid landing

**2. Lift well Description**

a) Total No. of Doors = 6 Nos.
b) Door size = 0.8m x 2.1 m
1.68 $mt^2$
c) Area of each door = 18.08 $ft^2$.

**3. Calculation of air quantity leakage through open lift well door be as follows;**

= **Area of lift lobby door ($mt^2$) x Exhaust air velocity of air assumed (m/second) x Nos. of Doors open.**

= 1.68 x 1 x 1 = 1.68 $m^3/s$

= (1.68 x 3600) / 1.7

= **3558 CFM**

**4. Calculation of air quantity leakage through lift well doors and cracks on other floors**

Perimeter of door = 5.8 m

Assume Gap =2.0 mm =0.002 m

Total No. of leakage door = 6 Nos.

Total leakage area = Perimeter of Door x Gap x No. of Leakage Door

= 5.8 x 0.002 x 6

= 0.0696 $mt^2$

Now, Assume Pressure Difference = 50 Pascal

Now, Air leakage through lift Well door and cracks = 0.827 x leakage area x √PD

=0.827 x 0.058 x √50

= 0.407$m^3/s$

=(0.407 x 3600) / 1.7 CFM

= **861.8 CFM**

Accounting for 5 % duct losses = (3558 + 861.8) x 1.05

= 4640.79 CFM

**One fan is provided for 2 nos. Lift well , So 9000 CFM @ 20 mm total static pressure of free inflow of air for Lift Well.**

# 12.24. ANNEXURE IX - DDR for AC9- SOUTH ASIAN STUDIES

## 12.24: ANNEXURE IX - (DDR for AC9- SOUTH ASIAN STUDIES)

### A. Introduction:

SAARC StudiesBuilding is part of academic block in South Asian University. This building includes Class Room, Museum of Earth Sc., Faculty office lounge, Admin office, Seminar Room, Faculty Rooms, P.H.D. cubicles, Archives + Record Room, IT Room, Fire control room, security room etc. Building consists of a Basement + Ground + 7 Floors and a total built-up area of 9688sq.mtr.

#### 1. Air Conditioning Objective:

Objective of air conditioning is to provide thermal comfort to all areas for SAU-Studies building in an efficient and cost-effective manner round the year. Temperatures and Indoor Air Quality shall be maintained in accordance with parameters as specified in the following sections of Basis of Design.

SAARC Studies building is served by Central chilled water system. The chilled water flowing through the “MS” pipe with HDPE Jacketing buried underground is connected to branch piping to serve all risers which are connected to all AHU’s.

#### 2. Ventilation Objective :

Objective of Mechanical Ventilation is to provide fresh air and vent out exhaust air to maintain indoor air quality and to have an escape route in case of fire. Mechanical ventilation system is being considered for Utility rooms, Basements, Kitchen/pantry, toilets and other similar areas using combination of centrifugal fans, axial flow fans, propeller fans and inline fans.

### B. General Building HVAC Design Criteria and Assumptions

This section of the report documents specific numbers used in the design of the SAU-Studies building. These assumptions are an essential part of making the transition from the project intent to installed equipment. Also the codes and guidelines for the designer and contractor which are to be followed during the different stages of project are outlined.

#### 1. CODES & STANDARDS:

The applicable Standards/Codes are:

(a) American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE).
- a.1 ASHRAE - 55
- a.2 ASHRAE - 90.1
- a.3 ASHRAE - 62.1
- a.4 ASHRAE - Fundamentals
- a.5 ASHRAE - HVAC Application
- a.6 ASHRAE - HVAC System & Equipment
- a.7 ASHRAE - Refrigeration

(b) Energy Conservation Building Code (ECBC)
(c) Duct construction standards as per relevant BIS Codes & SMACNA standards
(d) National Buildings Code-2005
(e) Air Filter as per ASHRAE-52.1 and 52.2
(f) National Electric code
(g) National Fire Protection code
(h) ISHRAE Standards
(i) GRIHA Manual
(j) IMC-2009

The following IS codes shall be applicable:

| S. No. | Material/item of Work | Standard/Code |
|---|---|---|
| 1. | Ducting Fabrication | IS: 655 |
| 2. | Galvanized Sheets/Wires | IS: 277 |
| 3. | Aluminum Sheets/Wires | IS: 737 |
| 4. | Horizontal Centrifugal Pumps | IS: 6595 |
| 5. | Mild Steel, ERW Pipes | IS: 1239, IS: 3589 |
| 6. | Pipe Fittings | IS: 1239 |
| 7. | Steel Pipe Flanges | IS: 6392 |
| 8. | Gate, Globe & Check Valves | |
| | • Up to 40 mm Gun metal | IS:778 |
| | • Butterfly valve of 50 mm and Above (Cast Iron) | IS:2906 |
| | • Balancing valve | IS:778 |
| | • Non Return valve | IS:5312 |
| 9. | Color Code for Identifications of pipes | IS: 2379 |
| 10. | 3 Phase induction motors | IS: 325 |
| 11. | Pressure and vacuum gauges | IS: 3624 |
| 12. | PVC insulated electric cables | IS: 1554 |
| 13. | Starters sheets/wires | IS: 8555 |
| 14. | Glossary of terms used in refrigeration and Air-conditioning | IS: 3615 |
| 15. | Hot die zinc coated steel pipes | IS: 4736-1968 |
| 16. | Expanded Polystyrene | IS: 4671 |

**Safety codes**

The following safety codes as laid down by ISI shall be followed:

| | | |
|---|---|---|
| 1. | Safety code for mechanical refrigeration | IS : 660 |
| 2. | Safety code for air-conditioning | IS : 659 |
| 3. | Safety code for scaffolding and ladders | IS : 3696 |
| 4. | Code for practice for safety and health Requirements in electrical and gas Welding & cutting operations | IS: 818 |
| 5. | Recommendations of safety procedures and practices In electrical works | IS: 5216 |

NOTE:- All the codes and standards are applicable only with the latest amendments only.

**<u>Green building/GRIHA features :</u>**

a) SouthAsian campus is targeting to be a GRIHA five star rated campus.
b) High efficient equipment will be used for HVAC system. Selection of High efficient fans for AHU and Ventilation system.
c) Variable speed drive shall be used on selected AHU and large ventilation fans.
d) Variable air volume system shall be used for selected areas as per the application.
e) Car parking exhaust system shall be equipped with CO sensors so that exhaust fans are operated as per permitted CO concentration levels.
f) Heat recovery wheels for pre-cooling OA by using the waste exhaust air wherever possible to lower down the fresh air load. This ensures reduced energy consumption despite higher fresh air intake.
g) Cooling tower selection for minimum drift and noise level, energy efficient motors, VFD for motor speed control.

**2. LOCATION:**

- Site Location : New Delhi
- Geographic Location : 28.38°N, 77.13°E
- Altitude : 216 m above mean sea level

**a) Design Conditions and Assumptions:**

The summer design condition is based on ISHRAE weather data and statistics of the most recent data of 10 year period, published by the India Metrological Department and *.epw* weather data files from the *DOE*.

The year round temperatures and climatic conditions is as below and system is evaluated for 8760 hours.

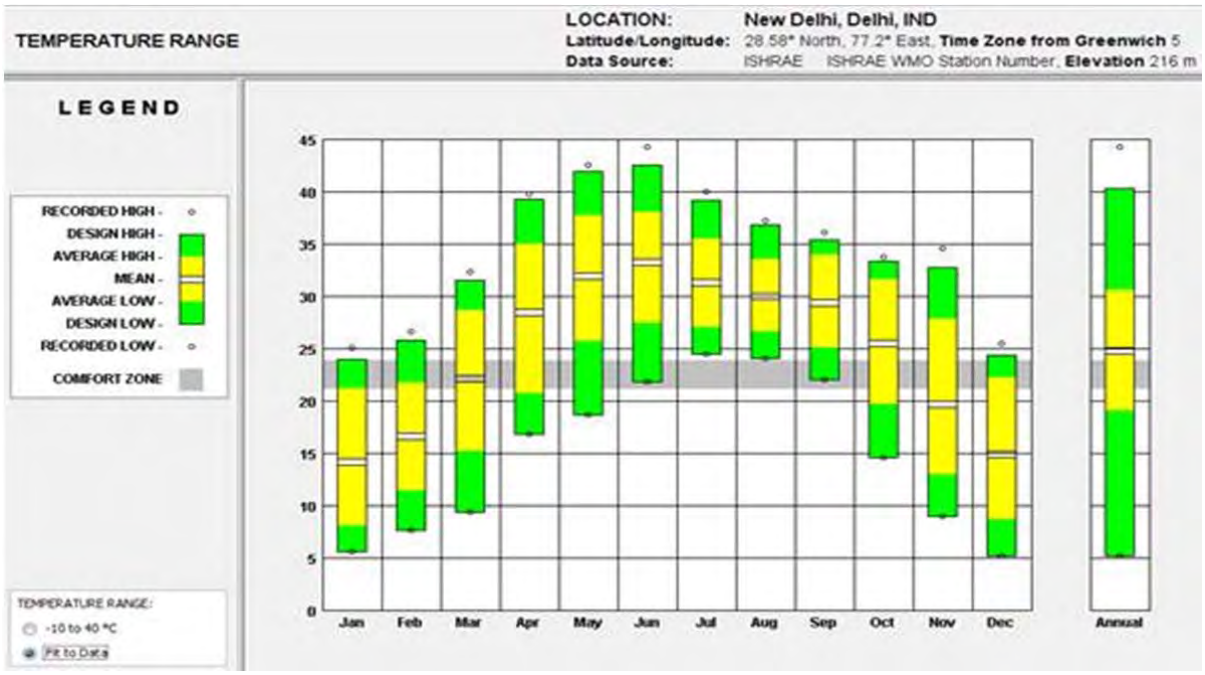



**Table-1 Design Assumptions**

| Description | Value (units) |
|---|---|
| Latitude/Longitude | 28.38°N, 77.13°E |
| Sea level | 216 m |
| Clearness number | 0.95 |
| Summer outdoor air DB/WB temperature | 43.3°C (109.94 °F) /23.89 (75.02 °F) |
| Winter outdoor air DB/WB temperature | 7.2°C (44.96 °F) / 5.0°C(41.0°F) |
| Monsoon outdoor air DB/WB temperature | 35°C (95.0°F)/ 28.3°C (83°F) |
| Ground reflectance | 0.20 |
| Roof U-value | 0.079 Btu/h. ft².°F |
| Overall Wall U-value | 0.1179 Btu/h. ft².°F |
| Glass U-value (summer/winter) | 0.31 Btu/h. ft².°F |
| Glass shading coefficient | 0.58 |
| Infiltration /Ex-filtration | As per ASHRAE 90.1 |

| | |
|---|---|
| Building system peak cooling load (day/month) | 17/6 |
| Cooling load design calculation program | CLTD, Trane Trace 700 |
| Winter Heat load design calculation program | UATD, Trane Trace 700 |
| Ductwork sizing program | Trane Ductulator |
| Cooling Safety factor/Heating Safety Factor | 10% |
| Fan heat gain safety factor | 5% |
| Diversity | 80% Overall on chiller plant |
| Typical Hours of Operation | As directed by SAU |

**b) Inside Design Conditions:**

Table below shows Room Ambient Temperature and Humidity Design Criteria for SAARC Studies buildings. The set points are considered on the basis of ASHRAE -55 Clause No. 5, Thermal Comfort charts and after discussion with SAU.

**Table-2- Inside Set Points conditions:**

| | **Inside conditions** | | | |
|---|---|---|---|---|
| | **Summer** | | **Winter** | |
| **Spaces** | **Temp.** | **Humidity** | **Temp.** | **Humidity** |
| SHOPS | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| ADMIN OFFICE | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| FACULTY OFFICE LOUNGE | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| MUSEUM OF EARTH SC. | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| FACULTY ROOM | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| SEMINAR ROOM | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| DIRECTOR'S OFFICE | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| SECRETARY ROOM | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| OFFICES | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| ARCHIVES + RECORD ROOM | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| LIBRARY | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| PHD CUBICLES | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| IT ROOM | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| FIRE CONTROL ROOM | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |

**3. Acoustic Criteria:**

Air-conditioning systems will be designed to maintain the following noise criteria (NC) level in various spaces as per NBC - 2005 - PART 8 Building Services Section 4, Acoustics, Sound Insulation and Noise Control.

- Museum of Earth : NC 40-45
- Classrooms : NC 40-45
- Seminar Room : NC 40-45
- Faculty Room : NC 35-40
- Office Space : NC 35-40
- Shops : NC 45-50
- Office Space : NC 35-40
- Library : NC 35-40

**4. Fresh Air:**

Adequate fresh air quantity shall be provided to air-conditioned spaces to maintain indoor air quality (IAQ) generally as per ASHRAE standard 62.1-2007.

- 10.0 CFM/person + 0.12 CFM/Sq.ft. for Class Rooms
- 7.5 CFM/person + 0.18 CFM/Sq.ft. for Shops
- 10 CFM/person + 0.12 CFM/Sq.ft. for Museum of Earth
- 5 CFM/person + 0.06 CFM/Sq.ft. for Faculty office Lounge
- 5 CFM /person + 0.12 CFM/Sq.ft. for Libraries
- 5 CFM /person + 0.06 CFM/Sq.ft. for Admin office
- 7.5 CFM/Person + 0.18 CFM/sq.ft for Archive + Record Room
- 5 CFM/Person + 0.06 CFM/sq.ft for Faculty rooms
- 5 CFM/Person + 0.06 CFM/sq.ft for Seminar Room

**5. Lighting Load:**

Following is the assumptions made for the purpose of considering lighting load and will be according to the electrical lighting design. ASHRAE 90.1-2007 will be used for any assumptions.

- 1.1 W/Sq.ft for Admin Office Space.
- 1.4 W/Sq.ft for classrooms.
- 1.4 W/Sq.ft for Museum of Earth Sc.
- 1.3 W/Sq.ft for library.
- 1.4 W/Sq.ft for Archive + Record Room
- 1.3 W/sq.ft for Faculty rooms
- 1.3 W/sq.ft for Conference room
- 1.1 W/Sq.ft for Shops.

**6. Equipment Loads**

Following is the assumptions made for the purpose of considering Equipment load and will be according to the ASHRAE Fundamentals-2005, chapter 30 & electrical design/equipment used.

- 1.2 W/Sq.ft for Admin Office Space.
- 0.25 W/Sq.ft for classrooms.
- 0.25 W/Sq.ft for Museum of Earth Sc.
- 1.5 W/Sq.ft for Shops.
- 0.5 W/Sq.ft for library.
- 0.5 W/Sq.ft for Faculty office Lounge
- 1.2 W/sq.ft for Faculty rooms
- 0.86 W/sq.ft for Conference room

**7. Occupancy**

Occupancy as per furniture layout of rooms as mentioned on the architectural plans.
For areas where capacity is not mentioned, it is assumed as per NBC-Part-8, Building Services, and Section-3, Table 4 or ASHRAE 62.1-2007 table 6-1.

**8. Mechanical Ventilation System:**

The following areas shall be provided with dedicated ventilation system with the number of air changes per hour for each space as identified herewith:

| | | | |
|---|---|---|---|
| a) | Toilets | : | 10 ACPH |
| b) | Car Parking | : | 6 (Normal Mode)/ 12 (Fire Mode) ACPH Exhaust & 6 (Normal Mode)/12 (Fire |

Mode) ACPH Fresh Air

c) Kitchen : 20 ACPH
d) Electrical Room : 20 ACPH

**9. Relative Pressure:**

- Toilet Rooms : Negative inside pressure
- Lift well : 50 Pa Positive Pressure
- Closed Staircase : 50 Pa Positive Pressure
- Lift lobby Pressurization : 30 Pa Positive Pressure
- All other areas : As per codes and standards

**C. Mechanical System Design Parameters & Philosophy:**

This section describes the assumptions, parameters considered for sizing and designing of various Mechanical equipments and its components. Below is the detailed description.

- SAARC Studies building shall be served by the central chilled water plant &hot water generator located in utility building.
- Chilled water network buried shall supply required chilled water to the building.

**1. Air Handling Units:**

- Unit shall be provided with filter, cooling coil & fan to serve the specific premises.
- During summer season, supply & return temperature of chilled water is considered are 44° F & 56° F.
- During winter season, supply & return temperature of water considered are 130° F & 110° F.
- Air Distribution to the rooms shall be provided with supply air duct with suitable terminals and return air through return air duct or plenum, as applicable.
- All duct subjected to temperature below dew point shall be insulted with XLPE with thermal conductivity of 0.037 W/m-k at 20°C mean temperature.
- Acoustic insulation on walls and ceiling of AHU Room with 50 mm thick resin bonded fiber glass.
- Fan motor shall be Class A type with class F insulation. The fan motor shall have efficiency class IE-3.

**2. Piping:**

- Hydronic Piping material for chilled/Heating water supply and return shall be of Heavy class Black steel (MS- Class C) Pipes. Piping up to and including 150 mm diameter shall be of heavy class black steel confirming to IS:1239 and piping greater than 150 mm shall be minimum 6 mm thick black steel confirming to IS:3589.
- Hydronic piping shall be insulated with closed cell elastomer with maximum thermal conductivity of 0.038 W/m-k at 38° C, when tested in accordance with EN- ISO 8947.
- Chilled water piping insulation thickness shall be 25 mm thick for 40 mm pipe and smaller, 40 mm thick for 50 mm to 150 mm pipe and 75 mm thick for pipe greater than 150 mm.
- Drain from the all the air-conditioning equipment shall be collected by GI drain pipe insulated with 9 mm thick closed cell elastomer material and connected to nearest drain point.

All chilled water pipes shall be mild steel Class ‘C’ (heavy duty) conforming to relevant BIS codes. All jointing in the pipe system shall be by welding. Various type of valves such as butterfly valves, balancing valves and non return valves shall be provided in water lines.

Condensate drain piping would be GI ‘B’ Class conforming to relevant BIS codes.

**PIPING SHALL BE SIZED FOR THE FOLLOWING DESIGN PARAMETERS**

Pipes shall be sized to provide maximum water velocities as follows:

| **Pipe Sizes** | **Maximum Velocity** |
|---|---|
| Up to 50mm | 0.6 m/sec |
| 65 to 100mm | 0.8 m/sec |
| 125 to 200mm | 1.5 m/sec |
| 250 to 300mm | 2.5 m/sec |
| 355mm and up | 3.0m/sec |

3. **Filtration:**

Re-circulated air (mixed outdoor & return air) at Air handling unit : Washable synthetic type air filter having 90% efficiency down to 10 micron MERV 8 and filter having 99% efficiency down to 3 microns MERV 13)

Re-circulated air (mixed outdoor & return air) at Ventilation units : Washable synthetic type air filter having 90% efficiency down to 10 microns (MERV)

4. **Duct Design Criteria:**

The following maximum duct design velocities will be used in the design of ductwork systems. Where a range is indicated, it is intended to represent velocities over a range of flow volume.

**Table-3**

| | **Meters/Second** |
|---|---|
| Low Pressure Systems | |
| - Main Duct | 7.5 |
| - Primary Branch | 5.0 |
| - Secondary Branch | 2.0-3.5 |
| Plenum | 5.0-6.0 |
| Medium Pressure Systems | 12.0 |
| Cooling Coils | 2.5 |
| Heating Coil | 4.0 |
| Filters | 2.5 |

The following maximum friction losses are to be used in conjunction with the velocities noted above.

| | **Pascal's/meter** |
|---|---|
| Low pressure systems | 1.0 |
| Medium pressure systems | 3.3 |

5. **Ventilation Fan Design Criteria:**

- Maximum fan outlet velocity for fan upto 450 mm dia : 9.14m/s(1800 FPM)
- Maximum fan outlet velocity for fan above 450 mm dia : 12m/s (2400 FPM)
- Maximum fan speed for fan upto 450 mm : 1440 RPM
- Maximum fan speed for fan above 450 mm : 1100 RPM

Note: Ventilation fans can be either axial type or centrifugal type.

**6. Diffuser and Grill Design Criteria:**

- All air outlets and intakes shall be made of extruded aluminum sections &shall present a neat appearance and shall be rigid with mechanical joints.
- Square and rectangular wall outlets shall have a flanged frame with the outside edges returned or curved 5 to 7 mm and fitted with a suitable flexible gasket between the concealed face of the flanges and the finished wall face. The core of supply air register shall have adjustable front louvers parallel to the longer side to give upto 22.5 degrees vertical deflection and adjustable back louvers parallel to the shorter side to achieve a horizontal spread air pattern to at least 45 degrees. Return air grilles shall have only front louvers. The outer framework of the grilles shall be made of not less than 1.6 mm thick aluminum sheet. The louvers shall be of aero foil design of extruded aluminum section with minimum thickness of 0.8mm at front and shall be made of 0.8mm thick aluminum sheet. Louvers may be spaced 18 mm apart.
- Square and rectangular ceiling outlets/intakes shall have a flange flush with the ceiling into which it is fitted or shall be of anti-smudge type. The outlets shall comprise an outer shell with duct collar and removable diffusing assembly. These shall be suitable for discharge in one or more directions as required. The outer shell shall not be less than 1.6 mm thick extruded section aluminum sheet. The diffuser assembly shall not be less than 0.80 mm thick extruded aluminum section.
- Circular ceiling outlets/intakes shall have either flush or anti smudge outer cone as specified in the tender specifications. Flush outer cones shall have the lower edge of the cone not more than 5 mm below the underside of the finished ceiling into which it is fitted. Anti-smudge cones shall have the outer cone profile designed to reduce dirt deposit on the ceiling adjacent to the air outlet. The metal sheet used for construction of these shall be minimum 1.6 mm thick extruded aluminum sheet.
- Linear diffusers shall have a flanged frame with the outside edges returned 3.5 mm and shall have one to four slots as required. The air quantity through each slot shall be adjustable. The metal sheet used for the construction of these shall be minimum 1.6 mm thick extruded aluminum sheet.
- Grilles and diffusers constructed of extruded aluminum sections shall have grille bars set straight, or deflected as required. These shall be assembled by mechanical interlocking of components to prevent distortion. These grilles and diffusers shall have a rear set of adjustable blades, perpendicular to the face blades for deflection purposes.
- All supply air outlets shall be fitted with a VOLUME CONTROL DEVICE, made of extruded aluminum gate section. The blades of the device shall be mill finish/ block shade pivoted on nylon brushes to avoid rusting & rattling noise, which shall be located immediately behind the outlet and shall be fully adjustable from within the occupied space without removing any access panel. The volume control device for circular cutlets shall be opposed blade radial/shutter type dampers, or two or more butterfly dampers in conjunction with equalizing grid. Opposed blade dampers shall be used for square and rectangular ceiling/ wall outlets and intakes.
-

**D. Building Cooling& Heating Requirement:**

This section of the report describes the Cooling (TR) for the various spaces of the buildings. Table below shows the building wise preliminary requirement:

**Table-4 Building Cooling& Heating Requirement:**

| S. No. | Floor | Area Description | Floor area (Sqft) | Occupancy (Nos.) | Fresh Air CFM | Dehumified CFM | Cooling TR | MBH |
|---|---|---|---|---|---|---|---|---|
| 1 | GROUND | SHOP-1 to 11 | 3640 | 44 | 730 | 11210 | 23.7 | 104 |
| 2 | | SHOP-12 | 278 | 4 | 65 | 1483 | 3.6 | 14 |
| | | | | | | | | |
| 3 | FIRST | FACULTY OFFICE & LOUNGE | 1710 | 32 | 265 | 1,526 | 6.60 | 30 |
| 4 | | FACULTY ROOM -1 to 3 | 416 | 6 | 40 | 560 | 0.76 | 2 |
| 5 | | FACULTY ROOM - 4 | 139 | 3 | 115 | 309 | 0.90 | 3 |
| 6 | | FACULTY ROOM -5 to 9 | 625 | 1 | 65 | 1,079 | 3.20 | 10 |
| 7 | | FACULTY ROOM - 10 | 128 | 5 | 15 | 422 | 0.93 | 4 |
| 8 | | FACULTY ROOM - 11 | 126 | 1 | 15 | 177 | 0.33 | 1 |
| 9 | | FACULTY ROOM - 12 | 251 | 1 | 25 | 396 | 0.85 | 3 |
| 10 | | FACULTY ROOM - 13 | 233 | 2 | 25 | 175 | 0.46 | 1 |
| 11 | | MUSEUM OF EARTH SCIENCE | 3321 | 120 | 1100 | 4,307 | 16.9 | 42 |
| 12 | | LOUNGE | 938 | 30 | 450 | 1,502 | 5.01 | 16 |
| | | | | | | | | |
| 13 | SECOND | FACULTY OFFICE & LOUNGE | 1710 | 32 | 250 | 1526 | 5 | 29.5 |
| 14 | | FR-14 to 16 | 416 | 3 | 40 | 311 | 1.0 | 3 |
| 15 | | FR-17 | 139 | 1 | 15 | 348 | 1.0 | 3 |
| 16 | | FR-18 to 22 | 625 | 5 | 65 | 1143 | 3.3 | 11 |
| 17 | | FR-23 | 125 | 1 | 15 | 420 | 1.0 | 3.8 |
| 18 | | FR-24 | 123 | 1 | 15 | 176 | 0.4 | 1.7 |
| 19 | | FR-25 | 245 | 2 | 25 | 392 | 1.0 | 3.8 |
| 20 | | FR-26 | 228 | 2 | 25 | 170 | 0.6 | 1.7 |
| 21 | | SEMINAR ROOM | 789 | 28 | 305 | 1219 | 4.2 | 12 |
| 22 | | DIRECTOR'S OFFICE | 621 | 14 | 110 | 887 | 2.9 | 9 |
| 23 | | SECRETARY | 402 | 4 | 45 | 272 | 1.0 | 2.7 |
| 24 | | ADMIN OFFICE-1 | 107 | 1 | 10 | 180 | 0.5 | 1.8 |
| 25 | | ADMIN OFFICE-2 to 3 | 194 | 2 | 25 | 144 | 0.5 | 1.4 |
| 26 | | ADMIN OFFICE-4 | 96 | 1 | 10 | 278 | 0.7 | 2.7 |
| 27 | | LOUNGE | 938 | 30 | 450 | 1502 | 5 | 16 |
| 28 | | ADMINISTRATION | 1383 | 12 | 150 | 1085 | 3.6 | 10.3 |
| | | | | | | | | |
| 29 | THIRD | ARCHIVES | 993 | 15 | 190 | 1012 | 4.1 | 10 |
| 30 | | LIBRARY | 1970 | 48 | 475 | 2317 | 9.7 | 23 |
| 31 | | LOUNGE | 870 | 32 | 400 | 1740 | 5 | 16 |
| 32 | | CLASSROOM-1,2 | 1675 | 120 | 1400 | 3961 | 16.1 | 38 |
| 33 | | CLASSROOM-3 | 991 | 60 | 720 | 2158 | 8.6 | 21.1 |
| | | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 34 | FOURTH | SEMINAR ROOM | 830 | 38 | 240 | 1326 | 5 | 13 |
| 35 | | PHD CUBICLES | 2352 | 24 | 260 | 2520 | 7.76 | 25 |
| | | | | | | | | |
| **TOTAL** | | | **29627** | | | | **151** | **489** |

**Total HVAC Load for SAU-STUDIES - 152 TR**
**SAARC-STUDIES Load on Central Plant (@80 % diversity) - 122 TR**

**Note:** IT room, Fire control room are based on DX type air conditioned.

**Table-5 DX Type Load**

| AREA | Sq. ft. | TR |
|---|---|---|
| IT ROOM | 274 | 2 |
| FIRE CONTROL ROOM | 256 | 3 |
| UPS ROOM | 185 | 1.5 |
| SECURITY ROOM | 307 | 1.9 |

AHU Zoning of the building is as shown in the drawings and based on best possible option, efficient option and area application.

- Museum of Earth Science to have its own independent AHUs.
- We are proposing of HRW (Heat Recovery Wheel) unit for saving energy and make the building energy efficient. Please see the below mention detailedof fresh air requirement in whole building,zone wise according to drawings.

| ZONE -1 | | | |
|---|---|---|---|
| **FLOOR** | **EQUIP. TAG** | **FRESH AIR (CFM)** | **SPACE SERVED** |
| FIRST | AHU-02-01 | 770 | Museum of Earth Sciences |
| SECOND | AHU-03-01 | 515 | Seminar Room, Director Room , Admin |
| THIRD | AHU-04-01 | 2120 | Classroom-1,2 &3 |
| FOURTH | AHU-05-01 | 610 | Seminar Room &PhD cubicles |
| FIFTH | Future Expansion | 500 | |
| SIXTH | Future Expansion | 500 | |
| SEVENTH | Future Expansion | 500 | |
| Total Fresh Air : **5515cfm** | | | |

**HRW (Heat Recovery wheel):**

Heat recovery wheel is used to reduce the cooling load of outside fresh air .The amount of outside air which is required for maintaining the indoor air quality is first passed through a rotating wheel in which enthalpy of dry air is stored. Return air of room(will pass through toilets and pantry through door transfer grille and will be collected in exhaust duct from respective floor) passes through heat recovery wheel where exchange of enthalpy (Hot & cool) takes place and the fresh air supply to indoor unit contains much lower temperature than the outside air. Since outside air supplied to indoor unit is having less amount of enthalpy, so the net cooling load required to bring the outside air temperature to room air temperature is very less. In this way we can save energy consumption and maintain good indoor air quality. Saving of cooling load calculation is as follow:

**Table: Heat recovery energy calculation:**

| - | PEAK WINTER | PEAK SUMMER |
|---|---|---|
| OUTSIDE CONDITION | - | - |
| DBT($^0$C) | 12.0 | 43.3 |
| DBT($^0$F) | 53.6 | 109.9 |
| WBT($^0$C) | 9.5 | 24.0 |
| WBT($^0$F) | 49.2 | 75.2 |
| RH (%) | 74 | 19.6 |
| Total Enthalpy(H1) | 19.8 | 38.3 |
| Fresh Air (CFM) | 6000 | 6000 |
| ROOM CONDITION | - | - |
| DBT($^0$C) | 21.0 | 24.0 |
| DBT($^0$F) | 69.8 | 75.2 |
| WBT($^0$C) | 14.5 | 17.1 |
| WBT($^0$F) | 58.1 | 62.8 |
| RH (%) | 50.0 | 50.0 |
| Total Enthalpy(H2) | 25.2 | 28.2 |
| RETURN AIR CONDITION | - | - |
| DBT($^0$C) | 24.0 | 26.0 |
| DBT($^0$F) | 75.2 | 78.8 |
| WBT($^0$C) | 17.0 | 18.7 |
| WBT($^0$F) | 62.6 | 65.7 |
| RH (%) | 50.0 | 50.0 |
| Total Enthalpy(H3) | 28.2 | 30.4 |
| CONDITION OF FRESH AIR AFTER HRWs | - | - |
| DBT($^0$C) | 18.0 | 34.7 |
| DBT($^0$F) | 64.4 | 94.4 |
| WBT($^0$C) | 13.3 | 21.4 |
| WBT($^0$F) | 55.9 | 70.4 |
| RH (%) | 62.0 | 34.8 |
| Total Enthalpy(H4) | 24.0 | 34.4 |
| - | | |
| Case 1 :Total cooling load required to bring down outside air to room condition | | |
| Cooling Load (TR) | 12.2 | 22.7 |
| Equivalent heating (MBH) | 145.8 | - |
| - | - | - |
| Case 2 :Total cooling load required to bring down outside air to room condition with the use of Heat recovery wheel | | |
| Cooling Load (TR) | 9.5 | 8.9 |
| Equivalent heating (MBH) | 113.4 | - |
| - | - | - |
| Total Saving in cooling load with the use of HRW unit | | |
| Cooling Load (TR) | 2.7 | 13.8 |

| | | |
|---|---|---|
| **Heating load (MBH)** | **32.4** | **-** |
| **Saving percentage** | **22%** | **61%** |

**Saving in one day operation of building during Summer(considering 9 hours operation in a day) = 13.8 x 10 x 0.65 = 89.7 kwh**

**Saving in one year operation of building during Summer (considering 250 operational days in a year) = 89.7 x 280 = 25116 kwh**

**E. Air Distribution Systems**

Various Options will be explored, evaluated and opted for air distribution and low side system.

- Variable volume air distribution
- Constant volume air distribution system

Individual spaces will be evaluated for suitability for the above systems. Based on a detailed energy analysis and nature/application of each space, all above systems will be evaluated and the best options based will be applied. For example, Lecture hall to go with under floor Air distribution system, classrooms, office will have VAV and so on.
SAU-Studies building shall be served through central chilled water Plant located at utility building through pump & piping network.

- **Tertiary Pump:**
  Tertiary pump will be provided at later stages of design into the building basement to accommodate the pressure requirements at each AHU. This will be after the calculation of the pump head for the pumps of central plant.
  There shall be provision of 2 tertiary pumps (1 working+ 1 standby). This ensures and maintains the required pressure and flow of chilled water to meet the building cooling load.

- **BTU Metering System**
  Metered chilled water will be provided through each AHU in the complex where in BTU meter will be provided for measuring the AHU chilled water use. This will help to keep a check on energy usage at each space.

- **Duct Construction and Fire Safety**
  All ducts shall be fabricated out of galvanized sheet steel (GSS) as per SMACNA standard for long life and as per fire norms. Motorized smoke dampers shall be installed within supply air ducts and return air ducts at AHU room wall crossings, to prevent spread of smoke / fire to the adjoining areas. Air handling unit fan motor shall also be tripped when smoke is sensed in the conditioned area served by the air handling unit.

- **Fresh Air requirement**
  Fresh air requirement for various spaces shall be either mechanically forced or infiltrated.

**F. MECHANICAL VENTILATION AND SMOKE EVACUATION SYSTEM:**
Mechanical ventilation system is being considered for Utility rooms, Basements, Kitchen/pantry, toilets and other similar areas using combination of centrifugal fans, axial flow fans, propeller fans and inline fans.

1. **Car Parking Extract and Supply:**
   Mechanical Ventilation for car parking in basement shall be ducted ventilation as per Revised NBC-2005 designed to permit 6 ACPH for normal ventilation, and 12 ACPH in case of fire. During Normal operation, Exhaust air @ 6 ACPH shall be exhausted through fans in the basement and the fresh air requirement shall be met through the Ramp openings available. To

cater to additional 6 ACPH (total 12 ACPH) in case of fire, another set of Tube-axial fans connected with exhaust air riser shall get actuated. During this period, additional supply air fans @6 ACPH shall also supply the fresh air into the basement car parking area (wherever openings are not sufficient for the fresh air).

Basement ventilation fans for normal operation shall be provided with variable frequency drive controlled through CO concentration level within parking area for energy conservation.

As per revised NBC-2005, there is one zone considered for parking ventilation in SAARC Studies building. Area detail & air quantity required are given in table below:

**Table-6 – Parking Ventilation**

| Space | Area Sq.ft | Height (ft) | ACPH for Exhaust air | ACPH for Fire Mode | Exhaust air CFM in Normal mode | Exhaust CFM Fire Mode | Exhaust Air Fan | Fresh Air Fan |
|---|---|---|---|---|---|---|---|---|
| Car Parking Zone 1 | 11384 | 12 | 6 | 6 | 13660 | 13660 | 01#13700 CFM (N) & 01#13700 CFM (F) | 40% Through Ramp& 60% Air for 1 No. 16500 cfm SA Fan |

All the basement parking ventilation fans should be fire rated for a minimum of 250 Deg C for a minimum of 2 Hrs. application. Fan motor shall be Class H type with class O insulation. The fan motor shall have efficiency class IE-3.

2. **Bath, Toilet and Services Exhaust:**
   Bath exhaust fans will be provided in buildings as required removing foul air and maintaining air quality. Toilets, Service room, electrical room etc will also have exhaust system installed. Toilet doors shall have an undercut (or an air transfer grill) so that some air from the surrounding spaces shall pass through this undercut /air transfer grill and exhausted out, using duct mounted fans. Toilets are ventilated through the ducting arrangement.

   Propeller, axial and duct mounted inline fan of required CFM and relative pressure serve the space. Approx. CFM for the different areas for various building in Stage-I is as shown in table:

**Table-7 –Ventilation Summary:**

| Room Name | Area SQFT. | ACPH | CFM |
|---|---|---|---|
| ELEC. PANEL ROOM-1 | 660 | 15 | 1980 |
| SERVICES | 518 | 12 | 1243 |
| MALE TOILET-1 | 104 | 10 | 208 |
| FEMALE TOILET-1 | 93.6 | 10 | 187 |
| HAND. TOILET-1 | 52 | 10 | 104 |
| ELEC. PANEL ROOM-2 | 88 | 15 | 264 |
| MALE TOILET-2 | 104 | 10 | 208 |
| FEMALE TOILET-2 | 93.6 | 10 | 187 |
| HAND. TOILET-2 | 52 | 10 | 104 |
| ELEC. PANEL ROOM-3 | 88 | 15 | 264 |
| MALE TOILET-3 | 104 | 10 | 208 |

| | | | |
|---|---|---|---|
| FEMALE TOILET-3 | 93.6 | 10 | 187 |
| HAND. TOILET-3 | 52 | 10 | 104 |
| ELEC. PANEL ROOM-4 | 88 | 15 | 264 |
| MALE TOILET-4 | 104 | 10 | 208 |
| FEMALE TOILET-4 | 93.6 | 10 | 187 |
| HAND. TOILET-4 | 52 | 10 | 104 |
| ELEC. PANEL ROOM-5 | 88 | 15 | 264 |
| MALE TOILET-5 | 104 | 10 | 208 |
| FEMALE TOILET-5 | 93.6 | 10 | 187 |
| HAND. TOILET-5 | 52 | 10 | 104 |
| ELEC. PANEL ROOM-6 | 88 | 15 | 264 |
| MALE TOILET-6 | 104 | 10 | 208 |
| FEMALE TOILET-6 | 93.6 | 10 | 187 |
| HAND. TOILET-6 | 52 | 10 | 104 |
| ELEC. PANEL ROOM-7 | 88 | 15 | 264 |
| MALE TOILET-7 | 104 | 10 | 208 |
| FEMALE TOILET-7 | 93.6 | 10 | 187 |
| HAND. TOILET-7 | 52 | 10 | 104 |
| ELEC. PANEL ROOM-8 | 88 | 15 | 264 |
| MALE TOILET-8 | 104 | 10 | 208 |
| FEMALE TOILET-8 | 93.6 | 10 | 187 |
| HAND. TOILET-8 | 52 | 10 | 104 |
| ELEC. PANEL ROOM-9 | 88 | 15 | 264 |
| **Total** | **3878.8** | | **9329** |

3. **Lift Well / Lift Lobby / Staircase Pressurization:**
   Fire escape staircases shall be provided with 50 Pa of Positive Pressurization and Lift well and lift lobby shall be provided with 50 and 30 Pa of Positive Pressurization arrangement, consisting of supply air fans installed on roof top. The fans shall connect to supply air ducts installed in vertical risers and inject air at each staircase landing, for achieving effective pressurization. Fans shall be sized to maintain minimum positive pressure of 50 Pa across the door. Make up air fans serving stairwell shall be provided with motorized damper at fan discharge to prevent humid fresh air entering into staircase well. These dampers shall be interlocked with fan motor and shall open upon getting signal from the smoke sensor. Lift wells shall also be similarly pressurized by supplying the air through fans installed on roof top.
   ***Refer to Annexure-A, B and C for Lift well, Lift lobby & Staircase pressurization**

**G. Brief Description of HVAC Equipments:**

**1. AIR HANDLING UNITS**

The air handling units shall be double skin construction, draw through type comprising of various sections such as mixing box, (the return air and fresh air are ducted), pre-filter section, cooling & heating coil sections, fan section, filters section, Double skinned panels shall be (60mm thick for units for AHUs made of galvanized steel, pressure injected with foam insulation of density 40 kg/m$^3$ .The entire framework shall be mounted on an aluminum alloy channel base. Panels shall be sealed to framework by heavy duty “O” ring gaskets held captive in the framed extrusion. All panels shall be detachable or hinged. Hinges shall made of die cast aluminum with stainless steel pivots, handles shall be made of hard nylon and be operational from both inside and outside of the unit. Thermal breaks shall be provided in the unit framework to prevent condensation at the panel joints during humid outside conditions. Units shall have

hinged, quick opening access door in fan and filter section. Access doors shall be double skin type. Condensate drain pan shall be fabricated from 18 gauge stainless steel sheet with all corners welded. It shall be isolated from bottom floor panel through 25 mm heavy duty urethane foam.

Centrifugal Fans shall be forward/ backward inclined blade type. Fan casing shall be made of galvanized steel sheet. Fan wheels shall be of galvanized steel. Fan wheels and pulleys shall be individually tested and precision balanced dynamically. Fans shall be imported.
Both fan and motor assemblies shall be mounted on a deep section aluminum alloy or galvanized steel base frame. The fan motor shall have efficiency class IE-3.

**2. Axial Fans**

The fan casing and Motor mounting plates should be manufactured from mild steel. The fan casing and flanges should have a minimum thickness of 3.0mm for fans up to and including 1000mm diameter, with thickness of 5mm for larger diameters. Flanges should be integral with casing and should be provided with bolt holes for connection. The casing assembly, complete with flanges, should be hot dip /spray galvanized after manufacture.
An external terminal box should be provided, as standard, on long case fans. Short case fans will have a terminal box on the motor only.
The pitch angle of the fan should be individually adjustable. The fan should be of the variable pitch angle or controllable pitch angle design. The supplier should be able to provide evidence that the impeller has been adequately stressed for running at the highest speed. The impeller should be balanced to G3.6 or better as defined in ISO 1940/1:1986 (6.3 mm/s peak to peak or 4.5mm/s rms).
The aerodynamic design of the fan should be such that the maximum power required by the fan occurs within the normal working ranges, i.e., it has a non-overloading characteristic.
The fan should be suitable for frequent starting applications and for continuous operation in ambient temperatures ranging from -43°C up to +63°C.
Fan motors should be at the totally enclosed, squirrel cage induction, continuous duty, and variable torque type. Fan motor shall be Class H type with class F insulation. The fan motor shall have efficiency class IE-3.

**3. Centrifugal Fans:**

Centrifugal fans shall be of double-width, double-inlet construction, with bearing on both sides, complete with access door, squirrel-cage induction motor, V-belt drive, belt guard etc.
Housing shall be of heavy gauge sheet steel in welded construction. It shall be rigidly reinforced and supported by structural angles. Split casing shall be provided on larger sizes of fans. However neoprene/ asbestos packing shall be provided throughout split joints to make it airtight. 1.2 mm galvanized wire mesh inlet guard, of 5cms sleeves shall be provided on both inlets. Housing shall be provided with access door with quick locking tension handles and neoprene gasket. Rotation arrow shall be clearly marked on the housing.
Fan wheel shall be backward curved non-overloading type unless otherwise specified. Fan wheel and housing shall be statically and dynamically balanced. Fan outlet velocity shall not exceed 610 meters per minute.
Shaft shall be constructed of steel, turned, ground and polished.
Bearings shall be of the sleeve/ball bearing type mounted directly on the fan housing. Bearing shall be self-aligned, oil grease packed, pillow block type.
Drive to fan shall be provided from 3 phase electric motor through belt with adjustable motor sheave and belt guard. Belt shall be of the oil resistant type. The number of belts shall be not less than two.Fan motor shall be Class A type with class F class insulation. The fan motor shall have efficiency class IE-3.

**4. Variable Speed Drives:**

Variable speed drive shall be factory installed on the Electrical panel. It will vary the fan motor speed by controlling the frequency and voltage of the electrical power to the motor. The capacity control logic shall automatically adjust motor speed and capacity control mechanism for maximum real world efficiency by analyzing information fed to it by sensors located either in return air path or potential difference sensors located across the duct.Unit must have less than 5% Total Demand Distortion (TDD) at equipment level.

Field power wiring shall be a single point connection and electrical plugs for incoming power wiring will be provided. All VSD components are designed to last the life of the AHU.

**5. Fire Dampers:**

Motorized fire damper shall be installed with supply & return duct at AHU room wall to prevent spread of smoke fire at adjoining areas dampers shall be robust constructions and tightly fitted. The design, method of handling and control, shall be suitable for the location and service required. Dampers and their operation devices shall be made robust, easily operable, and accessible through suitable access doors in the ducts. Every damper shall have an indicating device clearly showing the damper position at all times.

Fire dampers shall be motorized smoke & fire dampers type. It shall be supplied with spring loaded UL stamped fusible link to close fire damper in the event of rise in duct temperature. Fire damper shall also close on receipt of fire alarm signal to cut off air supply instantaneously. An electric limit switch shall also be operated by the closing of fire damper, which in turn shall switch off power supply to AHU blower motor as well as strip heaters(If installed).

**6. Dampers**

Dampers shall be opposed blade type. Blades shall be made of double skinned aerofoil aluminum/ GI section with integral gasket and assembled within a rigid extruded aluminum alloy frame. All linkages and supporting spindles shall be made of aluminum/GI or nylon, turning in Teflon bushes. Manual dampers shall be provided with a Bakelite knob for locking damper blades in position.

**7. Grilles and Diffusers:**

Supply air grilles shall be provided with vertical and horizontal adjustable bars and volume control multi-louver damper which shall be key operated from the front of the grille. All linear diffusers shall be powder coated extruded aluminum. All linear grilles shall be of extruded aluminum.

**8. Insulation:**

Thermal insulation shall be applied to air distribution ductwork and to components within distribution systems such as fans, and cooler casings which convey conditioned air within AHU rooms and to ductwork (including recirculation air ductwork) conveying warmed or chilled air through unconditioned spaces or the open air. Unless otherwise indicated, distribution systems conveying conditioned, warmed or chilled air through conditioned spaces shall not be insulated. Distribution system conveying fresh air. Thermal insulation shall be applied to chilled water pipe work distribution systems and to components within distribution systems such as valves. Where thermal insulation is applied to the outside of piped and ducted services. The vapor barrier shall be applied such that it is continuous and given protection to the whole surface of the insulation which it protects. It shall not be pierced or otherwise damaged by supports or by the application of external cladding. At points of support means of load distribution shall be provided as necessary.

| Space | Insulation Thickness |
|---|---|
| Duct in conditioned Space | 19.00 mm (XLPE) |
| Duct in unconditioned space | 25.0 mm (XLPE) |

**9. Acoustic lining of AHU Rooms:**

Acoustic insulation on walls and ceiling of Air handling unit's rooms with 50mm thick resin bonded fiber glass slabs fixed in frame work and finished with vapor barrier and perforated aluminum sheet

two walls and ceiling of air conditioning plant room and air handling unit rooms may be provided with acoustic lining of resin bonded fibre glass. The surface shall be cleaned and frame work of 22 gage GI fabricated Channels 25 mm x 50 mm screwed back to back at 60 cm centre's shall be provided vertically and horizontally so that 60 x 60 cm squares are formed. The gaps between frames shall be filled with 50 mm thick about 60 cm x 60 cm cut panels of resin bonded fiberglass slabs. The entire surface shall then be covered with fiberglass tissue and 26 gage perforated aluminum sheet, 60 cm or 120 cm wide having at least 15 percent perforations, fixed with sheet metal screws. Over-lapping of sheets shall be covered with Aluminum beading. Acoustic lining of walls shall be terminated approximately 15 cm above the finished floor to prevent damage to insulation due to accidental water-logging in plant/AHU rooms.

**10. Acoustic lining over ducts:**

Ducts shall be lined internally with acoustic insulation as detailed below:

- The Inside surface of duct on which the acoustic lining is to be provided shall be clean free from all dust and grease.
- Then 25 x 25 sq.mm section of minimum 1.25 mm thick G.I. sheet shall be fixed on both ends of the duct piece.
- The insulation slabs shall then be fixed between these section of ducts using CPRX adhesive compound and stickpins.
- The insulation shall then be covered with Reinforced plastic/ fiber glass tissue, sealing all joints so that no fiber is visible.
- The insulation shall finally be covered with minimum 0.5 mm thick perforated aluminum sheet having perforations between 20-40%

**11. Filters:**

**i. Pre-filters (fabric type)**

Synthetic fiber Pre-filters shall be in light weightaluminium framed with non woven synthetic fiber replaceable media. The filter shall have an efficiency of 90 percent down to 10 microns particles size when tested as per B.S.2831 standards. The filter frame shall be of aluminium and shall be suitable for mounting in Air handling units or ducts as required at site. The velocity across the face of the filter shall not exceed 500 FPM and the pressure drop across the filter shall not exceed 4mm.

**ii. Microvee filters (fine filters):**

Microvee filters shall be of dry type. Filters media shall be made from washable nonwoven synthetic fibre replaceable media reinforced with HDPE cloth & Aluminum mesh, specially treated with antifungal and bactericidal agents to prevent growth of micro organisms. The filter media shall be treated to permit washing with water several times before discharged. The media shall be properly supported and spaced so that air flow through the filter is uniform. The filter shall be housed in aluminium frame work. Filters shall be designed to remove particle down to 5 micron size and with efficiently of 98.0 percent tested as per BS 2831 using Test Dust II. The filters shall be installed in the air handling units after the chilled water coils. They shall be capable of being replaced or removed for servicing without the use of special tools.

## H. BUILDING MANAGEMENT SYSTEM:

Building automation and control systems would control and monitor system such as air handling units, Tertiary Pumps, Fans in Parking area, Lift and miscellaneous electrical and plumbing points.
A totally direct digital control (DDC) system with electric Actuation control Valve and Damper would be considered.
There would be preference to systems, which support open protocol, i.e., BACNET.

**MONITORING/ CONTROLLING POINTS FOR BMS:**

| S. No. | Description |
|---|---|
| | **HVAC SYSTEM**<br>**AIR CONDITIONING SYSTEM** |
| | |
| **A** | **OUTSIDE AIR** |
| | Outside Air Temperature and RH |
| | |
| **B** | **AIR HANDLING UNITS (with RH & Temp Control) (Common areas)** |
| | AHU Blower Status |
| | AHU Manual Operation Status |
| | AHU FAN ON/OFF Status |
| | AHU Motor trip Status |
| | AHU Run Status |
| | AHU Filter Status |
| | AHU Return Air Temperature & RH |
| | AHU modulate Chilled Water Valve |
| | VAV/ VFD |
| | Fresh air Damper control |
| | Fresh air damper Feedback |
| | Supply/Return Fire Damper status |
| | |
| **C** | **VENTILATION FANS/TOILET FANS** |
| **D** | **LIFTS MONITORING** |
| **E** | **ELECTRICAL ENERGY** |
| **F** | **BASEMENT FANS** |
| **G** | **TERTIARY CHILLED WATER PUMP** |
| **H** | **HEAT RECOVERY WHEEL** |

# ANNEXURE A, B and C
# FOR
# SAARC STUDIES PRESSURIZATION CALCULATION

**I. Annexure – A**

**Pressurization of each Staircase (Basement)**

**1. Leakage path from pressurized staircase are as follows**

a) Door at each mid landing
b) Door on the basement floor

**2. Staircase Description**

a) Total No. of Doors = 2 Nos.
b) Door size = 1.5 m x 2.1 m
c) Area of each door = 3.15 $mt^2$ or 33.9 $ft^2$.

**3. Calculation of air quantity leakage through open staircase door as follows;**

= Area of staircase door ($mt^2$) x Exhaust air velocity of air assumed (m/second) x Nos. of Doors open.

= 3.15 x 1 x 1 = 3.15 $m^3/s$

= (3.15 x 3600) / 1.7

= 6670 CFM

**4. Calculation of air quantity leakage through staircase doors and cracks on other floors**

Perimeter of door = 7.2 m

Assume Gap = 2.0 mm =0.002 m

Total No. of leakage door = 2 Nos.

Total leakage area = Perimeter of Door x Gap x No. of Leakage Door

= 7.2 x 0.002 x 2

= 0.0288 $mt^2$

Now, Assume Pressure Difference = 50 Pascal

Now, Air leakage through Staircase door and cracks = 0.827 x leakage area x √PD

= 0.827 x 0.0288 x √50

= 0.169$m^3/s$

= (0.842 x 3600) / 1.7 CFM

= 357 CFM

Accounting for 5 % duct losses = (6670 + 357) x 1.05

= 7379.28 CFM

**Say 8,000 CFM @30 mm of WG total static pressure of free inflow of air for Each Staircase Pressurization.**

**Annexure – B:**

**Pressurization of each Lift Lobby (Basement to 7th Floor)**

**1. Leakage path from pressurized lift lobby are as follows**

a) Door at each mid landing
a) Door on the ground floor

**2. Staircase Description**

a) Total No. of Doors = 9 Nos.
b) Door size = 1.5 x 2.1 mt.
c) Area of each door = 3.15 $mt^2$ or 33.9 $ft^2$.

**3. Calculation of air quantity leakage through open lift lobby door be as follows;**

= Area of lift lobby door ($mt^2$) x Exhaust air velocity of air assumed (m/second) x Nos. of Doors open.

= 3.15 x 1 x 2 = 6.3$m^3$/s

= (6.3 x 3600) / 1.7

= 13341 CFM

**4. Calculation of air quantity leakage through lift lobby doors and cracks on other floors**

Perimeter of door = 7.2 m

Assume Gap =2.0 mm = 0.002 m

Total No. of leakage door = 9 Nos.

Total leakage area = Perimeter of Door x Gap x No of Leakage Door

=7.2 x 0.002 x 9

= 0.1296 $mt^2$

Now, Assume Pressure Difference = 30 Pascal

Now, Air leakage through lift Lobby door and cracks = 0.827 x leakage area x √PD

= 0.827 x 0.1296 x √30

= 0.587$m^3$/s

=(0.587 x 3600) / 1.7 CFM

= **1243 CFM**

Accounting for 5 % duct losses = (13341 + 1243) x 1.05

= 15313 CFM

**Say 16000 CFM @30 mm of WG total static pressure of free inflow of air for each Lift Lobby.**

**Annexure – C:**

**Pressurization of each Lift Well (Basement to 7th Floor)**

**1. Leakage path from pressurized lift well are as follows**

a) Door at each mid landing

**2. Staircase Description**

a) Total No. of Doors = 9 Nos.
b) Door size = 0.8m x 2.1 m
c) Area of each door = 1.68 $mt^2$ or 18.08 $ft^2$.

**3. Calculation of air quantity leakage through open lift well door be as follows;**

= **Area of lift lobby door ($mt^2$) x Exhaust air velocity of air assumed (m/second) x Nos. of Doors open.**

= 1.68 x 1 x 1 = 1.68 $m^3/s$

= (1.68 x 3600) / 1.7

= **3558 CFM**

**4. Calculation of air quantity leakage through lift well doors and cracks on other floors**

Perimeter of door = 5.8 m

Assume Gap =2.0 mm =0.002 m

Total No. of leakage door = 9 Nos.

Total leakage area = Perimeter of Door x Gap x No. of Leakage Door

= 5.8 x 0.002 x 9

= 0.1044 $mt^2$

Now, Assume Pressure Difference = 50 Pascal

Now, Air leakage through lift Well door and cracks = 0.827 x leakage area x √PD

=0.827 x 0.1044 x √50

= 0.61$m^3/s$

=(0.61 x 3600) / 1.7 CFM

= **1293 CFM**

Accounting for 5 % duct losses = (3558 + 1293) x 1.05

= 5094 CFM

**Say 5,100 CFM @30 mm of WG total static pressure of free inflow of air for each Lift Well.**

# 12.25. ANNEXURE X - DDR for EXTERNAL DEVELOPMENT

## 12.25 : ANNEXURE X - DDR for EXTERNAL DEVELOPMENT

### A. Introduction:

South Asian University is an International level educational campus proposed to be located at Maidan Garhi, New Delhi. The University includes Academic blocks, Library, Hostels, Residences, Gymnasiums, Health center etc. The Overall campus has a total plot area of 95.7 acres.

- Site Location : New Delhi
- Geographic Location : 28.56°N
- Altitude : 233m above mean sea level

**1. Purpose:**

The primary purpose of this report is to provide and describe a permanent record of the HVAC system for the South Asian University, New Delhi. In addition to describing the system, the fundamental assumption used for design is also outlined.

This information is critical to ensure the contractor, other disciplines operator, and future designers understand the assumptions made and the limitations of the systems. Without this information, one has to guess at the designer's line of reasoning during their design process. Throughout the design process, the basis of design needs to be consistent with the project intent. The project intent is shown in the basis of design, the designer transformed the project intent and challenges into reality.

**2. Project Description:**

South Asian University is an educational Campus, proposed as an International level university for SAARC country students located at Maidan Garhi, New Delhi. The university includes Academic blocks, Library, Hostels, Residences, Gymnasiums, Health center etc. The Overall campus has a total built-up area of 65 acres approx. and will be constructed in three stages.

### B. Air Conditioning Philosophy of the project:

The Air conditioning approach to the South Asian University is by a centralized district cooling plant of required capacity. District Cooling is an environmental friendly technology for producing and distributing refrigeration to various buildings located in the vicinity of cooling plant. For an efficient system all included parts of the supply chain need to function efficient. A District Cooling system consist of centralized production plant(s), a distribution network and energy transfer station (AHU) to the building which require air conditioning. Shown below is a pictorial representation of district cooling system.

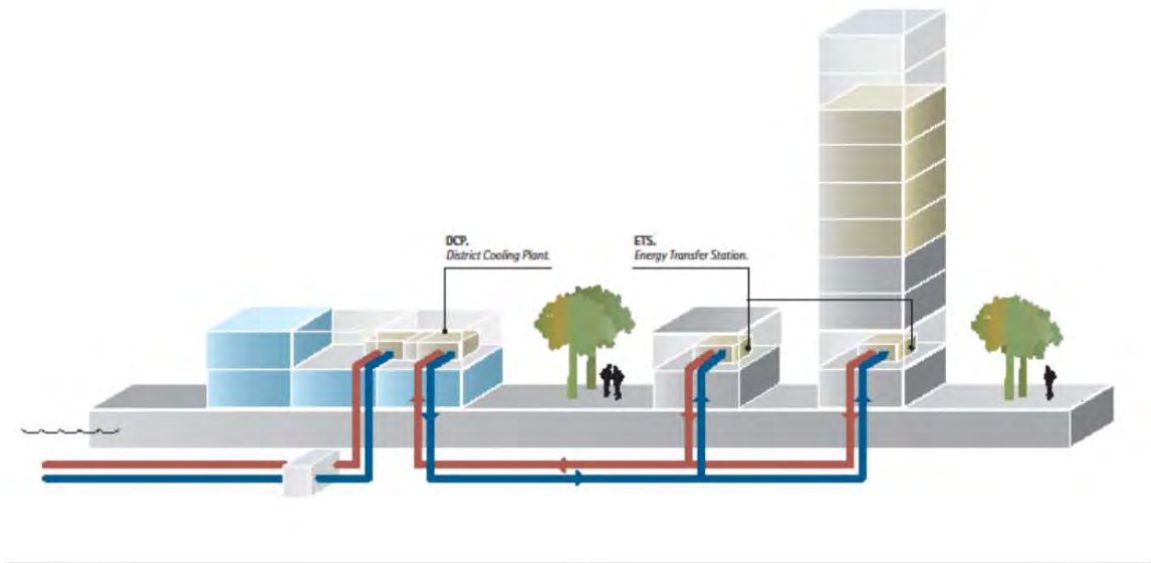



***Figure 1: District cooling system – general schematics***

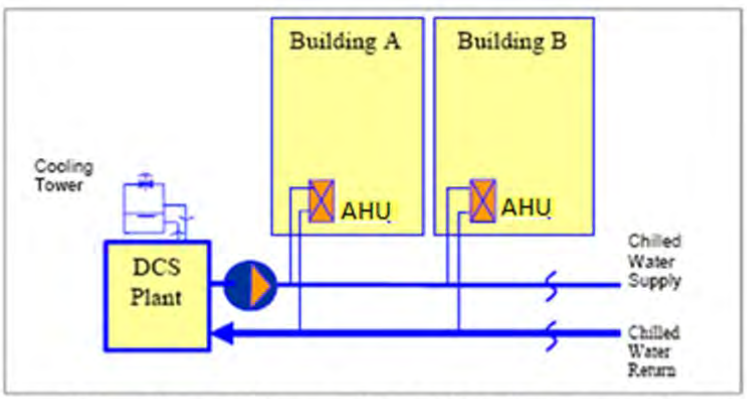



**Figure 1.2 Schematic Diagram of DCS with Cooling Tower for Heat Rejection**

A suitable space to be provided for the installation of the District Cooling system, Energy Transfer Station (ETS) equipment, the "ETS Plant Room for District Cooling". This should include space for the service lines, interconnecting pipes as well as floor drain and fresh water piping.

**Codes and Standards**

These standards must be used for the primary side, but are recommended for the Secondary side as well.

- IS 1239: MS "C" Class pipe up to 150 mm dia.
- IS 3589: MS "C" Class pipe above 150 mm dia.
- IS 13205: Code of practice for Polyurethane insulation by In Situ pouring method.
- IS 14164: Code of practice for industrial application and finishing of thermal insulation material from -80 $^0$C to +700 $^0$C.
- IS 4984: Specification for HDPE Pipe- Water Supply.
- IS 14333: Specification for HDPE Pipe- Sewerage.

**C. <u>Chilled Water Distribution Plan to the entire campus :</u>**

Chilled water supply and return pipe shall be brought out from the utility building and shall be buried underground to run around the campus in order to serve each and every building with the required

flow rate of chilled/hot water. Pipe shall be running near to the building and a tapping of adequate size shall be taken off from the main line to serve the various building of the campus.

Piping shall be installed at the locations shown on the drawings, properly graded and secured to ensure noiseless circulation throughout the system. Supply and Return piping shall be properly erected to prevent the formation of air and water pockets. Any location that tends to trap air or hold water shall have air vents installed at the high points.

- Hydronic Piping material for chilled/heating water supply and return shall be of Heavy Class Black steel (Pre Insulated MS"C" Class) Pipes. Piping up to and including 150 mm diameter shall be of heavy class black steel confirming to IS:1239 and piping greater than 150 mm shall be minimum 6 mm thick black steel confirming to IS:3589. All jointing in the pipe system shall be by welding. Various type of valves such as butterfly valves, balancing valves and non return valves shall be provided in water lines. Condensate drain piping would be GI 'B' Class conforming to relevant BIS codes.
- With all buildings on a common header in chilled water system, the following pump configuration has been proposed:
  a. 6 working+1 standby for normal operating chillers.
  b. 1 working+1 standby for 24X7 operating chillers.

Piping shall be sized for the following design parameters:

- Maximum velocity : 1.2 m/sec (4FPS) (For piping 50 mm and under)

  : 2.5 m/sec (8.2FPS) (For piping over 50 mm)

- Maximum Friction : 15KPa for 30m run (5 ft/100 ft)

**D. <u>System Guidelines:</u>**

The following major design criteria shall be used in implementation of these standards:

**1) <u>Chilled Water/Heating Water Temperature:</u>**

**a. Supply Side**

i. Operating temperature 44 ± 3 $^0$ F (Chilled Water)/ 120 ± 5 Degrees F (Heating Water).
ii. Operating pressure 160 psig maximum

**b. Return Side**

i. Operating temperature 56 ± 3 $^0$ F (Chilled Water)/ 100 ± 5 Degrees (Heating Water).
ii. Operating pressure 160 psig maximum

**c. Design Temperature Differential**

i. Preferred 12 Degrees F (Chilled water)/20 Degrees F (Heating Water).
ii. Minimum 10 Degrees F (Chilled water).

**b) <u>Component Matrix and Guidelines</u>:**

| System | Installation | Piping | Valves | Testing | Insulation | Excavation / Backfill |
|---|---|---|---|---|---|---|
| **Chilled Water** | Buried | Pre Insulated MS"C" Class | Buried | Testing and Flushing Guideline | Polyurethane foam(PUF) | Site, Civil, and Grounds |

**2) Buried Chilled Water Piping:**

i. Pre insulated MS"C" Class (heavy duty) pipe
a. Minimum pressure rating: 160 psig
b. Joints: Electric Arc Welding
c. Flanged connections: at valves only

ii. Minimum depth of top of piping shall be 1000 mm below final surface grade. Slope piping upwards toward building, provide air vents at all high points.

iii. Direct-buried chilled water piping shall be insulated with polyurethane foam with maximum thermal conductivity of 0.021W/m k at $24^0$ C when tested in accordance to IS:12436

iv. The polyurethane insulation properties shall be in accordance to ASTM C1029, Type-III- Specification for spray applied rigid cellular polyurethane thermal insulation", compressive strength ≥ 300 kPa and closed cell content ≥ 88 %

v. The insulation jacket for $90^0$ elbows (standard elbows) shall be molded, seamless HDPE. Extrusion welded or butt fusion welded HDPE may be used for short radius $90^0$ elbows.

vi. The insulation jacket for tees and odd angle elbows shall be molded seamless HDPE, extrusion welded or butt fusion welded HDPE.

vii. The outer casing/jacket shall be made of HDPE pipe of 4 mm thick for pipe dia 60 mm and above with a density of 900 to 960 kg/$m^3$. For pipe smaller than 60 mm dia, thickness of HDPE jacket shall be lower than 4 mm as per standard for HDPE pipes.

**3) Valves for Buried Chilled Water Piping:**

I. Manual valve:

Valve with ANSI B16.1 or IS 4984, Class 250 ductile iron body, ASTM A-564 Type 630 condition H-1150 shaft extended to grade level, nylon coated ductile iron disc; EPDM seat; class 125/150 bolt pattern; flanged connection; 250 psi bubble tight shut off and dead end service; Manual actuators shall be of the traveling nut, self-locking type and shall be designed to hold the valve in any intermediate position between fully open and fully closed without fluttering or creeping. The actuator shall have mechanical stops that will withstand and input torque of 450 ft/lb. against each stop. Manual isolation valve shall be provided on Chilled Water Supply and Chilled Water Return lines outside of each building within 5 feet from entering the building, at each street crossing and at each take-off from mains. Terminate the shaft extension in a manhole buffalo box with cover to protect the shaft from ground traffic.

II. Air Vent valve:

Apollo flanged ball valve in a manhole buffalo box with cover at grade to protect the shaft from ground traffic. Vent piping shall be MS "C" Class, fusion welded and flanged at connection to ball valves.

III. Companion flange:

Provide ductile iron extensions to each side of valve, bolt to pre insulated MS pipe flange with stainless steel bolts and nuts, applicable gasket.

**Note :-** Provide weather & soil protected permanent label on chilled water supply and return line. It shall be after 10 meter interval of pipe. The label shall be as per standards. Use permanent code and letter coloring unaffected by moisture and other substances contained in trench backfill material.
Also a warning and caution stating "CAUTION: Buried chilled water piping distribution below or similar wording shall be made on ground at every 50 meter.
Wherever the pipe is open to atmosphere, it shall be covered with Aluminum cladding.

## E. Broad Specification for Pre Insulated MS Pipe:

- The core pipe shall be MS, ERW heavy duty class to IS: 1239 & IS: 3589. All pipes shall be with beveled ends for welded joint.
- All underground hydronic piping shall be insulated with polyurethane foam (PUF) with maximum thermal conductivity of 0.021 W/m k at 24° C, when tested in accordance with IS: 12436 complete with HDPE jacket.
- All above ground hydronic piping shall be insulated with polyurethane foam (PUF) with maximum thermal conductivity of 0.021 W/m k at 24° C, when tested in accordance with IS: 12436.
- The insulation shall be rigid cellular polyurethane foam, injected between the core pipe and the outer casing/jacket, having a density of 40 kg/m3 (2.5 lbs/$ft^3$) nominal and thermal conductivity coefficient of 0.021W/m°K (max) at a mean temperature of 24°C (75°F). The insulation shall meet IS: 12436 specifications with typical operating temperature between -30°C to +100°C.
- Chilled water piping insulation thickness shall be 25 mm thick for 40 mm pipe and smaller, 40 mm thick for 50 mm to 150 mm pipe and 75 mm thick for pipe greater than 150 mm.
- The outer casing/jacket shall be made of extruded high-density polyethylene (HDPE) pipe having a density of 900 to 960 kg/$m^3$. HDPE wall thickness shall be 4mm thick for pipe of 60.3 mm dia and above. For small bore pipes (below 60.3mm) available HDPE pipes shall be used, where thickness can be lower than 4mm as per standard for HDPE pipes. Material shall be UV resistant.
- Pre-insulation process shall be by high pressure foaming machine. Due care shall be taken to avoid air gaps.
- All ends of straight pipes and fittings shall be sealed with polyolefin end seal, applied to the exposed ends of the insulation for protection against moisture ingress.
- The field joint insulation shall consist of polyurethane foam chemical poured into a 4mm thick HDPE sheet roll-up around the joint. Contractor shall provide methodology for approval of consultant before proceeding with work at site.
- The service pipe shall be hydrostatically pressure tested at a minimum of 150 % of the design pressure in accordance with ASME B31.1. Hydro testing shall be performed prior to applying the insulation and jacket at the field joint. A heat shrinkable or weldable HDPE casing which is pressure testable shall be installed over the field joint area and pressure tested in accordance with the manufacturer's instruction prior to insulating the field joint area.
- The system shall be non corrosive, non-metallic, structurally strong completely water proof and entirely resistance to attack by salts, water and all ground chemicals normally encountered.
- All straight sections fittings, anchors end seals and other accessories shall be factory prefabricated to the project dimensions. The same may be allowed at site if OWNER permits.
- Pipe movement due to thermal expansion shall be accommodated with expansion loops or elbows.
- PVC warning tape shall be provided 300 mm above the buried throughout the length of the pipe .

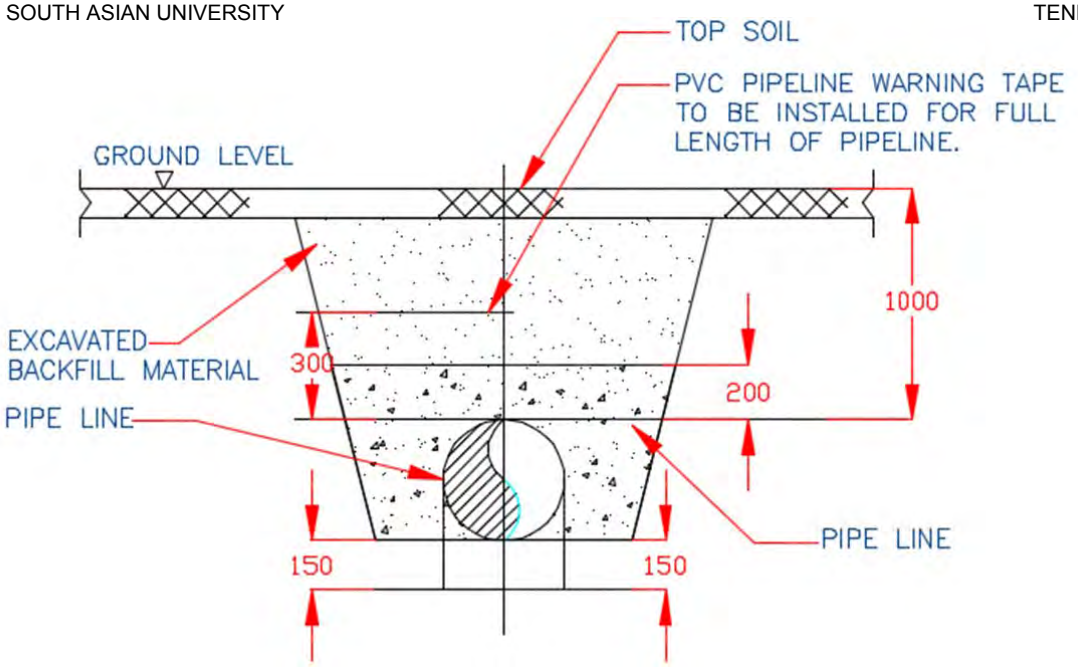



**Figure 1 : Typical Buried pipe laying arrangement.**

**<u>Image 1 : MS pipe with PUF spacer blocks.</u>**

**Image 2 : MS pipe with PUF insulation and HDPE jacketing.**

**TABLE 1 : CHILLED WATER PIPE SIZING CALCULATION**

| Pipe Sizing Table- Site Plan, SAU | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **S. No.** | **Node** | **Building Total Cooling Load(TR)** | **Cooling (TR)** | **Flow rate(USGPM)** | **Friction Rate (feet/100 feet)** | **Maximum Velocity (ft/sec)** | **Pipe Dia (mm)** | **Pipe Dia inside the building(mm)** |
| 1 | Plant Room | | 4756 | 9512 | 2 to 3 | 8.2 | 600 | - |
| 2 | After Art & Convention | 693 | 4063 | 8126 | 2 to 3 | 8.2 | 500 | 250 |
| 3 | After LSES | 1400 | 2663 | 5326 | 2 to 3 | 8.2 | 400 | 350 |
| 4 | After Phy Chem Maths | 788 | 1875 | 3750 | 2 to 3 | 8.2 | 350 | 250 |
| 5 | After Law and Humanities | 656 | 1219 | 2438 | 2 to 3 | 8.2 | 350 | 250 |
| 6 | After Admin | 559 | 660 | 1320 | 2 to 3 | 8.2 | 250 | 250 |
| 7 | After Library | 406 | 254 | 508 | 2 to 3 | 8.2 | 200 | 200 |
| 8 | After SAARC | 254 | - | | | 8.2 | 200 | 150 |

# 12.26. ANNEXURE XI - DDR for U1 - UTILITY BUILDING

## 12.26 : ANNEXURE XI - DDR for UTILITY BUILDING

### A. Introduction:

South Asian University is an International level educational campus proposed to be located at Maidan Garhi, New Delhi. The university includes Academic blocks, Library, Life Science and Bio-technology, Earth science, Physical & Chemical science, Mathematics & IT, Economics & Social science, Law & Humanities, Art & Design, Business school, Undergraduate studies, Research Centre and data Centre, Residences & Health center etc. The Overall campus has a total plot area of 93.68 acres.

- Site Location : New Delhi
- Geographic Location : 28.56°N
- Altitude : 233m above mean sea level

1. **Purpose:**

The primary purpose of this report is to provide and describe a permanent record of the HVAC Chiller plant room for the South Asian University, New Delhi. In addition to describing the system, the fundamental assumption used for design is also outlined.

This information is critical to ensure the contractor, other disciplines operator, and future designers understand the assumptions made and the limitations of the systems. Without this information, one has to guess at the designer's line of reasoning during their design process. Throughout the design process, the basis of design needs to be consistent with the project intent. The project intent is shown in the basis of Design; the designer transformed the project intent and challenges into reality.

2. **Project Description:**

South Asian University is an educational Campus, proposed as an International level University for SAARC country students located at Maidan Garhi, New Delhi. The university includes Academic blocks, Library, Life Science and Bio-technology, Earth science, Physical & Chemical science, Mathematics & IT, Economics & Social science, Law & Humanities, Art & Design, Business school, Undergraduate studies, Research centre and data Centre, Residences & Health center etc. The Overall campus has a total built-up area of 540405 sq.mtr.

3. **Sustainability and Energy Goals:**

a) South Asian campus is targeting to be a GRIHA five star rated campus.
b) High efficient equipment will be used for HVAC system.
c) Water cooled Centrifugal chiller is used for higher COP, IPLV and less KW/TR.
d) Primary pump and secondary pump is used to pump the water from central plant unit to all the building.
e) Tertiary pump is used in each building to reduce the primary & secondary pump head and pumping energy.
f) High Efficient fans for AHU & Ventilation system with variable speed drive are used.
g) The overall potable water requirement will be reduced substantially by using treated Water. Energy saving of 30% or higher will be achieved in overall project.
h) Variable speed drive shall be used on secondary pumps and cooling tower fans.
i) Cooling tower is selected for minimum drift and noise level, energy efficient motors, VFD for motor speed control.
j) Scale ban is used for water softening. This will reduce the corrosion inside condenser and evaporation coil, Making the chiller and cooling tower efficient.

4. **Utility Block Objective:**

The objective of this report is to describe the following:

1. Cooling /heating Load for Chiller Plant Room
2. Chiller Plant Sizing
   - Total Cooling/Heating Load for each Building using TRANE TRACE
   - Diversity of Occupancy for each building
   - Sizing of Chillers
   - Sizing of electric operated hot water Generator
   - Sizing of Primary & secondary pump
   - Sizing of cooling Tower and its components
   - Sizing of air Separator and Expansion Tank

The high side of engineering services, A/C Plant Room will be made common for all the above facilities. It will comprise of water cooled centrifugal chillers/hot water generator, chilled water and condenser water pumps, cooling tower, expansion tank, air separator & Electrical panels.

Chilled/Hot water from plant room shall be supplied to all academic and administration buildings, Sports facilities, convention center and Dining area of the Hostels. Campus chilled water will run in loops to minimize pressure drop in the MS pipes buried in the ground.

The design approach shall be sensitive to environmental issues. The main thrust shall be laid on energy conservation, safety and ease of maintenance and current progressive technological developments. Few of the important issues considered in our design are listed below:

- The central plant will use centrifugal chillers with refrigerant R-134a with zero ozone depletion factors.
- Central plant chiller shall be managed with chiller plant manager with provision for future equipments.
- Chillers shall be water-cooled and shall have high energy efficient motors limiting input power per ton to 0.6 KW/TR during direct cooling mode, and still lower KW/TR at part load operation and COP & IPLV of the chiller shall be 6.3 & 0.6 respectively as per AHRI/ASHRAE 90.1-2013 norms.
- Chiller plant manager of chiller shall be selected keeping provision for future Equipment.
- High energy efficient Primary and secondary pump is used for pumping water from Central chiller plant to all of the building. High efficiency motor of IE 3 is used.
- Cooling tower is used for supplying cooled water to condenser coil of chiller for achieving maximum COP. All cooling tower shall be CTI Certified. High efficiency motor of IE3 (Premium efficiency) rating is used.
- Hot water for winter space heating is generated through electric operated hot water generators and shall be located centrally in the central plant room. The hot water generators shall be electric type. The HWG shall be having minimum efficiency of 88% AFUE or as per ASHRAE - 90.1-2013.

**B. Chiller plant Design Criteria and Assumptions**

This section of the report documents specific numbers used in the design of the overall campus and individual buildings. These assumptions are an essential part of making the transition from the project intent to installed equipment and the codes are guidelines for the designer and contractor which are to

be followed during the different stages of project.

**1. CODES & STANDARDS:**

The applicable Standards/Codes are:

(a) American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE).
- ASHRAE 90.1-2013
- HVAC Application - 2007
- HVAC System & Equipment - 2008
- AHRI-550/590-2003

(b) BS-4485

(c) Energy Conservation Building Code(ECBC) 2007 (Revised Version May 2008)

(d) National building Code-2005

(e) IMC -2009

The following IS codes shall be applicable:

| S. No. | Material/item of Work | Standard/Code |
|---|---|---|
| 1. | Horizontal Centrifugal Pumps | IS: 1620 |
| 2. | Mild Steel, ERW Pipes | IS: 1239, IS: 3589 |
| 3. | Pipe Fittings | IS: 1239 |
| 4. | Steel Pipe Flanges | IS: 6392 |
| 5. | Gate, Globe & Check Valves | |
| | • Up to 40 mm gun metal | IS : 778 |
| | • Butterfly valves of 50 mm and Above (cast iron) | IS: 780, IS: 2906 |
| | • Balancing Valves | IS : 778 |
| | • Non Return Valves | IS : 5312 |
| 6. | Color Code for Identifications of pipes | IS: 2379-1963 |
| 7. | 3 Phase induction motors | IS: 325 |
| 8. | Bourdon type pressure gauges | IS: 3624 |
| 9. | PVC insulated electric cables | IS: 1554 |
| 10. | Starters sheets/wires | IS: 8555 |
| 11. | Specific requirements for Direct switching of motors | IS: 4064 (Part II) |
| 12. | Inspection and testing of Installation | IS: 732 (Part III) |
| 13. | Hot die zinc coated steel pipes | IS: 4736-1968 |
| 14. | Expanded polystyrene | IS: 4671 |

**Safety codes:**

The following safety codes as laid down by ISI shall be followed:

1. Safety code for mechanical refrigeration IS : 660
2. Safety code for air-conditioning IS : 659
3. Safety code for scaffolding and ladders IS : 3696
4. Code for practice for safety and health Requirements in electrical and gas Welding & cutting operations IS: 3696
5. Code of safety procedures and practices In electrical works IS: 5216

## 2. LOCATION:

The proposed SAU University campus is to be located at Maidan Garhi, New Delhi.

- Site Location :New Delhi
- Geographic Location :28.56°N
- Altitude : 233m above mean sea level

### a) Design Conditions and Assumptions:

The summer design condition is based on statistics of the most recent data of 10 year period, published by the India Meteorological Department and .epw weather data files from the DOE.

In design of a high performance building, it is important to evaluate year round building performance for equipment selection and also study the influence of other natural parameters like wind speed, solar orientation etc. for optimizing performance. The year round temperatures and climatic conditions is as below and system is evaluated for 8760 hours.

**Table-1- Design conditions**

| Description | Value (units) |
|---|---|
| Roof U-value | 0.0793 Btu/h. ft².°F |
| Overall Wall U-value | 0.105 Btu/h. ft².°F |
| Glass U-value (summer/winter) | 0.317 Btu/h. ft².°F |
| Glass shading coefficient | 0.58 |
| Summer outdoor air DB/WB temperature | 43.3°C (109.94 °F) /23.9 (75.02 °F) |
| Winter outdoor air DB/WB temperature | 7.2°C (44.96 °F) /5.0°C(41.0°F) |
| Monsoon outdoor air DB/WB temperature | 35°C (41.0°F)/28.3°C (82.94) |

### b) Mechanical System Design Parameters:

This section describes the assumptions, parameters considered for sizing and designing of various Mechanical equipments and its components. Below is the detailed description.

### 1. Water Chilling Machine:

Performance rating of the water chilling machines shall be based on the following design parameters:

- Temperature of chilled water entering chiller : (13.3° C) 56°F
- Temperature of chilled water leaving chiller : (6.67°C) 44°F
- Temperature of condenser water entering condenser : (31.1° C) 88° F
- Temperature of condenser water leaving condenser : (36.3° C) 97.5°
- Fouling factor for evaporator in FPS unit : 0.0002
- Fouling factor for condenser in FPS unit : 0.0005
- Refrigerant : R-134a
- Minimum COP at ARI conditions (100%load) : 6.3

Chillers shall be selected as per AHRI and the efficiencies shall be minimum as per ASHRAE-90.1-2013 standards. Also, power consumption of the chiller will be as per AHRI norms.

## 2. Cooling Tower:

Cooling tower is designed based on following Design parameter:

- Hot Water Temperature : 97.30°F
- Cold Water Temperature : 88.00°F
- Wet Bulb Temperature : 83.00°F
- Water flow rate : 3000.00 USGPM
- Heat Rejection Capacity : 35,18,550 Kcal/hr

- Type : Induced Draught Counter flow
- Wet bulb approach : 5°F
- Evaporation loss : 0.88%
- Drift loss : 0.01%
- Total water loss : 0.89% (without bleed off)
- . Motor HP : 10 HP x 04 Nos.
  RPM : 570
  Type : Squirrel Cage (IP55), TEAO, EFF-2
- Tower structure
  Casing : FRP
  Basin : FRP

## 3. Electric Hot water Generator:

Hot Water generator is selected based on following parameters:

- Water Temperature “IN” : 45 Degree C(113 °F)
- Water temperature “OUT” : 50 Degree (122 °F)
- Working pressure : 230 P.S.I (16 kg)
- Water flow Rate : 2860 LPM at delta T 5 Deg
- Material and thk. of hot water tank : Mild Steel Body 10mm Shell & 40mm End plates
- Type of Heater : Water Resistance Immersion Type,
- Material of Heater : Copper Tube, duly chrome plated With M.S Flange.
- Test pressure : 300 PSI.
- Insulation Material Thickness : 50mm Thick resin bounded fiber Glass wool(32 Kg density)
- Material of cladding : Aluminum Sheet, 0.63 mm GAUGE.
- Capacity : 1000KW each

**4. Mechanical Ventilation System:**

The following areas shall be provided with dedicated ventilation system with the number of air changes, or CFM per Sq.ft, for each space as as per NBC – 2005, Part-8, Section-3 Table-5:

Plant Room: Min. 20 ACPH
Electrical Room: Min 20 ACPH
U.G Pump Room: Min 20 ACPH

**5. Piping:**

- Hydronic Piping material for chilled/Heating water supply and return shall be of Heavy class Black steel (MS- Class C) Pipes. Piping up to and including 150 mm diameter shall be of heavy class black steel confirming to IS:1239 and piping greater than 150 mm shall be minimum 6 mm thick black steel confirming to IS:3589 and minimum 7mm thick M.S. sheet for pipes of 350mm dia. & above.
- Hydronic piping shall be insulated with closed cell elastomer with maximum thermal conductivity of 0.038 W/m-k at 38° C, when tested in accordance with EN- ISO 8947.
- Chilled water piping insulation thickness shall be 25 mm thick for 40 mm pipe and smaller, 40 mm thick for 50 mm to 150 mm pipe and 75 mm thick for pipe greater than 150 mm.
- Drain from the all the air-conditioning equipment shall be collected by GI drain pipe insulated with 9 mm thick closed cell elastomer material and connected to nearest drain point.

All chilled water pipes shall be mild steel Class 'C' (heavy duty) conforming to relevant BIS codes. All jointing in the pipe system shall be by welding. Various types of valves such as butterfly valves, balancing valves and non return valves shall be provided in water lines.

Condensate drain piping would be GI 'B' Class conforming to relevant BIS codes.

**PIPING SHALL BE SIZED FOR THE FOLLOWING DESIGN PARAMETERS**

Pipes shall be sized to provide maximum water velocities as follows:

| **Pipe Sizes** | **Maximum Velocity** |
|---|---|
| Up to 50mm | 0.6 m/sec |
| 65 to 100mm | 0.8 m/sec |
| 125 to 200mm | 1.5 m/sec |
| 250 and above | 2.5 m/sec |

**c) Quality Assurance programme:**

1. Pressure vessels shall be designed and constructed with safety devices in accordance with ANSI/ASHRAE 15-1989 safety Code and ASME/GB Code.

2. Chillers shall be product of a manufacturer / licensee normally supplying this type of equipment who has completed at least **five (or as agreed by SAU)** installation of approximately the same capacity (documentary evidence shall be submitted).

3. The chillers shall be designed / manufactured and tested in accordance with the applicable portions of the latest revisions of the following standards and codes

| | |
|---|---|
| AHRI 550/ 590-2003 | Performance rating of water chilling packages using the vapour compression cycle. |

| | |
|---|---|
| AHRI 575 | Standard method of measuring machinery sound within equipment room. |
| ASME Code | American Society of Mechanical Engineers.<br>(Div. 1 code for unfired pressure vessels – section Viii, design, construction, testing and certification of pressure vessels), or equivalent GB code |
| ANSI-B9.1 | Safety code for mechanical refrigeration (overall general safety requirements, relief device sizing etc) |
| ISO R281 | Rolling Bearing – dynamic load ratings and rating life |

**d) Interface with BAS/BMS SYSTEM:**

1. All necessary hardware / soft ware to integrate the chillers panel to BAS/BMS system shall be provided by manufacturing/supplier.

2. For the integration of microprocessor panel of the chilling machine with the Building Automation System, an interface control document shall be developed by BAS/BMS vendor. It shall be responsibility of HVAC contractor to provided following to BAS vendor for preparing the interface.

**C. Campus Cooling and Heating requirements:**

This section of the report describes the Cooling (TR) and Heating (MBH) requirement for the various building in the entire campus. Trane Trace 700 is used to calculate 8760 hours cooling/Heating loads estimations and summary is given in the following table.

**TABLE - 2 - Cooling Requirement**

| As per Architectural Plans | | | | HVAC | Tonnage Required (Tonnage) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **S No.** | **Description** | **No. Of Floors** | Floor Area | Conditioned Area as per Trane Trace(SM) | Package II(TR) | | Package III(TR) | | Package III Future (TR) | |
| | | | Total ( sm) | | Day Use | Night Use | Day Use | Night Use | Day Use | Night Use |
| 1 | Administration | B+G+5 | 13896 | 7705 | - | - | 559 | 112 | | |
| 2 | Library | B+G+5 | 15028 | 8690 | - | - | 379 | 152 | | |
| 3 | Faculty of Life Science and Biotechnology | B+LG+G+6 | 44781 | 29108 | 1519 | 608 | - | - | - | - |
| | Faculty of Earth Sciences | | | | | | - | - | - | - |
| 4 | Faculty of Physical and Chemical Sciences | B+G+4 | 27638 | 13016 | - | - | 788 | 118 | 83 | 12 |
| | Faculty of Mathematics & IT | B+G+4 | | | - | - | | | | |
| 5 | Faculty of Humanities | B+G+3 | 26416 | 10601 | - | - | 560 | 84 | 96 | 14 |
| | Faculty of Law | B+G+3 | | | - | - | | | | |
| 6 | Faculty of Art and Design | B+LG+G+4 | 36212 | 13546 | - | - | 695 | 139 | | |
| 7 | Convention Center , Art Galleries and | B+LG+G+3 | | | - | - | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Museum | | | | | | | | | |
| 8 | Institute of South Asian Studies | B+G+7 | 9665 | 4366 | - | - | 152 | 61 | 70 | 28 |
| | Inter Disciplinary Research Centers+Data Center | | | | - | - | | | | |
| | | Total | 248793.17 | 87032 | 1519 | 608 | 3133 | 665 | 249 | 55 |
| | | ** Sub Total | | | 1519 | | 3133 | | 249 | |
| | | Grand Total | | | 4901 | | | | | |

* Future Buildings
** Area includes HVAC load for Future Building as per SAU Master Plan

| Given | Assumed | High Side Sizing with Diversity (Without Future of Package III) | | | | |
|---|---|---|---|---|---|---|
| | Total Air - Conditioned Area | Cooling Load | Diversity | Cooling | Day | Night |
| Package | sq m | TR | % | TR | TR | TR |
| Package-II | 29108 | 1519 | 75% | **1139** | 1139 | 608 |
| Package-III | 57924 | 3133 | 75% | **2350** | 2350 | 665 |
| Total | 87032 | 4651 | | **3489** | **3489** | **1273** |

We propose to install following configuration for package II & III (without considering future load of existing building)

**<u>Centrifugal Chiller</u>**

**For Package II & III**

- 4 Nos. x 900 TR working Centrifugal Chiller for cooling.

**However, considering the cooling load of future spaces in the tender package III Buildings, The additional 249 TR will not be catered through this configuration.**

**Below is the chart showing cooling TR**

| Given | Assumed | High Side Sizing with Diversity (With Future of Package III) | | | | |
|---|---|---|---|---|---|---|
| | Total Air - Conditioned Area | Cooling Load | Diversity | Cooling | Day | Night |
| Package | sq m | TR | % | TR | TR | TR |
| Package-II | 29108 | 1519 | 75% | **1139** | 1139 | 608 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Package-III | 57924 | 3132 | 75% | **2349** | 2349 | 667 |
| Package-III Future | | 249 | 75% | **187** | 187 | 55 |
| Total | 87032 | 4940 | | **3705** | **3705** | **1336** |

**Thus, it is recommended to install following configuration for package II & III**

**Centrifugal Chiller**

**For Package II & III**

- 4 Nos. x 1000 TR working Centrifugal Chiller for cooling.

**Primary Pump**

**For Package II & III**

- 4 Nos. x Primary water pumping Machine -**2000 USGPM Flow and 18 m Head** (4 Nos. Working).

**Secondary Pump**

**For Package II & III**

- 4 Nos. x Secondary water pumping Machine -**2000 USGPM Flow and 50 m Head** (4 Nos. Working).

**TABLE -3- Heating Requirement**

| As per Architectural Plans | | | | HVAC | Heating Required (MBH) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **S No.** | **Description** | **No. of Floors** | Floor Area | Conditioned Area as per Trane Trace(SM) | Package I I (MBH) | | Package I II (MBH) | | Package I II Future (MBH) | |
| | | | Total( sq m) | | Day Use | Night Use | Day Use | Night Use | Day Use | Night Use |
| 1 | Administration | B+G+5 | 13896 | 7705 | - | - | 1416 | 142 | - | - |
| 2 | Library | B+G+5 | 15028 | 8690 | - | - | 963 | 241 | - | - |
| 3 | Faculty of Life Science and Biotechnology | B+LG+G+6 | 44781 | 29108 | 3758 | 1729 | - | - | - | - |
| | Faculty of Earth Sciences | | | | | | - | - | - | - |
| 4 | Faculty of Physical and Chemical Sciences | B+G+3 | 27638 | 13016 | - | - | 2071 | 518 | 125 | 31 |
| | Faculty of Mathematics & IT | B+G+4 | | | - | - | | | | |
| 6 | Faculty of Humanities | B+G+3 | 26416 | 10601 | - | - | 1532 | 383 | 269 | 67 |
| | Faculty of Law | B+G+3 | | | - | - | | | | |
| 7 | Faculty of Art and Design | B+LG+G+4 | 36212 | 13546 | - | - | 1937 | 484 | - | - |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 8 | Convention Center , Art Galleries and Museum | B+LG+G+3 | | | - | - | | | | |
| 11 | Institute of South Asian Studies | B+G+7 | 9665 | 4366 | - | - | 489 | 147 | 235 | 71 |
| | Inter Disciplinary Research Centers | | | | - | - | | | | |
| | | Total | 248793 | 87032 | 3758 | 1729 | 8408 | 1914 | 629 | 169 |
| | | Sub Total | | | 3758 | | 8408 | | 629 | |
| | | Grand Total | | | 12166 | | | | | |

* Future Buildings

| Given | | Assumed | High Side Sizing (Without future of package III) | | | | |
|---|---|---|---|---|---|---|---|
| | Total Floor Area (Only AC) | Total Air - Conditioned Area (65%) | Heating Load | Diversity | Heating | Day | Night |
| Package | (FAR) sq m | sq m | MBH | % | MBH | MBH | MBH |
| Package-II | 29108 | 18920 | 3758 | 75% | **2819** | 2819 | 1729 |
| Package-III | 57924 | 37651 | 8508 | 75% | **6381** | 6381 | 1939 |
| Total | 87032 | 56571 | 12266 | | **9200** | **9200** | **3668** |

We propose to install following configuration for package II & III (without considering future load of existing building)

**<u>Electric Resistance Hot Water Generator:</u>**

**For Package II & III**

- 3 Nos. x 3415 MBH(1000 KW) -Working Hot water Generator.

**However, considering the heating MBH of future spaces in the tender package III Buildings, The additional 629 MBH will also be catered through this configuration.**

**Below is the chart showing heating MBH**

| Given | High Side Sizing with Diversity |
|---|---|

| | Total Floor Area (Only AC) | Heating Load | Diversity | Heating | Day | Night |
|---|---|---|---|---|---|---|
| Package | (FAR) sq m | MBH | % | MBH | MBH | MBH |
| Package-II | 29108 | 3758 | 75% | **2819** | 2819 | 1729 |
| Package-III | 57924 | 8408 | 75% | **6306** | 6306 | 1914 |
| Package-III Future | | 629 | 75% | **472** | 472 | 169 |
| Total | 87032 | 12895 | | **9597** | **9597** | **3812** |

## D. Proposed Air-condition System for High side

The central chilled water plant comprises of 4 Nos. x 1000 TR Water Cooled Centrifugal Chiller in which 4 Nos. chillers is working . All chiller supply and return pipe are connected to a common header and from there chilled water is distributed to the whole campus.

The chilled water from this central cooling plant is supplied via buried insulated MS “C” class pipes HDPE Jacketing upto the tertiary pump located in basement in all of the following Building:

a. Administration Building
b. Library
c. Faculty of Life Science and Biotechnology & Faculty of Earth Sciences
d. Faculty of Physical and Chemical Sciences & Faculty of Mathematics & IT
e. Faculty of Law & Humanities
f. Faculty of Art and Design & Convention Center , Art Galleries and Museum
g. Institute of South Asian Studies & Inter Disciplinary Research Centers Data Center

With all buildings connected on a common header in Chilled water system, the following pump Configuration has been proposed:

- 4 Nos. Working primary chilled water pump - **2000 USGPM flow ,18 m head**
- 4 Nos. Working secondary chilled water pump - **2000 USGPM flow,50 m head** Secondary chilled water pump shall be operated with variable frequency drive for making the chilled water plant room energy efficient.

End Suction tertiary pump with VFD is placed at the basement of every building to reduce the pumping head on primary and secondary pump. This will reduce the pump head and will save lots of pumping energy.

For 24 x 7 operational areas, will be served by central chiller plant only. As per the load-demand during night time 1-2 no. chillers will remain in operation and remaining will be cut down with the command from BMS.

Data Centre/Server room of administration building will remain operational for 24 X 7. Cooling in these area is provided with the help of dual fluid (Chilled water and DX type). During summer, when some of chiller is in operation for 24 X 7, PAC will operate on chilled water system for 24 hrs. and during winter/Non-Working hours, when chiller is off, direct expansion unit will work to provide cooling in data center/server room

To suit the varying loads due to inherent operational nature of these buildings and to provide better operating efficiency, Secondary chilled water pumps are proposed with variable speed drives operating with pressure differential sensor located in the pipe work

Heat from the chiller machine is dissipated to atmosphere via the cooling towers which are located on roof of utility building. Total No. of cooling towers used in central plant room are 2 Nos. X 2000 TR and 1 Nos. X 1000 TR .The cooling tower fan motors (in lieu of condenser water pumps) are proposed with variable speed drives to have an energy efficient system operation. Condenser water pumps are being

provided to circulate water between condenser of the chiller and the cooling towers and their configuration is as follows:

- 4 Nos. Working condenser water pump- **3000 USGPM, 22 m head.**

**Pump Head Calculation is attached as ANNEXURE A**

**Cooling tower water requirement:**

| | |
|---|---|
| Total Peak load of entire Campus with diversity (TR) | 3705 |
| Water loss in cooling tower Litre per TR per hours | 8 |
| No. of operating hours/day | 10 |
| Considering Diversity @ 80 % | 0.8 |
| Water Required for evaporation losses in Cooling Tower/day(KLD) | 238 |

An inline air separator (sized based on the flow rate of 4 x 1000 TR is also being provided on chilled water return pipe to remove entrained air. Make up water requirement of the chilled water system is very minimal being a closed loop system. Pipe based on 0.5% of flow rate is being provided with motorized valve and double non-return valve along with Pressure Transmitter and pressure gauge. In case of fall of pressure in the make-up water line below a preset limit, the pressure transmitter signal leads to an alarm being raised and motorized
Valve is signaled to open and closes after the water pressure reaches a preset level.
The make-up water pipe is also provided with Double check valve (RPZD type) to
Avoid any contamination of potable water in case of back flow. The operation of the valve is likely to be minimal as chance of water loss is not expected during operation of the system.

The chilled water system will be two pipe systems and a changeover is provided in the mechanical central plant to switch between heating and cooling mode.

During winter Season, heating to the entire campus will be achieved by electrical hot water generator. Hot water generated in electric heater is connected to the main header and is circulated to the entire campus. A motorized valve is used to make the change over. Primary and secondary pump used during summer season for cooling the campus is used for circulating hot water during winter season but operating at much lower speed, as the amount of hot water required to heat the entire campus is less. So it may happen that 2 or 3 Nos. pump will remain in working and rest will cut off. The entire pump is with variable frequency drive.

All foundations shall be protected from mechanical damage by providing epoxy coated angle nosing. Seismic restraints requirement shall also be considered. Plant machinery in the central plant room shall be placed on PCC/RCC foundation in the basement and shall be provided with anti-vibratory supports.

Centrifugal Chillers for cooling and Hot water generator for heating shall be provided to serve the purpose of thermal comfort.

**Hydronic piping:**

- Hydronic piping material for chilled water supply and return shall be of Heavy Class Black Steel (MS - Class "C") pipes. Piping upto and including 150mm dia. shall be of Heavy class black steel conforming to

IS: 1239 and Piping greater than 150mm shall be Black steel (thickness not less than 6 mm) conforming to IS: 3589 and minimum 7mm thick M.S. sheet for pipes of 350mm dia. & above.

All above ground and underground Hydronic piping shall be insulated with closed-cell elastomeric with maximum thermal conductivity of 0.038 W/m-K at 38 degrees C mean temperature,
when tested in accordance with EN ISO 8497 and maximum water vapor permeability of 1.163 ng/s-m-Pa when tested in accordance with EN 13469.
Chilled water piping insulation thickness shall be 25 mm thick for 40 mm pipe and smaller; 40 mm thick for 50 mm to 150 mm pipe and 75 mm for pipes above 150 mm dia shall be provided.
Drain from all the Air conditioning equipment shall be collected by GI drain pipe insulated with closed cell elastomeric and connected to nearest drain point. For all floor mounted AHUs, Ceiling Suspended AHUs and Ducted Fan Coil units, CHW supply and return temperatures considered are 6.7 Deg C & 12.2 Deg C respectively.

Hydronic piping sizes are selected based on maximum frictional loss of 5 ft.of water/100 ft and velocity less than 8 fps due to diversity of usage of this facility.

Chilled water system shall be designed for self-balancing of water flows. Therefore, 2-way PICV automatic balancing cum control valve shall be designed in major branch pipes and at each AHU for the fine tuning balancing of the chilled water/hot water system. The material of the piping shall be Mild Steel ‘C’ Class (heavy duty) for chilled/ hot / condenser water pipes and ‘B’ class GI for condensate drain pipes.

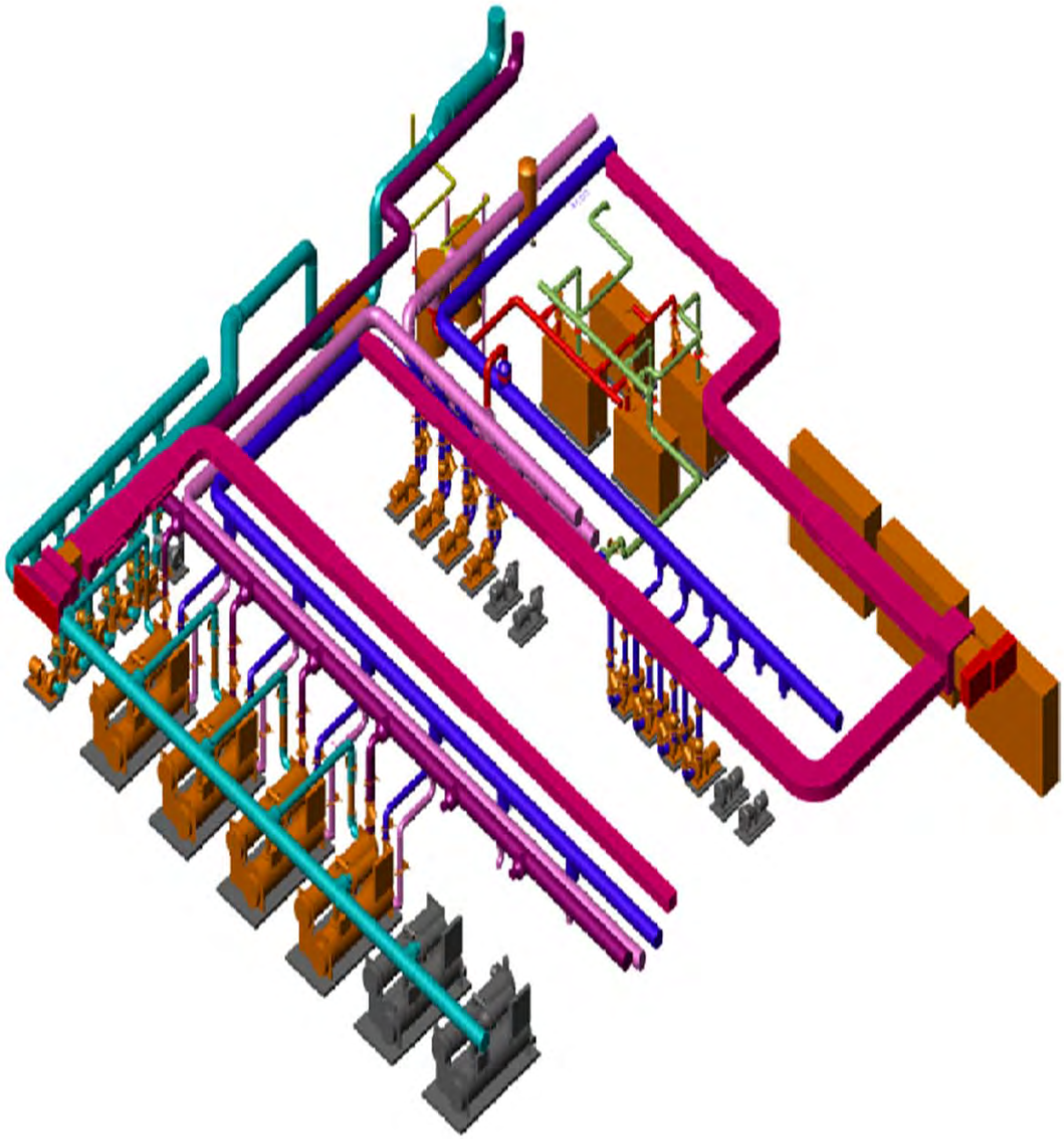


Image 1- Isometric view plant room

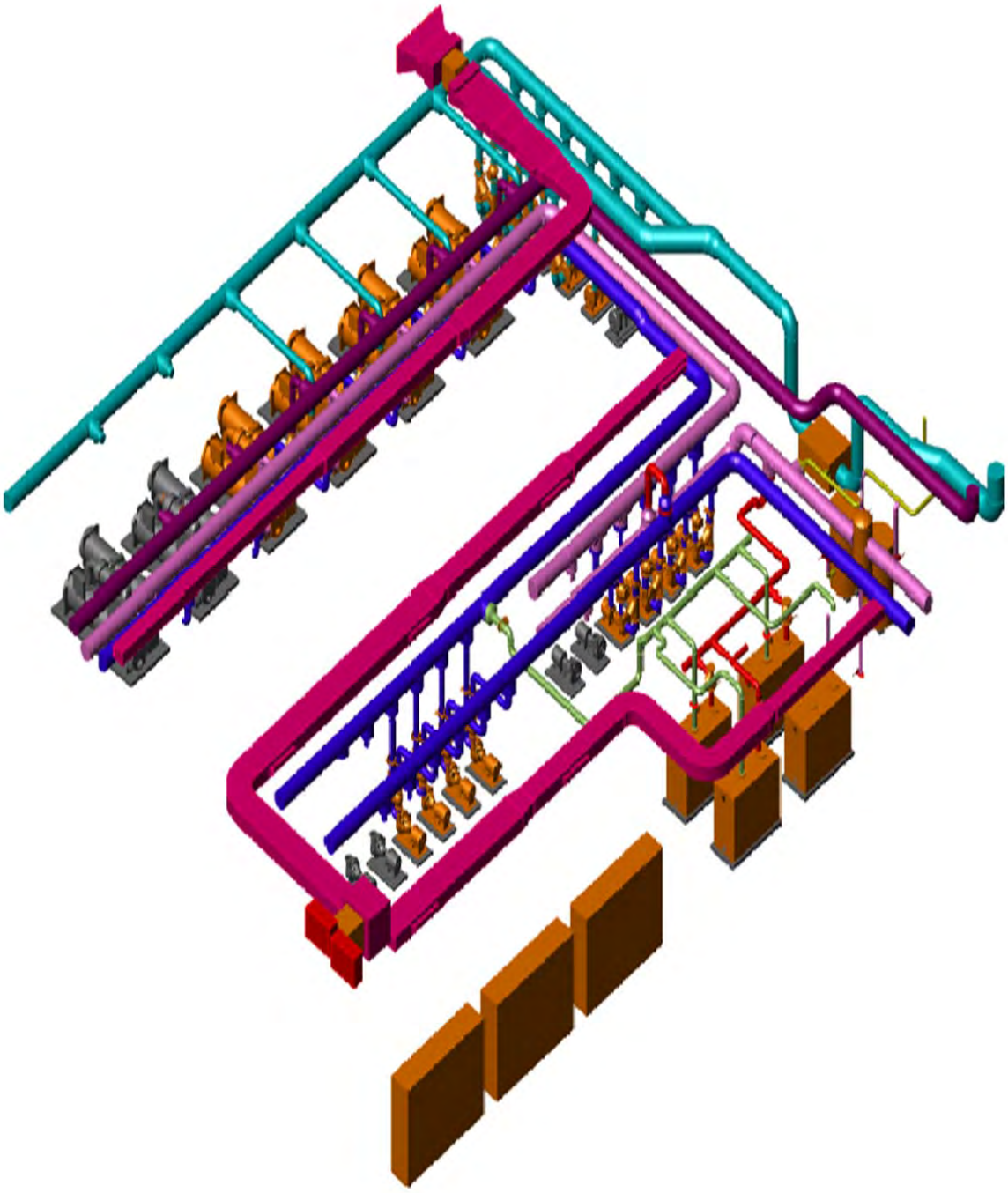


Image 2- Isometric view plant room

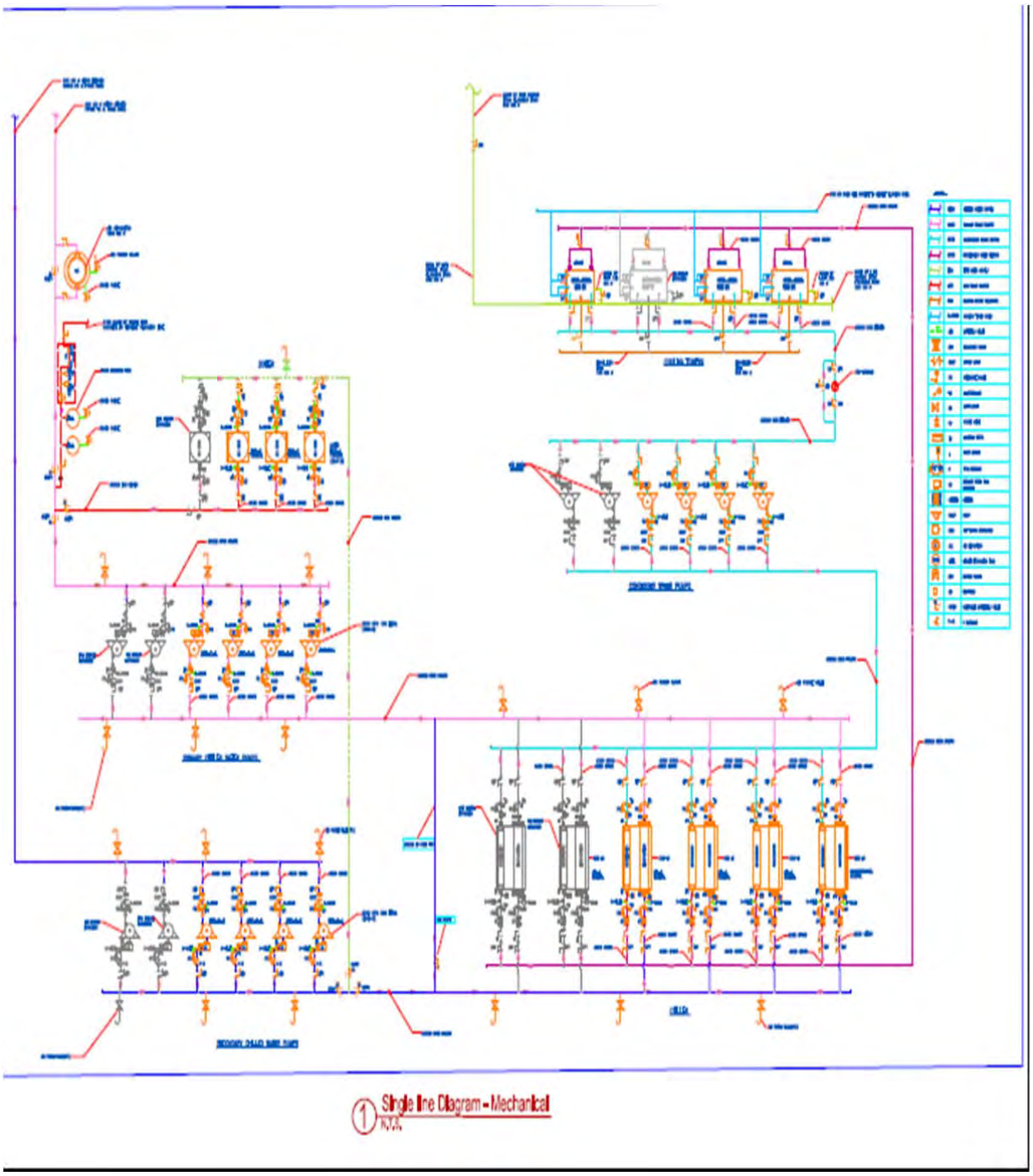



Image 3 - Schematic plant room

## E. MECHANICAL VENTILATION SYSTEM:

Mechanical ventilation system is being considered for plant room and shall be provided with dedicated ventilation system with the number of air changes, or CFM per Sq.ft, for each space as per NBC – 2005, Part-8, Section-3 Table-5:

| S. No. | Floor | Space description | Area (sqft) | Height(ft) | ACPH | CFM |
|---|---|---|---|---|---|---|
| 1 | BASEMENT | HVAC PLANT ROOM | 14890 | 16.4 | 20 | 81398 |
| 2 | BASEMENT | PUMP ROOM | 2808 | 16.4 | 20 | 15350 |
| 3 | GROUND | SAU GIS ROOM | 1130 | 16.4 | 20 | 6176 |
| 4 | GROUND | SAU DG SWITCHGEAR | 1334 | 16.4 | 20 | 7294 |
| 5 | GROUND | BRPL GIS ROOM | 2378 | 16.4 | 20 | 13000 |
| 6 | GROUND | SAU CONTROL ROOM | 16 | 16.4 | 20 | 90 |
| 7 | GROUND | BRPL BATTERY ROOM | 237 | 16.4 | 20 | 1294 |
| 8 | GROUND | SAU BATTERY ROOM | 237 | 16.4 | 20 | 1294 |
| 9 | GROUND | BRPL CONTROL ROOM | 16 | 16.4 | 20 | 90 |
| 10 | GROUND | SAU SWITCHGEAR ROOM | 1302 | 16.4 | 20 | 7117 |
| 11 | GROUND | PANEL ROOM | 1054 | 16.4 | 20 | 5764 |

**Table- 4 - DX Type unit for plant room air conditioning area:**

| Sr. No | Floor | Room Description | Area(sqft) | Cooling TR | Description |
|---|---|---|---|---|---|
| 1 | GROUND | BRPL MAINTEN. | 160 | 1.5 | 1.59 TR |
| 2 | GROUND | SAU MAINTEN. | 160 | 1.5 | 1.59 TR |
| 3 | FIRST | OFFICE | 2485 | 16 | 7.98 x 2 Nos. Ductable Unit |
| | | | | | |

## F. BRIEF OUTLINE OF SPECIFICATIONS FOR MAJOR EQUIPMENTS:

### 1.0 Chiller (centrifugal type):

A. CENTRIFUGAL COMPRESSOR:

The compressor shall be single / multiple stage open / hermetic type, using Refrigerant- HFC 134 a. The impeller shaft shall be either direct driven or connected to the speed increasing gear. It shall be self-aligned and balanced and shall be assembled in the compressor casing. The driven end of the gear shaft shall be connected with the motor through a flexible coupling. The impeller shall be cast from alloy steel / aluminum alloy. This shall be statically and dynamically balanced to ensure vibration free operation. Casing design shall ensure that major wearing parts, bearings thrust bearings are accessible for maintenance and replacement. Condensed liquid refrigerant shall be injected in to the compressor discharge to reduce discharge gas temperature and to reduce sound level of the compressor.

B. LUBRICATION SYSTEM:

Lubrication oil shall be force-fed to all compressor bearings, gears,and rotating surfaces by an external variable speed oil pump. The oil pump shall vary oil flow to the compressor based on operating and stand-by conditions, ensuring adequate lubrication at all times. The oil pump shall operate prior to start-up, during compressor operation and during coastdown. Compressor shall have an auxiliary reservoir to provide lubrication during coastdown in the event of a power failure.

An oil reservoir, separate from the compressor, shall contain the submersible 2 HP oil pump and a 3000 watt oil heater, thermostatically controlled to remove refrigerant from the oil. The oil reservoir shall be designed in accordance with applicable pressure vessel code and listed as part of the chiller by a nationally recognized tsting laboratory.

Oil shall be filtered by an externally mounted ½ micron replaceable cartridge oil filter equipped with service valves. Oil cooling shall be done via a refrigerant cooled / water cooled oil cooler, with all piping factory installed. Oil side of the oil cooler shall be provided with service valves. An automatic oil return system to recover any oil that may have migrated to the evaporator shall be provided. Oil piping shall be completely factory installed and tested.

i. High efficiency oil filters.

ii. Low oil pressure cutout.

iii. Oil coolers and oil heaters (with built-in-thermostat) to aid maintaining constant temperature.

iv. Oil level indicator.

v. Oil pressure control with pressure gauges and thermometer.

The compressor shaft seal shall consist of a spring loaded precision carbon ring high temperature elastomer "O" ring static seal and stress relieved precision lapped collars. The seal must effectively prevent the leakage of refrigerant along the shaft during shut down periods. During operation an oil film under pressure should prevent outward leakage of refrigerant.

Oil cooler shall be in built part of chiller package. Oil cooler shall be shell & tube / PHE type. Condensed liquid refrigerant shall be used for oil cooling purpose.

C. CAPACITY CONTROL:

The compressor shall be equipped with combination of speed control and PRV position control. Chiller shall be capable of unloading up to 15% of full load even at constant entering condenser water temp without surging and without hot gas bypass. Manufacturer must furnish computerised performance sheet at constant entering condenser water temp for verification of unloading up to 25%.

D. ELECTRIC MOTOR :

The main electric motor and drive shall be furnished by chilling machine manufacturer in order to ensure system compatibility and drive train optimisation. Motor system shall be suitable for 415±10% volts, 3 phase, 50 cycles AC supply. Motor shall be squirrel cage induction type. The motor shall be suitable for load characteristics and the operational duty of the driven equipment.

The motor shall be capable of successful operation when running at rated load with variations in voltage and frequency as follows :

i. Within ± 10% of rated voltage with rated frequency.
ii. Within ± 5% of rated frequency with rated voltage.

DRIVE :

The compressor shall be driven directly or through speed increasing gears as required. The gears and pinions shall be pressure lubricated. The gears shall be provided with oil filter and submerged oil pump. The gears should be of helical type with crown teeth designed such that more than one tooth is in contact at all times to provide even distribution of compressor load and quiet operation. Gears should be integrally assembled in the compressor rotor support and be film lubricated. Each gear should be

individually mounted in its own journal and thrust bearings to isolate it from impeller and motor shafts.

E. EVAPORATOR AND CONDENSER :

**a. Evaporator (Chiller)**

Evaporator will be of the shell-and-tube, flooded type designed for 235 psig working pressure on the refrigerant side with hinged marine water boxes. Shell will be fabricated from rolled carbon steel plate with fusion welded seams; have carbon steel tube sheets, drilled and reamed to accommodate the tubes; and intermediate tube supports spaced no more than four feet apart. The refrigerant side will be designed, tested and stamped with ASME Boiler and Pressure Vessel Code, Section VIII- Division 1 or Equivalent "GB Code". Tubes shall be high-efficiency, internally and externally enhanced type having plain copper lands at all intermediate tube supports to provide maximum tube wall thickness at the support area. Each tube will be roller expanded into the tube sheets providing a leak-proof seal, and be individually replaceable. Two liquid level sight glasses will be located on the side of the shell to aid in determining proper refrigerant charge. Suction baffles will be located around the sides and above the falling film section to prevent liquid refrigerant carryover to the compressor. The evaporator will have a refrigerant relief device sized to meet the requirements of ASHRAE 15 Safety Code for Mechanical Refrigeration.

Chiller shall be factory insulated with 19 mm thick nitrile rubber / or equivalent thermal insulation as per manufacturers standard with vapour barrier, thermal insulation material. The insulation shall be applied in such a manner that water boxes and covers shall be removable without damaging it.

**b. Condenser**

The condenser shall be horizontal, shell and tube type. Condenser will be of the shell-and-tube type, designed for 235 psig working pressure on the refrigerant side with hinged marine water boxes. Shell will be fabricated from rolled carbon steel plate with fusion welded seams; have carbon steel tube sheets, drilled and reamed to accommodate the tubes; and intermediate tube supports spaced no more than four feet apart. The refrigerant side will be designed, tested and stamped with ASME Boiler and Pressure Vessel Code, Section VIII- Division 1 or Equivalent "GB Code". Tubes shall be high-efficiency, internally and externally enhanced type having plain copper lands at all intermediate tube supports to provide maximum tube wall thickness at the support area. Each tube will be roller expanded into the tube sheets providing a leak-proof seal, and be individually replaceable.

**C. MICRO PROCESSOR BASED CONTROL PANEL :**

General: The chiller shall be controlled by a stand-alone microprocessor based control center. The chiller control panel shall provide control of chiller operation and monitoring of chiller sensors, actuators, relays and switches.

Control panel: The control panel shall include a 10.4 in. diagonal color liquid crystal display (LCD) surrounded by "soft " keys which are redefined based on the screen displayed at that time. This shall be mounted in the middle of a keypad interface and installed in a locked enclosure. The screen shall detail all operations and parameters, using a graphical representation of the chiller and its major components. Panel verbiage shall be available in other languages as an option with English always available. Data shall be displayed in either English or Metric units. Smart Freeze Point Protection shall run the chiller at 36.00°F leaving chilled water temperature, and not have nuisance trips on low water temperature. The sophisticated program and sensor shall monitor the chiller water temperature to prevent freeze up. When needed Hot Gas Bypass is available as an option. The panel shall display countdown timer messages so the operator knows when functions are starting and stopping. Every programmable point shall have a pop-up screen with the allowable ranges, so that the chiller can not be programmed to operate outside of its design limits.

The chiller control panel shall also provide:

1. System operating information including:
    a. Return and leaving chilled water temperature
    b. Return and leaving condenser water temperature
    c. Evaporator and condenser saturation temperature
    d. Differential oil pressure
    e. Percent motor current
    f. Evaporator and condenser saturation temperature
    g. Compressor discharge temperature
    h. Oil reservoir temperature
    i. Compressor thrust bearing positioning and oil temperature
    j. Operating hours
    k. Number of compressor starts

2. Digital programming of setpoints through the universal keypad including:
    a. Leaving chilled water temperature
    b. Percent current limit
    c. Pull-down demand limiting
    d. Six-week schedule for starting and stopping the chiller, pumps and tower
    e. Remote reset temperature range

3. Status messages indicating:
    a. System ready to start
    b. System running
    c. System coast down
    d. System safety shutdown-manual restart
    e. System cycling shutdown-auto restart
    f. System pre lube
    g. Start inhibit

4. The text displayed within the system status and system details field shall be displayed as a color coded message to indicate severity: red for safety fault, orange for cycling faults, yellow for warnings, and green for normal messages.

5. Safety shutdowns enunciated through the display and the status bar, and consist of system status, system details, day, time, cause of shutdown, and type of restart required. Safety shutdowns with a fixed speed drive shall include:
    a. Evaporator – low pressure
    b. Evaporator – transducer or leaving liquid probe
    c. Evaporator – transducer or temperature sensor
    d. Condenser – high pressure contacts open
    e. Condenser – high pressure
    f. Condenser – pressure transducer out of range
    g. Auxiliary safety – contacts closed
    h. Discharge – high temperature
    i. Discharge – low temperature
    j. Oil – high temperature
    k. Oil – low differential pressure
    l. Oil – high differential pressure
    m. Oil – sump pressure transducer out of range
    n. Oil – differential pressure calibration
    o. Oil – variable speed pump – pressure setpoint not achieved
    p. Control panel – power failure
    q. Motor or starter – current imbalance
    r. Thrust bearing – proximity probe clearance
    s. Thrust bearing - proximity probe out – of – range

t. Thrust bearing – high oil temperature
u. Thrust bearing – oil temperature sensor
v. Watchdog – software reboot

5.1 Safety shutdowns with a VSD Shall include:
a. VSD shutdown – requesting fault data
b. VSD – stop contacts open
c. VSD – 105% motor current overload
d. VSD – high phase A, B,C inverter heat sink temp.
e. VSD – high converter heat sink temperature
f. harmonic filter – high heat sink temperature
g. harmonic filter – high total demand distribution

6. Cycling shutdowns enunciated through the display and the status bar, and consists of system status, system details, day, time, cause of shutdown, and type of restart required. Cycling shutdowns with a fixed speed drive shall include:
a. Multiunit cycling – contacts open
b. System cycling - contacts open
c. Oil - low temperature differential
d. Oil – low temperature
e. Control panel - power failure
f. Leaving chilled liquid - low temperature
g. Leaving chilled liquid - flow switch open
h. Motor controller – contacts open
i. Motor controller – loss of current
j. Power fault
k. Control panel - schedule
l. Starter – low supply line voltage
m. Starter – low supply line voltage
n. Proximity probe – low supply voltage
o. Oil - variable speed pump - drive contacts open

**7.** Security access to prevent unauthorized change of set points, to allow local or remote control of the chiller, and to allow manual operation of the pre rotation vanes and oil pump. Access shall be through ID and password recognition, which is defined by three different levels of user competence: view, operator, and service.

8. Trending data with the ability to customize points of once every second to once every hour. The panel shall trend up to 6 different parameters from a list of over 140, without the need of an external monitoring system.

9. The operating program stored in non-volatile memory (EPROM) to eliminate reprogramming the chiller due to AC power failure or battery discharge. Programmed set points shall be retained in lithium battery-backed RTC memory for a minimum of 11 years with power removed from the system.

10. A fused connection through a transformer in the compressor motor starter to provide individual over- current protected power for all controls.

11. A numbered terminal strip for all required field interlock wiring.

12. An RS-232 port to output all system operating data, shutdown / cycling message, and a record of the last 10 cycling or safety shutdowns to a field-supplied printer. Data logs to a printer at a set programmable interval. This data can be preprogrammed to print from 1minute to 1day.

13. The capability to interface with a building automation system to provide:
a. Remote chiller start and stop

b. Remote leaving chiller liquid temperature adjust
c. Remote current limit set point adjust
d. Remote ready to start contacts
e. Safety shutdown contacts
f. Cycling shutdown contacts
g. Run contacts

**D. COMPRESSOR MOTOR STARTER:**

A variable speed drive will be factory installed on the chiller. It will vary the compressor motor speed by controlling the frequency and voltage of the electrical power to the motor. The adaptive capacity control logic shall automatically adjust motor speed and compressor pre-rotation vane position independently for maximum part-load efficiency by analyzing information fed to it by sensors located throughout the chiller.

Drive will be PWM type utilizing IGBT's with a power factor of 0.95 or better at all loads and speeds.

The variable speed drive will be unit mounted in a NEMA 1 enclosure with all power and control wiring between the drive and chiller factory installed, including power to the chiller oil pump. Field power wiring shall be a single point connection and electrical lugs for incoming power wiring will be provided. The entire chiller package will be UL listed.

The following features will be provided:

Door interlocked circuit breaker capable of being padlocked.
UL listed ground fault protection.
Over voltage and under voltage protection.
3-phase sensing motor over current protection.
Single phase protection.
Insensitive to phase rotation.
Over temperature protection.

Digital readout at the chiller unit control panel of output frequency, output voltage, 3-phase output current, input Kilowatts and Kilowatt-hours, As part of the filter package; input KVA, total power factor, 3 phase input voltage, 3 phase input current, 3 phase input voltage total harmonic distortion (THD), 3 phase current total demand distortion (TDD), self diagnostic service parameters. Separate meters for this information will not be acceptable.

KW Meter - The unit's input power consumption will be measured and displayed digitally via the unit's control panel. The KW meter accuracy is typically +/- 3% of reading. KW meter scale is 0 - 788 KW

KWh Meter – The unit's cumulative input power consumption is measured and displayed digitally via the unit's control panel. The KWh meter is resettable and its accuracy is typically +/- 3% of reading. KWh meter scale is 0 – 999,999 kWh.

Ammeter – Simultaneous three-phase true RMS digital readout via the unit control panel. Three current transformers provide isolated sensing. The ammeter accuracy is typically +/- 3% of reading. Ammeter scale is 0 - 545 A RMS.

Voltmeter – Simultaneous three-phase true RMS digital readout via the unit control panel. The voltmeter accuracy is typically +/- 3% of reading. Voltmeter scale is 0 – 670 VAC.

Elapsed Time Meter – Digital readout of the unit's elapsed running time (0 – 876,600 hours, resettable) is displayed via the unit control panel.

**2.0 Primary and condenser water pump:**

**General:**

The pumps shall be single-stage, close-coupled, in-line suction and discharge ports of identical diameter with top-pull-out design. Hence, the rotating unit can be removed and serviced without disconnecting the suction and discharge piping.

The pump and motor shall be factory assembled at the pump manufacturer's facility. Installation instructions shall be included with pump at time of shipment. The pump manufacturer shall have complete unit responsibility.

**Features of Construction:**

**1. Pump Casing:**

Pump spiral volute casing shall be of in-line design robust construction with integrally-cast base at bottom in order to transmit pipe load to the base and foundation (Small pumps can be without base). Liquid passages in the casing shall be smooth finish to ensure high Efficiency.

Pump casing shall capable of withstanding 1.5 times the design pressure.

Pump casing shall be EN-GJL-250 Grey Cast Iron and capable of withstanding to the maximum pressure developed by the pump.

Flange dimensions are in accordance with EN 1092-2 or ISO 7005-2. Pump casing shall be fitted with bronze wear ring.

**2. Impeller:**

The impeller shall be cast bronze enclosed type with smooth surface finish for minimum frictional loss. This ensures high Efficiency. Impeller shall be keyed to the shaft and secured by impeller lock nut.

All impellers are dynamically balanced to ISO 1940-1: Grade G6.3. The thrust balancing can be of balancing holes or back vanes.

The direction of rotation of the impeller is clockwise when viewed from the drive end.

**3. Shaft:**

Pump shaft shall be Austenitic stainless steels according to EN 1.4301 / AISI 304 stub shaft and the same shall be, ground and polished to final dimensions and be adequately sized to with stand all stresses, hydraulic loads, vibrations and torques coming in during operation.

Shaft run-out shall be limited at the seal face and at the impeller to 0.05 mm.

Shaft shall be provided with Mechanical seal as default fitment to provide leak free operation.

**4. Wear Rings:**

A renewable type bronze wearing ring shall be provided in the pump casing to maintain close running clearance and to minimize leakage and recirculation losses and to ensure high pump efficiency.

**5. Mechanical Seals:**

The stuffing box cavity shall be sealed off at the pump shaft by an internally or externally-flushed mechanical seal with carbon / Silicon carbide face material, suitable for continuous operation up to 140 Deg C.

**6. Bearings:**

As radial and axial forces are absorbed by the fixed bearing in the motor drive-end, the pump requires no bearing.

Bearing shall be effectively sealed to prevent loss of lubricant or entry of dust or water.

**7. Coupling:**

The pump coupling should be of close-coupled type with stub shaft.

**8. Motors:**

Motor shall be a flange mounted, totally enclosed fan-cooled motors with main dimensions according to IEC standards. Electrical tolerances are to IEC 60034. Motor shall be high-efficient type.

Motor shall be to with IP 55 enclosure. The class of insulation shall be F with temperature rise limited to Class B.

Motor shall be suitable for operation on a 415 V (± 10% variation), 50Hz ± 5%, 3phase, or 240V-1phase AC supply. Motor shall be suitable for both DOL and / or STAR/DELTA starting

Pump and motor shall be factory aligned, and shall be realigned by the contractor as per factory recommendations after installation.

**9. Working pressure:**

Maximum allowable working pressure (MAWP) for all the pressure containing parts shall in no case be less than the maximum discharge pressure produced by the pump at shut off (including tolerances), at the max suction pressure, for the maximum impeller diameter and the maximum continuous speed.

Pump shall be rated for minimum of 10 bar working pressure.

**10. Vibration:**

The pump(s) vibration limits shall conform to Hydraulic Institute ANSI/HI 1.1-1.5-1994; section 1.4.6.1.1 or ISO 10816 for recommend acceptable unfiltered field vibration limits (as measured per HI 1.4.6.5.2) for pumps with rolling contact bearings.

**11. Sound Level:**

Sound pressure level of the pump driver shall be max 78 dbA* measured at 1.8m distance from pump for the duty points.

(* Note: Based on the motor kW and speed according to ISO 3743)

**12. Pump & Motor Selection:**

The pump(s) selected shall for Preferred Operating Region (POR) unless otherwise approved by the engineer.

The pumps shall be factory manufactured, assembled and hydrostatically tested as per Hydraulic Institute standards in an ISO 9001 approved facility.

Motor should be of variable frequency drive compatible.

Motor should be selected as non-over-loading type.

Note: The motor nameplate rating for pumps under parallel operation shall not be less than the max BKW indicated on the pump data sheet (the power at the END of the curve for the rated impeller) or shall have the specified margin as per this clause whichever is greater. The pump motors shall also be suitable for Start-up under open discharge valve condition.

**3.0 Secondary Pump:**

**General:**

The pumps shall be close coupled, single stage, centrifugal, foot mounted volute type radial split casing, end suction with back-pull out design. Hence, the rotating unit can be removed and serviced without disconnecting the suction and discharge piping.

The pump and base frame shall be factory assembled at the pump manufacturer's facility. Installation instructions shall be included with pump at time of shipment. The pump manufacturer shall have complete unit responsibility.

**Features of Construction:**

**1. Pump Casing:**

Pump casing shall be of robust construction with integrally-cast pedestal support feet in order to transmit pipe load to the base and foundation (Small pumps can be without feet). Liquid passages in the casing shall be smooth finish to ensure high Efficiency.

Pump casing shall capable of withstanding 1.5 times the design pressure.

Pump casing shall be EN-GJL-250 Grey Cast Iron according to BS EN 1561: 1997 and capable of withstanding to the maximum pressure developed by the pump.

Flange dimensions are in accordance with EN 1092-2.

Pump casing shall be fitted with bronze wear ring.

Pump casing shall have tapped and plugged holes for priming and draining.

**2. Impeller:**

The impeller shall be lead free cast bronze enclosed type with smooth surface finish for minimum frictional loss. This ensures high Efficiency. Impeller shall be keyed to the shaft and secured by impeller lock nut.

All impellers are dynamically balanced to ISO 1940-1: Grade G6.3. The thrust balancing can be of balancing holes or back vanes.

The direction of rotation of the impeller is clockwise when viewed from the motor.

**3. Shaft:**

Pump shaft shall be Austenitic stainless steels according to EN 1.4301 / AISI 304 stub shaft and the same shall be, ground and polished to final dimensions and be adequately sized to with stand all stresses, hydraulic loads, vibrations and torques coming in during operation.

Shaft shall be designed in such a way that first critical speed will be at least 25% away from the maximum rotating speed.

Shaft run-out shall be limited at the seal face and at the impeller to 0.05 mm.

Shaft shall be provided with Mechanical seal as default fitment to provide the leak free operation.

**4. Wear Rings:**

A renewable type bronze wearing ring shall be provided in the pump casing to maintain close running clearance and to minimize leakage and recirculation losses.

**5. Mechanical Seals:**

The liquid cavity shall be sealed off at the pump shaft by an internally-flushed mechanical seal with carbon seal seat and Silicon carbide seal ring, suitable for continuous operation at 284 Deg F (140 Deg C). The mechanical shaft seal has dimensions according to EN 12756.

**6. Bearings:**

Antifriction ball bearings shall be of standard type and shall meet minimum L-10 rating life up to 40000 hrs.

Bearing of the pump shall be effectively sealed to prevent loss of lubricant or entry of dust or water.

**7. Coupling:**

The pump coupling should be of close-coupled type with stub shaft.

**8. Motors:**

Motor shall be a horizontal, foot mounted, totally enclosed fan-cooled, standard squirrel cage induction motors with main dimensions according to IEC standards. Electrical tolerances are to IEC 60034. Motor shall be energy efficient type.

Motor shall be to with IP 55 enclosure. The class of insulation shall be F with temperature rise limited to Class B.

Motor shall be suitable for operation on a 415 V (± 10% variation), 50Hz ± 5%, 3phase, or 240V-1phase AC supply. Motor shall be suitable for both DOL and / or STAR/DELTA starting.

Pump and motor shall be factory aligned, and shall be realigned by the contractor as per factory recommendations after installation.

**9. Base Plates:**

Base plate shall be of fabricated steel and securely welded cross members. Grouting area shall be fully open. The combined pump and motor base plate shall be sufficiently stiff as to limit the susceptibility of vibration.

The base plate should be provided with lifting lugs.

**10. Working pressure:**

Maximum allowable working pressure (MAWP) for all the pressure containing parts shall in no case be less than the maximum discharge pressure produced by the pump at shut off (including tolerances), at the max suction pressure, for the maximum impeller diameter and the maximum continuous speed.

Note: MAWP shall not be less than 10 kg/cm² for pumps with DN150 flanges & 16 kg/cm² for pumps with DN32 to DN250 flanges.

Pump shall be rated for minimum of 10bar working pressure.

**11. Vibration:**

The pump(s) vibration limits shall conform to Hydraulic Institute ANSI/HI 1.1-1.5-1994; section 1.4.6.1.1 or ISO 10816 for recommend acceptable unfiltered field vibration limits (as measured per HI 1.4.6.5.2) for pumps with rolling contact bearings.

**12. Sound Level:**

Sound pressure level of the pump driver shall be max 82 dbA* measured at 1.8m distance from pump for the duty points.

(* Note: Based on the motor kW and speed according to ISO 3743)

**13. Pump & Motor Selection:**

The pump(s) selected shall conform to EN 733 standards for Preferred Operating Region (POR) unless otherwise approved by the engineer.

The pumps shall be factory manufactured, assembled and hydrostatically tested as per Hydraulic Institute standards in an ISO 9001 approved facility.

Motor should be of variable frequency drive compatible.

Motor should be selected as non-over-loading type.

Note: The motor nameplate rating for pumps under parallel operation shall not be less than the max BKW indicated on the pump data sheet (the power at the END of the curve for the rated impeller) or shall have the specified margin as per this clause whichever is greater. The pump motors shall also be suitable for Start-up under open discharge valve condition.

## 4.0 Cooling Tower

1. **Type:**
   Cooling Towers shall be Forced/Induced Draft Series in accordance with the Drawings and Schedule of Quantities. These cooling towers should be designed with special emphasis for minimizing water loses especially drift loss and splash losses.

2. **FRP Forced/Induced Draft Cooling Tower: -**
   Fibre glass-reinforced plastic Cooling Towers shall be suitable for outdoor installation. Tower shall be vertical, Forced/Induced Draft counter flow type in fibre-glass reinforcement plastic construction, complete with fan, motor, surface and spray section, eliminators, steel supports, as called for in Schedule of Quantities.

3. **Capacity:**
   The cooling tower capacities shall be as per the Drawings and Schedule of Quantities.

4. **Side Casing:**
   This shall be made out of FRP with smooth surface for minimum resistance to airflow. It shall have sufficient structural strength to withstand high wind velocities and vibration. The casing shall be installed in the fibreglass-reinforced basin. The tower supporting structure shall be made out of hot dipped galvanized frame. The tower shall have FRP panels with adequate reinforcement.

5. **Cold Water Basin:**
   Cold water basin shall be a deep fibreglass reinforced sump with which cooling tower super structure shall be supported.

   Basin fittings shall include the following:

   i. Bottom Outlet.
   ii. Drain at under side of suction side sheet.
   iii. Overflow fixed to inside of casing side sheet.
   iv. Ball type automatic make-up water valve.
   v. Equalizing connection where required.

6. **Distribution System:**

   Hot water distribution system should be Gravity Flow comprising of static header and branch arms system.

7. **Fillings:**
   Fillings shall be made of corrosion proof and rigid film in cross fluted design and arranged in square / rectangular form, and shall be elevated from the floor of the cold water basin to facilitate cleaning and easy replacement. They shall be arranged in such a manner as to ensure negligible resistance to airflow and to eliminate backwater spots and prevent fouling through scales that may form. In order to reduce carry-over losses through entrainment of moisture drops in air stream, PVC drift eliminators shall be installed. The fills shall be of High efficiency.

**8. Mechanical Equipment:**

Fan shall be made of Cast Aluminium Alloy and the propeller type, lightweight rotor fitted with multiple aerofoil blades. The entire fan assembly shall be balanced. Fan shall be direct driven motor 415 +/- 10% volts, 3 phase, 50 cycles AC supply, totally-enclosed, fan-cooled, weather-proof construction, designed and selected to operate in humid air stream. Fan shall be protected by fan guard and shall be easily accessible for inspection and maintenance. A service ladder shall also be provided for greater convenience. The mechanical equipment assembly shall be adequately supported on a rugged steel base welded to tubular support assuring vibration-free support. Fan guard shall be provided to prevent birds from nesting during idling periods. All fans shall be direct driven. Towers from 165 TR onwards wherever possible, shall have twin fans with twin motors, direct driven.

**9. Panel Colour**

For FRP cooling towers, the contractor shall obtain approval from the Architect/Consultant for available colors for the casing panels. The cooling tower shall be procured of the colour, strictly in accordance with written approval of Architect/Consultants and should have a striking finish.

Accessories:

Each cold water basin shall be provided with a deep, non-cavitating, and outlet sump complete with a suitable suction strainer having duplicate screen. The strainer shall have handles for easy removal.

The cooling tower basin shall be provided with automatic float valve with a stop valve for continuous make up water flow, quick fill arrangement with stop valve, over-flow and drain connections with stop valves.

Steel ladders shall be provided in such a manner and location as necessary to give safe and complete access to all parts of tower requiring inspection. Each ladder shall be made of 40mm x 40mm x 6mm angle iron sides and 16mm straps and shall be bolted to the tower on the top and bottom.

Hot dipped galvanized Bird Screen should be fixed on top to prevent any particles from entering the cooling tower.

All hardware shall be electroplated. All pipe connections shall be hot dip galvanized. All other technical parameters should confirm to FD/ID series cooling towers.

5. **Air Separator**

Circulating the water through the Vortex Air Separator creates a vortex or whirlpool action, sending the heavier air-free water to the outer portion of the tank and allowing the lighter air-entrained water mixture to move into the lower velocity center. At the centre of the vortex the air is released from the water forms bubbles and exits through an air vent or compression tank installed above. Instead of relying entirely on low velocity separation, the Vortex Air Separator offers the advantage of efficient separation in a much smaller tank. Air-free water flow means improved systems operation and lower operating costs.

The Vortex Air Separators eliminate entrained air from heating and cooling systems providing these benefits:

- Allows quick venting of air at start-up
- Reduces annoying noise caused by air entrained in the system
- Reduces service costs due to air-bound piping
- Extends the life of the system by reducing corrosion and erosion
- Improves heat transfer efficiency in boilers, fan coils, chillers, etc.
- Reduces the overall energy costs of your system
- Optimizes pump performance by reducing incidences of ‘air lock’

**6.0 Expansion Tank:**

Manufactured in accordance with ASME Section VIII for unfired pressure vessels, the pre-charged diaphragm and bladder type tanks separate the air and water within the tank providing the following benefits.

- Tanks can be size up to 80% smaller than a conventional tank
- Improved system performance
- Reduced system corrosion
- Reduced requirement for chemical treatment
- Eliminates water-logged Expansion Tanks
- Stabilizes system pressure
- Dampens pressure transients (Water Hammer)
- Prevents Air Ingress
-

**6.0 Electric Hot water Generator:**

Details of Electric hot water Generator are as below:

- Type : Horizontal (Indoor Installation)
- Construction: M.S. Body 10mm Shell, 40mm End plate, Top openable with sufficient number of Nut Bolts.
- Inlet-outlet: 10" Pipe Flange ends.
- Heating Elements : Electric Resistance Immersion Type, Copper Tube Chrome plated
- Capacity: 25KW X 8Nos. = 200KW X 02 Steps. = 400KW 25KW X 4Nos. = 100KW X 06 Steps. = 600KW
- Test Pressure : 300 PSIG
- Internal Wiring: Internally Factory wired complete with Electrical Panel.
- Controls: Step Controller, Thermometers, Pressure Gauges with Ball Valves, Pressure relief Valve, Low Level cutout, with Sight Glass and Autovent.
- Insulation: 50mm Thick Resin Bounded Fiber Glass wool & claded with 0.6mmAluminum Sheet on M.S. Frame welded to Generator Body.

**7.0 Scale Ban:**

SCALEBAN in used in chiller plant for achieving long-term benefits with Zero Scale condition.

| **Parameter Limits With Scaleban** | |
|---|---|
| **Source of Water** | Raw Water |
| **Water Pre-treatment** | Clarified |
| **Chemicals :**<br>**Except anti scalent chemical others will be used to avoid Algae and corrosion problem in cooling tower circuit** | |

**MAJOR ADVANTAGES:**

- No pre-treatment i.e. softening of water required thereby saving of water wasted in regeneration.
- System will work directly on Raw Water / Bore Water.
- Complete elimination of De-scaling Chemicals.

- Losses due to scale formation are totally saved.
- No maintenance, electricity costs for Scaleban Equipment.

**IMPORTANT:**

- Before Installing Scale ban equipments, the Heat Exchanger /condenser / cooler tubes should be thoroughly cleaned.
- To install Scale ban along with Flanged Connections in the individual inlet to the HE, a distance piece of about one meter is to be removed just at the inlet, which exists near HE.
- It may take 1-2 days for installation of Scale ban in your Applications, so this should be planned in advance before commencing of the plant.
- Installation should be done in supervision of our Engineer.
- The Installation Date can be decided as per your instructions.
- Maintenance of pH of Re-circulating water between7.0-8.5 will be necessary for the working of Scale ban, for which one person will be deputed at your plant for a period for a week.
- You shall arrange the lodging / Boarding expenses for the person deputed for pH maintenance

**8.0 Piping:**

Chilled water system shall be designed for self balancing of water flows. Therefore, 2-way PICV automatic balancing cum control valve shall be designed in major branch pipes and at each chiller/condenser for the fine tuning balancing of the chilled water/hot water system.

The material of the piping shall be Mild Steel “C” class (heavy duty) for Chilled/Hot/ Condenser water pipes and “B” Class GI for condensate drain pipes.

Condensate drain piping would be GI ‘B’ Class conforming to relevant BIS codes whereas in shafts PVC pipe has been considered.

Chilled water piping buried underground shall be MS "C" class pipe.

**9.0 VFD (Variable Frequency drive):**

Variable Frequency Drives (VFD) shall be used with cooling tower fan, chillers, and secondary chilled water pumps to vary flow of chilled water to various terminal units in response to load demand, by varying the speed of chilled water pumps. VFD shall be pulse width modulation type, suitable for pump motor ratings.

**10.0 Sound & Vibration Isolator:**

Mechanical services shall generally be designed and installed with provision to contain noise and transmission of vibration, generated by moving plant and equipment are source to achieve acceptable Noise rating for NC levels for occupied space. Vibration isolator shall be designed for minimum isolation efficiency of 90%.

All items of rotating/reciprocating plant and equipment shall be isolated from the foundation/structure by the use of anti-vibration material, mounting or spring loaded support fixed to either concrete bases, inertia blocks or support steels as indicated.

**11.0 SHEET METAL DUCT (SITE FABRICATED):**

**GENERAL:**

Supply, fabrication, installation and testing of all sheet metal ducts & supply, installation, testing and balancing of all grilles, registers and diffusers, in accordance with these specifications and the general arrangement shown on the drawings.

Duct work shall mean all ducts, casings, dampers, access doors, joints, vanes, stiffeners,

hangers and supports etc.
All ducts shall be fabricated according to SMACNA & IS277 & 655 from galvanized steel sheets of zinc grade G27 or Z90 of the following thickness as indicated in schedule of quantities & as described in the relevant latest IS code.

**1. RECTANGULAR DUCT:**

| Dimensions of Ducts | GI sheet | | Type of Joints | Type of Bracing |
|---|---|---|---|---|
| | Thickness (mm) | Gauge | | |
| Upto 600 | 0.63 | 24 | G.I. Flange at 2.5 Centre | Cross Bracing |
| 601 to 750 | 0.63 | 24 | ------- | ------ |
| 751 to 1000 | 0.63 | 24 | 25x25x3mm angle iron frame with 6mm dia nuts and bolts. | 25x25x3mm M.S. angle bracing at 1500mm from joints. |
| 1000 to 1500 | 0.80 | 22 | 25x25x3mm angle iron frame with 8mm dia nuts and bolts. | 25x25x3mm M.S. angle bracing at 1500mm from joints. |
| 1501 to 2250 | 1.0 | 20 | 40x40x5mm angle iron be cross braced diagonally with 10mm dia nuts & bolts at 125 centre. | 40x40x3mm M.S. angle bracing at 1200mm from joints or 40x40x3 mm M.S. angle diagonal bracing. |
| 2250 and above | 1.25 | 18 | 50x50x6mm angle iron frame with 10mm dia nuts & bolts at 125 centre. | 50x50x3mm M.S. angle bracing at 1200mm from joints or 50x50x3 mm M.S. angle diagonal bracing. |

**iii) HANGERS FOR DUCT:**

| Duct Size (mm) | Spacing (M) | Size of MS angle (mm x mm) | Size of rod dia (mm) |
|---|---|---|---|
| Upto 750 | 2.4 | 25 x 3 | 8 |
| 751 to 1500 | 2.4 | 40 x 5 | 10 |
| 1501 to 2250 | 2.4 | 50 x 5 | 12 |
| 2251 to above | 2.4 | 50 x 5 | 12 |

**iv) FABRICATION:**

All ducts irrespective of size shall be fabricated and installed in workman like manner, generally conforming to SMACNA & IS277 & 625.

a) Ducts so identified on the drawings shall be acoustically lined with thermal insulation as described in the section `Insulation' and as indicated in schedule of quantities. Duct dimensions shown on drawings are overall sheet metal dimensions inclusive of the acoustic lining, where required and indicated in schedule of quantities.

b) Ducts shall be straight and smooth on the inside with neatly finished joints. All joints shall be made air tight.

c) Changes in dimensions and shape of ducts shall be gradual. Curved elbows, unless otherwise indicated, shall have a centre line radius equal to one and a half times the width of the duct. Air turns shall be installed in all vanes, arranged to permit the air to make the turn

without appreciable turbulence. Suitable vanes shall be provided in duct collar to have uniform/ proper air distribution.

d) Ducts shall be fabricated as per details shown on drawings. All ducts shall be rigid and shall be adequately supported and braced where required with standing seams, tees, or angles of sample size to keep the ducts true to shape and to prevent bulking, vibration, breathing or oil canning.

e) All sheet metal connections, partitions and plenums required to confine the flow of air to and through 18g GI/16 gauge aluminium, thoroughly stiffened with 25mm x 25mm x 3mm angle iron braces and fitted with all necessary doors as required to give access to all parts of the apparatus. Access Doors shall be not less than 45cm x 45cm in size.

**vi) INSTALLATION :( As per SMACNA & IS277 & 625)**

All ducts shall be installed generally as per the drawings and in strict accordance with approved shop drawings to be prepared by the Contractor.

- The Contractor shall provide and neatly erect all sheet metal work as may be required to carry out the intent, of these specifications and drawings. The work shall meet with the approval of Owner's site representative in all its parts and details.

- All necessary allowances and provisions shall be made by the Contractor for beams, pipes, or other obstructions in the building, whether or not the same are shown on the drawings. Where necessary to avoid beams or other structural work, plumbing or other pipes, and/ or conduits, the ducts shall be transformed, divided or curved to one side, the required area being maintained, all as per the site requirements.

- If a duct cannot be run as shown on the drawings, the contractor shall install the duct between the required points by any path available, in accordance with other services and as per approval of Owners site representatives.

- All duct work shall be independently supported from building structure. Duct shall be supported to the ceiling with the help of anchor fasteners by drilling holes in concrete slab and inserting anchor fasteners and bolts. All horizontal ducts shall be rigidly and securely supported, in approved manner with trapeze hangers formed of MS rods and angle iron under ducts at not greater than 2.4 meter centres. All vertical duct work shall be supported by structural members at each floor.
  If duct is passing through in such areas where space between ceiling slab to false ceiling is more than 1500 mm than duct should be supported by wall mounted brackets of 40x40x3 mm angle.
  Ducting over furred ceiling shall be supported from the slab above, or from beams, after obtaining approval of Owner's site representative. In no case shall any duct by supported from false ceiling hangers or be permitted to rest on false ceiling. All metal work in dead or furred down spaces shall be erected in time to occasion no delay to other contractors on the building.
- Where metal ducts or sleeves terminate in wood work, tight joints shall be made by means of closely fitted heavy flanged collars. Where ducts pass through brick or masonry opening and wooden frame work shall be provided within the opening and crossing ducts provided with heavy flanged collars on each side of wooden frame work, so that duct crossing is made leak-proof.

- All ducts shall be totally free from vibration under all conditions of operation. Whenever duct work is connected to fans, air handling units or blower coil units that may cause vibrations in the ducts, ducts shall be provided of closely woven, rubber impregnated double layer canvas or neoprene coated fibre glass fire resistant flexible connection. The flexible connections

located close to the unit, in mutually perpendicular directions. The flexible sleeve at least 10cm long securely bonded and bolted on both sides. Sleeve shall be made smooth and the connecting duct work rigidly held by independent supports on both ends. The flexible connection shall be suitable for pressures at the point of installation and shall be class 'O' smoke rated.

- Air conditioning unit and exhaust fans shall be connected to duct work by inserting at air inlet and air outlet a double canvass sleeve. Each sleeve shall minimum 150mm securely bolted to duct and the connecting duct work rigidly held in line with unit inlet or outlet and shall be class 'O' smoke rated.

- All ducts above 450 mm are to be cross broken to provide rigidity to the ducts.

**2.0 DAMPERS:**

- At the junction of each branch duct with main duct and split of main duct, splitter dampers must be provided. Dampers shall be two gauges heavier than gauge of the large duct, and shall be rigid in construction to the passage of air. This item shall be a part of ducting and shall not be charged separately. All dampers shall be as per ISO-10294-1:1996 & tested to UL555 with minimum 2 hr fire rating.
- The volume control dampers shall be of opposed blade type, lever operated and complete with locking devices, which will permit the dampers to be adjusted and locked in any positions. Quantity of volume control dampers for ducts, plenum and grills shall be covered separately in BOQ.
- 2.3 Automatic and manual volume opposed blade dampers shall be complete with frames and bronze bearings as per drawings. Dampers and frames shall be constructed of 1.6 mm steel and blades shall not be over 225 mm wide. The dampers for fresh air inlet shall additionally be provided with fly mesh screen, on the outside, of 0.8 mm thickness with fine mesh specking.
- 2.4 Wherever required for system balancing, provide a volume balancing opposed blade damper with quadrant and thumb screw lock. Provide damper rod and damper block with upset screws. Quantity of volume control dampers shall be covered separately in BOQ.
- 2.5 After completion of the duct work, dampers are to be adjusted and set to deliver the required amounts of air as specified on the drawings.
- 2.6 The fire dampers shall be provided in all the main supply and return air ducts weather shown in the drawings or not. The damper shall be multi-blade type as per drawings.

**3.0 MISCELLANEOUS:**

- All ducts above 450 mm are to be cross broken to provide rigidity to the ducts.
- All duct work joints are to be true right angle or approaching with all sharp edges removed.
- Smoke rated sponge rubber gaskets also to be provided behind the flange of all grilles.
- Each branch from the duct, leading to a grille, shall be provided with an air deflector to divert the air into the grille through the branch.
- Inspection doors measuring at least 450 mm x 450 mm are to be provided in each system at an appropriate location, as directed by Project Manager/Engineer-in-charge/Consultants.
- Diverting vanes must be provided at the bends exceeding 600 mm and at branches connected into the main duct without a neck.
- Proper hangers and supports should be provided to hold the duct rigidly, To keep them straight and to avoid vibrations. Additional supports are to be provided where required for rigidity or as directed by Project Manager/Engineer-in-charge/Consultants.

- The ducts should be routed directly with a minimum of directional change.
- The duct work shall be provided with additional supports /hangers, wherever required or as directed by the directed by Project Manager/Engineer-in-charge/Consultants, at no extra cost.
- All duct supports, flanges, hangers and damper boxes etc. shall be either zinc coated or given 2 coats of anti corrosion red oxide paint before installation and one coat of aluminium paint after the erection, at no extra cost.
- All angle iron flanges to be welded electrically and holes to be drilled.
- All the angle iron flanges to be connected to the GSS ducts by rivets at 100 mm centres.
- All the flanged joints, to have a 3 mm neoprene rubber gasket to the flanges with Adhesive.
- The G.S.S. Ducts should be lapped 6 mm across the flanges.
- The ducts should be supported by approved type supports at a distance not exceeding 2.4 metres and at every vertical floor penetration.
- Sheet metal connection pieces, partitions and plenums required shall be constructed of 1.25 (18 gauge) sheet thoroughly stiffened with 25 mm x 25 mm angle iron braces and fitted with access doors.
- Readymade (factory fabricated) flanges shall be used for all ducting.
- All duct joints shall be filled up by silicon.
- All duct penetrations in fire rated walls and slabs shall be filled up by fire resistant materials of fire rating not less than fire rating of wall / slab.

**4.0 GRILLES:**

- The supply and return air grilles shall be fabricated from aluminium extruded sections. The supply and return air grille shall have single horizontal extruded section fixed louvers. The grilles may or may not be with an outer frame. The grille flange shall be fabricated out of 20x20x1.5 mm aluminum angle. Grilles longer than 450 mm shall have intermediate supports for the horizontal louvers.
- The grilles shall have opposed blade dampers of M.S. Black sheets, which shall be key operated from the grille face wherever required as approved.
- The damper blades shall be of 0.63 mm (24 Gauge) M.S. Black sheets and shaped to form air tight joints. The frame work for dampers shall be fabricated from 0.63 mm (24 gauge) M.S. Black sheet.

## 12. VENTILATION & EXHAUST FANS:

### a. Propeller Type Wall Exhaust Fans

Propeller fan shall be direct-driven, three or four blade type, mounted on a steel mounting plate with orifice ring.

Mounting Plate shall be of steel construction, square with streamlined venturi inlet (reversed for supply applications) coated with baked enamel paint. Mounting plate shall be of standard size, constructed of 12 to 16 gauge sheet steel depending upon the fan size. Orifice ring shall be correctly formed by spinning or stamping to provide easy passage of air without turbulence and to direct the air stream.

Fan Blades shall be constructed of aluminum or steel. Fan hub shall be of heavy welded steel construction with blades bolted to the hub. Fan blades and hub assembly shall be statically and dynamically balanced at the manufacturer's works.

Shaft shall be of steel, accurately ground and shall be of ample size for the load transmitted and shall not pass through first critical speed thru the full range of specified fan speeds.

Motor shall be standard (easily replaceable) permanent split capacitor or shaded pole for small sizes, totally enclosed with pre-lubricated sleeve or ball bearings, designed for quiet operation with a maximum speed of 1000 rpm for fans 60 cm dia or larger and 1440 rpm for fans 45 cm dia and smaller. Motors for larger fans shall be suitable for 415±6% volts, 50 cycle's 3 phase power supply, and for smaller fans shall be suitable for 220±6% volts, 50 cycle's single phase power supply. Motors

shall be suitable for either horizontal or vertical service as indicated on drawings and system design requirements. The motor shall be rated for IP-55.

**Accessories:**

The following accessories shall be provided with propeller fans:

- Wire guard on inlet side and bird screen at the outlet.
- Fixed or gravity louvers built into an aluminum steel frame at the outlet.
- Electronic speed controller for controlling fan speed for single phase fan motor and variable speed drives for three phase motors.
- Single phase preventers for 3 phase fans.

Fan shall be as per IS: 2312-1967 Specs for propeller type AC ventilating fans

**b. Inline Fan:**

Inline type of fans shall be G.E.C make or equivalent. Fan shall be of the broad type, ring or diaphragm mounted. Fans shall be provided with gravity louvers. Fan drive shall be single phase or three phase motors as indicated in the schedule of equipment and shall be complete with starter.

**1. Casing:**

Casing shall be welded construction fabricated with 14 gauges M.S. Sheet with spray galvanization. Minimum zinc deposition shall conform to class 375 of IS: 277.The minimum thickness of casing shall not be less than 3 mm. The fan scroll shall be attached to the side plate by means of continuous lock seam. 18 gauge galvanized wire mesh inlet screens of 50 mm sieves shall be provided on both inlets. Housing shall be provided with standard clean out and door with quick locking tension handles and neoprene gasket. Rotation arrow shall be clearly marked on the housing.

**2. Impeller:**

The impeller shall have die-formed, backward/forward curved blade (wherever mentioned in the BOQ), welded to the rim and back plates to have a non-over loading characteristic of the fan. Rim shall be spun to have a smooth contour if required, intermediate stiffening rings shall be provided. Shaft sleeves shall be furnished wherever required. The impeller, pulley and housing shall be statically and dynamically balanced. Fan velocity shall not exceed 1800 FPM.

**3. Shaft:**

Shaft shall be constructed of SAE 1040 steel turned ground and polished. Shaft sizes shall be carefully calculated and designed such that the maximum operating speed (RPM) shall not exceed 75% of the first critical speed.

**4. Bearings:**

The bearing shall be self-aligning, heavy duty ball, roller or sleeve bearings. Bearing shall be selected for quiet operation and shall be grease pack, pillow block type. Bearings shall be maintenance free with permanently lubricated sealed ball bearing type.

**c. Tube Axial flow fan**

Axial flow fan shall be of tube axial type and shall be suitable for mounting in duct or floor/slab as required/indicated on the tender drawings.

**1. Impellers:**

Single piece cast aluminum or steel impeller shall be with blades of design to give maximum efficiency and shall vary in twist and width from hub to top to effect equal air distribution along the blade length. Single piece fan and hub shall be statically and dynamically balanced. Maximum clearance between blade tip and the fan housing at the specified speed shall be 5 mm. Impellers blades shall be whirl tested to a speed 25% above the design operating speed. Extended grease leads for external lubrication shall be provided. The fan blade shall be adjustable type so that actual air flow can be achieved at site as per indicated in Drawings & BOQ.

**2. Casing:**

Casing shall be constructed of 14 gauge sheet steel, properly reinforced for rigidity. Fan casing, motor mount and straightening vanes shall be of welded steel construction motor mounting plate shall be minimum 12.5 mm thick and machined to receive motor flanges. Casing shall be provided with two nos. wide, hinged doors which open easily. Inspection doors with handle and neoprene gasket shall be provided. Casing shall have flanged connection on both ends for ducted applications. Support brackets for ceiling suspensions shall be welded to casing for connection to hanger bolts. Straightening vanes shall be aerodynamically designed for maximum efficiency by converting velocity pressure to static pressure potential and minimizing turbulence. Casing shall be bondorized, primed and finish coated with enamel paint.

**3. Motor:**

Motor shall be squirrel cage, totally enclosed, fan cooled, and constant speed, suitable for 415 ± 10% volts, 50 Hz, 3 phase power supply, and motor nameplate horsepower shall be more than brake horse power by a minimum of 10%. Motor speed shall not exceed 1450 R.P.M (4 poles). The fan and motor combination selected for particular requirement shall be of the most efficient type so that sound level and energy consumption is minimum. Motor conduit box shall be mounted on exterior of the casing. Wires from the motor to the conduit box shall be protected from the air stream by enclosing in a flexible metal conduit. The motor shall have ‘F’ class insulation with IP 55 protection.

**4. Vibration Isolation:**

Base shall be provided for each fan. Base for both fan and motor shall be built as an integral part and shall be mounted on a concrete foundation through cushy foot vibration isolators. The concrete foundations shall be at least 15 cm above the finished floor level and shall be further isolated from the structural floor through 5 cm. Thick layers of sand all around, topped with bitumen. In case ceiling hung fan within the ceiling shall be provided Vibration Isolation Suspension (VIS) shall be provided in each of string.

## G. ANNEXURE A- PUMP HEAD CALCUALTION

### 1. PRIMARY PUMP HEAD CALCULATION

| PRIMARY PUMP | | | | | | |
|---|---|---|---|---|---|---|
| CHILLED WATER PIPE | | | | | | |
| | Pipe dia (mm) | RMT | FT | Pressure Drop (ft/100Ft) | total drop (ft) | |
| **Pipe Length** | 600 | 134 | 428.8 | 1.5 | 6.432 | |
| **No of bend** | 10 | 18 | 590.4 | 1.5 | 8.856 | |
| **Pipe Length** | 250 | 28 | 91.84 | 1.5 | 1.38 | |
| **No of bend** | 3 | 6.1 | 60.024 | 1.5 | 0.90 | |
| **Total Pressure drop in pipes** | | | | **ft** | **17.57** | |
| | | | | | | |
| CHILLED WATER PIPING VALVES | | | | | | |
| | Dia (mm) | Equ.leng-th in Feet | QTY | Pressure Drop (ft/100Ft) | Total Drop (ft) | |
| NRV | 250 | 98.4 | 1 | 2.5 | 2.46 | |
| Y strainer | 250 | 104.96 | 1 | 2.5 | 2.624 | |
| Butterfly valve | 250 | 12.136 | 2 | 2.5 | 0.6068 | |
| Butterfly Valve(Chiller) | 250 | 12.136 | 2 | 2.5 | 0.6068 | |
| Balancing Valve(Chiller) | 250 | 288.64 | 1 | 2.5 | 7.216 | |
| Motorised Butterfly Valve(chiller) | 250 | 12.1 | 1 | 2.5 | 0.3025 | |
| **Total Pressure drop in Valves** | | | | **ft** | **13.8161** | |
| | | | | | | |
| **TOTAL PRESSURE DROP IN THE SYSTEM (METERS)** | | | | | | |
| | | | | | | |
| **Pipes & Bend Loss** | **Valves** | **CHILLER** | **AHU** | **Total** | **10% EXTRA** | |
| **5.36** | **4.21** | **4.51** | **0.00** | **14.08** | **15** | **IN METERS** |
| | | | | **SELECTED HEAD** | | **18** |

## 2. SECONDARY PUMP HEAD CALCULATION

| SECONDARY PUMP | | | | | | |
|---|---|---|---|---|---|---|
| CHILLED WATER PIPE | | | | | | |
| | Pipe dia (mm) | RMT | FT | Pressure Drop (ft/100Ft) | total drop (ft) | |
| **Pipe Length** | 600 | 780 | 2558.4 | 1.5 | 38.376 | |
| **No of bend** | 6 | 18 | 354.24 | 1.5 | 5.3136 | |
| **Pipe Length** | 550 | 160 | 524.8 | 1.5 | 7.87 | |
| **No of bend** | 2 | 13 | 85.28 | 1.5 | 1.28 | |
| **Pipe Length** | 500 | 260 | 852.8 | 1.5 | 12.79 | |
| **No of bend** | 3 | 12 | 118.08 | 1.5 | 1.77 | |
| **Pipe Length** | 450 | 320 | 1049.6 | 1.5 | 15.74 | |
| **No of bend** | 3 | 12 | 118.08 | 1.5 | 1.77 | |
| **Pipe Length** | 400 | 120 | 393.6 | 1.5 | 5.90 | |
| **No of bend** | 1 | 10 | 32.8 | 1.5 | 0.49 | |
| **Pipe Length** | 350 | 380 | 1246.4 | **1.5** | 18.70 | |
| **No of bend** | 3 | 7.6 | 75 | 1.5 | 1.13 | |
| **Pipe Length** | 300 | 420 | 1377.6 | **1.5** | 20.66 | |
| **No of bend** | 6 | 6.1 | 120.048 | 1.5 | 1.80 | |
| **Pipe Length** | 200 | 156 | 511.68 | **1.5** | 7.68 | |
| **No of bend** | 1 | 6.1 | 20.008 | 1.5 | 0.30 | |
| | | | | | | |
| **Total Pressure drop in pipes** | | | | **ft** | **139.77552** | |
| CHILLED WATER PIPING VALVES | | | | | | |
| | | | | | | |
| | **Dia (mm)** | **Equ.leng-th in Feet** | **QTY** | **Pressure Drop (ft/100Ft)** | **Total Drop (ft)** | |
| NRV | 250 | 98.4 | 1 | 2.5 | 2.46 | |
| Y strainer | 150 | 68.8 | 1 | 2.5 | 1.72 | |
| Butterfly valve | 250 | 12.1 | 2 | 2.5 | 0.6068 | |
| Butterfly Valve(Chamber) | 600 | 24.9 | 2 | 2.5 | 1.2464 | |
| Butterfly Valve(Chamber) | 150 | 6.9 | 2 | 2.5 | 0.344 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Butterfly Valve(Pump) | 150 | 6.9 | 2 | 3.5 | 0.483 | |
| | | | | | | |
| **Total Pressure drop in Valves** | | | | **ft** | **6.8602** | |
| **TOTAL PRESSURE DROP IN THE SYSTEM (METERS)** | | | | | | |
| | | | | | | |
| **Pipes & Bend Loss** | **Valves** | **CHILLER** | **AHU** | **Total** | **10% EXTRA** | |
| **42.61** | **2.09** | **0.00** | **0.00** | **44.71** | **49** | **IN METERS** |
| | | | | **SELECTED HEAD** | | **50** |

## 3. CONDENSOR PUMP HEAD CALCULATION

| CONDENSER PUMP | | | | | | |
|---|---|---|---|---|---|---|
| CONDENSER WATER PIPE | | | | | | |
| | **Pipe dia (mm)** | **RMT** | **FT** | **Pressure Drop (ft/100 Ft)** | **total drop (ft)** | |
| **Pipe Length** | 800 | 89 | 284.8 | **1.5** | 4.272 | |
| **No of bend** | 6 | 20 | 393.6 | 1.5 | 5.904 | |
| **Pipe length** | 300 | 18 | 59.04 | **1.5** | 0.89 | |
| **No of bend** | 3 | 9.1 | 89.544 | 1.5 | 1.34 | |
| | | | | | | |
| **Total Pressure drop in pipes** | | | | **ft** | **12.40** | |
| **CHILLED WATER PIPING VALVES** | | | | | | |
| | | | | | | |
| | **Dia (mm)** | **Equ.leng-th in Feet** | **QTY** | **Pressure Drop (ft/100 Ft)** | **Total Drop (ft)** | |
| NRV | 300 | 121.36 | 1 | 2.5 | 3.034 | |
| Y strainer | 300 | 131.2 | 1 | 2.5 | 3.28 | |
| Butterfly valve | 300 | 13.12 | 2 | 2.5 | 0.656 | |
| Balancing Valve | 300 | 321.44 | 1 | 2.5 | 8.036 | |
| Butterfly valve | 80 | 3.28 | 2 | 2.5 | 0.164 | |
| Butterfly valve | 100 | 4.592 | 2 | 2.5 | 0.2296 | |
| Butterfly valve | 150 | 6.888 | 1 | 2.5 | 0.1722 | |
| Pot Strainer | 800 | 265.68 | 1 | 2.5 | 6.642 | |
| | | | | | | |
| **Total Pressure drop in Valves** | | | | **ft** | **22.2138** | |
| | | | | | | |
| **TOTAL PRESSURE DROP IN THE SYSTEM (METERS)** | | | | | | |
| | | | | | | |
| **Pipes & Bend Loss** | **Valves** | **CONDENSER** | **AHU** | **Total** | **10% EXTRA** | |
| **3.78** | **6.77** | **7.71** | **0.00** | **18.27** | **20** | **IN METERS** |

# 12.27. ANNEXURE XII - DDR for AC1&C1 - FACULTY OF ART & DESIGN AND CONVENTION CENTRE

## 12.27: ANNEXURE XII - DDR for FACULTY OF ART & DESIGN AND CONVENTION CENTRE

### A. Introduction:

Art & Convention Building is part of academic block in South Asian University. This building includes Class Room, Exhibition space, Lecture Theater, Studio, Music Dance Studio, Cafeteria, Session Room, Design Studio, Meeting Room, Office, Seminar Room, Faculty Rooms, PhD Room, Faculty Room , Lab, Workshop, Art Gallery/Museum etc..

Building consists of a Basement + Ground + 4 Floors and a total built-up area of 13358 sq.mtr.

**Air Conditioning Objective:**

Objective of air conditioning is to provide thermal comfort to all areas for Art & Convention building in an efficient and cost-effective manner round the year. Temperatures and Indoor Air Quality shall be maintained in accordance with parameters as specified in the following sections of Basis of Design.

Art & Convention building is served by Central chilled water system. The chilled water flowing through the “MS” pipe with HDPE Jacketing buried underground is connected to branch piping to serve all risers which are connected to all AHU’s.

### B. General Building HVAC Design Criteria and Assumptions

This section of the report documents specific numbers used in the design of the Art & Convention building. These assumptions are an essential part of making the transition from the project intent to installed equipment. Also the codes and guidelines for the designer and contractor which are to be followed during the different stages of project are outlined.

#### 1. CODES & STANDARDS:

The applicable Standards/Codes are:

(a) American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE).
- a.1 ASHRAE - 55
- a.2 ASHRAE - 90.1
- a.3 ASHRAE - 62.1
- a.4 ASHRAE - Fundamentals
- a.5 ASHRAE - HVAC Application
- a.6 ASHRAE - HVAC System & Equipment
- a.7 ASHRAE - Refrigeration

(b) Energy Conservation Building Code (ECBC)
(c) Duct construction standards as per relevant BIS Codes & SMACNA standards
(d) National Buildings Code-2005
(e) Air Filter as per ASHRAE-52.1 and 52.2
(f) National Electric code
(g) National Fire Protection code
(h) ISHRAE Standards
(i) GRIHA Manual
(j) IMC-2009

The following IS codes shall be applicable:

| S. No. | Material/item of Work | Standard/Code |
|---|---|---|
| 1. | Ducting Fabrication | IS: 655 |
| 2. | Galvanized Sheets/Wires | IS: 277 |

| | | |
|---|---|---|
| 3. | Aluminum Sheets/Wires | IS: 737 |
| 4. | Horizontal Centrifugal Pumps | IS: 6595 |
| 5. | Mild Steel, ERW Pipes | IS: 1239, IS: 3589 |
| 6. | Pipe Fittings | IS: 1239 |
| 7. | Steel Pipe Flanges | IS: 6392 |
| 8. | Gate, Globe & Check Valves | |
| | • Up to 40 mm Gun metal | IS:778 |
| | • Butterfly valve of 50 mm and Above (Cast Iron) | IS:2906 |
| | • Balancing valve | IS:778 |
| | • Non Return valve | IS:5312 |
| 9. | Color Code for Identifications of pipes | IS: 2379 |
| 10. | 3 Phase induction motors | IS: 325 |
| 11. | Pressure and vacuum gauges | IS: 3624 |
| 12. | PVC insulated electric cables | IS: 1554 |
| 13. | Starters sheets/wires | IS: 8555 |
| 14. | Glossary of terms used in refrigeration and Air-conditioning | IS: 3615 |
| 15. | Hot die zinc coated steel pipes | IS: 4736-1968 |
| 16. | Expanded Polystyrene | IS: 4671 |

**Safety codes**

The following safety codes as laid down by ISI shall be followed:

| | | |
|---|---|---|
| 1. | Safety code for mechanical refrigeration | IS : 660 |
| 2. | Safety code for air-conditioning | IS : 659 |
| 3. | Safety code for scaffolding and ladders | IS : 3696 |
| 4. | Code for practice for safety and health Requirements in electrical and gas Welding & cutting operations | IS: 818 |
| 5. | Recommendations of safety procedures and practices In electrical works | IS: 5216 |

NOTE: - All the codes and standards are applicable only with the latest amendments only.

**2. LOCATION:**

- Site Location : New Delhi
- Geographic Location : 28.38°N, 77.13°E
- Altitude : 216 m above mean sea level

**a) Design Conditions and Assumptions:**

The summer design condition is based on ISHRAE weather data and statistics of the most recent data of 10 year period, published by the India Metrological Department and *.epw* weather data files from the *DOE*.

The year round temperatures and climatic conditions is as below and system is evaluated for 8760 hours.

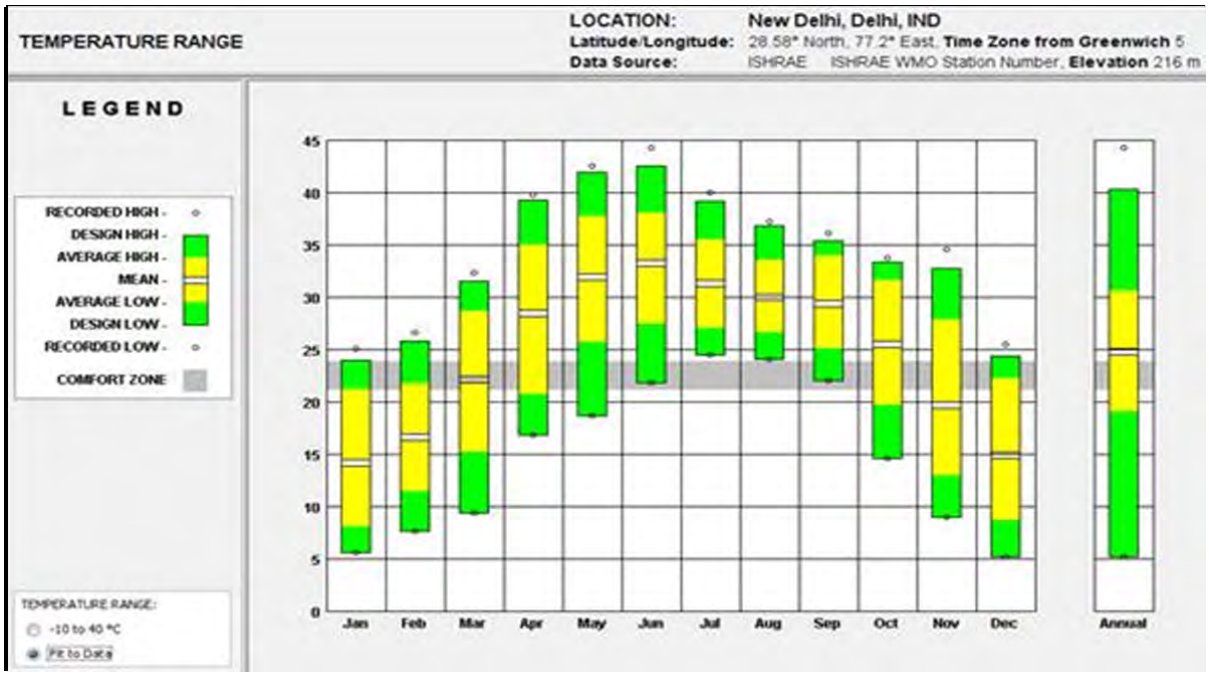



**Table-1 Design Assumptions**

| Description | Value (units) |
|---|---|
| Latitude/Longitude | 28.38°N, 77.13°E |
| Sea level | 216 m |
| Clearness number | 0.95 |
| Summer outdoor air DB/WB temperature | 43.3°C (109.94 °F) /23.89 (75.02 °F) |
| Winter outdoor air DB/WB temperature | 7.2°C (44.96 °F) / 5.0°C(41.0°F) |
| Monsoon outdoor air DB/WB temperature | 35°C (95.0°F)/ 28.3°C (83°F) |
| Ground reflectance | 0.20 |
| Roof U-value | 0.079 Btu/h. ft².°F |
| Overall Wall U-value | 0.1179 Btu/h. ft².°F |
| Glass U-value (summer/winter) | 0.31 Btu/h. ft².°F |
| Glass shading coefficient | 0.58 |

| | |
|---|---|
| Infiltration /Ex-filtration | As per ASHRAE 90.1 |
| Cooling load design calculation program | CLTD, Trane Trace 700 |
| Winter Heat load design calculation program | UATD, Trane Trace 700 |
| Ductwork sizing program | Trane Ductulator |
| Cooling Safety factor/Heating Safety Factor | 10% |
| Fan heat gain safety factor | 5% |
| Diversity | 80% Overall on chiller plant |
| Typical Hours of Operation | As directed by SAU |

**b) Inside Design Conditions:**

Table below shows Room Ambient Temperature and Humidity Design Criteria for Art & Conventionbuildings. The set points are considered on the basis of ASHRAE -55, Thermal Comfort charts and after discussion with SAU.

**Table-2- Inside Set Points conditions:**

| | **Inside conditions** | | | |
|---|---|---|---|---|
| | **Summer** | | **Winter** | |
| **Spaces** | **Temp.** | **Humidity** | **Temp.** | **Humidity** |
| MEETING ROOM | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| OFFICE | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| DEANS ROOM | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| ENTRANCE LOBBY | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| EXHIBITION SPACE | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| LAB -1,2,3,4 | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| STUDENT LOUNGE | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| LECTURE THEATRE | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| ENTRANCE LOUNGE/RECEPTION | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| CAFETERIA | 25 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| MUSIC DANCE STUDIO | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| STUDIO | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| CLASSROOM | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| SESSION ROOM 1,2,3,4 | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| DOUBLE HT STUDIO | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| DESIGN STUDIO | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| DISCUSSION ROOM | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| SEMINAR ROOM | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| MULTI HALL | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| FILM MAKING STUDIO | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| PHD ROOM | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| MINI THEATRE | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| WORKSHOP | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| EXHIBITION SPACE | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |
| ART GALLERY/MUSEUM | 24 ± 1 °C | 55 ± 5% | 20 ± 1 °C | Min. 30% |

**3. Acoustic Criteria:**

Air-conditioning systems will be designed to maintain the following noise criteria (NC) level in

various spaces as per NBC - 2005 - PART 8 Building Services Section 4, Acoustics, Sound Insulation And Noise Control.

- Design Studio : NC 35-40
- Seminar room : NC 35-40
- Office Space : NC 35-40
- Auditorium / Stage /Mini Theatre : NC 35-40

**4. Fresh Air:**

Adequate fresh air quantity shall be provided to air-conditioned spaces to maintain indoor air quality (IAQ) generally as per ASHRAE standard 62.1-2007.

- 10.0 CFM/person + 0.18 CFM/Sq.ft. for Class Room
- 10 CFM/person + 0.06 CFM/Sq.ft. for Design Studio
- 5 CFM/person + 0.06 CFM/Sq.ft. for Meeting Room
- 5 CFM/person + 0.06 CFM/Sq.ft. for Office
- 5 CFM /person + 0.06 CFM/Sq.ft. for Entrance Lobby
- 7.5 CFM /person + 0.06 CFM/Sq.ft. for Exhibition Space
- 10 CFM/Person + 0.06 CFM/Sq.ft for Session Room
- 5 CFM/Person + 0.06 CFM/Sq.ft for Multi-Purpose Room
- 5 CFM/Person + 0.06 CFM/sq.ft for Seminar Room
- 10 CFM/Person + 0.06 CFM/sq.ft for Lecture Theater
- 10 CFM/Person + 0.06 CFM/sq.ft for Workshop
- 10 CFM/Person + 0.06 CFM/sq.ft for Mini Theater
- 7.5 CFM/Person + 0.18 CFM/sq.ft for Cafeteria
- 7.5 CFM/Person + 0.06 CFM/sq.ft for Art Gallery/Museum

**5. Lighting Load:**

Following is the assumptions made for the purpose of considering lighting load and will be according to the electrical lighting design. ASHRAE 90.1-2007 will be used for any assumptions.

- 1.0 W/Sq.ft forOffice
- 1.4 W/Sq.ft for Classroom
- 1.6 W/Sq.ft for Dance/Music Studio
- 1.4 W/Sq.ft for Cafeteria
- 1.0 W/Sq.ft for Art Gallery/Museum
- 1.1 W/sq.ft for Faculty Room
- 1.3 W/sq.ft for Seminar Room
- 1.4 W/Sq.ft for Lecture Theater
- 1.6 W/Sq.ft for Mini Theater
- 1.4 W/Sq.ft for Workshop
- 1.3 W/Sq.ft for Meeting Room
- 1.4 W/Sq.ft for Studio
- 1.3 W/Sq.ft for Lobby

**6. Equipment Loads**

Following is the assumptions made for the purpose of considering Equipment load and will be according to the ASHRAE Fundamentals-2005, chapter 30 & electrical design/equipment used.

- 1.2 W/Sq.ft for Office.

- 0.25 W/Sq.ft for Classroom.
- 0.5 W/Sq.ft for Dance/Music Studio
- 1.0 W/Sq.ft for Cafeteria
- 0.25 W/Sq.ft for Art Gallery/Museum
- 1.2 W/sq.ft for Faculty Room
- 0.25 W/sq.ft for Seminar Room
- 0.25 W/Sq.ft for Lecture Theater
- 0.25 W/Sq.ft for Mini Theater
- 0.5 W/Sq.ft for Workshop
- 0.25 W/Sq.ft for Meeting Room
- 0.5 W/Sq.ft for Studio

**7. Occupancy**

Occupancy as per furniture layout of rooms as mentioned on the architectural plans.
For areas where capacity is not mentioned, it is assumed as per NBC-Part-8, Building Services, and Section-3, Table 4 or ASHRAE 62.1-2007 table 6-1.

**8. Mechanical Ventilation System:**

The following areas shall be provided with dedicated ventilation system with the number of air changes per hour for each space as identified herewith:

| | | | |
|---|---|---|---|
| a) | Toilets | : | 10 ACPH |
| b) | Car Parking | : | 6 (Normal Mode)/ 12 (Fire Mode) ACPH Exhaust & 6 (Normal Mode)/12 (Fire Mode) ACPH Fresh Air |
| c) | Kitchen | : | 20 ACPH |
| d) | Electrical Room | : | 20 ACPH |

**9. Relative Pressure:**

- Toilet Rooms : Negative inside pressure
- Lift well : 50 Pa Positive Pressure
- Closed Staircase : 50 Pa Positive Pressure
- Lift lobby Pressurization : 30 Pa Positive Pressure
- All other areas : As per codes and standards

## C. Mechanical System Design Parameters & Philosophy:

This section describes the assumptions, parameters considered for sizing and designing of various Mechanical equipment's and its components. Below is the detailed description.

- Art & Convention building shall be served by the central chilled water plant & Electric hot water generator located in utility building.
- Chilled water network buried shall supply required chilled water to the building.

**1. Air Handling Units:**

- Unit shall be provided with filter, cooling coil & fan to serve the specific premises.

- During summer season, supply & return temperature of chilled water is considered are 44° F & 56° F.
- During winter season, supply & return temperature of water considered are 130° F & 110° F.
- Air Distribution to the rooms shall be provided with supply air duct with suitable terminals and return air through return air duct or plenum, as applicable.
- All duct subjected to temperature below dew point shall be insulted with XLPE with thermal conductivity of 0.037 W/m-k at 20°C mean temperature.
- Fan motor shall be Class A type with class F insulation. The fan motor shall have efficiency class IE-3.

**2. Piping:**

- Hydronic Piping material for chilled/Heating water supply and return shall be of Heavy class Black steel (MS- Class C) Pipes. Piping up to and including 150 mm diameter shall be of heavy class black steel confirming to IS:1239 and piping greater than 150 mm shall be minimum 6 mm thick black steel confirming to IS:3589.
- Hydronic piping shall be insulated with closed cell elastomer with maximum thermal conductivity of 0.038 W/m-k at 38° C, when tested in accordance with EN- ISO 8947.
- Chilled water piping insulation thickness shall be 25 mm thick for 40 mm pipe and smaller, 40 mm thick for 50 mm to 150 mm pipe and 75 mm thick for pipe greater than 150 mm.
- Drain from the all the air-conditioning equipment shall be collected by GI drain pipe insulated with 9 mm thick closed cell elastomer material and connected to nearest drain point.

All chilled water pipes shall be mild steel Class 'C' (heavy duty) conforming to relevant BIS codes. All jointing in the pipe system shall be by welding. Various type of valves such as butterfly valves, balancing valves and non return valves shall be provided in water lines.

Condensate drain piping would be GI 'B' Class conforming to relevant BIS codes.

**PIPING SHALL BE SIZED FOR THE FOLLOWING DESIGN PARAMETERS**

Pipes shall be sized to provide maximum water velocities as follows:

| **Pipe Sizes** | **Maximum Velocity** |
|---|---|
| Up to 50mm | 0.6 m/sec |
| 65 to 100mm | 0.8 m/sec |
| 125 to 200mm | 1.5 m/sec |
| 250 to 300mm | 2.5 m/sec |
| 355mm and up | 3.0m/sec |

**3. Filtration:**

Re-circulated air (mixed Outdoor & return air) at AHU : Washable synthetic type air filter having 90% efficiencydown to 10 micron MERV 8 and filter having 99% efficiency down to 3 microns (MERV 13)

Re-circulated air (mixed

Outdoor & return air) at
Ventilation unit : Washable synthetic type air filter having 90% efficiency down to 10 microns (MERV)

4. **Duct Design Criteria:**

The following maximum duct design velocities will be used in the design of ductwork systems. Where a range is indicated, it is intended to represent velocities over a range of flow volume.

**Table-3**

| | **Meters/Second** |
|---|---|
| Low Pressure Systems | |
| - Main Duct | 7.5 |
| - Primary Branch | 5.0 |
| - Secondary Branch | 2.0-3.5 |
| Plenum | 5.0-6.0 |
| Medium Pressure Systems | 12.0 |
| Cooling Coils | 2.5 |
| Heating Coil | 4.0 |
| Filters | 2.5 |

The following maximum friction losses are to be used in conjunction with the velocities noted above.

| | **Pascal's/meter** |
|---|---|
| Low pressure systems | 1.0 |
| Medium pressure systems | 3.3 |

5. **Ventilation Fan Design Criteria:**

- Maximum fan outlet velocity for fan upto 450 mm dia : 9.14m/s(1800 FPM)
- Maximum fan outlet velocity for fan above 450 mm dia : 12m/s (2400 FPM)
- Maximum fan speed for fan upto 450 mm : 1440 RPM
- Maximum fan speed for fan above 450 mm : 1100 RPM

Note: Ventilation fans can be either axial type or centrifugal type.

6. **Diffuser and Grill Design Criteria:**

- All air outlets and intakes shall be made of extruded aluminum sections &shall present a neat appearance and shall be rigid with mechanical joints.
- Square and rectangular wall outlets shall have a flanged frame with the outside edges returned or curved 5 to 7 mm and fitted with a suitable flexible gasket between the concealed face of the flanges and the finished wall face. The core of supply air register shall have adjustable front louvers parallel to the longer side to give upto 22.5 degrees vertical deflection and adjustable back louvers parallel to the shorter side to achieve a horizontal spread air pattern to at least 45 degrees. Return air grilles shall have only front louvers. The outer framework of the grilles shall be made of not less than 1.6 mm thick aluminum sheet. The louvers shall be of aero foil design of extruded aluminum section with minimum thickness of 0.8mm at front and shall be made of 0.8mm thick aluminum sheet. Louvers may be spaced 18 mm apart.
- Square and rectangular ceiling outlets/intakes shall have a flange flush with the ceiling into which it is fitted or shall be of anti-smudge type. The outlets shall comprise an outer shell with duct collar and removable diffusing assembly. These shall be suitable for

discharge in one or more directions as required. The outer shell shall not be less than 1.6 mm thick extruded section aluminum sheet. The diffuser assembly shall not be less than 0.80 mm thick extruded aluminum section.

- Circular ceiling outlets/intakes shall have either flush or anti smudge outer cone as specified in the tender specifications. Flush outer cones shall have the lower edge of the cone not more than 5 mm below the underside of the finished ceiling into which it is fitted. Anti-smudge cones shall have the outer cone profile designed to reduce dirt deposit on the ceiling adjacent to the air outlet. The metal sheet used for construction of these shall be minimum 1.6 mm thick extruded aluminum sheet.
- Linear diffusers shall have a flanged frame with the outside edges returned 3.5 mm and shall have one to four slots as required. The air quantity through each slot shall be adjustable. The metal sheet used for the construction of these shall be minimum 1.6 mm thick extruded aluminum sheet.
- Grilles and diffusers constructed of extruded aluminum sections shall have grille bars set straight, or deflected as required. These shall be assembled by mechanical interlocking of components to prevent distortion. These grilles and diffusers shall have a rear set of adjustable blades, perpendicular to the face blades for deflection purposes.
- All supply air outlets shall be fitted with a VOLUME CONTROL DEVICE, made of extruded aluminum gate section. The blades of the device shall be mill finish/ block shade pivoted on nylon brushes to avoid rusting & rattling noise, which shall be located immediately behind the outlet and shall be fully adjustable from within the occupied space without removing any access panel. The volume control device for circular cutlets shall be opposed blade radial/shutter type dampers, or two or more butterfly dampers in conjunction with equalizing grid. Opposed blade dampers shall be used for square and rectangular ceiling/ wall outlets and intakes.

**D. Building Cooling and Heating Requirements:**

This section of the report describes the Cooling (TR) and Heating (MBH) requirement for the various spaces of the buildings. Table below shows the building wise preliminary requirements:

**Table-4 Building Heating and cooling Requirements:**

| Sr.no | Floor | Area Description | Floor area (Sqft) | No.of Person | Dehumified (CFM) | Cooling ( TR) | Heating (MBH) |
|---|---|---|---|---|---|---|---|
| 1 | LOWER GROUND | LECTURE THEATRE DBL HGT | 3081 | 180 | 4149 | 21.5 | 50.6 |
| 2 | | WORKSHOP | 2853 | 48 | 2852 | 11.4 | 24.6 |
| 3 | | OFFICE | 2251 | 31 | 1931 | 7.5 | 17.8 |
| 4 | | WORKSHOP | 3503 | 58 | 4452 | 20.0 | 30.2 |
| 5 | | STUDENT LOUNGE | 405 | 7 | 372 | 2.1 | 3.3 |
| 6 | | EXHIBITION SPACE | 7298 | 100 | 5302 | 22.7 | 53.2 |
| 7 | | ART GALLERY/MUSEUM | 12230 | 150 | 8685 | 36.9 | 88.2 |
| | | | | | | | |
| 8 | GROUND | MEETING ROOM | 661 | 37 | 1,510 | 5.0 | 11.3 |
| 9 | | OFFICE 1 | 191 | 4 | 384 | 1.1 | 3.0 |
| 10 | | OFFICE 2 | 238 | 4 | 424 | 1.2 | 3.4 |
| 11 | | ADMIN | 596 | 9 | 607 | 2.3 | 5.4 |
| 12 | | DEANS ROOM | 818 | 22 | 1,137 | 4.1 | 10.0 |
| 14 | | EXHIBITION SPACE | 3145 | 52 | 5,084 | 13.6 | 45.2 |
| 15 | | EXIHIBITION | 1989 | 25 | 1,603 | 6.6 | 19.2 |
| 16 | | CAFETERIA | 7272 | 156 | 9,444 | 36.0 | 87.4 |
| 17 | | ENTRANCE | 9070 | 45 | 8,729 | 29.9 | 92.6 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | LOUNGE/RECEPTION | | | | | |
| 18 | | OFFICE | 1138 | 15 | 745 | 5.6 | 5.9 |
| | | | | | | | |
| 19 | FIRST | MUSIC DANCE STUDIO | 2033 | 41 | 2,398 | 9.4 | 19.1 |
| 20 | | STUDIO | 1022 | 25 | 1,257 | 5.6 | 11.6 |
| 21 | | STUDIO | 997 | 31 | 1,489 | 6.5 | 12.3 |
| 22 | | STUDIO | 997 | 28 | 1,445 | 6.2 | 12.1 |
| 23 | | STUDIO | 1048 | 28 | 1,478 | 6.3 | 12.4 |
| 24 | | FR 1 - FR9 ( X9) | 984 | 27 | 1,340 | 4.4 | 11.7 |
| 25 | | CLASSROOM | 940 | 54 | 1,135 | 5.4 | 8.0 |
| 26 | | CLASSROOM | 991 | 54 | 1,446 | 6.1 | 10.6 |
| 27 | | CLASSROOM | 661 | 46 | 1,407 | 4.8 | 10.6 |
| 28 | | CLASSROOM | 661 | 46 | 1,386 | 4.7 | 9.7 |
| 29 | | CLASSROOM | 693 | 46 | 1,394 | 4.7 | 9.7 |
| 30 | | CLASSROOM | 661 | 27 | 1,242 | 4.3 | 10.7 |
| 31 | | M GREEN ROOM | 322 | 10 | 411 | 1.4 | 3.7 |
| 32 | | PREFUNCTION SPACE | 1799 | 30 | 2,307 | 7.8 | 23.0 |
| 33 | | GREEN ROOM | 424 | 10 | 506 | 1.7 | 4.2 |
| 34 | | SESSION ROOM 1 | 1653 | 25 | 1,731 | 6.7 | 14.6 |
| 35 | | SESSION ROOM 2 | 1612 | 25 | 1,245 | 5.5 | 12.1 |
| 36 | | SESSION ROOM | 1653 | 25 | 1,646 | 6.5 | 15.3 |
| 37 | | CORRIDOR | 8910 | 10 | 6,920 | 13.0 | 76.0 |
| 38 | | STAGE/AUDITORIUM | 7815 | 746 | 20,692 | 104.9 | 276.7 |
| | | | | | | | |
| 40 | SECOND | DOUBLE HT STUDIO | 1245 | 16 | 4,121 | 12.1 | 40.2 |
| 42 | | DESIGN STUDIO 1 | 1035 | 16 | 1,124 | 4.7 | 10.9 |
| 43 | | DESIGN STUDIO 3 | 2020 | 25 | 2,279 | 8.9 | 22.5 |
| 44 | | DISCUSSION ROOM | 1239 | 29 | 1,416 | 5.3 | 12.2 |
| 45 | | SEMINAR ROOM 2 | 956 | 49 | 2,242 | 7.1 | 14.4 |
| 46 | | DESIGN STUDIO | 1022 | 18 | 1,325 | 4.8 | 11.7 |
| 47 | | DESIGN STUDIO | 997 | 13 | 1,476 | 4.5 | 12.7 |
| 48 | | DESIGN STUDIO | 1022 | 18 | 1,564 | 5.0 | 13.2 |
| 49 | | SEMINAR ROOM | 991 | 49 | 1,781 | 6.1 | 12.2 |
| 50 | | STUDENT LOUNGE | 491 | 10 | 1,093 | 2.6 | 8.5 |
| 51 | | REVIEW ROOM | 2071 | 41 | 2,710 | 9.6 | 24.3 |
| 53 | | CORRIDOR RIGHT | 8091 | 10 | 5,200 | 18.2 | 81.3 |
| 54 | | MULTI PURPOSE HALL | 5001 | 45 | 6,172 | 24.6 | 89.0 |
| 55 | | PREFUNCTION AREA | 1898 | 25 | 4,684 | 14.5 | 51.6 |
| | | | | | | | |
| 57 | THIRD | DESIGN STUDIO | 949 | 12 | 1,331 | 4.7 | 13.5 |
| 58 | | DESIGN STUDIO | 991 | 18 | 1,164 | 4.8 | 11.0 |
| 59 | | DESIGN STUDIO | 2071 | 24 | 3,024 | 8.8 | 26.2 |
| 60 | | DESIGN STUDIO | 993 | 18 | 1,584 | 5.0 | 13.3 |
| 61 | | OFFICE | 311 | 10 | 492 | 1.6 | 3.6 |
| 62 | | FILM MAKING STUDIO | 3078 | 62 | 5,141 | 19.8 | 64.8 |
| 63 | | RA 1 -6 (X6) | 738 | 18 | 1,972 | 5.1 | 14.2 |
| 64 | | RA 7 - RA10 (X4) | 476 | 12 | 492 | 1.8 | 3.3 |
| 66 | | STUDENT LOUNGE | 491 | 10 | 667 | 1.9 | 5.9 |
| 67 | | VIP LOUNGE | 1144 | 25 | 1,195 | 4.1 | 9.7 |
| 68 | | CORRIDOR | 7292 | 10 | 5,300 | 17.2 | 105.7 |
| | | | | | | | |
| 69 | FOURTH | SEMINAR ROOM | 305 | 14 | 571 | 1.9 | 4.7 |
| | | FR1 - FR10 (X10) | 1266 | 40 | 3,771 | 9.8 | 29.0 |
| 70 | | RA 15 - RA 16 (X4) | 560 | 20 | 802 | 2.8 | 6.2 |
| 71 | | PASSAGE | 1484 | 11 | 997 | 3.4 | 11.6 |
| 72 | | PHD CUBICAL | 949 | 15 | 1,513 | 4.2 | 14.5 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 73 | | PHD CUBICAL | 1956 | 28 | 2,807 | 7.9 | 25.2 |
| 74 | | STUDENT LOUNGE | 491 | 10 | 798 | 2.3 | 7.6 |
| 75 | | CLASS ROOM | 1022 | 63 | 1,915 | 6.9 | 15.2 |
| 76 | | FUTURE EXP 1 | 997 | 15 | 1,627 | 4.5 | 15.6 |
| 77 | | FUTURE EXP 2 | 1019 | 15 | 1,370 | 4.4 | 12.2 |
| 78 | | FR11 ROOM | 236 | 4 | 426 | 1.2 | 3.6 |
| | | | | | | | |
| TOTAL | | | 149515 | | 186429 | 695 | 1937 |

**Total HVAC Load for ART & CONVENTION - 695TR**
**ART & CONVENTION Load on Central Plant (@80 % diversity) - 556TR**

**Note:**IT room, Server room, UPS Room, Fire Control Room, LV Room are based on DX type air conditioned.

**Table-5 DX Type Load**

| Sr.no | Floor | Area Description | Floor area (Sqft) | No.of Person | Cooling (TR) | WORKING |
|---|---|---|---|---|---|---|
| 1 | LOWER GROUND | LV ROOM 1 | 52 | 1 | 1 | 1 WORKING + 1 STANDBY |
| 2 | | LV ROOM 2 | 158 | 1 | 1.5 | 1 WORKING + 1 STANDBY |
| 3 | | UPS ROOM 1 | 318 | 1 | 1.5 | 1 WORKING + 1 STANDBY |
| 4 | | UPS ROOM 2 | 468 | 1 | 2.1 | 1 WORKING + 1 STANDBY |
| 5 | GROUND | LV ROOM | 52 | 1 | 1 | 1 WORKING + 1 STANDBY |
| 6 | | SECURITY ROOM | 307 | 1 | 1.5 | 1 WORKING + 1 STANDBY |
| 7 | | IT ROOM | 305 | 1 | 1.5 | 1 WORKING + 1 STANDBY |
| 8 | | FIRE CONTROL ROOM | 291 | 1 | 1.5 | 1 WORKING + 1 STANDBY |
| 9 | FIRST | LV ROOM | 37 | 1 | 1 | 1 WORKING + 1 STANDBY |
| 10 | SECOND | LV ROOM | 52 | 1 | 1 | 1 WORKING + 1 STANDBY |
| 11 | THIRD | LV ROOM | 52 | 1 | 1 | 1 WORKING + 1 STANDBY |
| 12 | FOURTH | LV ROOM | 52 | 1 | 1 | 1 WORKING + 1 STANDBY |

AHU Zoning of the building is as shown in the drawings and based on best possible option, efficient option and area application.

- We are proposing of HRW (Heat Recovery Energy) unit for saving energy and make a building energy efficient. Please see the below mention detailedof fresh air requirement in whole building,zone wise according to drawings.

**Total Fresh air passing through HRW :- 25050 CFM**

**HRW (Heat Recovery wheel):**

Heat recovery wheel is used to reduce the cooling load of outside fresh air .The amount of outside air which is required for maintaining the indoor air quality is first passed through a rotating wheel in which enthalpy of dry air is stored. Return air of room(will pass through toilets and pantry through door transfer grille and will be collected in exhaust duct from respective floor) passes through heat recovery wheel where exchange of enthalpy (Hot & cool) takes place and the fresh air supply to indoor unit contains much lower temperature than the outside air. Since outside air supplied to indoor unit is having less amount of enthalpy, so the net cooling load required to bring the outside air temperature to room air temperature is very less. In this way we can save energy consumption and maintain good indoor air quality. Saving of cooling load calculation is as follow.

**Table: Heat recovery energy calculation:**

| | PEAK WINTER | PEAK SUMMER |
|---|---|---|
| **OUTSIDE CONDITION** | | |
| DBT($^0$C) | 12.0 | 43.3 |
| DBT($^0$F) | 53.6 | 109.9 |
| WBT($^0$C) | 9.5 | 24.0 |
| WBT($^0$F) | 49.2 | 75.2 |
| RH (%) | 74 | 19.6 |
| Total Enthalpy(H1) | 19.8 | 38.3 |
| Fresh Air (CFM) | 25050 | 25050 |
| **ROOM CONDITION** | | |
| DBT($^0$C) | 21.0 | 24.0 |
| DBT($^0$F) | 69.8 | 75.2 |
| WBT($^0$C) | 14.5 | 17.1 |
| WBT($^0$F) | 58.1 | 62.8 |
| RH (%) | 50.0 | 50.0 |
| Total Enthalpy(H2) | 25.2 | 28.2 |
| **RETURN AIR CONDITION** | | |
| DBT($^0$C) | 24.0 | 26.0 |
| DBT($^0$F) | 75.2 | 78.8 |
| WBT($^0$C) | 17.0 | 18.7 |
| WBT($^0$F) | 62.6 | 65.7 |
| RH (%) | 50.0 | 50.0 |
| Total Enthalpy(H3) | 28.2 | 30.4 |
| **CONDITION OF FRESH AIR AFTER HRWs** | | |

| | | |
|---|---|---|
| DBT($^0$C) | 18.0 | 34.7 |
| DBT($^0$F) | 64.4 | 94.4 |
| WBT($^0$C) | 13.3 | 21.4 |
| WBT($^0$F) | 55.9 | 70.4 |
| RH (%) | 62.0 | 34.8 |
| Total Enthalpy(H4) | 24.0 | 34.4 |
| | | |
| **Case 1 :Total cooling load required to bring down outside air to room condition** | | |
| **Cooling Load (TR)** | 50.7 | 94.9 |
| **Equivalent heating (MBH)** | 608.7 | 1138.5 |
| | | |
| **Case 2 :Total cooling load required to bring down outside air to room condition with the use of Heat recovery wheel** | | |
| **Cooling Load (TR)** | 39.5 | 37.1 |
| **Equivalent heating (MBH)** | 473.4 | 445.3 |
| | | |
| **Total Saving in cooling load with the use of HRW unit** | | |
| **Cooling Load (TR)** | 11.3 | 57.8 |
| **Heating load (MBH)** | 135.3 | 693.3 |
| **Saving percentage** | **22%** | **61%** |
| | | |

**Saving in one day operation of building during Summer = 11.3 x 10 x 0.65 = 73.45 kwh/day**

**Saving in one year operation of building during Summer = 73.45 x 280 = 20566 kwh/year**

## E. Air Distribution Systems

Various Options will be explored, evaluated and opted for air distribution and low side system.

- Variable volume air distribution
- Constant volume air distribution system
- Under floor Air Distribution System

Individual spaces will be evaluated for suitability for the above systems. Based on a detailed energy analysis and nature/application of each space, all above systems will be evaluated and the best options based will be applied. For example, Lecture theatre and auditorium& stage to go with under floor air distribution system, Classrooms, office will have VAV and so on.
Art & Convention building shall be served through central chilled water Plant located at utility building through pump & piping network.

- **Tertiary Pump:**

Tertiary pump will be provided at later stages of design into the building basement to accommodate the pressure requirements at each AHU. This will be after the calculation of the pump head for the pumps of central plant.
There shall be provision of 2 tertiary pumps (1 working+ 1 standby). This ensures and maintains the required pressure and Flow of chilled water to meet the Building Cooling load.

- **BTU Metering System**

Metered chilled water will be provided through each AHU in the complex where in BTU meter will be provided for measuring the AHU chilled water use. This will help to keep a check on energy usage at each space.

- **Duct Construction and Fire Safety**

All ducts shall be fabricated out of galvanized sheet steel (GSS) as per SMACNA standard for long life and as per fire norms. Motorized smoke dampers shall be installed within supply air ducts and return air ducts at AHU room wall crossings, to prevent spread of smoke / fire to the adjoining areas. Air handling unit fan motor shall also be tripped when smoke is sensed in the conditioned area served by the air handling unit.

- **Fresh Air requirement**

Fresh air requirement for various spaces shall be either mechanically forced or infiltrated.
For labs areas, fresh air dampers are located on AHU room for supplying required fresh air.

## F. MECHANICAL VENTILATION SYSTEM:

Mechanical ventilation system is being considered for Basements,Kitchen/pantry, toilets, store and other similar areas using combination of centrifugal fans, axial flow fans, propeller fans and inline fans.

1. **Car Parking Extract and Supply:**

Mechanical Ventilation for car parking in basement shall be ducted ventilation as per Revised NBC-2005 designed to permit 6 ACPH for normal ventilation, and 12 ACPH in case of fire. During Normal operation, Exhaust air @ 6 ACPH shall be exhausted through fans in the basement and the fresh air requirement shall be met through the Ramp openings available. To cater to additional 6 ACPH (total 12 ACPH) in case of fire, another set of Tube-axial fans connected with exhaust air riser shall get actuated. During this period, additional supply air fans @6 ACPH shall also supply the fresh air into the basement car parking area (wherever openings are not sufficient for the fresh air).
Basement ventilation fans for normal operation shall be provided with variable frequency drive controlled through CO concentration level within parking area for energy conservation.
As per revised NBC-2005, there are 2 zone considered for parking ventilation in Art & Convention building. Area detail & air quantity required are given in table below.

**Table-6 – Parking Ventilation- Lower Basement**

| Space | Area(sq.ft) | Height (ft) | ACPH for Exhaust air | ACPH for Fire Mode | Exhaust CFM in Normal mode(CFM) | Exhaust CFM Fire Mode(CFM) | Exhaust Air Fan | Fresh Air Fan |
|---|---|---|---|---|---|---|---|---|
| Zone 1 | 28536 | 12.6 | 6 | 6 | 36035 | 36035 | 01 # 36100CFM (N) & 01 # 36100 CFM (F) | 01 # 36100CFM (N) & 01 # 36100 CFM (F) |
| Zone 2 | 24995 | 12.6 | 6 | 6 | 31564 | 31564 | 01 # 31600 CFM (N) & 01 # 31600 CFM (F) | 01 # 31600 CFM (N) & 01 # 31600 CFM (F) |

**Table-7 – Smoke Evacuation - Upper Basement**

| Space | Area(sq.ft) | Height (ft) | ACPH for Fire Mode | Exhaust CFM Fire mode(CFM) | Exhaust Air Fan | Fresh Air Fan |
|---|---|---|---|---|---|---|
| Convention | 24995 | 12.6 | (6+6) | 63200 | 02 # 31600 CFM (F) | 02 # 31600CFM (F) |

All the basement parking ventilation fans should be fire rated for a minimum of 250 Deg C for a minimum of 2 Hrs. application. Fan motor shall be Class H type with class O insulation. The fan motor shall have efficiency class IE-3.

2. **Bath, Toilet, Services and Lab Exhaust:**
   Bath exhaust fans will be provided in buildings as required removing foul air and maintaining air quality. Toilets, Service room electrical room etc will also have exhaust system installed. Toilet doors shall have an undercut (or an air transfer grill) so that some air from the surrounding spaces shall pass through this undercut /air transfer grill and exhausted out, using duct mounted fans. Toilets are ventilated through the ducting arrangement.

   Propeller, axial and duct mounted inline fan of required CFM and relative pressure serve the space. Approx. CFM for the different areas for various building in Stage-I is as shown in table:

**Table-7 –Ventilation Summary:**

| VENTILATION CALCULATION | | | | | | |
|---|---|---|---|---|---|---|
| Sr.No | Room Name | Floor | Area (Sq.m) | Height (ft) | ACPH | CFM |
| 1 | ELEC. ROOM | Basement | 48 | 12.6 | 20 | 2157 |
| 2 | KITCHEN | | 128 | 12.6 | 30 | 8710 |
| 3 | STORE ROOM | | 50 | 12.6 | 12 | 1359 |
| 4 | ELEC. ROOM | | 58 | 12.6 | 20 | 2632 |
| 5 | SERVICE & STORE | | 172 | 12.6 | 20 | 7772 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 6 | STORE ROOM | | 61 | 12.6 | 12 | 1658 |
| 7 | SERVICES ROOM | | 75 | 12.6 | 20 | 3410 |
| | | | | | | |
| 1 | STORE ROOM | Lower Ground Floor | 75 | 12.6 | 12 | 2038 |
| 2 | ELEC. ROOM | | 25 | 12.6 | 20 | 1132 |
| 3 | STORE/ARCHIVES | | 190 | 12.6 | 12 | 5163 |
| 4 | UTILITY ROOM | | 65 | 12.6 | 20 | 2944 |
| 5 | STORE | | 45 | 12.6 | 12 | 1223 |
| 6 | STORE | | 45 | 12.6 | 12 | 1223 |
| 7 | ELEC. ROOM | | 45 | 12.6 | 20 | 2038 |
| 8 | STORE & UTILITY ROOM | | 155 | 12.6 | 12 | 4212 |
| | | | | | | |
| 1 | TOILET 1 | Ground | 4.7 | 12.6 | 10 | 106 |
| 2 | PANTRY | | 6.5 | 12.6 | 15 | 221 |
| 3 | TOILET | | 4.7 | 12.6 | 10 | 106 |
| 4 | FEMALE TOILET | | 14.9 | 12.6 | 10 | 337 |
| 5 | MALE TOILET | | 14.9 | 12.6 | 10 | 337 |
| 6 | ELEC. ROOM | | 21.8 | 12.6 | 20 | 987 |
| 7 | FEMALE TOILET | | 18.5 | 12.6 | 10 | 419 |
| 8 | MALE TOILET | | 18.5 | 12.6 | 10 | 419 |
| 9 | ELEC. ROOM | | 26.8 | 12.6 | 20 | 1213 |
| 10 | FEMALE TOILET | | 24.5 | 12.6 | 10 | 555 |
| 11 | MALE TOILET | | 24.5 | 12.6 | 10 | 555 |
| 12 | TOILET | | 5.1 | 12.6 | 10 | 115 |
| 13 | KITCHEN | | 105.5 | 12.6 | 40 | 9557 |
| | | | | | | |
| 1 | TOILET 1 | First | 4.7 | 12.6 | 10 | 106 |
| 2 | FEMALE TOILET | | 14.9 | 12.6 | 10 | 337 |
| 3 | MALE TOILET | | 14.9 | 12.6 | 10 | 337 |
| 4 | ELEC. ROOM | | 21.8 | 12.6 | 20 | 987 |
| 5 | FEMALE TOILET | | 18.5 | 12.6 | 10 | 419 |
| 6 | MALE TOILET | | 18.5 | 12.6 | 10 | 419 |
| 7 | FEMALE TOILET | | 24.5 | 12.6 | 10 | 555 |
| 8 | MALE TOILET | | 24.5 | 12.6 | 10 | 555 |
| 9 | TOILET | | 5.1 | 12.6 | 10 | 115 |
| | | | | | | |
| 1 | STORE | Second | 16.5 | 12.6 | 12 | 447 |
| 2 | TOILET 1 | | 4.7 | 12.6 | 10 | 106 |
| 3 | MALE TOILET | | 14.9 | 12.6 | 10 | 337 |
| 4 | FEMALE TOILET | | 14.9 | 12.6 | 10 | 337 |
| 5 | ELEC. ROOM | | 21.8 | 12.6 | 20 | 987 |
| 6 | STORE | | 23.4 | 12.6 | 12 | 635 |
| 7 | TOILET | | 18.5 | 12.6 | 10 | 419 |
| 8 | ELEC. ROOM | | 27.8 | 12.6 | 20 | 1260 |
| 9 | TOILET 2 | | 24.5 | 12.6 | 10 | 555 |
| 10 | MALE TOILET | | 24.5 | 12.6 | 10 | 555 |
| 11 | FEAMLE TOILET | | 5.1 | 12.6 | 10 | 115 |
| 12 | STORE | | 25.9 | 12.6 | 12 | 704 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 13 | JANITOR ROOM | | 40.2 | 12.6 | 10 | 910 |
| | | | | | | |
| 1 | STORE | Third | 68.1 | 12.6 | 12 | 1850 |
| 2 | TOILET 1 | | 4.7 | 12.6 | 10 | 106 |
| 3 | MALE TOILET | | 14.9 | 12.6 | 10 | 337 |
| 4 | FEMALE TOILET | | 14.9 | 12.6 | 10 | 337 |
| 5 | ELEC. ROOM | | 21.8 | 12.6 | 20 | 987 |
| 6 | STORE | | 17.5 | 12.6 | 12 | 476 |
| 7 | STORE | | 17.5 | 12.6 | 12 | 476 |
| 8 | ELEC. ROOM | | 36.5 | 12.6 | 20 | 1654 |
| 9 | TOILET 2 | | 24.5 | 12.6 | 10 | 555 |
| 10 | MALE TOILET | | 24.5 | 12.6 | 10 | 555 |
| 11 | FEAMLE TOILET | | 5.1 | 12.6 | 10 | 115 |
| 12 | STORE | | 28.4 | 12.6 | 12 | 771 |
| | | | | | | |
| 1 | TOILET 1 | Fourth | 4.7 | 12.6 | 10 | 106 |
| 2 | MALE TOILET | | 14.9 | 12.6 | 10 | 337 |
| 3 | FEMALE TOILET | | 14.9 | 12.6 | 10 | 337 |
| 4 | ELEC. ROOM | | 21.8 | 12.6 | 20 | 987 |

3. **Lift Well / Lift Lobby / Staircase Pressurization:**
Fire escape staircases shall be provided with 50 Pa of Positive Pressurization and Lift well and lift lobby shall be provided with 50 &30 Pa of Positive Pressurization arrangement, consisting of supply air fans installed on roof top. The fans shall connect to supply air ducts installed in vertical risers and inject air at each staircase landing, for achieving effective pressurization. Fans shall be sized to maintain minimum positive pressure of 50 Pa across the door. Make up air fans serving stairwell shall be provided with motorized damper at fan discharge to prevent humid fresh air entering into staircase well. These dampers shall be interlocked with fan motor and shall open upon getting signal from the smoke sensor. Lift wells shall also be similarly pressurized by supplying the air through fans installed on roof top.
***Refer to Annexure-A, B and C for Lift well, lift lobby & Staircase pressurization**

## G. Brief Description of HVAC Equipments:

### 1. AIR HANDLING UNITS

The air handling units shall be double skin construction, draw through type comprising of various sections such as mixing box, (the return air and fresh air are ducted), pre-filter section, cooling & heating coil sections, fan section, filters section, Double skinned panels shall be (60mm thick for units for AHUs made of galvanized steel, pressure injected with foam insulation (density 40 KG/ M3 .The entire framework shall be mounted on an aluminum alloy channel base. Panels shall be sealed to framework by heavy duty “O” ring gaskets held captive in the framed extrusion. All panels shall be detachable or hinged. Hinges shall made of die cast aluminum with stainless steel pivots, handles shall be made of hard nylon and be operational from both inside and outside of the unit. Thermal breaks shall be provided in the unit framework to prevent condensation at the panel joints during humid outside conditions. Units shall have hinged, quick opening access door in fan and filter section. Access doors shall be double skin type. Condensate drain pan shall be fabricated from 18 gauge stainless steel sheet with all corners welded. It shall be isolated from bottom floor panel through 25 MM heavy duty urethane foam.

Centrifugal Fans shall be forward/ backward inclined blade type. Fan casing shall be made of galvanized steel sheet. Fan wheels shall be of galvanized steel. Fan wheels and pulleys shall be individually tested and precision balanced dynamically. Fans shall be imported.
Both fan and motor assemblies shall be mounted on a deep section aluminum alloy or galvanized steel base frame. The fan motor shall have efficiency class IE-3 or EFF-1, whichever is more efficient.

**2. Axial Fans**

The fan casing and Motor mounting plates should be manufactured from mild steel. The fan casing and flanges should have a minimum thickness of 3.0mm for fans up to and including 1000mm diameter, with thickness of 5mm for larger diameters. Flanges should be integral with casing and should be provided with bolt holes for connection. The casing assembly, complete with flanges, should be hot dip /spray galvanized after manufacture.
An external terminal box should be provided, as standard, on long case fans. Short case fans will have a terminal box on the motor only.
The pitch angle of the fan should be individually adjustable. The fan should be of the variable pitch angle or controllable pitch angle design. The supplier should be able to provide evidence that the impeller has been adequately stressed for running at the highest speed. The impeller should be balanced to G3.6 or better as defined in ISO 1940/1:1986 (6.3 mm/s peak to peak or 4.5mm/s rms).
The aerodynamic design of the fan should be such that the maximum power required by the fan occurs within the normal working ranges, i.e., it has a non-overloading characteristic.
The fan should be suitable for frequent starting applications and for continuous operation in ambient temperatures ranging from -43°C up to +63°C.
Fan motors should be at the totally enclosed, squirrel cage induction, continuous duty, and variable torque type. Fan motor shall be Class A type with class Fclass insulation. The fan motor shall have efficiency class IE-3 or EFF-1, whichever is more efficient.

**3. Centrifugal Fans:**

Centrifugal fans shall be of double-width, double-inlet construction, with bearing on both sides, complete with access door, squirrel-cage induction motor, V-belt drive, belt guard etc.
Housing shall be of heavy gauge sheet steel in welded construction. It shall be rigidly reinforced and supported by structural angles. Split casing shall be provided on larger sizes of fans. However neoprene/ asbestos packing shall be provided throughout split joints to make it airtight. 1.2 mm galvanized wire mesh inlet guard, of 5cms sleeves shall be provided on both inlets. Housing shall be provided with access door with quick locking tension handles and neoprene gasket. Rotation arrow shall be clearly marked on the housing.
Fan wheel shall be backward curved non-overloading type unless otherwise specified. Fan wheel and housing shall be statically and dynamically balanced. Fan outlet velocity shall not exceed 610 meters per minute.
Shaft shall be constructed of steel, turned, ground and polished.
Bearings shall be of the sleeve/ball bearing type mounted directly on the fan housing. Bearing shall be self-aligned, oil grease packed, pillow block type.
Drive to fan shall be provided from 3 phase electric motor through belt with adjustable motor sheave and belt guard. Belt shall be of the oil resistant type. The number of belts shall be not less than two.Fan motor shall be Class A type with class F class insulation. The fan motor shall have efficiency class IE-3 or EFF-1, whichever is more efficient.

**4. Variable Speed Drives:**

Variable speed drive shall be factory installed on the Electrical panel. It will vary the fan motor speed by controlling the frequency and voltage of the electrical power to the motor. The capacity control logic shall automatically adjust motor speed and capacity control mechanism for maximum real world efficiency by analyzing information fed to it by sensors located either in return air path or potential difference sensors located across the duct.Unit must have less than 5% Total Demand Distortion (TDD) at equipment level.

Field power wiring shall be a single point connection and electrical plugs for incoming power wiring will be provided. All VSD components are designed to last the life of the AHU.

**5. Fire Dampers:**

Motorized fire damper shall be installed with supply & return duct at AHU room wall to prevent spread of smoke fire at adjoining areas dampers shall be robust constructions and tightly fitted. The design, method of handling and control, shall be suitable for the location and service required. Dampers and their operation devices shall be made robust, easily operable, and accessible through suitable access doors in the ducts. Every damper shall have an indicating device clearly showing the damper position at all times.

Fire dampers shall be motorized smoke & fire dampers type. It shall be supplied with spring loaded UL stamped fusible link to close fire damper in the event of rise in duct temperature. Fire damper shall also close on receipt of fire alarm signal to cut off air supply instantaneously. An electric limit switch shall also be operated by the closing of fire damper, which in turn shall switch off power supply to AHU blower motor as well as strip heaters(If installed).

**6. Dampers**

Dampers shall be opposed blade type. Blades shall be made of double skinned aerofoil aluminum/ GI section with integral gasket and assembled within a rigid extruded aluminum alloy frame. All linkages and supporting spindles shall be made of aluminum/GI or nylon, turning in Teflon bushes. Manual dampers shall be provided with a Bakelite knob for locking damper blades in position

**7. Grilles and Diffusers:**

Supply air grilles shall be provided with vertical and horizontal adjustable bars and volume control multi-louver damper which shall be key operated from the front of the grille. All linear diffusers shall be powder coated extruded aluminum. All linear grilles shall be of extruded aluminum.

**8. Insulation:**

Thermal insulation shall be applied to air distribution ductwork and to components within distribution systems such as fans, and cooler casings which convey conditioned air within AHU rooms and to ductwork (including recirculation air ductwork) conveying warmed or chilled air through unconditioned spaces or the open air. Unless otherwise indicated, distribution systems conveying conditioned, warmed or chilled air through conditioned spaces shall not be insulated. Distribution system conveying fresh air. Thermal insulation shall be applied to chilled water pipe work distribution systems and to components within distribution systems such as valves. Where thermal insulation is applied to the outside of piped and ducted services. The vapor barrier shall be applied such that it is continuous and given protection to the whole surface of the insulation which it protects. It shall not be pierced or otherwise damaged by supports or by the application of external cladding. At points of support means of load distribution shall be provided as necessary.

| Space | Insulation Thickness |
|---|---|
| Duct in conditioned Space | 19.00 mm (XLPE) |
| Duct in unconditioned space | 25.0 mm (XLPE) |

**9. Acoustic lining of AHU Rooms:**

Acoustic insulation on walls and ceiling of Air handling unit's rooms with 50mm thick resin bonded fibre glass slabs fixed in frame work and finished with vapor barrier and perforated aluminum sheet

two walls and ceiling of air conditioning plant room and air handling unit rooms may be provided with acoustic lining of resin bonded fibre glass. The surface shall be cleaned and frame work of 22 gage GI fabricated Channels 25 mm x 50 mm screwed back to back at 60 cm centre's shall be provided vertically and horizontally so that 60 x 60 cm squares are formed. The gaps between frames shall be filled with 50 mm thick about 60 cm x 60 cm cut panels of resin bonded fiberglass slabs. The entire surface shall then be covered with fiberglass tissue and 26 gage perforated aluminum sheet, 60 cm or 120 cm wide having at least 15 percent perforations, fixed with sheet metal screws. Over-lapping of sheets shall be covered with Aluminum beading. Acoustic lining of walls shall be terminated approximately 15 cm above the finished floor to prevent damage to insulation due to accidental water-logging in plant/AHU rooms.

**10. Acoustic lining over ducts:**

Ducts shall be lined internally with acoustic insulation as detailed below:

- The Inside surface of duct on which the acoustic lining is to be provided shall be clean free from all dust and grease.
- Then 25 x 25 sq.mm section of minimum 1.25 mm thick G.I. sheet shall be fixed on both ends of the duct piece.
- The insulation slabs shall then be fixed between these section of ducts using CPRX adhesive compound and stickpins.
- The insulation shall then be covered with Reinforced plastic/ fiber glass tissue, sealing all joints so that no fiber is visible.
- The insulation shall finally be covered with minimum 0.5 mm thick perforated aluminum sheet having perforations between 20-40%

**11. Filters:**

**i. Pre-filters (fabric type)**

Synthetic fiber Pre-filters shall be in light weightaluminium framed with non woven synthetic fiber replaceable media. The filter shall have an efficiency of 90 percent down to 10 microns particles size when tested as per B.S.2831 standards. The filter frame shall be of aluminium and shall be suitable for mounting in Air handling units or ducts as required at site. The velocity across the face of the filter shall not exceed 500 FPM and the pressure drop across the filter shall not exceed 4mm.

**ii. Microvee filters (fine filters):**

Microvee filters shall be of dry type. Filters media shall be made from washable nonwoven synthetic fibre replaceable media reinforced with HDPE cloth & Aluminum mesh, specially treated with antifungal and bactericidal agents to prevent growth of micro organisms. The filter media shall be treated to permit washing with water several times before discharged. The media shall be properly supported and spaced so that air flow through the filter is uniform. The filter shall be housed in aluminium frame work. Filters shall be designed to remove particle down to 5 micron size and with efficiently of 98.0 percent tested as per BS 2831 using Test Dust II. The filters shall be installed in the air handling units after the chilled water coils. They shall be capable of being replaced or removed for servicing without the use of special tools.

## H. BUILDING MANAGEMENT SYSTEM:

Building automation and control systems would control and monitor system such as air handling units, Tertiary Pumps, Fans in Parking area, Lift and miscellaneous electrical and plumbing points.
A totally direct digital control (DDC) system with electric Actuation control Valve and Damper would be considered.
There would be preference to systems, which support open protocol, i.e., BACNET.

**MONITOR & CONTROLLING POINTS FOR BMS:**

| S. No. | Description |
|---|---|

| | |
|---|---|
| | **HVAC SYSTEM**<br>**AIR CONDITIONING SYSTEM** |
| | |
| **A** | **OUTSIDE AIR** |
| | Outside Air Temperature and RH |
| | |
| **B** | **AIR HANDLING UNITS (with RH & Temp Control) (Common areas)** |
| | AHU Blower Status |
| | AHU Manual Operation Status |
| | AHU FAN ON/OFF Status |
| | AHU Motor trip Status |
| | AHU Run Status |
| | AHU Filter Status |
| | AHU Return Air Temperature & RH |
| | AHU modulate Chilled Water Valve |
| | VAV/ VFD |
| | Fresh air Damper control |
| | Fresh air damper Feedback |
| | Supply/Return Fire Damper status |
| | |
| **C** | **VENTILATION FANS/TOILET FANS** |
| **D** | **LIFTS MONITORING** |
| **E** | **ELECTRICAL ENERGY** |
| **F** | **BASEMENT FANS** |
| **G** | **TERTIARY CHILLED WATER PUMP** |
| **H** | **HEAT RECOVERY WHEEL** |

# ANNEXURE A, B and C
# FOR
# PRESSURIZATION CALCULATION FOR FACULTY OF ART & DESIGN AND CONVENTION CENTRE

**ANNEXURE A:**

**Pressurization ofStaircase (Lower Basement and Upper Basement) (Grid E, F, 18, 19)**

1. **Leakage path from pressurized staircase are as follows**
   a) Door at each mid landing
   b) Door on the basement floor

2. **Staircase Description**
   a) Total No. of Doors = 2 Nos.
   b) Door size = 1.6 m x 2.1 m
   c) Area of each door = 3.36 $mt^2$ or 36.2 $ft^2$.

3. **Calculation of air quantity leakage through open staircase door as follows;**
   = Area of staircase door ($mt^2$) x Exhaust air velocity of air assumed (m/second) x Nos. of Doors open.

   = 3.36 x 1 x 1 = $m^3/s$

   = (3.36 x 3600) / 1.7

   = 7115 CFM

4. **Calculation of air quantity leakage through staircase doors and cracks on other floors**

   Perimeter of door = 7.4 m

   Assume Gap = 1.0 mm =0.001 m

   Total No. of leakage door = 1Nos.

   Total leakage area = Perimeter of Door x Gap x No. of Leakage Door

   = 7.4 x 0.001 x 1

   = 0.0074 $mt^2$

   Now, Assume Pressure Difference = 50 Pascal

   Now, Air leakage through Staircase door and cracks = 0.827 x leakage area x √PD

   = 0.827 x 0.0074 x √50

   = 0.0432 $m^3/s$

   = (0.0432 x 3600) / 1.7 CFM

   = 92 CFM

   Total CFM = (7115 + 92)

   = 7200 CFM

**Say 7200 CFM with Total static pressure of 30 mm of WG for Staircase Pressurization.**

**Pressurization of Staircase (Lower Basement and Upper Basement) (Grid I, J, 19, 20)**

1. **Leakage path from pressurized staircase are as follows**
   a) Door at each mid landing
   b) Door on the basement floor

2. **Staircase Description**

a) Total No. of Doors = 2 Nos.

b) Door size = 1.6 m x 2.1 m

c) Area of each door = 3.36 $mt^2$ or 36.2 $ft^2$.

**3. Calculation of air quantity leakage through open staircase door as follows;**

= Area of staircase door ($mt^2$) x Exhaust air velocity of air assumed (m/second) x Nos. of Doors open.

= 3.36 x 1 x 1 = $m^3/s$

= (3.36 x 3600) / 1.7

= 7115 CFM

**4. Calculation of air quantity leakage through staircase doors and cracks on other floors**

Perimeter of door = 7.4 m

Assume Gap = 1.0 mm =0.001 m

Total No. of leakage door = 1 Nos.

Total leakage area = Perimeter of Door x Gap x No. of Leakage Door

= 7.4 x 0.001 x 1

= 0.0074 $mt^2$

Now, Assume Pressure Difference = 50 Pascal

Now, Air leakage through Staircase door and cracks = 0.827 x leakage area x √PD

= 0.827 x 0.0074 x √50

= 0.0432 $m^3/s$

= (0.0432 x 3600) / 1.7 CFM

= 92 CFM

Total CFM = (7115 + 92)

= 7200 CFM

**Say 7200 CFM with Total static pressure of 30 mm of WG for Staircase Pressurization.**

**Pressurization of Staircase (Lower Basement and Upper Basement) (Grid J, K, 13, 14)**

**1. Leakage path from pressurized staircase are as follows**

a) Door at each mid landing
b) Door on the basement floor

2. **Staircase Description**

a) Total No. of Doors = 2 Nos.
b) Door size = 1.6 m x 2.1 m
c) Area of each door = 3.36 $mt^2$ or 36.2 $ft^2$.

**3. Calculation of air quantity leakage through open staircase door as follows;**

= Area of staircase door ($mt^2$) x Exhaust air velocity of air assumed (m/second) x Nos. of Doors open.

= 3.36 x 1 x 1 = $m^3/s$

= (3.36 x 3600) / 1.7

= 7115 CFM

**4. Calculation of air quantity leakage through staircase doors and cracks on other floors**

Perimeter of door = 7.4 m

Assume Gap = 1.0 mm =0.001 m

Total No. of leakage door = 1 Nos.

Total leakage area = Perimeter of Door x Gap x No. of Leakage Door

= 7.4 x 0.001 x 1

= 0.0074 $mt^2$

Now, Assume Pressure Difference = 50 Pascal

Now, Air leakage through Staircase door and cracks = 0.827 x leakage area x √PD

= 0.827 x 0.0074 x √50

= 0.0432 $m^3/s$

= (0.0432 x 3600) / 1.7 CFM

= 92 CFM

Total CFM = (7115 + 92)

= 7200 CFM

**Say 7200 CFM with Total static pressure of 30 mm of WG for Staircase Pressurization.**

**Pressurization of Staircase (Lower Basement and Upper Basement) (Grid L, M, 8, 9)**

**1. Leakage path from pressurized staircase are as follows**

a) Door at each mid landing
b) Door on the basement floor

**2. Staircase Description**

a) Total No. of Doors = 2 Nos.
b) Door size = 1.9 m x 2.1 m
c) Area of each door = 3.99 $mt^2$ or 42.9 $ft^2$.

**3. Calculation of air quantity leakage through open staircase door as follows;**

= Area of staircase door ($mt^2$) x Exhaust air velocity of air assumed (m/second) x Nos. of Doors open.
= 3.99 x 1 x 1 = 3.99$m^3$/s
= (3.99 x 3600) / 1.7
= 8449 CFM

**4. Calculation of air quantity leakage through staircase doors and cracks on other floors**

Perimeter of door = 8 m

Assume Gap = 1.0 mm =0.001 m

Total No. of leakage door = 1 Nos.

Total leakage area = Perimeter of Door x Gap x No. of Leakage Door

= 8 x 0.001 x 1

= 0.008 $mt^2$

Now, Assume Pressure Difference = 50 Pascal

Now, Air leakage through Staircase door and cracks = 0.827 x leakage area x √PD

= 0.827 x 0.008 x √50

= 0.0467 $m^3$/s
= (0.0467 x 3600) / 1.7
CFM

= 99 CFM

Total CFM = (8449 + 99)
= 8548CFM

**Say 8600 CFM with Total static pressure of 30 mm of WG for Staircase Pressurization.**

**Pressurization of Staircase (Lower Basement and Upper Basement) (Grid N, P, 4, 5)**

**1. Leakage path from pressurized staircase are as follows**

a) Door at each mid landing
b) Door on the basement floor

2. **Staircase Description**

a) Total No. of Doors = 2 Nos.
b) Door size = 1.9 m x 2.1 m
c) Area of each door = 3.99 $mt^2$ or 42.9 $ft^2$.

**3. Calculation of air quantity leakage through open staircase door as follows;**

= Area of staircase door ($mt^2$) x Exhaust air velocity of air assumed (m/second) x Nos. of Doors open.

= 3.99 x 1 x 1 = 3.99$m^3$/s

= (3.99 x 3600) / 1.7

= 8449 CFM

**4. Calculation of air quantity leakage through staircase doors and cracks on other floors**

Perimeter of door = 8 m

Assume Gap = 1.0 mm =0.001 m

Total No. of leakage door = 1 Nos.

Total leakage area = Perimeter of Door x Gap x No. of Leakage Door

= 8 x 0.001 x 1

= 0.008 $mt^2$

Now, Assume Pressure Difference = 50 Pascal

Now, Air leakage through

Staircase door and cracks = 0.827 x leakage area x √PD

= 0.827 x 0.008 x √50

= 0.0467 $m^3$/s

= (0.0467 x 3600) / 1.7 CFM

= 99 CFM

Total CFM = (8449 + 99)

= 8548 CFM

**Say 8600 CFM with Total static pressure of 30 mm of WG for Staircase Pressurization.**

**Pressurization of Staircase (Lower Basement +Upper Basement +G+4) (Grid G, H, 4, 5)**

**1. Leakage path from pressurized staircase are as follows**

a) Door at each mid landing

b) Door on the basement floor

2. **Staircase Description**

a) Total No. of Doors = 7 Nos.

b) Door size = 1.4 m x 2.1 m

c) Area of each door = 2.94 $mt^2$ or 31.6 $ft^2$.

**3. Calculation of air quantity leakage through open staircase door as follows;**

= Area of staircase door ($mt^2$) x Exhaust air velocity of air assumed (m/second) x Nos. of Doors open.

= 2.94 x 1 x 2 =5.88 $m^3$/s

= (5.88 x 3600) / 1.7
= 12451 CFM

**4. Calculation of air quantity leakage through staircase doors and cracks on other floors**

Perimeter of door = 6 m

Assume Gap = 1.0 mm =0.001 m

Total No. of leakage door = 5 Nos.

Total leakage area = Perimeter of Door x Gap x No. of Leakage Door

= 6 x 0.001 x 5

= 0.03 $mt^2$

Now, Assume Pressure Difference = 50 Pascal

Now, Air leakage through Staircase door and cracks = 0.827 x leakage area x √PD

= 0.827 x 0.03 x √50

= 0.175 $m^3/s$

= (0.175 x 3600) / 1.7 CFM

= 371 CFM

Total CFM = (12451 + 371)

= 12822CFM

**Say 12900CFM with Total static pressure of 30 mm of WG for Staircase Pressurization.**

**Pressurization of Staircase (Lower Basement and Upper Basement) (Grid A, C, 7, 8)**

**1. Leakage path from pressurized staircase are as follows**

a) Door at each mid landing
b) Door on the basement floor

2. **Staircase Description**

a) Total No. of Doors = 2 Nos.
b) Door size = 1.9 m x 2.1 m
c) Area of each door = 3.99 $mt^2$ or 42.9 $ft^2$.

**3. Calculation of air quantity leakage through open staircase door as follows;**

= Area of staircase door ($mt^2$) x Exhaust air velocity of air assumed (m/second) x Nos. of Doors open.
= 3.99 x 1 x 1 = 3.99$m^3/s$
= (3.99 x 3600) / 1.7
= 8449 CFM

**4. Calculation of air quantity leakage through staircase doors and cracks on other floors**

Perimeter of door = 8 m

Assume Gap = 1.0 mm =0.001 m

Total No. of leakage door = 1 Nos.

Total leakage area = Perimeter of Door x Gap x No. of Leakage Door

= 8 x 0.001 x 1

= 0.008 $mt^2$

Now, Assume Pressure Difference = 50 Pascal

Now, Air leakage through Staircase door and cracks = 0.827 x leakage area x √PD

= 0.827 x 0.008 x √50

= 0.0467 $m^3/s$

= (0.0467 x 3600) / 1.7 CFM

= 99 CFM

Total CFM = (8449 + 99)

= 8548 CFM

**Say 8600CFM with Total static pressure of 30 mm of WG for Staircase Pressurization.**

**Pressurization of Staircase (Lower Basement and Upper Basement) (Grid G', G, 13, 14)**

1. **Leakage path from pressurized staircase are as follows**
   a) Door at each mid landing
   b) Door on the basement floor

2. **Staircase Description**
   a) Total No. of Doors = 2 Nos.
   b) Door size = 1.9 m x 2.1 m
   c) Area of each door = 3.99 $mt^2$ or 42.9 $ft^2$.

3. **Calculation of air quantity leakage through open staircase door as follows;**
   = Area of staircase door ($mt^2$) x Exhaust air velocity of air assumed (m/second) x Nos. of Doors open.
   = 3.99 x 1 x 1 = 3.99$m^3/s$
   = (3.99 x 3600) / 1.7
   = 8449 CFM

4. **Calculation of air quantity leakage through staircase doors and cracks on other floors**

Perimeter of door = 8 m

Assume Gap = 1.0 mm =0.001 m

Total No. of leakage door = 1 Nos.

Total leakage area = Perimeter of Door x Gap x No. of Leakage Door

= 8 x 0.001 x 1

= 0.008 $mt^2$

Now, Assume Pressure Difference = 50 Pascal

Now, Air leakage through Staircase door and cracks = 0.827 x leakage area x √PD

= 0.827 x 0.008 x √50

= 0.0467 $m^3/s$

= (0.0467 x 3600) / 1.7 CFM

= 99 CFM

Total CFM = (8449 + 99)

= 8548 CFM

**Say 8600CFM with Total static pressure of 30 mm of WG for Staircase Pressurization.**

**Pressurization of Staircase (Lower Basement and Upper Basement) (Grid H, I, 10, 11)**

1. **Leakage path from pressurized staircase are as follows**
   a) Door at each mid landing
   b) Door on the basement floor

2. **Staircase Description**
   a) Total No. of Doors = 2 Nos.
   b) Door size = 1.5 m x 2.1 m
   c) Area of each door = 3.15 $mt^2$ or 33.9 $ft^2$.

3. **Calculation of air quantity leakage through open staircase door as follows;**

   = Area of staircase door ($mt^2$) x Exhaust air velocity of air assumed (m/second) x Nos. of Doors open.
   = 3.15 x 1 x 1 =3.15$m^3/s$
   = (3.15 x 3600) / 1.7
   = 6670 CFM

4. **Calculation of air quantity leakage through staircase doors and cracks on other floors**

   Perimeter of door = 7.2 m

   Assume Gap = 1.0 mm =0.001 m

   Total No. of leakage door = 1 Nos.

   Total leakage area = Perimeter of Door x Gap x No. of Leakage Door

= 7.2 x 0.001 x 1

= 0.0072 $mt^2$

Now, Assume Pressure Difference = 50 Pascal

Now, Air leakage through Staircase door and cracks = 0.827 x leakage area x √PD

= 0.827 x 0.0072 x √50

= 0.0421$m^3$/s

= (0.0421 x 3600) / 1.7 CFM

= 89 CFM

Total CFM = (6670 + 89)

= 6759CFM

**Say 6800CFM with Total static pressure of 30 mm of WG for Staircase Pressurization.**

**ANNEXURE B:**

**Pressurization of Lift Lobby (Basement + Lower ground + Ground + 3 Floor) (Grid I, J, 19, 20)**

1. **Leakage path from pressurized lift lobby are as follows**
   a) Door on the ground floor

2. **Staircase Description**
   a) Total No. of Doors = 6 Nos.
   b) Door size = 1.6 x 2.1 mt.
   c) Area of each door = 3.36$mt^2$ or 36.2 $ft^2$.

3. **Calculation of air quantity leakage through open lift lobby door be as follows;**
   = Area of lift lobby door ($mt^2$) x Exhaust air velocity of air assumed (m/second) x Nos. of Doors open.
   = 3.36 x 1 x 1 = 3.36 $m^3$/s
   = (3.36 x 3600) / 1.7
   = **7115 CFM**

4. **Calculation of air quantity leakage through lift lobby doors and cracks on other floors**

Perimeter of door = 7.4 m

Assume Gap = 1.0 mm = 0.001 m

Total No. of leakage door = 5 Nos.

Total leakage area = Perimeter of Door x Gap x No of Leakage Door

= 7.4 x 0.001 x 5

= 0.037 $mt^2$

Now, Assume Pressure = 30 Pascal

Difference

Now, Air leakage through lift
Lobby door and cracks = 0.827 x leakage area x √PD

= 0.827 x 0.037 x √30

= 0.167 $m^3/s$

=(0.167 x 3600) / 1.7 CFM

**= 354 CFM**

Total CFM = (7115 + 354)

= 7469 CFM

**Say 7600 CFM with Total static pressure of 30 mm of WG for Staircase Pressurization.**

**Pressurization of Service Lift Lobby (Basement + Lower ground + Ground + 3 Floor) (Grid I, J, 18, 19)**

1. **Leakage path from pressurized lift lobby are as follows**
   a) Door on the ground floor

2. **Staircase Description**
   a) Total No. of Doors = 6 Nos.
   b) Door size = 1.6 x 2.1 mt.
   c) Area of each door = 3.36mt$^2$ or 36.2 ft$^2$.

3. **Calculation of air quantity leakage through open lift lobby door be as follows;**
   = Area of lift lobby door (mt$^2$) x Exhaust air velocity of air assumed (m/second) x Nos. of Doors open.
   = 3.36 x 1 x 1 = 3.36 m$^3$/s
   = (3.36 x 3600) / 1.7
   = **7115 CFM**

4. **Calculation of air quantity leakage through lift lobby doors and cracks on other floors**

Perimeter of door = 7.4 m

Assume Gap = 1.0 mm = 0.001 m

Total No. of leakage door = 5 Nos.

Total leakage area = Perimeter of Door x Gap x No of Leakage Door

= 7.4 x 0.001 x 5

= 0.037 mt$^2$

Now, Assume Pressure Difference = 30 Pascal

Now, Air leakage through lift Lobby door and cracks = 0.827 x leakage area x √PD

= 0.827 x 0.037 x √30

= 0.167 m$^3$/s

=(0.167 x 3600) / 1.7 CFM

**= 354 CFM**

Total CFM = (7115 + 354)

= 7469 CFM

**Say 7600 CFM with Total static pressure of 30 mm of WG for Staircase Pressurization.**

**Pressurization of Lift Lobby (Basement + Lower ground + Ground + 3 Floor) (Grid G, H, 6, 9)**

1. **Leakage path from pressurized lift lobby are as follows**
   a) Door on the ground floor

2. **Staircase Description**

a) Total No. of Doors = 6 Nos.
b) Door size = 1.6 x 2.1 mt.
c) Area of each door = 3.36mt$^2$ or 36.2 ft$^2$.

**3. Calculation of air quantity leakage through open lift lobby door be as follows;**

= Area of lift lobby door (mt$^2$) x Exhaust air velocity of air assumed (m/second) x Nos. of Doors open.
= 3.36 x 1 x 1 = 3.36 m$^3$/s
= (3.36 x 3600) / 1.7
= **7115 CFM**

**4. Calculation of air quantity leakage through lift lobby doors and cracks on other floors**

Perimeter of door = 7.4 m

Assume Gap = 1.0 mm = 0.001 m

Total No. of leakage door = 5 Nos.

Total leakage area = Perimeter of Door x Gap x No of Leakage Door

= 7.4 x 0.001 x 5

= 0.037 mt$^2$

Now, Assume Pressure Difference = 30 Pascal

Now, Air leakage through lift Lobby door and cracks = 0.827 x leakage area x √PD

= 0.827 x 0.037 x √30

= 0.167 m$^3$/s

=(0.167 x 3600) / 1.7 CFM

**= 354 CFM**

Total CFM = (7115 + 354)

= 7469 CFM

**Say 7600 CFM with Total static pressure of 30 mm of WG for Staircase Pressurization.**

**Pressurization of Service Lift Lobby (Basement + Lower ground + Ground + 3 Floor) (Grid B, C, 9, 10)**

**1. Leakage path from pressurized lift lobby are as follows**

a) Door on the ground floor

2. **Staircase Description**

a) Total No. of Doors = 6 Nos.
b) Door size = 1.9 x 2.1 mt.
c) Area of each door = 3.99mt$^2$ or 42.9 ft$^2$.

**3. Calculation of air quantity leakage through open lift lobby door be as follows;**

= Area of lift lobby door ($mt^2$) x Exhaust air velocity of air assumed (m/second) x Nos. of Doors open.

= 3.99 x 1 x 1 = 3.99 $m^3/s$

= (3.99 x 3600) / 1.7

= **8449 CFM**

**4. Calculation of air quantity leakage through lift lobby doors and cracks on other floors**

| | |
|---|---|
| Perimeter of door | = 8 m |
| Assume Gap | = 1.0 mm = 0.001 m |
| Total No. of leakage door | = 5 Nos. |
| Total leakage area | = Perimeter of Door x Gap x No of Leakage Door |
| | = 8 x 0.001 x 5 |
| | = 0.040 $mt^2$ |
| Now, Assume Pressure Difference | = 30 Pascal |
| Now, Air leakage through lift Lobby door and cracks | = 0.827 x leakage area x √PD |
| | = 0.827 x 0.040 x √30 |
| | = 0.181 $m^3/s$ |
| | =(0.181 x 3600) / 1.7 CFM |
| | **= 383 CFM** |
| Total CFM | = (8449 + 383) |
| | = 8832 CFM |

**Say 9000 CFM with Total static pressure of 30 mm of WG for Staircase Pressurization.**

**Pressurization of Service Lift Lobby (Basement + Lower ground + Ground + 3 Floor) (Grid H, I, 8, 9)**

**1. Leakage path from pressurized lift lobby are as follows**

a) Door on the ground floor

2. **Staircase Description**

a) Total No. of Doors = 6 Nos.

b) Door size = 1.4 x 2.1 mt.

c) Area of each door = 2.94$mt^2$ or 31.6 $ft^2$.

**3. Calculation of air quantity leakage through open lift lobby door be as follows;**

= Area of lift lobby door ($mt^2$) x Exhaust air velocity of air assumed (m/second) x Nos. of Doors open.

= 2.94 x 1 x 1 = 2.94 $m^3/s$

= (2.94 x 3600) / 1.7

**6226 CFM**

**4. Calculation of air quantity leakage through lift lobby doors and cracks on other floors**

Perimeter of door = 7 m

Assume Gap = 1.0 mm = 0.001 m

Total No. of leakage door = 5 Nos.

Total leakage area = Perimeter of Door x Gap x No of Leakage Door

= 7 x 0.001 x 5

= 0.035 $mt^2$

Now, Assume Pressure Difference = 30 Pascal

Now, Air leakage through lift Lobby door and cracks = 0.827 x leakage area x √PD

= 0.827 x 0.035 x √30

= 0.1585 $m^3/s$

=(0.1585 x 3600) / 1.7 CFM

**= 335 CFM**

Total CFM = (6226+ 335)

= 6561 CFM

**Say 6600 CFM with Total static pressure of 30 mm of WG for Staircase Pressurization.**

**ANNEXURE C:**

**Pressurization of each Lift Well (Basement to 4th Floor)(Grid- I,J,19,20)- For lift 1 & 2**

**1. Leakage path from pressurized lift well are as follows**

a) Door at each mid landing

**2. Staircase Description**

a) Total No. of Doors = 7 Nos.

b) Door size = 1 m x 2.1 m

c) Area of each door = 2.1 $mt^2$ or 22.62.1 $mt^2$.

**3. Calculation of air quantity leakage through open lift well door be as follows;**

= **Area of lift lobby door ($mt^2$) x Exhaust air velocity of air assumed (m/second) x Nos. of Doors open.**

= 2.1 x 1 x 1 = 2.1 $m^3/s$

= (2.1 x 3600) / 1.7

= **4447 CFM**

**4. Calculation of air quantity leakage through lift well doors and cracks on other floors**

Perimeter of door = 6.2 m

Assume Gap = 1.0 mm =0.001 m

Total No. of leakage door = 6 Nos.

Total leakage area = Perimeter of Door x Gap x No. of Leakage Door

= 6.2 x 0.001 x 6

= 0.0372 $mt^2$

Now, Assume Pressure Difference = 50 Pascal

Now, Air leakage through lift Well door and cracks = 0.827 x leakage area x √PD

=0.827 x 0.0372 x √50

= 0.2173 $m^3/s$

=(0.2173 x 3600) / 1.7 CFM

**= 460 CFM**

Accounting for 5 % duct losses = (4447 + 460) x 1.05

= 5153 CFM

**Say 5000 CFM @ 30 mm WG static pressure of free inflow of air for each Lift Well.**

**Pressurization of Service Lift Well ( LowerBasement to 4th Floor)(Grid- J,K ,18,19)**

1. **Leakage path from pressurized lift well are as follows**
   a) Door at each mid landing

2. **Staircase Description**
   a) Total No. of Doors = 7 Nos.
   b) Door size = 1 m x 2.1 m
   2.1 $mt^2$ or 22.6
   c) Area of each door = 2.1 $mt^2$.

3. **Calculation of air quantity leakage through open lift well door be as follows;**
   = **Area of lift lobby door ($mt^2$) x Exhaust air velocity of air assumed (m/second) x Nos. of Doors open.**
   = 2.1 x 1 x 1 = 2.1 $m^3/s$
   = (2.1 x 3600) / 1.7
   = **4447 CFM**

4. **Calculation of air quantity leakage through lift well doors and cracks on other floors**

Perimeter of door = 6.2 m

Assume Gap = 1.0 mm =0.001 m

Total No. of leakage door = 6 Nos.

Total leakage area = Perimeter of Door x Gap x No. of Leakage Door

= 6.2 x 0.001 x 6

= 0.0372 $mt^2$

Now, Assume Pressure Difference = 50 Pascal

Now, Air leakage through lift Well door and cracks = 0.827 x leakage area x √PD

=0.827 x 0.0372 x √50

= 0.2173 $m^3/s$

=(0.2173 x 3600) / 1.7 CFM

**= 460 CFM**

Accounting for 5 % duct losses = (4447 + 460) x 1.05

= 5153 CFM

**Say 5000 CFM @ 30 mm static pressure of free inflow of air for each Lift Well**

**Pressurization of Service Lift Well ( Lower Basement to 3rd Floor)(Grid- J,K ,18,19)**

1. **Leakage path from pressurized lift well are as follows**
   a) Door at each mid landing

2. **Staircase Description**
   a) Total No. of Doors = 6 Nos.
   b) Door size = 1 m x 2.1 m
   2.1 $mt^2$ or 22.6
   c) Area of each door = 2.1 $mt^2$.

3. **Calculation of air quantity leakage through open lift well door be as follows;**
   = **Area of lift lobby door ($mt^2$) x Exhaust air velocity of air assumed (m/second) x Nos. of Doors open.**
   = 2.1 x 1 x 1 = 2.1 $m^3/s$
   = (2.1 x 3600) / 1.7
   = **4447 CFM**

4. **Calculation of air quantity leakage through lift well doors and cracks on other floors**

Perimeter of door = 6.2 m

Assume Gap = 1.0 mm =0.001 m

Total No. of leakage door = 5 Nos.

Total leakage area = Perimeter of Door x Gap x No. of Leakage Door

= 6.2 x 0.001 x 5

= 0.031 $mt^2$

Now, Assume Pressure Difference = 50 Pascal

Now, Air leakage through lift Well door and cracks = 0.827 x leakage area x √PD

=0.827 x 0.031 x √50

= 0.1812 $m^3/s$

=(0.1812 x 3600) / 1.7 CFM

**= 384 CFM**

Accounting for 5 % duct losses = (4447 + 384) x 1.05

= 5072 CFM

**Say 5000 CFM @ 30 mm WG static pressure of free inflow of air for each Lift Well**

**Pressurization of each Lift Well (Lower Basement to 3rd Floor) (Grid- G,H ,6,9)- (1 to 6)**

1. **Leakage path from pressurized lift well are as follows**
   a) Door at each mid landing

2. **Staircase Description**
   a) Total No. of Doors = 6 Nos.
   b) Door size = 1 m x 2.1 m
   2.1 $mt^2$ or 22.6
   c) Area of each door = 2.1 $mt^2$.

3. **Calculation of air quantity leakage through open lift well door be as follows;**
   = **Area of lift lobby door ($mt^2$) x Exhaust air velocity of air assumed (m/second) x Nos. of Doors open.**
   = 2.1 x 1 x 1 = 2.1 $m^3/s$
   = (2.1 x 3600) / 1.7
   = **4447 CFM**

4. **Calculation of air quantity leakage through lift well doors and cracks on other floors**

Perimeter of door = 6.2 m

Assume Gap = 1.0 mm =0.001 m

Total No. of leakage door = 5 Nos.

Total leakage area = Perimeter of Door x Gap x No. of Leakage Door

= 6.2 x 0.001 x 5

= 0.031 $mt^2$

Now, Assume Pressure Difference = 50 Pascal

Now, Air leakage through lift Well door and cracks = 0.827 x leakage area x √PD

=0.827 x 0.031 x √50

= 0.1812 $m^3/s$

=(0.1812 x 3600) / 1.7 CFM

**= 384 CFM**

Accounting for 5 % duct losses = (4447 + 384) x 1.05

= 5072 CFM

**Say 5000 CFM @ 30 mm WG static pressure of free inflow of air for each Lift Well**
**Pressurization of Service Lift Well (Lower Basement to 3rd Floor) (Grid- B,C ,10,11)**

1. **Leakage path from pressurized lift well are as follows**
   a) Door at each mid landing

2. **Staircase Description**
   a) Total No. of Doors = 6 Nos.
   b) Door size = 1.1 m x 2.1 m
   2.31 $mt^2$ or
   c) Area of each door = 24.92.31 $mt^2$.

3. **Calculation of air quantity leakage through open lift well door be as follows;**
   = **Area of lift lobby door ($mt^2$) x Exhaust air velocity of air assumed (m/second) x Nos. of Doors open.**
   = 2.31 x 1 x 1 = 2.31 $m^3/s$
   = (2.31 x 3600) / 1.7
   = **4892 CFM**

4. **Calculation of air quantity leakage through lift well doors and cracks on other floors**

Perimeter of door = 6.4 m

Assume Gap = 1.0 mm =0.001 m

Total No. of leakage door = 5 Nos.

Total leakage area = Perimeter of Door x Gap x No. of Leakage Door

= 6.4 x 0.001 x 5

= 0.032 $mt^2$

Now, Assume Pressure Difference = 50 Pascal

Now, Air leakage through lift Well door and cracks = 0.827 x leakage area x √PD

=0.827 x 0.032 x √50

= 0.1871 $m^3/s$

=(0.1871 x 3600) / 1.7 CFM

**= 396 CFM**

Accounting for 5 % duct losses = (4892 + 396) x 1.05

= 5552 CFM

**Say 5500 CFM @ 30 mm WG static pressure of free inflow of air for each Lift Well**

# 12.28. LIST OF APPROVED MAKES HVAC WORKS

## 12.28. LIST OF APPROVED MAKES FOR HVAC WORKS

| Sr. No | Material Description | Approved Makes | | | | |
|---|---|---|---|---|---|---|
| 1 | Centrifugal Chiller | York | Carrier | Daikin | Trane | **Dunham Bush - Voltas** |
| 2 | Cooling Tower | Bell | Paharpur | Advance | | |
| 3 | AHU's | Zeco | Edgetech | Brightflow | | Waves |
| 4 | FCU's | Zeco | Edgetech | Brightflow | | Waves |
| **5** | **Air Washer** | **Edgetech** | **Humidin** | **Zeco** | | |
| **6** | **Dry Scrubber** | **Edgetech** | **Humidin** | **Zeco** | **Espair** | **Trion** |
| 7 | Motors | Siemens | ABB | General Electric | | |
| 8 | Heat Recovery Units | Edgetech | Zeco | Flakt Woods | | |
| 9 | Variable Refrigerant Flow System | Mitsubishi | Daikin | Carrier Midea | | Panasonic |
| 10 | Split AC Unit | Mitsubishi | Daikin | Carrier Midea | | Panasonic |
| 11 | Precision Air Conditioning | Climaveneta | Blue-Box | Emerson | | Stulz |
| 12 | Pumps | Xylem | Grundfoss | Armstrong | | |
| 13 | Expansion Tank | Xylem | Grundfoss | Armstrong | | |
| 14 | Air Seperator | Xylem | Grundfoss | Armstrong | | |
| 15 | Hot Water Generators | Rapid Cool | Emerald | Ross Boilers | | |
| 16 | VFD | Siemens | Danfoss | ABB | | |
| 17 | VAV Box | Titus | Trox | Trane | | |
| 18 | HEPA Filter | Mechmark | Camfil | Freudenberg Filtration | | Spectrum |
| 19 | Filters | Mechmark | Camfil | Purolator | | |
| 20 | Air Purifiers | Pure Air | Alpha Scrub | Magneto | | |
| **21** | **Fans** | | | | | |
| 22 | Centrifugal Fans | Kruger | Green Heck | Lau | | Nicotra |
| 23 | Cabinet Fans | Kruger | Lau | Caryaire | | |
| 24 | Vane/ Tube Axial Fans | Kruger | Green Heck | Lau | | Nicotra |
| 25 | Propeller Fans | Kruger | Green Heck | Lau | | Nicotra |
| 26 | Inline Fans | Kruger | Green Heck | Lau | | Nicotra |
| 27 | Electrical Panel | EAP | Tricolite | SPC | | Adlec |
| **28** | **GSS Ducting Sheet** | **Jindal** | **TATA** | **SAIL** | | |
| 29 | GSS Factory Fabricated Duct | Rolastar | Zeco | Ductofab | | |
| 30 | Flexible Duct | Thermaflex | Rolastar | GP Spira | | |
| 31 | Duct Support | Hilti | Kanwal | Gripple | | |
| 32 | Grills | Ruskin Titus | Trox | Systemair | | |
| 33 | Diffuser | Ruskin Titus | Trox | Systemair | | |
| 34 | Louvers | Titus | Caryaire | Brightflow | | Conair |
| 35 | Back Draft Dampers | Brightflow | Caryaire | Zeco | | Conair |
| 36 | Fire Dampers | Titus | Trox | Caryaire | | Conair |
| 37 | Fire Damper Actuators | Johnson | Honeywell | Belimo | | |
| 38 | Volume Control Dampers | Titus | Conaire | Caryaire | | |
| 39 | Volume Control Damper | Johnson | Honeywell | Belimo | | |

| | | | | | |
|---|---|---|---|---|---|
| | Actuators | | | | |
| 40 | PICV Vlaves | Danfoss | Belimo | Honeywell | |
| 41 | Refrigerant Piping | Mandev | Rajco | Kembla | |
| 42 | Aluminium Sheet | Hindalco | Balco | Jindal | |
| 43 | Welding Rods | Advani | L & T | Maruti weld | |
| 44 | Anchor Fastner | Hilti | Fisher | Canco | |
| 45 | Paints | Asian | Nerolac | Berger | |
| 46 | M.S Pipes | Sail | Tata | Jindal | Zeco |
| **47** | **Pre-Insulated Pipe with HDPE Jacket** | **G.P Spira** | **Llyod Insulation** | **Zeco** | |
| **48** | **Hume Pipe** | **KK concrete** | **Pragati** | | |
| 49 | Balancing Valves | Honeywell | Danfoss | Advance | Castle |
| 50 | Non Return Valve | Advance | Belimo | Honeywell | Castle |
| 51 | Purge Valves | Anergy | Advance | Belimo | Castle |
| 52 | Flexible connection | Easyflex | BDK | Resistoflex | |
| 53 | Pressure Gauge | Taylor | H Guru | Emerald | |
| 54 | Temperature Gauge | Taylor | H Guru | Emerald | |
| 55 | Thermostat | Honeywell | JCI | Dwyer | |
| 56 | Y strainer | Sant | Sandhu | Emerald | |
| 57 | Expansion Bellows/ Pipe Support / Vibraton Eliminator | Resistoflex | Kanwal | Radcoflex | |
| 58 | Butterfly and Ball Valves | Audco | Advance | Belimo | |
| 59 | XLPE Cross Linked Insulation | Trocellen | Thermobreak | Cani | |
| 60 | PUF Insulation | Lloyd | Supreme | A-flex | |
| 61 | Pipe Insulation | Armacell | K-flex | Supreme | |
| 62 | Accoustic Insulation | Armacell | Owen's Corning | K-flex | |
| 63 | Aluminium Tape | Johnson | Birla 3M | Wonder Polymer | |
| 64 | De-scaling Products | Scaleban | **Scaleguard** | | |
| 65 | PVC Pipe | Astral | Supreme | Finolex | |
| 66 | ACB | Schneider | Siemens | ABB | |
| 67 | MCCB | Schneider | Siemens | ABB | |
| 68 | Isolators | Indo-Asian | ABB | Schneider | |
| 69 | Current transformer | L&T | Schneider | ABB | |
| 70 | MCB | Indo-Asian | ABB | Schneider | |
| 71 | Fuse | Bussman | L&T | ABB | |
| 72 | Meters | Schneider | Siemens | Trinity | |
| 73 | UV Emitters | **Sterlite(USA)** | **Ruks (Canada)** | | |
| | | | | | |

# 13.0 BUILDING MANAGEMENT SYSTEM (BMS) WORKS

# TECHNICAL SPECIFICATIONS

## 13.1. GENERAL

### 13.1.1. BMS GENERAL DESCRIPTION

a The Building Management System (BMS) shall be a complete system designed for use with the enterprise IT systems. This functionality shall extend into the equipment rooms. Devices residing on the automation network located in equipment rooms and similar shall be fully IT compatible devices that mount and communicate directly on the IT infrastructure in the facility. Contractor shall be responsible for coordination with the owner's IT staff to ensure that the BMS will perform in the owner's environment without disruption to any of the other activities taking place on that LAN. The Building Automation LAN Network shall be completely separate & independent to any other IT or LAN Network of the Building Services.

b Any and all components of the BMS that are connected via field bus or IP network, including the network controllers, field controllers, application specific controllers, server and user interface software, system and controller programming tools and software applications shall be designed, engineered, and tested to work together as a complete building management system, and shall be manufactured by the same BMS manufacturer. Systems that use or require network controllers, field controllers, application specific controllers, server and user interface software, programming tools and software from more than one BMS manufacturer shall not be accepted.

c All points of user interface shall be on standard PCs that do not require the purchase of any special software from the BMS manufacturer for use as a building operations terminal. The primary point of interface on these PCs will be a standard Web Browser.

d Where necessary and as dictated elsewhere in these Specifications, Servers shall be used for the purpose of providing a location for extensive archiving of system configuration data, and historical data such as trend data and operator transactions. All data stored will be through the use of a standard data base platform: Microsoft SQL Server Express or Microsoft SQL Server as dictated elsewhere in this specification.

e The work of the single BMS Contractor shall be as defined individually and collectively in all Sections of this Division specification together with the associated Point Sheets and Drawings and the associated interfacing work as referenced in the related documents.

f The BMS work shall consist of the provision of all labor, materials, tools, equipment, software, software licenses, software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, samples, submittals, testing, commissioning, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, temporary protection, cleaning, cutting and patching, warranties, services, and items, even though these may not be specifically mentioned in these Division documents which are required for the complete, fully functional and commissioned BMS.

g Provide a complete, neat and workmanlike installation. Use only manufacturer employees who are skilled, experienced, trained, and familiar with the specific equipment, software, standards and configurations to be provided for this Project.

h Manage and coordinate the BMS work in a timely manner in consideration of the Project schedules. Coordinate with the associated work of other trades so as to not impede or delay the work of associated trades.

i The BMS as provided shall incorporate, at minimum, the following integrated features, functions and services:

  i Operator information, alarm management and control functions.

ii Enterprise-level information and control access.

iii Information management including monitoring, transmission, archiving, retrieval, and reporting functions.

iv Diagnostic monitoring and reporting of BMS functions.

v Offsite monitoring and management access.

vi Standard applications for terminal HVAC systems.

vii [Indoor Air Quality monitoring and control]

j Communication between the BMS, the control panels and any work-stations shall be over a high speed TCP/IP network. All nodes on this network shall be peers. The operator shall not have to know the panel identifier or location to view or control an object. Application Specific Controllers shall be constantly scanned by the network controllers to update point information and alarm information.

Building functions to be monitored

The equipment to be monitored and controlled include the following:

i Control of Chillers with Primary, Secondary Chilled Water Pumps, Condenser Water Pumps and Cooling Towers.

ii Measurement and monitoring of the chilled water temperatures and flows.

iii Critical AHU temperature performance against set-points.

iv Monitoring and control of central exhaust and make up air units.

v Monitoring of water tank levels.

vi Control and Monitoring of the domestic water transfer and booster pumps.

vii Time control (on/off) for front of house corridor lighting.

viii Monitoring only of life safety elements such as stair pressurization fans, smoke extract fans, sprinkler pumps, etc.

ix Energy metering using special Energy Software with dashboard and reporting tools should capture & display the data like Average daily consumption (YOY), Daily Min – Avg – Max demand, Utility wise demand analysis, Energy scorecard, Monthly energy profile analysis.

### 13.1.2. QUALITY ASSURANCE - CODES AND APPROVALS

**a General**

i The Building Management System Contractor shall be the primary manufacturer-owned branch office that is regularly engaged in the engineering, programming, installation and service of total integrated Building Management Systems.

ii The BMS Contractor shall be a recognized national manufacturer, installer and service provider of BMS.

iii The Building Management System (BMS) installer shall be a BMS manufacturer-owned branch office, or an independent controls contractor who is factory trained and authorized by the BMS manufacturer to sell, service and support the Building Management System specified herein.

iv Independent controls contractors who are authorized by the BMS manufacturer must provide a letter written and signed by a company officer of the specific BMS manufacturer. This document must be dated within the 30 days prior to bid submittal and must state that they are currently a “direct authorized representative” in good standing for the BMS manufacturer for the building management system products described and listed in this specification, that they have “direct purchasing access” to all of the BMS manufacturer’s controllers, servers, software and components and technical support, and that they will continue to be an Authorized representative with this access for the duration of the installation and warranty phases of project.

v If an independent controls contractor is to be considered via addendum, the contractor must provide a letter written by a company officer of the specific BMS manufacturer with the following verbiage; “should this contractor fail to provide a complete and operational system (as judged by the owner/engineer), the Manufacturer will complete the project to the Engineer’s satisfaction at no additional cost to the Owner”. This letter must be dated within 30 days prior to bid submittal and provided to the engineer along with the other supporting documentation at the time of request for equivalence.

vi The BMS Contractor shall have a branch facility within a 100-mile radius of the job site supplying complete maintenance and support services on a 24 hour, 7-day-a-week basis. The BMS Contractor shall have at this facility at least eight (8) factory trained, directly employed and full time technical staff, spare parts inventory, and all necessary test and diagnostic equipment.

vii As evidence and assurance of the contractor’s ability to support the Owner's system with service and parts, the contractor must have been in the BMS business for at least the last ten (10) years and have successfully completed total projects of at least 10 times the value of this contract in each of the preceding five years.

viii The Building Management System architecture shall consist of the products of a manufacturer regularly engaged in the production of Building Management Systems, and shall be the manufacturer’s latest standard of design at the time of bid.

**b Workplace Safety and Hazardous Materials**

i Provide a safety program in compliance with the Contract Documents.

ii The BMS Contractor shall have a corporately certified comprehensive Safety Certification Manual and a designated Safety Supervisor for the Project.

iii The Contractor and its employees and sub trades shall comply with federal, state and local safety regulations.

iv The Contractor shall ensure that all subcontractors and employees have written safety programs in place that covers their scope of work, and that their employees receive the training required by the OSHA rules that have jurisdiction for at least each topic listed in the Safety Certification Manual.

v Hazards created by the Contractor or its subcontractors shall be eliminated before any further work proceeds.

vi Hazards observed but not created by the Contractor or its subcontractors shall be reported to either the General Contractor or the Owner within the same day. The Contractor shall be required to avoid the hazard area until the hazard has been eliminated.

vii The Contractor shall sign and date a safety certification form prior to any work being performed, stating that the Contractors' company is in full compliance with the Project safety requirements.

viii The Contractor's safety program shall include written policy and arrangements for the handling, storage and management of all hazardous materials to be used in the work in compliance with the requirements of the AHJ at the Project site.

ix The Contractor's employees and subcontractor's staff shall have received training as applicable in the use of hazardous materials and shall govern their actions accordingly.

**c Quality Management Program**

i Designate a competent and experienced employee to provide BMS Project Management. The designated Project Manager shall be empowered to make technical, scheduling and related decisions on behalf of the BMS Contractor. At minimum, the Project Manager shall:

1. Manage the scheduling of the work to ensure that adequate materials, labor and other resources are available as needed.
2. Manage the financial aspects of the BMS Contract.
3. Coordinate as necessary with other trades. Be responsible for the work and actions of the BMS workforce on site.
4. Spare Parts availability at site will be communicated & ensured by vendors at the handover of the project. While suggestible to maintain 2% of each Line Item's qty of BOQ shall be procured by vendor in the client premise while handing over the project to operation. For the same client will place the requirement & Purchase order separately to respective manufacturer.

**d References**

ALL WORK SHALL CONFORM TO THE FOLLOWING CODES AND STANDARDS, AS APPLICABLE:

i National Fire Protection Association (NFPA) Standards.

ii National Electric Code (NEC) and applicable local Electric Code.

iii Underwriters Laboratories (UL) listing and labels.

iv UL 864 UUKL Smoke Control

v UL 268 Smoke Detectors.

vi UL 916 Energy Management

vii NFPA 70 - National Electrical Code.

viii NFPA 90A - Standard for The Installation Of Air Conditioning And Ventilating Systems.

ix NFPA 92A and 92B Smoke Purge/Control Equipment.

x Factory Mutual (FM).

xi American National Standards Institute (ANSI).

xii National Electric Manufacturer's Association (NEMA).

xiii American Society of Mechanical Engineers (ASME).

xiv American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) [user note: add ASHRAE 62 IAQ as applicable].

xv Air Movement and Control Association (AMCA).

xvi Institute of Electrical and Electronic Engineers (IEEE).

xvii American Standard Code for Information Interchange (ASCII).\

xviii Electronics Industries Association (EIA).

xix Occupational Safety and Health Administration (OSHA).

xx American Society for Testing and Materials (ASTM).

xxi Federal Communications Commission (FCC) including Part 15, Radio Frequency Devices.

xxii Americans Disability Act (ADA)

xxiii ANSI/EIA 909.1-A-1999 (LonWorks)

xxiv ANSI/ASHRAE Standard 195-2008 (BACnet)

xxv NOTE: IN THE CASE OF CONFLICTS OR DISCREPANCIES, THE MORE STRINGENT REGULATION SHALL APPLY.

xxvi NOTE: ALL WORK SHALL MEET THE APPROVAL OF THE AUTHORITIES HAVING JURISDICTION AT THE PROJECT SITE

### 13.1.3. SUBMITTALS

#### a SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

i The BMS contractor shall submit a list of all shop drawings with submittals dates within 30 days of contract award.

ii Submittals shall be in defined packages. Each package shall be complete and shall only reference itself and previously submitted packages. The packages shall be as approved by the Architect and Engineer for Contract compliance.

iii Allow 15 working days for the review of each package by the Architect and Engineer in the scheduling of the total BMS work.

iv Equipment and systems requiring approval of local authorities must comply with such regulations and be approved. Filing shall be at the expense of the BMS Contractor where filing is necessary. Provide a copy of all related correspondence and permits to the Owner.

v Prepare an index of all submittals and shop drawings for the installation. Index shall include a shop drawing identification number, Contract Documents reference and item description.

vi The BMS Contractor shall correct any errors or omissions noted in the first review.

vii At a minimum, submit the following: BMS network architecture diagrams including all nodes and interconnections.

1. Systems schematics, sequences, and flow diagrams.
2. Points schedule for each point in the BMS, including: Point Type, Object Name, Expanded ID, Display Units, Controller type, and Address.
3. Samples of Graphic Display screen types and associated menus.
4. Detailed Bill of Material list for each system or application, identifying quantities, part numbers, descriptions, and optional features with Final I /O List.
5. Control Damper Schedule including a separate line for each damper provided under this section and a column for each of the damper attributes, including: Code Number, Fail Position, Damper Type, Damper Operator, Duct Size, Damper Size, Mounting, and Actuator Type.
6. Room Schedule including a separate line for each VAV box and/or terminal unit indicating location and address
7. Control Valve Schedules including a separate line for each valve provided under this section and a column for each of the valve attributes: Code Number, Configuration, Fail Position, Pipe Size, Valve Size, Body Configuration, and Close off Pressure, Capacity, Valve CV, Design Pressure, and Actuator Type.
8. Details of all BMS interfaces and connections to the work of other trades.
9. Product data sheets or marked catalog pages including part number, photo and description for all products including software.
10. System write up
11. DDC & DDC panel schedule including the quantity and unit rate for each type of controller offered for the requirement.
12. Cable schedule

### 13.1.4. ACCEPTANCE

a The BMS contractor shall completely check out, calibrate and test all connected hardware and software to insure that the system performs in accordance with the approved specifications and sequences of operations approved.

b Witnessed acceptance demonstration shall display and demonstrate each type of data entry to show site specific customizing capability; demonstrate parameter changes; execute digital and analogue commands; and demonstrate DDC Loop stability via trend of inputs and outputs

### 13.1.5. Record Documentation:

a Operation and Maintenance Manuals

Three (3) copies of the Operation and Maintenance Manuals shall be provided to the Owner's Representative upon completion of the Project. The entire Operation and Maintenance Manual shall be furnished on Compact Disc Media, and include the following for the BMS provided:

i Table of contents.

ii As-built system record drawings. Computer Aided Drawings (CAD) record drawings shall represent the as-built condition of the system and incorporate all information supplied with the approved submittal.

iii Manufacturer's product data sheets or catalog pages for all products including software.

iv System Operator's manuals.

v Archive copy of all site-specific databases and sequences.

vi BMS network diagrams.

vii Interfaces to all third-party products and work by other trades.

b THE OPERATION AND MAINTENANCE MANUAL CD shall be self-contained, and include all necessary software required to access the product data sheets. A logically organized table of contents shall provide dynamic links to view and print all product data sheets. Viewer software shall provide the ability to display, zoom, and search all documents.

c ON-LINE DOCUMENTATION: After completion of all tests and adjustments the contractor shall provide a copy of all as-built information and product data to be installed on a customer designated computer workstation or server.

**d AMC SCHEDULE:**

During the comprehensive Annual Maintenance Contract Period the vendor shall provide the under mentioned services as per below;

i **Quarterly Preventive Maintenance Visits** – The Preventive visit shall be carried after every 3 month of the contract period and the service date/s would be decided in consultation with the customer. Necessary reports shall be submitted to customer.

ii **Corrective Maintenance:** Visit shall be made as and when required. Necessary training shall be provided by Vendor to Client's staff to do first level checkup. Engineer for corrective maintenance shall only be called when the system or any of its components are found malfunctioning.

**iii Response Time:**

1. The Vendor response time shall not be more than 4 hours, once the complaint has been communicated by client. The Vendor's Engineer shall be at site on the same working day once the Breakdown has been registered & communicated to vendor. The contact details by vendor must be shared once contract is in place.

2. For breakdowns requiring change of field equipment / controllers etc shall not require a resolution time of not more than 48 hours.

**iv Exclusion from Services:**

1. Any kind of Civil or Carpentry Work.
2. Any modifications / up gradation of hardware / software.
3. Consumables like batteries etc. will not cover under this contract.
4. Any kind of modification due to change of locations on equipment or addition / deletion are not in scope of vendor's services.
5. Any other services not specifically mentioned in Annexure I.

### 13.1.6. WARRANTY

a Standard Material and Labor Warranty:

1. Provide a one-year labor and material warranty on the BMS.
2. If within twelve (12) months from the date of acceptance of product, upon written notice from the owner, it is found to be defective in operation, workmanship or materials, it shall be replaced, repaired or adjusted at the option of the BMS Contractor at the cost of the BMS Contractor.
3. Supplier shall have an in-place support facility within 60 Kilometers of the site with technical staff, spare parts inventory and all necessary test and diagnostic equipment.

### 13.1.7. TRAINING

a All training shall be by the BMS Contractor and shall utilize Operators manuals and as-built documentation.

b Operator training shall include 80-hour sessions encompassing modifying text and graphics, sequence of operation review, selection of all displays and reports, use of all specified OWS functions, use of Portable Operators Terminals, troubleshooting of sensors (determining bad sensors), and password assignment and modification.

c One training session shall be conducted at system completion, and the other shall be conducted forty-five days after system completion.

### 13.1.8. WORK INCLUDED

a Provide a Building Management and Control System (BMC) incorporating central server hardware and software, Direct Digital Control (DDC), equipment monitoring, and control consisting of a Building management system (BMS); Advanced DDC Controllers (DDCs) interfacing directly with sensors, actuators and environmental delivery systems (i.e. chilled water distribution, etc.); Air Handling Unit DDC controllers, electric controls and mechanical devices for all items described herein including dampers, valves, panels; a primary communication network to allow data exchange from DDC to DDC; terminal equipment, DDC Controllers interfacing with sensors, actuators, terminal equipment devices; a secondary BACnet MS/TP Communication network interfacing DDCs to network automation controllers ; hardware and software interfaces to third-party control equipment.

b Provide all labour, materials, tools, services and equipment required to complete controls and instrumentation work according with this Section of Specification. The scope of work of controls specified by this section shall include but not limited to the following:

i Provide wiring in conduits which shall be done in accordance with the requirements of Electrical Section.

ii Provide wells for immersion temperature sensors. These wells shall be given to the MEP Contractor for installation.

iii Provide all necessary fluid flow measuring devices.

iv Provide all DDC Controllers with field devices - such as Control Valves with matching flanges, Butterfly Valves for chillers, Control Damper Actuators, Sensors, Thermostats, Actuators, Level Controllers, Transducers, Power Monitoring Unit, and Controllers, specified by this section.

v Provide the selector switches AUTO/OFF/ON for AHUs and Fans which shall be controlled by BMS.

vi Provide all computer work Stations with peripherals

c The mechanical and electrical general requirements are specified under Mechanical & Electrical Section and the same are related on this section for equipment which should be installed under that requirement.

d The BMS contractor shall be responsible for arranging, coordinating and supervising the installation of specified devices by this section in suitable manner to ensure that supplied equipment shall be installed according to the manufacturer instructions.

e The BMS contractor shall declare the Controller's Panel wise UPS Power requirement on field. The UPS Power Point shall be provided by Electrical Contractor as per design submitted by BMS contractor. The Co-ordination responsibility will be of BMS contractor to receive the UPS Power Point by Electrical Contractor.

f Wire components of Mechanical Division (Section) of BMS together with field devices in accordance with the requirements of Electrical Section. Include wiring and termination between control components and electrical auxiliary contacts in starter panels of fans, pumps, and any other equipment or devices as indicated in this section or required for the proper functioning of controls as described in this section. All necessary transformers, relays, auxiliary devices shall be provided by this Contractor to accomplish specified control function.

g The system, state of the art technology, freely expandable for any future expansion plans. The system (BMS) shall have a minimum controlling capacity of 10,000 physical points & 40,000 Soft points without upgrading the BMS data server software or related hardware. In general the system shall support “Open Architecture Concept” with capability to Dynamic Data Exchange (DDE) Link. The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers and operator devices, while re-using existing controls equipment.

h The BMS as provided shall incorporate, at minimum, the following integrated features, functions and services:

i Operator information, alarm management and control functions.
ii Enterprise-level information and control access.
iii Information management including monitoring, transmission, archiving, retrieval, and reporting functions.
iv Diagnostic monitoring and reporting of BMS functions.
v Offsite monitoring and management access.
vi Standard applications for terminal HVAC systems.
vii Indoor Air Quality monitoring and control

### 13.1.9. ACCEPTABLE BIDDERS AND BID PROCEDURES

a The system shall be engineered, programmed, and installed by personnel trained and regularly employed by the BMS manufacturer.

b The system shall be engineered, programmed, and installed by personnel trained by the BMS manufacturer and regularly employed by the manufacturer's recognized, approved, certified, or authorized agent. The agent shall have complete responsibility for proper installation and operation of the BMS including checkout, test, calibration, commissioning, and warranty of the equipment and the entire system. The BMS shall be installed in strict compliance with the specifications.

c Technical Proposal: It is the intent of this specification to define a state-of-the-art distributed computerized Building Management and Control System which is user friendly, has known reliability, is extremely responsive, and which is to be designed, installed, implemented, and supported by a local office of the manufacturer by people skilled in providing functional and efficient solutions to building system needs.

d Bids (Nominated BMS Contractor by Main Contractor) by Wholesalers, Contractors, and Franchised Dealers, Applied Channel Distributors or any firm who is not manufacturer of BMS systems shall not be acceptable.

e The system shall be engineered, programmed, and installed by personnel trained and regularly employed by the BMS manufacturer.

f Supplier shall have an in-place support facility within 50 kilometres of the site with technical staff, spare parts inventory and all necessary test and diagnostic equipment.

## 13.2. DOCUMENT STRUCTURE

The Document explains the detailed Design Description for using multiple faculty blocks and its various components for HVAC, Electrical & other Services. The Document covers the detailed Design Description for Building Management Solution requirement & its implementation at South Asian University in Maidangarhi, New Delhi Campus for below mentioned locations for the current phase requirement.

The document gives the detailed technical specification of the hardware and software of the central Building Management System, the direct digital controllers and specifications for the sensors and actuators, in addition to any interface requirements with other systems.

a Faculty of Art, Design & convention Centre – This Building includes Amphitheatre, Art Gallery, Cafeteria, Dean's Room & official's sitting, Mini-theatre, Class Rooms, Convention Centre Auditorium, Design Studios etc. Building consists of a basement + Ground Floor + 4 Floors.

b Faculty of Life Science & Earth science Building - This building includes Laboratories, Lecture hall, Lounge, PI room, specialized room, Animal holding & central Instrumentation room, Cafeteria etc. Building consists of a basement + Lower Ground + 6 Floors and a service floor on the top and a total built-up area of 44781.67 Sq. Mtr.

c Faculty of Physics Chemistry & Maths-IT – This Building includes Dean's & Official's Sitting, Class Rooms, various labs, conference Rooms, Department Library, Cafeteria, Meeting Rooms & Faculty Sitting etc. Building consists of a Basement + Ground Floor + 3 Floors divided in to 2 Zones.

d Faculty of Legal Studies & Humanities – This Building includes Dean's & Official's Sitting, Class Rooms, Multiple Halls, conference Rooms, Cafeteria, Meeting Rooms & Faculty Sitting etc. Building consists of a Basement + Ground Floor + 3 Floors.

e Administration Building – This Building includes Facilitation Center, Exhibition Center, Conference Room, Cafeteria, Director's, officials & General Admin sitting. Building consists of a Basement + Ground Floor + 5 Floors.

f Library – This Building includes Genral Reading Area, Book Storage, Cafeteria, officials & General Admin sitting, Meeting Rooms etc. Building consists of a Basement + Ground Floor + 5 Floors.

g SAARC Haat – Building consists of a Basement + Ground Floor + 4 Floors.

h Faculty club and Guest House - This Building includes Dining halls, Banquet hall, Guest rooms, Gym, Aerobics room, Yoga room, etc. The Overall Faculty Club and Guest House has a total built-up area of 2140 Sq. Mtr.

i Faculty & Staff Housing Building – The Building includes flats for faculty having living, dining room, toilets, kitchen and bathroom. Three of these block are to be constructed in this phase. Each Faculty & Staff Housing block consists of 6 tower and a basement & having total built-up area of 19822 Sq. Mtr.

### 13.2.2. The Utilities Scope and Integration -

The proposed Building Management System should be capable of controlling / monitoring of following major significant building utilities:

a Heating, ventilation & air-conditioning (HVAC) system

b Lighting

c Electrical Power Distribution System

d Backup DG power system

e UPS power system

f Fire detection and Fire Fighting System

g Lift/Elevators

h Water Treatment and Management/Plumbing

The BMS system shall also able to map the other **third party System via integration for control and monitoring purpose,** where ever possible as per current Mechanical Electrical and plumbing Services. Few are listed below;

a Chillers

b VFD's for pumps & AHU

c Mechanical ventilation

d Fire Detection & Alarm System

e Water management & treatment

f Hot water and solar power generation.

g UPS

h Energy Meters

i Elevators etc.

The Intelligent Building Management System software package shall be equipped with minimum requirements as per mentioned below;

a Complete system operation software.

b Active graphics software.

c Energy management system software.

d Alarm indication software.

e Enterprise Assets Solution

f Energy Usage Consumption both electrical and thermal (Monthly, Daily)

g Equipment Efficiency monitor (transformer)

h Chiller System COP (KW/TR) with benchmarking & equipment performance indicators.

i Monthly $CO_2$ Emission.

Following points shall be displayed/controlled as minimum thru software integration of Chiller Microprocessor Control Panel:

a Leaving Chilled Water Temperature

b Entering Chilled Water Temperature

c Leaving Condenser Water Temperature

d Entering Condenser Water Temperature

e Compressor Current Draw

f Evaporator Refrigerant Pressure

g Condenser Refrigeration Pressure

h Condenser Discharge Refrigerant Temperature

i Evaporator Refrigerant Temperature

j Condenser Refrigeration Temperature

k Oil Temperature

l Oil Pressure Differential

m Chiller Status

n Condenser Water Flow Status

o Chiller Water Flow Status

p Manual Reset Alarm

q Auto Reset Alarm

r Communication Status

s Chiller Enable

t Chilled Water Set Point

u Demand Limit Set Point

Following points shall be displayed/controlled as minimum thru software integration of VFD Microprocessor Control Panel:

a VFD Speed Control

b VFD-Power (Kw)

c VFD -Consumption (Kwh)

d VFD - Fault Alarm

e VFD - Bypass Status

f VFD -Speed (Rpm) Feedback

g Ctl Address

h Frequency Output

i Speed

j Current

k Torque

l Power Percentage

m Drive Temperature

n KWH

o Run Time Hours

p Dc Bus Voltage Percentage

q Last Fault

r First Fault

s Second Fault

t Ok Fault

u Reset Fault

v Error Status

### 13.2.3. DESCRIPTION OF PLANT OPERATION

**Air-Conditioning System**

**a Water Chilling Machines**

i Carry out software integration with the micro-processor panel of water chilling machine.
ii All the points displayed on the chiller micro-processor panel shall be duplicated on the BMS screen.
iii Isolate individual chiller at OUT and condenser at OUT through motorized butterfly valves.
iv Enable and disable chilling machine.
v Carry out chilled water temperature reset with respect to chilled water valve position at the AHUs.
vi Monitor chilled / condensing water supply temperature at the outlet of chilling machine.
vii Monitor manual operation status.
viii Monitor flow status through chiller/condenser of the machine.
ix Automatic changeover of SUMMER and WINTER modes.
x Sequence each chilling unit through BAS to maintain equal run time. Carry out chilled water temperature reset with respect to chilled water valve position at the AHUs through BAS.
xi Carry out Software Integration with Microprocessor panels of the Water Chilling Machine with RS-485 connectivity on Modbus/BACNet protocol for chilling machines.
xii Control and monitor motorized butterfly valves in chilled / condensing water line through BAS for isolating the flow through machine during shut-off period of each machine.

xiii Monitor chilled / condensing water supply temperature at the outlet of each chilling machine through BAS.

1. Monitor manual operation status of each machine through BAS.
2. Monitor flow status through chiller/condenser of the machine by BAS through dedicated flow switch at each machine.

**b Primary & Secondary Chilled Water Pumps**

i Start-stop each pump in accordance with demand.
ii Sequence each pump to maintain equally run time
iii Monitor any pump being switched on a manual basis.
iv Carry out software integration with secondary chilled water pumps for varying the speed in accordance with the load.
v Monitor status of pump
vi Monitor energy consumption.

**c Condenser Water Pumps**

i Monitor the pump header pressure.
ii Monitor tertiary circuit header temperatures IN and OUT.
iii Start-stop each pump in accordance with demand.
iv Sequence each pump to maintain equally run time
v Monitor any pump being switched on a manual basis.
vi Monitor status of pump
vii Monitor energy consumption.

**d Heat Pumps**

i Isolate Heat Pumps and Water Cooled Chillers header circuit through Motorized Butterfly valves.
ii Monitor Heat Pump Header IN and OUT temperature.
iii Monitor individual Heat Pump OUT temperature.
iv Monitor manual operation status.
v Monitor flow status through Heat Pumps.

**e Cooling Towers**

i Isolate individual Cooling Towers at IN and OUT through motorized Butterfly valves.
ii Monitor ambient wet bulb temperature.
iii Switch on/off each cooling tower in accordance with the demand.
iv Monitor status of the cooling tower fans.
v Monitor low water levels in each cooling tower.
vi Control and monitor motorized butterfly valve provided at inlet & outlet of the cooling tower.
vii Monitor water outlet temperature at each cooling tower.
viii Control RPM of CT fans based on the demand
ix Sequence operation of cooling tower to maintain equal run time.
x Monitor energy consumption.

**f General**

i Monitor common chilled water supply and return temperature in header through BAS.

ii Monitor common condenser water and return temperature in header through BAS
iii Monitor chilled water flow rate and temperature in chilled water circuit through BAS.
iv Monitor status of Pressurized expansion tank filling pumps through BAS.
v Monitor outside air temperature and relative humidity through BAS.
vi Monitor chilled water temperature in main return header through BAS.
vii Start-up of air-conditioning system in following sequence through BAS:
viii Open motorized valve for chiller, condenser & cooling tower.
ix Start operation of cooling tower fans.
x Start operation of pumps.
xi Start operation of air handling units.
xii Start operation of water chilling machines.
xiii Shut-down of air-conditioning system in following sequence through BAS.
xiv Stop operation of water chilling machines.
xv Stop operation of pumps
xvi Stop operation of cooling towers.
xvii Stop operation of air handling units
xviii Close motorized valves for chiller, condensers & cooling tower.
xix Monitor direction of flow in the de-coupler pipe of primary-secondary pumping system through BAS.
xx Monitor energy consumption (KWH and BTU) and work out Chiller System COP.

**g Air Handling Units**

i Remote start/stop of each air handling unit through BAS and carry out the duty cycling (from AHU panel).
ii Monitor the running status of each blower fan through BAS and keep log of the number of hours run.
iii Monitor filter status of each AHU through BAS & give an alarm in case the filter gets choked.
iv Monitor the return air temperature through BAS & give an alarm for a high/low supply air temperature.
v Monitor relative humidity in the return air through BAS.
vi Control the chilled water-modulating valve, to maintain the room conditions through BAS.
vii Indicate any unit running in Manual mode through BAS
viii Control RPM of supply air fans through BAS based on the indoor zone temperature.
ix Modulate outdoor air quantity being added into air handling unit room.
x Monitor $CO_2$ levels in each zone through BAS and modulate fresh air damper to ensure difference between outdoor and indoor $CO_2$ level is maintained less than 530 ppm. If levels are not maintained, bring up an alarm if the values are higher than the maximum $CO_2$ levels permitted in ASHRAE standards 60.1-2004.
xi Monitor duct static pressure to ensure minimum design static pressure is maintained at farthest end of duct during modulation of air quantity.
xii Carry out software integration with VFD panel of supply / return air fan and display all electrical parameters.
xiii Monitor energy consumption.

**h Variable Air Volume Boxes**

i Carryout software integration with BAS for VAV boxes to monitor damper position and temperature in each room.

### 13.2.4. Ventilation System

**a Propeller Fans/In-line Fans**

i Following shall be carried out through BAS:
ii Start/stop of each propeller fan
iii Indicate any unit running in manual mode.

**b Centrifugal fans and AHU fan sections for ventilation**

i Following shall be carried out through BAS:
ii Start/stop of each fan
iii Monitor status of blower.
iv Indicate any unit running in manual mode.

**c Staircase/Elevator shaft pressurization / smoke extract fan**

i Monitor status of blower during emergency mode through BAS

### 13.2.5. Plumbing & Fire Fighting System Including STP

a Monitor basement sump pump operation status.

b Monitor high level status of basement sumps.

c Monitor bore well, Hydro pneumatic and transfer pumps operation status.

d Monitor water level of basement underground tanks.

e Monitor line pressure for pressurized pipes.

f Battery status monitoring for fire pumps.

### 13.2.6. UPS SYSTEM

a Software integration with UPS monitoring system to duplicate the data being monitored by UPS monitoring system.

b Monitoring temperature in UPS & Server Rooms.

### 13.2.7. Fire Alarm System

a Software Integration of Fir Alarm Control Panel with Rs-485 connectivity on Modbus/Bacnet Protocol.

### 13.2.8. BTU METERING SYSTEM:

a View Data Dynamically

i Dynamic Energy, Temperature and Flow Data Tree View or Graphic View
ii Role and Feature Based Security
iii Define Users – Create different users for the system

iv Administration to assign privileges and user configurations

b Various Versions based on number of Meters connected (Tag Based) –

i Directly connected to the BTU / Energy Meters thru a Gateway
ii Through BMS software History Block

c Define Faculty & Blocks – Add various Department in Facility

i Define Meters
ii Assign and Allocate the Meter/s to users
iii Allocate Common Area Meters
iv Allocate percentage distribution of common meters

d Generate Various Customized Reports – Dynamic, Historical, Monthly

**e** Define Tariffs and Costs for metering and if required billing as well.

## 13.3. TECHNICAL SPECIFICATIONS

### 13.3.1. General Description

a The Building Management System (BMS) shall use an open architecture and fully support a multi-vendor environment. To accomplish this effectively, the BMS shall support open communication protocol standards and integrate a wide variety of third-party devices and applications. The system shall be designed for use on the Internet, or intranets using off the shelf, industry standard technology compatible with other owner provided networks.

b The Building Management System shall consist of the following:

i Standalone Network Automation / Supervisory Controller(s)
ii Field Level DDC Controller(s)
iii Input/ Output Module(s)
iv Local Display Device(s)
v Portable Operator's Terminal(s)
vi Distributed User Interface(s)
vii Network processing, data storage and communications equipment
viii Other components required for a complete and working BMS

c The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers and operator devices, while re-using existing controls equipment.

d Use of any External dongle is strictly prohibited due to owner's license protection & user rights. The BMS System Software should not get uploaded by any external dongle & Owners right shall not be dependent on any external dongle.

e Soft points count shall be unlimited in the software. If any of the vendor have the limitation then the installing software shall have minimum 35000 nos of soft point licenses to provide the future expansion without any extra cost implication.

f The supplied software must support minimum 10 Nos of Concurrent Users.

g BMS Software, Energy Management Software & Energy Information Kiosk must be provided of the same OEM. No 3rd Party Software will be accepted.

h Any software getting used for the project shall be installed locally in the supplied server only. Cloud based application will not be accepted.

i The supplied software shall have the remote System Access via mobile or web shall be for unlimited no. of users. No add-on software shall be accepted for the same.

j System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution.

k The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

l The System shall maintain all settings and overrides through a system reboot.

m System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution.

n The System shall comply with (UL) 864 (UUKL) Ninth Edition Smoke Control Listing including the UL 864 Ninth Edition Standard for Control Units and Accessories for Fire Alarm Systems.

o The System shall comply with the following NFPA Codes and Standards as applicable:

i NFPA 70 National Electrical Code
ii NFPA 72 National Fire Alarm Code
iii NFPA 101 Life Safety Code
iv NFPA 90A Standard for the Installation of Air-Conditioning and Ventilation Systems
v NFPA 92B Guide for Smoke Management Systems in Malls, Atria, and Large Areas

p The System shall comply with the following International Code Council (ICC) Codes:

i Building Officials and code Administrators International (BOMA) model code
ii International Conference of Building Officials (ICBO) model code
iii Southern Building Code Congress International (SBCCI) regulations
iv Acceptable Manufacturers
1. Johnson Controls, Inc., Metasys
2. Honeywell, Enterprise Building Integrator (EBI)
3. Siemens Building Systems, APOGEE

### 13.3.2. BMS Server Hardware

a The server hardware shall comply with the following hardware specifications:

b I7 Processor, 2.93GHz, 4MB Cache with 4 GB RAM, & 1 TB HDD, 10/100 Mbps Ethernet card, USB connection & internal modem, Microsoft(R) Windows(R) 7 OS & above Professional Enterprise & ultimate edition with SQL server 2008 R2 express software, Web server software, DVD-ROM Drive (with RAM) for MS 2008, 100/1000 Mbps NIC for Network connection and anti-virus software with 22" colour graphics LCD monitor as per Tender Specifications/ relevant standards/ as per direction of engineer-in-charge .If the contractor's server requirement is more than what is specified here, the contractor shall quote the configuration that meets their requirement at no additional cost to owner. Accessories included Optical Mouse, Key Pad, LaserJet colour A4 printer to be included with the with the above hardware configuration.

### 13.3.3. BMS SYSTEM - SOFTWARE & PRODUCT DESCRIPTION:

**BMS SYSTEM ARCHITECTURE**

The system architecture shall be as follows:

**a AUTOMATION NETWORK**

i The automation network shall be based on a PC industry standard of Ethernet TCP/IP. Where used, LAN controller cards shall be standard “off the shelf” products available through normal PC vendor channels.
ii The BMS shall network multiple user interface clients, automation engines, system controllers and application-specific controllers. Provide application and data server(s) as required for systems operation.
iii All BMS devices on the automation network shall be capable of operating at a communication speed of 100 Mbps, with full peer-to-peer network communication.
iv Supervisory Engine / Controller shall reside on the automation network.
v The automation network will be compatible with other enterprise-wide networks. Where indicated, the automation network shall be connected to the enterprise network and share resources with it by way of standard networking devices and practices.

**b CONTROL NETWORK**

i Network Controller shall provide supervisory control over the control network and shall support all three (3) of the following communication protocols:
1. BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9
   - The Supervisory Controller shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
   - The Supervisory Controller shall be tested and certified as a BACnet Building Controller (B-BC).

ii LonWorks enabled devices using the Free Topology Transceiver (FTT-10a).

iii Control networks shall provide either “Peer-to-Peer,” Master-Slave, or Supervised Token Passing communications, and shall operate at a minimum communication speed of 9600 baud.
iv DDC Controllers shall reside on the control network.
v Control network communication protocol shall be BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135.
vi A BACnet Protocol Implementation Conformance Statement (PICS) shall be provided for each controller device (master or slave) that will communicate on the BACnet MS/TP Bus.
vii The PICS shall be submitted 10 days prior to bidding.
viii The Control Network on single bus can go up to 1500 Mtr on 22AWG without repeater.

**c INTEGRATION**

i Hardwired
1. Analog and digital signal values shall be passed from one system to another via hardwired connections.
2. There will be one separate physical point on each system for each point to be integrated between the systems.

ii Direct Protocol (Integrator Panel)
1. The BMS system shall include appropriate hardware equipment and software to allow bi-directional data communications between the BMS system and 3rd party manufacturers’ control panels. The BMS shall receive, react to, and return information from multiple building systems, including but not limited to the chillers, boilers, variable frequency drives, power monitoring system, and medical gas
2. All data required by the application shall be mapped into the Automation Engine’s database, and shall be transparent to the operator.
3. Point inputs and outputs from the third-party controllers shall have real-time interoperability with BMS software features such as: Control Software, Energy

Management, Custom Process Programming, Alarm Management, Historical Data and Trend Analysis, Totalization, and Local Area Network Communications.

iii BACnet Protocol Integration - BACnet

1. The neutral protocol used between systems will be BACnet over Ethernet and comply with the ASHRAE BACnet standard 135-2008.
2. A complete Protocol Implementation Conformance Statement (PICS) shall be provided for all BACnet system devices.
3. The ability to command, share point object data, change of state (COS) data and schedules between the host and BACnet systems shall be provided.

## d USER INTERFACE

### i DEDICATED WEB BASED USER INTERFACE

1. Where indicated on plans the BMS Contractor shall provide and install a personal computer for command entry, information management, network alarm management, and database management functions. All real-time control functions, including scheduling, history collection and alarming, shall be resident in the BMS Supervisory Controller to facilitate greater fault tolerance and reliability.

2. Dedicated User Interface Architecture – The architecture of the computer shall be implemented to conform to industry standards, so that it can accommodate applications provided by the BMS Contractor and by other third party applications suppliers, including but not limited to Microsoft Office Applications. Specifically, it must be implemented to conform to the following interface standards.

- Microsoft Internet Explorer for user interface functions
- Microsoft Office Professional for creation, modification and maintenance of reports, sequences other necessary building management functions
- Microsoft Outlook or other e-mail program for supplemental alarm functionality and communication of system events, and reports
- Required network operating system for exchange of data and network functions such as printing of reports, trends and specific system summaries

### ii OPERATOR WORKSTATION CONFIGURATION –

1. The Personal Computer(s) Hardware shall be configured as follows:

- Memory – 4 MB Cache with RAM of 8 GB (4GB Minimum)
- CPU– I7 Processor, 2.93GHz Clock Speed Hard Drive – 1TB free hard drive space (256 GB minimum)
- Hard drive backup system – CD/RW, DVD/RW or network backup software provided by IT department
- CD ROM Drive – 16X performance
- 100/1000 Mbps NIC for Network connection and anti-virus software
- Ports – (2) Serial and (1) parallel, (2) USB ports
- Keyboard – 101 Keyboard and Optical Mouse
- 22” color graphics LCD monitor
- LAN communications – Ethernet communications board; 3Comm or equal

2. Operating System Software
   - Windows XP Professional or Windows 7 (64 bit)
   - Where user interface is not provided via browser, provide complete operator workstation software package, including any hardware or software keys. Include the original installation disks and licenses for all included software, device drivers, and peripherals.
   - Provide software registration cards to the Owner for all included software.

3. Peripheral Hardware
   - Reports printer:
     - LaserJet colour A4 printer
     - Print Speed – 600 DPI Black, 300 DPI Color
     - Buffer – 64 K Input Print Buffer
     - Color Printing – Include Color Kit
     - If the Vendor's server requirement is more than what is specified here, the contractor shall quote the configuration that meets their requirement at no additional cost to owner.

iii DEDICATED WEB BASED USER INTERFACE

1. All features and functions of the dedicated user interface previously defined in this document shall be available on any computer connected directly or via a wide area or virtual private network (WAN/VPN) to the automation network and conforming to the following specifications.

2. The software shall run on the Microsoft Internet Explorer (6.0 or higher) browser supporting the following functions:
   - Configuration
   - Commissioning
   - Data Archiving
   - Monitoring
   - Commanding
   - System Diagnostics

3. Minimum hardware requirements:
   - 4GB RAM
   - 2.93 GHz Clock Speed i7 Microprocessor
   - 500 GB Hard Drive.
   - 1 Keyboard with 83 keys (minimum).
   - 22" colour graphics LCD monitor
   - Optical Mouse or other pointing device

IV SITE MANAGEMENT USER INTERFACE APPLICATION COMPONENTS

1. OPERATOR INTERFACE
   - An integrated browser based client application shall be used as the user operator interface program.
   - The System shall employ an event-driven rather than a device polling methodology to dynamically capture and present new data to the user.

- All Inputs, Outputs, Set-points, and all other parameters as defined within Part 3, shown on the design drawings, or required as part of the system software, shall be displayed for operator viewing and modification from the operator interface software.
- The user interface software shall provide help menus and instructions for each operation and/or application.
- The system shall support customization of the UI configuration and a home page display for each operator.
- The system shall support user preferences in the following screen presentations:
  - Alarm
  - Trend
  - Display
  - Applications
- All controller software operating parameters shall be displayed for the operator to view/modify from the user interface. These include: set-points, alarm limits, time delays, PID tuning constants, run-times, point statistics, schedules, and so forth.
- The Operator Interface shall incorporate comprehensive support for functions including, but not necessarily limited to, the following:
  - User access for selective information retrieval and control command execution
  - Monitoring and reporting
  - Alarm, non-normal, and return to normal condition annunciation
  - Selective operator override and other control actions
  - Information archiving, manipulation, formatting, display and reporting
  - BMS internal performance supervision and diagnostics
  - On-line access to user HELP menus
  - On-line access to current BMS as-built records and documentation
  - Means for the controlled re-programming, re-configuration of BMS operation and for the manipulation of BMS database information in compliance with the prevailing codes, approvals and regulations for individual BMS applications
- The system shall support a list of application programs configured by the users that are called up by the following means:
  - The Tools Menu
  - Hyperlinks within the graphics displays
  - Key sequences
- The operation of the control system shall be independent of the user interface, which shall be used for operator communications only. Systems that rely on an operator workstation to provide supervisory control over controller execution of the sequences of operations or system communications shall not be acceptable.

2. NAVIGATION TREES

- The system will have the capability to display multiple navigation trees that will aid the operator in navigating throughout all systems and points connected. At minimum provide a tree that identifies all systems on the networks.

- Provide the ability for the operator to add custom trees. The operator will be able to define any logical grouping of systems or points and arrange them on the tree in any order. It shall be possible to nest groups within other groups. Provide at minimum 5 levels of nesting.

- The navigation trees shall be “dockable” to other displays in the user interface such as graphics. This means that the trees will appear as part of the display, but can be detached and then minimized to the Windows task bar. A simple keystroke will reattach the navigation to the primary display of the user interface.

3. ALARMS

- Alarms shall be routed directly from Supervisory Controller to PCs and servers. It shall be possible for specific alarms from specific points to be routed to specific PCs and servers. The alarm management portion of the user interface shall, at the minimum, provide the following functions:
  - Log date and time of alarm occurrence.
  - Generate a "Pop-Up" window, with audible alarm, informing a user that an alarm has been received.
  - Allow a user, with the appropriate security level, to acknowledge, temporarily silence, or discard an alarm.
  - Provide the ability to direct alarms to an e-mail address or alphanumeric pager. This must be provided in addition to the pop up window described above. Systems that use e-mail and pagers as the exclusive means of annunciating alarms are not acceptable.
  - Configuration of which Supervisory Controller offline alarms are seen by each user
  - Any attribute of any object in the system may be designated to report an alarm.

- The BMS shall annunciate diagnostic alarms indicating system failures and non-normal operating conditions.
- The BMS shall allow a minimum of 4 categories of alarm sounds customizable through user defined wav. files.
- The BMS shall annunciate application alarms at minimum, as required by Part 3.

4. REPORTS AND SUMMARIES

- Reports and Summaries shall be generated and directed to the user interface displays, with subsequent assignment to printers, or disk. As a minimum, the system shall provide the following reports:
  - All points in the BMS
  - All points in each BMS application
  - All points in a specific controller
  - All points in a user-defined group of points
  - All points currently in alarm
  - All points locked out
  - All user defined and adjustable variables, schedules, interlocks and the like.
- Summaries and Reports shall be accessible via standard UI functions and not dependent upon custom programming or user defined HTML pages.
- Selection of a single menu item, tool bar item, or tool bar button shall print any displayed report or summary on the system printer for use as a building management and diagnostics tool.
- Provide the capability to view, command and modify large quantities of similar data in tailored summaries created online without the use of a secondary application like a spreadsheet. Summary definition shall allow up to seven user defined columns describing attributes to be displayed including custom column labels. Up to 100 rows per summary shall be supported. Summary viewing shall be available over the network using a standard Web browser.
- Energy reports shall be configurable from predefined, preconfigured templates. Required includes but shall not be limited to:
  - Energy Overview
  - Load Profile

  - Simple Energy Cost
  - Consumption
  - Equipment Runtime
  - Energy Production
- Reports shall be selectable by date, time, area and device. Each report shall include a color visual summary of essential energy information.

5. SCHEDULES
   - A graphical display for time-of-day scheduling and override scheduling of building operations shall be provided. At a minimum, the following functions shall be provided:
     - Weekly schedules
     - Exception Schedules
     - Monthly calendars
   - Weekly schedules shall be provided for each group of equipment with a specific time use schedule.
   - It shall be possible to define one or more exception schedules for each schedule including references to calendars
   - Monthly calendars shall be provided that allow for simplified scheduling of holidays and special days for a minimum of five years in advance. Holidays and special days shall be user-selected with the pointing device or keyboard, and shall automatically reschedule equipment operation as previously defined on the exception schedules.
   - Changes to schedules made from the User Interface shall directly modify the Supervisory Controller schedule database.
   - Schedules and Calendars shall comply with ASHRAE SP135/2008 BACnet Standard.
   - The Calendar object supports an option to add a reference to another Calendar Object that is designated to be the master for the facility. Any Supervisory and BAC calendars can be configured to reference a single master Global Calendar. Changes to the master global calendar are automatically synced with all calendars that are referenced.
   - Selection of a single menu item or tool bar button shall print any displayed schedule on the system printer for use as a building management and diagnostics tool.
   - Software shall be provided to configure and implement optimal start and stop programming based on existing indoor and outdoor environmental conditions as well as equipment operating history
   - The system Solar Clock shall support the scheduling and energy management functions. The Solar Clock will calculate the sunrise, sunset, and sun angle values for a specified latitude and longitude. A time offset can also be specified. An example would be to use the Solar Clock object as a master to an interlock to turn lights on 30 minutes after sunset and off 30 minutes before sunrise.

6. SECURITY/PASSWORDS
   - Multiple-level passwords access protection shall be provided via roles and permissions. The feature will allow the system to base access on a user's job title or role and allow the user/manager access interface control, display, and database manipulation capabilities based on an assigned password.
   - Roles may be copied and altered to meet specific roles and permissions based on the particular policies.
   - Each user shall have the following: a (Local) user account name (with a maximum of 30 characters), a complex password or passphrase (with a min of 8 characters and a max of 50 characters), other user account policies (such as session timeout), timesheet access based on day of the week and time of day, and specific user view.
   - The system shall allow each user to change his or her password at will.

- When entering or editing passwords, the system shall not echo the actual characters for display on the monitor.
- A maximum of 150 categories may be used to determine or assign areas of responsibilities to each user account. A maximum of 13 (of the 150) named categories which are specifics such as “No Access, View, Advanced Review, Operate, Intervene, Diagnostic, Manage Item Events, Manage Every, and Configure Items”.
- A minimum of 100 unique passwords shall be supported.
- Operators shall be able to perform only those commands available for their respective passwords. Display of menu selections shall be limited to only those items defined for the access level of the password used to log-on.
- Operators shall be further limited to only access, command, and modify those buildings, systems, and subsystems for which they have responsibility. Provide a minimum of 100 categories of systems to which individual operators may be assigned.
- The system shall automatically generate a report of log-on/log-off and system activity for each user. Any action that results in a change in the operation or configuration of the control system shall be recorded, including: modification of point values, schedules or history collection parameters, and all changes to the alarm management system, including the acknowledgment and deletion of alarms.
- The system shall have the ability to provide a Department of Defense (DoD) specific warning banner for applicable sites that warns the user they are accessing a restricted site.
- After successful login to the Site Management Portal (SMP) the last time and date that user name was previously logged in is shown on the screen.
- Each login attempt is recorded in the system Audit Log with the option to record the IP address of the PC that made the login.

7. SCREEN MANAGER

- The system will allow a customized image on the login screen (i.e. organization name, logo).
- User View navigations can be displayed as either a set of tabs or a drop down list.
- Allows user preference for assigning of a background color for when an object is Out of Service which will enable the operator to quickly distinguish points that have been commanded to this state.
- The User Interface shall be provided with screen management capabilities that allow the user to activate, close, and simultaneously manipulate a minimum of 4 active display windows plus a network or user defined navigation tree.

8. DYNAMIC COLOR GRAPHICS

- The graphics application program shall be supplied as an integral part of the User Interface. Browser or Workstation applications that rely only upon HTML pages shall not be acceptable.
- The graphics applications shall include a create/edit function and a runtime function. The system architecture shall support an unlimited number of graphics documents (graphic definition files) to be generated and executed. The graphics shall be able to display and provide animation based on real-time data that is acquired, derived, or entered.
- Graphics runtime functions – A maximum of 16 graphic applications shall be able to execute at any one time on a user interface or workstation with 4 visible to the user. Each graphic application shall be capable of the following functions:
  - All graphics shall be fully scalable
  - The graphics shall support a maintained aspect ratio.
  - Multiple fonts shall be supported.
  - Unique background shall be assignable on a per graphic basis.

- The color of all animations and values on displays shall indicate the status of the object attribute.
- Graphics that represent buildings or systems shall allow natural links and transitions between related detailed tabular views of data that complement the graphic.

- Operation from graphics – It shall be possible to change values (set-points) and states in system controlled equipment directly from the graphic.
- Floor Plan graphics – The user interface shall provide graphic applications that summarize conditions on a floor. Floor plan graphics shall indicate thermal comfort using dynamic colors to represent zone temperature deviations from zone set-point(s). Floor plan graphics shall display overall metrics for each zone in the floor.
- Aliasing – Many graphic displays representing part of a building and various building components are exact duplicates, with the exception that the various variables are bound to different field values. Consequently, it shall be possible to bind the value of a graphic display to aliases, as opposed to the physical field tags.
- Graphic editing tool – A graphic editing tool shall be provided that allows for the creation and editing of graphic files. The graphic editor shall be capable of performing/defining all animations, and defining all runtime binding.
  - The graphic editing tool shall provide a library of standard HVAC equipment, floor plan, lighting, security and network symbols.
  - The graphic editing tool shall provide for the creation and positioning of library symbols by dragging from tool bars or drop-downs and positioning where required.
  - The graphics editing tool shall permit the importing of AutoCAD drawings for use in the system.
  - The graphic editing tool shall be able to add additional content to any graphic by importing images in the SVG, PNG or JPG file formats.

9. HISTORICAL TRENDING AND DATA COLLECTION

- Each Automation Engine shall store trend and point history data for all analog and digital inputs and outputs, as follows:
  - Any point, physical or calculated, may be designated for trending. Two methods of collection shall be allowed:
    Defined time interval
    Upon a change of value
  - Each Automation Engine shall have the capability to store multiple samples for each physical point and software variable based upon available memory, including an individual sample time/date stamp. Points may be assigned to multiple history trends with different collection parameters.

- Trend and change of value data shall be stored within the engine and uploaded to a dedicated trend database or exported in a selectable data format via a provided data export utility. Uploads to a dedicated database shall occur based upon one of the following: user-defined interval, manual command, or when the trend buffers are full. Exports shall be as requested by the user or on a time scheduled basis.
- The system shall provide a configurable data storage subsystem for the collection of historical data. Data can be stored in SQL database format.
- The system shall provide data to enable optimization capabilities including fault detection and diagnostics, advanced analytics and central plant optimization without the need of a gateway or additional hardware.

10. TREND DATA VIEWING AND ANALYSIS

- Provide a trend viewing utility that shall have access to all database points.
- It shall be possible to retrieve any historical database point for use in displays and reports by specifying the point name and associated trend name.
- The trend viewing utility shall have the capability to define trend study displays to include multiple trends
- Displays shall be able to be single or stacked graphs with on-line selectable display characteristics, such as ranging, color, and plot style.
- Display magnitude and units shall both be selectable by the operator at any time without reconfiguring the processing or collection of data. This is a zoom capability.
- Display magnitude shall automatically be scaled to show full graphic resolution of the data being displayed.
- The Display shall support the user's ability to change colors, sample sizes, and types of markers.

11. DATABASE MANAGEMENT

- Where a separate SQL database is utilized for information storage the System shall provide a Database Manager that separates the database monitoring and managing functions by supporting two separate windows.
- Database secure access shall be accomplished using standard SQL authentication including the ability to access data for use outside of the Building Automation application.
- The database managing function shall include summarized information on trend, alarm, event, and audit for the following database management actions:
  - Backup
  - Purge
  - Restore
- The Database Manager shall support four tabs:
- Statistics – shall display Database Server information and Trend, Alarm (Event), and Audit information on the BMS System Databases.
- Maintenance – shall provide an easy method of purging records from the BMS System Server trend, alarm (event), and audit databases by supporting separate screens for creating a backup prior to purging, selecting the database, and allowing for the retention of a selected number of day's data.
- Backup – Shall provide the means to create a database backup file and select a storage location.
- Restore – shall provide a restricted means of restoring a database by requiring the user to log into an Expert Mode in order to view the Restore screen.
- The Status Bar shall appear at the bottom of all BMS Software Database Manager Tabs and shall provide information on the current database activity. The following icons shall be provided:
  - Ready
  - Purging Record from a database
  - Action Failed
  - Refreshing Statistics
  - Restoring database
  - Shrinking a database
  - Backing up a database
  - Resetting internet information Services
  - Starting the BMS System Device Manager
  - Shutting down the BMS System Device Manager
  - Action successful

- The Database Manager monitoring functions shall be accessed through the Monitoring Settings window and shall continuously read database information once the user has logged in.
- The System shall provide user notification via taskbar icons and e-mail messages when a database value has exceeded a warning or alarm limit.
- The Monitoring Settings window shall have the following sections:
  - General – Shall allow the user to set and review scan intervals and start times.
  - Email – Shall allow the user to create and review e-mail and phone text messages to be delivered when a Warning or Alarm is generated.
  - Warning – shall allow the user to define the Warning limit parameters, set the Reminder Frequency, and link the e-mail message.
  - Alarm – shall allow the user to define the Alarm limit parameters, set the Reminder Frequency, and link the e-mail message.
  - Database login – Shall protect the system from unauthorized database manipulation by creating a Read Access and a Write Access for each of the Trend, Alarm (Event) and Audit databases as well as an Expert Mode required to restore a database.
- The Monitoring Settings Taskbar shall provide the following informational icons:
  - Normal – Indicates by color and size that all databases are within their limits.
  - Warning - Indicates by color and size that one or more databases have exceeded their Warning limit.
  - Alarm - Indicates by color and size that one or more databases have exceeded their Alarm limit.
- The System shall provide user notification via Taskbar icons and e-mail messages when a database value has exceeded a warning or alarm limit.

12. DEMAND LIMITING AND LOAD ROLLING

- The System shall provide a Demand Limiting and Load Rolling program for the purpose of limiting peak energy usage and reducing overall energy consumption.
- The System shall support both Sliding Window and Fixed Window methods of predicting demand.
- The System shall support three levels of sensitivity in the Sliding Window demand calculations for fine tuning the system.
  - Low Setting – Sheds loads later and over the shortest amount of time. Maximizes the time the equipment is on.
  - Medium Setting – Sheds loads earlier over a longer amount of time than the Low Setting. Increases the time the equipment is on and decreases the probability of exceeding the Tariff Target over the Low Setting.
  - High Setting – Sheds loads earlier over a longer amount of time than the Medium Setting. Minimizes the probability of exceeding the Tariff Target.
- The System shall have both a Shed Mode and a Monitor Only Mode of operation.
  - When the Shed Mode is engaged, the System shall actively control the Demand.
  - When the Monitor Mode is engaged, the System will simulate the shedding action but will not take any action.
- The Demand Limiting program shall monitor the energy consumption rate and compare it to a user defined Tariff Target. The system shall maintain consumption below the target by selectively shedding loads based upon a user defined strategy.
- The Demand Limiting program shall be capable of supporting a minimum of 10 separate Load Priorities. Each load shall be user assigned to a Load Priority.
- The Demand Limiting program shall be capable of supporting a minimum of 12 separate Tariff Targets defining the maximum allowed average power during the current interval.

- The System shall support a Maximum Shed Time for each load as determined by the user.
- The system shall restore the load before the Maximum Shed time has expired.
- The System shall support a Minimum Shed Time for each load as determined by the user.
- The system shall not restore the load sooner than the Minimum Shed Time has expired.
- The System shall support a Minimum Release Time for each load as determined by the user. The System shall not shed the load until it has been off for the Minimum Release time.
- The System shall support three user defined options if the meter goes unreliable.
- Shedding – The currently shed loads will be released as their Maximum shed Times expire.
- Maintain the Current Shed Rate – The System will use the Demand Limiting shed rate that was present when the meter went unreliable.
- Use Unreliable Meter Shed Rate – the system will control to a user defined Unreliable Shed Rate target.
- The Load Rolling program shall sum the loads currently shed and compare it to a user defined Load Rolling Target. The system shall maintain consumption below the target by selectively shedding loads based upon a user defined Load Priority.
- The Load Rolling program shall be capable of supporting a minimum of 10 separate Load Priorities. Each load shall be user assigned to a Load Priority.
- The Load Rolling program shall be capable of supporting a minimum of 12 separate Tariff Targets defining the amount of power by which the demand must be reduced.
- The System shall provide the user with a Load Tab that displays all of the Demand Limiting and Load Rolling parameters for any selected load.
- The System shall provide the user with a Load Summary that displays all of the loads associated with the Demand Limiting and Load Rolling programs. Status Icons for each load shall indicate:
  - Load is Offline
  - Load is disabled
  - Load is shed
  - Load is locked
  - Load is in Comfort Override
- The Load Summary shall include a Load Summary Runtime view listing the following load conditions:
  - Load Priority
  - Shed Strategy
  - Load Rating
  - Present Value
  - Ineligibility Status
  - Active Timer
  - Time Remaining
  - Last Shed Time

## e PORTABLE OPERATOR TERMINAL

i For systems that do not provide full access to systems configuration and definition via the Browser Based user interface the BMS Contractor shall provide a portable operator terminal for programming purposes. The terminal shall be configured as follows:

1. Personal Laptop Computer Manufacturer – Dell, Compaq or HP
2. 1 GB RAM (256 MB minimum) – XP Professional
3. 1.8 GHz Clock Speed Pentium 4 Microprocessor (800 MHz minimum)

4. 40 GB Hard Drive (40 GB minimum)
5. (1) CD-ROM Drive, 32x speed
6. (1) Serial (1) Parallel (2) USB ports
7. 1 Keyboard with 83 keys (minimum).
8. Integral 2 button Track Point or Track Ball.
9. 10" SVGA 1024x768 resolution color display
10. Two PCMCIA Type II or one Type III card slot
11. Complete operator workstation software package, including any hardware or software.
12. Original printed manuals for all software and peripherals.
13. Original installation disks or CD for all software, device drivers, and peripherals
14. Software registration cards for all included software shall be provided to the Owner.
15. Carrying case
16. Spare battery.
17. External power supply/battery charger

ii Proprietary Portable Terminal

1. Manufacturers providing proprietary portable terminals shall submit technical data sheets for the terminal and all associated software and hardware.
2. The proprietary terminal shall meet the same operator interface software requirements as specified above.

iii Software

1. Portable operator terminals shall support all controllers within the system on a direct-connect communications basis.
2. When used to access First or Second Tier controllers, the portable operator terminal shall utilize the standard operator workstation software, as previously defined.
3. When used to access Application Specific Controllers, the portable operator terminal shall utilize either the standard operator workstation software, as previously defined, or controller-specific utility software.

## f BMS SYSTEM USER INTERFACE

i BMS Contractor shall provide and install all computer hardware and software required for the purpose of configuration and consolidation of information and programs required for the delivery of a Task Focused, Web Based Portal to the BMS. The BMS System User Interface shall provide a natural, complementary extension to the B site management user interface previously described.

ii The user interface architecture shall be implemented to conform to industry standards, so that is can accommodate the required applications provided by the BMS Contractor as well as communicate information to and from any size control system.

iii The exact same user interface shall be accessible from any type of personal computer or mobile device running any type of operating system (ex. iOS, Android, Windows).

iv The interface shall automatically adapt and optimize the information displayed to fit the screen size of the client device and shall also be touch friendly.

v The user interface shall organize and display information using customer specific locations and spaces. At a minimum, the user interface shall provide:

4. Organization of all space, equipment and point information in a familiar way, reducing the need for extensive training prior to use.
5. A navigation mechanism for users to select the specific location or space to display information for – only spaces and locations in the navigation tree, nothing more.
6. The ability to search for and/or bookmark any location or space by name for quick access to critical or troublesome areas.
7. The same navigation mechanisms apply across any client device (ex. Smart phone, tablet, personal computer) for consistency and ease of use.

vi Plug-ins and special native app software (ex. Downloaded and installed from an app store) shall not be required to conduct daily operations of buildings and equipment.

vii The user interface shall clearly display equipment relationships without custom graphic generation.

viii The user interface shall provide a single display of all potential issues in a facility including items currently in alarm, warning, override, out-of-service and offline.

ix The user interface shall provide a single display of all activity related to a specific piece of equipment including user changes, discarded user changes, pending alarms, discarded alarms and acknowledged alarms.

x The user interface shall provide support for up to 100 concurrent users from an unlimited number of individuals with defined password access to the system.

xi Provide the capability to view, command and modify large quantities of similar data in tailored summaries without the use of a secondary application, like a spreadsheet. These summaries shall be automatically generated or user defined. User defined summaries shall allow up to seven user defined columns describing attributes to be displayed including custom column labels. Up to 100 rows per summary shall be supported.

## g READY ACCESS PORTAL USER INTERFACE

i BMS Contractor shall provide and install all computer hardware and software required for the purpose of configuration and consolidation of information and programs required for the delivery of a Task Focused, Web Based Portal to the BMS. The Ready Access Portal shall provide a natural, complementary extension to the BMS site management user interface previously described.

ii Ready Access Portal Architecture – The architecture of the system shall be implemented to conform to industry standards, so that it can accommodate the required applications provided by the BMS Contractor as well as communicate information to and from the BMS system Site Director.

iii PC Hardware – The personal computer(s) shall be configured as follows:

1. Memory – 2 GB (1 GB Minimum)
2. CPU– i7 processor. 2.8 Hz Clock Speed (2.0 GHz minimum)
3. Hard Drive – 500 GB free hard drive space (80 GB minimum)
4. Hard drive backup system – CD/RW, DVD/RW or network backup software provided by IT department
5. DVD ROM Drive – 16X performance
6. Ports – (1) Serial, (2) USB ports
7. Keyboard – 101 Keyboard and 2 Button Mouse
8. CRT configuration
9. 21” Flat Panel Monitor 1280 x 1024 resolution minimum
10. 16 bit or higher color resolution
11. LAN communications – Ethernet communications board; 100Mbps Min.

iv Operating System Software

12. Windows XP Professional, IIS Version 5.1, .Net Version 2.0, SQL server 2005 Express software with SP2 or <Alternately> Microsoft Windows Server 2003 OS with SP2, IIS Version 6.0, .Net version 2.0 and SQL Server 2005 with SP@
13. Provide required software and hardware required for integration of computing hardware on enterprise IT network.
14. Provide software registration cards to the Owner for all included software.

v User Interface Application Components

15. The ready access portal shall provide an intuitive user interface to key BMS Software functions and tasks via web browser.
16. Plug-ins or special software shall not be required for access to alarm, summary, schedule and trend data.

17. The portal shall include the ability to view full graphical representations of systems and equipment on PC platforms
18. The control system shall provide Secure Sockets Level (SSL) and Active Directory service support. If the Active Directory service and Single Sign-On features are enabled and the user is logged in to the Windows desktop, the login screen does not appear and access to the system is automatic.
19. Provide a common tool for graphics creation, schedule creation, custom programming, user access and hardware definition
20. Information shall be accessible on both personal computer and handheld device platforms as follows:

ii Personal computers – Internet Explorer Version 7.0 recommended

iii Handheld devices – Internet Explorer for Window Mobile Version 5.0 or 6.0 recommended, as well as Apple i-Phone, i-Touch, or i-Pad. UI is optimized for devices with a 240 x 320 pixel screen size (QVGA).

vi Operator Interface

1. Password access shall be as described previously for management portal UI
2. Once logged in, the System shall display a pre-selected screen tailored to the task requirements of the individual user.
3. The User Interface shall utilize an intuitive navigation and display method designed for operators who access the system for casual information and control or on an infrequent basis. It shall feature three basic components.
4. Radio buttons for selection of the type of information to be displayed including Alerts, Summary, Schedules and Diagnostics
5. Navigation tree for selection of the specific data to be displayed on screen for the selected type. The navigation tree may be hidden and expanded by the operator to optimize the display of information
6. A display window that provides the selected information by type in a pre-configured tabular format

vii The user interface software shall provide help menus and instructions for each operation and/or application.

viii The system shall provide support for up to 100 concurrent users from an unlimited universe individual with defined password access to the system

ix The system shall utilize Secure Sockets Level (SSL) support as required to allow the ready access portal to communicate across a network in a way designed to prevent eavesdropping, tampering, and message forgery. It provides endpoint authentication and communications privacy over the network using cryptography

x The system shall have the capability to display multiple navigation trees that correspond to the user views configured in the management portal UI.

xi The alert summary of the ready access portal shall, at the minimum, provide the following information

1. Alert (Alarm) type
2. Date and time of alert occurrence
3. Priority (color coded to level)
4. Item name.
5. Item value (if applicable)
6. Message
7. Any attribute of any object in the system may be designated to report an alarm

xii A standard summary on the ready access portal shall, at the minimum, provide the following information

1. Point type graphic icon
2. Item name
3. Item value
4. Item status

5. Access to the Change Value window (if applicable) for the purpose of setting, holding or releasing an item value

xiii A custom summary on the ready access portal shall display user-specified summaries of key data sets that can be quickly filtered and sorted. Items within these custom summaries can be commanded.

xiv A graphic view on the ready access portal shall display as described previously for management portal UI.

xv The schedule detail summary of the ready access portal shall, at the minimum, provide the following information

1. Scheduled occurrences including time and value
2. Scheduled overrides including start time, end time and value
3. A list of all scheduled items including name and attribute, value, status and priority
4. Access to the Add Temporary Override window for the purpose of adding a temporary override to the schedule

xvi The diagnostic (trend) summary of the ready access portal as viewed on a personal computing device shall provide the following information.

1. Item name
2. Item status
3. Trend name
4. Trend status
5. Full path name
6. Access to trend detail summary including trended value, time and date arranged in a user selectable format of 1 hour, 12 hours, 24 hours, 48 hours or 72 hours

Approved Make – Johnson Controls Metasys/Siemens Apogee / Honeywell (Comfort Point)

**h ENERGY MONITORING SYSTEM**

**i Scope:**

The Energy Dashboard and Reporting Software Shall have following Capabilities: -

1. The EMS shall be web-based application software complete with all necessary associated databases and other software that may be required for its complete functionality to meet the intent of the Particular Specification.

2. The EMS shall collect the data from Building Management System (BMS) and shall provide comprehensive data visualization capabilities in terms of dashboards and reports for monitoring and analyzing.
   - Energy trends
   - Energy performance
   - Energy comparison
   - Chiller and Plant Parameter Trends
   - Chiller and Plant Performance

3. The EMS shall also have the option to be configured as a complete Tenant Billing application. A separate tenant portal to be provided to allow the tenant to monitor their utility consumptions, past billing data and shall act as a communication window with the building facility manager.

4. The EMS shall have the option of interacting with site Building Management Systems (BMS) for triggering ON/OFF Lighting and HVAC units.

5. The work shall include design, manufacture, works testing, supply, delivery to site, installation, site testing, commissioning, data validation with Building Management

System (BMS) and making good any bugs/defects that occur during the defect liability period. The successful bidder shall be providing a complete user manual.

ii **Software features**: The EMS software shall be built on the following

1. Operating System – The EMS shall operate on Windows Server 2003, Windows Server 2008 (32 bit & 64bit), Windows XP, Windows 7, Window 8
2. Web Browser support – EMS shall be accessed using any of the standard web browser namely Internet Explorer 7 and above, Goggle Chrome, Mozilla Firefox
3. Backend - Microsoft .NET (version 3.5 and higher) technology.
4. Front End User Interface - The front end user interface shall be built on rich user interface namely Adobe Flash version 3.0 or higher, html 5
5. Database – MS SQL Server 2005 and above.
6. Reporting Tools – Crystal Report version 11 and above.
7. Dashboard – Standard Flash / HTML 5 components.
8. Tablet Compatibility – The EMS Dashboards and Reports shall be accessible on standard tablet operating platforms namely iOS and Android.
9. Automated E-mail: The software shall have the capability to publish reports to a Web server or send them to a person/entire organization (user configurable) via e-mail.

iii **Functional features:** The EMS software shall be built on the following

1. **Data Collection:** EMS shall collect the data from Building Automation Systems by any of the following methodologies
   - Open Database connectivity namely SQL, MS-Access etc.
   - Real Time connectivity to the BMS through standard protocols like BACnet IP, MODBUS IP, SNMP, OPC.
   - Web Services.
   - Any other custom data sources.
   - The EMS software on a single server installation shall be able to collect the data from multiple BMS/ control system instances on any permutation of the data sources mentioned above. There should be a simple user interface to select the data source and mapping of points to the EMS.
   - When connected to an Open Database source of BMS/other control and monitoring systems, the EMS software shall have the capability to fetch historical records from the BMS/Other control & monitoring systems up to previous 5 (five) years at a minimum.

2. **Data Normalization -** EMS shall be able to normalize the data fetched from single/multiple systems as per the user defined nomenclature (parameter name and corresponding unit of measure).

3. **Data Storage / Management -** EMS shall be able to normalize the data fetched from single/multiple systems as per the user defined nomenclature (parameter name and corresponding unit of measure).

   - The BMS/other control system parameters mapped to the EMS shall be stored in a Microsoft SQL database. The data shall be stored for a period of 5 years from the date of implantation. There shall be adequate provision for back-up/ restoration of the EMS database.

   - Provide database for the storage of equipment parameters data, run hours, point data (temperature, pressure etc.), events, performance data etc which should be stored in

a system database. This database should be as per industry standard supporting SQL.

- The database should be scalable and shall continue to operate efficiently with at least 500 controllers / 1000 meters connected to the systems.

- The database should also store data in efficient manner to minimize total space consumed by the database. Repetition of data within or across the tables should be avoided.

- The database should store all data retrieved from devices/meters and generated by the system including:
  - Trend Logs with time stamps
  - After hour's usage including:
    Time started.
    Duration
    Tenancy or origin of the request (e.g. user, specific switch etc.)
  - Historical event log.
  - System faults.
  - Communication faults.
  - Operator activity such a logon, manual override etc.
  - Trend logs.

- The database should be able to store calculated data for different types of source data, including
  - Instantaneous data points
  - Incremental data points
  - Status data points
  - Trigger points
  - Totalization points

- The historical database shall also provide tables for definition of number of parameters that shall be entered manually or imported. These parameters shall include (but not limited to):
  - Building and tenancy area.
  - Energy cost parameters
  - Weather data
  - Energy and power specifications for connected equipment
  - Commissioning data for all services such as measured airflows, water flows, pressure drops etc.
  - Building occupancy levels
  - Coefficient for greenhouse gas equivalents

  These parameters shall be used in the reporting system to drive values for energy reports.
- The database should support tools to manage the database over time. An operator should be able to archive data based on the following criteria:
  - A quantity of records
  - A date range
- The operator should be able to archive database anytime. The archive location should be selectable by the operator and should include options such as network drives, CD, DVD or DAT tape or removable hard disk.
- The application shall also support retrieved data from an archive so that it can be displayed or reports generated.

- It shall be possible to access the archive data and online data simultaneously to generate display or report containing information from both sources.

**4. Data Verification & Alerts –**

- EMS software shall be able to identify 'bad' data at the source during the data collection process from BMS/other control systems and will reject such instances. Integrity of source data is critical to the facility and EMS software that uses manipulation of source data during the data verification process shall not be acceptable.

- EMS should be able to automatically handle the below site data issue scenarios:
  - Site meter resets
  - Data spikes
  - Missing meter data for a duration of up to 120 hours at a time.
  - Site network failure and ensuing data loss for a duration of up to 120 hours at a time
- EMS should keep an audit trail of all site data issue events.

  - **Auto-failover recovery for critical service with alerts -** The EMS shall have capability for auto failover recovery for the critical services, and should be able to provide designated personnel (user configurable) with alerts via email in case of site failure events.

  - **Secure User Access –** The software shall feature Windows NT® integrated security. Only registered users or groups with access rights may view, execute, and manage reports. The Web Interface should also support role-based user preferences for customizing the user interface and overall reporting experience for each user.

  - **User Interface (UI):** The UI shall be rich, intuitive and user friendly. It should include graphical display through which an operator can perform access and manipulation of the UI functions as specified and shown.

    The display shall be capable of showing both static images and dynamic data from the field. Dynamic data shall be capable of being updated once every 15 minutes or less.

    The dynamic data should be able to display in the form of text, animated trend charts. GUI display shall clearly provide the following forms of data:

    - Valid dynamic data from the field – actual and calculated
    - User entered data.
    - Out of range, missing data
    - Meter, devices, equipment location and hierarchy.

    The user should have the following functionalities at a minimum on the user interface:

    - Define new dashboards through simple point and click based selections
    - Ability to reconfigure layout dashboard layout using intuitive drag and drop feature.
    - Ability to select from multiple color schemes.

- Ability to logically organize dashboards by filters and tabs based on user defined criteria such as physical location (buildings / floors), logical aggregation, type of meters and type of charts

➢ **Charting/ Dashboard for Data Visualization**

EMS shall have at minimum basic charts templates based on industry best practice for energy monitoring for direct visualization of key energy parameters, such as:

- Utility Consumption trends – Electricity, Water, Gas – with benchmarks.
- Electricity load profile
- Electrical power factor
- Energy baseline and performance

EMS shall be capable of the following Charting & Data Visualization features at the minimum

- User selectable facility/building dashboard in a multiple building/facility environment
- Facility wise comparison of similar parameters/KPI
- Pre-defined and User definable dashboards
- Automatic update of the dashboard when new data is delivered.
- Multiple chart types namely Horizontal & vertical bar charts, Line chart, Pie Chart and dial gauge.
- Provision of multiple Y-axis (for line/Bar charts) for different parameter types.
- Provision to 'drill down' through multiple time resolution – yearly, monthly, daily, hourly – on a single dashboard.
- User selectable date selection (date/month/year) for on-the-fly data representation at the dashboard.
- Automated data grouping by time interval (hour, day and month) in a single dashboard.
- The value of the sample data point at the dashboard/ Chart shall be available on a tool tip.
- Ability to zoom in/out of the dashboard for better viewing of trends.
- Ability to generate reports out of dashboard graphs – export in pdf and word format.
- Ability to export dashboard graph data into CSV or XLSX format

Provision for marking out consumption for holidays and weekends in a different color.


- **Dashboard – Energy Performance**

EMS software shall generate the following dashboards but not limited to

- Yearly Energy (electricity) Consumption and drill down to daily
- Yearly Water/Gas/Btu Consumption and drill down to daily
- Yearly Carbon Footprint and drill down to daily
- Yearly Energy Cost drill down to daily
- Monthly minimum/maximum/average demand
- Energy usage distribution and top contributors.
- Monthly Demand profiling on calendar view to compare day-of-the-week wise comparison of energy performance.
- Energy Usage Index (Kwh/unit area) profiling and benchmarking.
- Monthly calendar dashboard for visualizing data trend (up to hourly resolution) for one whole month in a calendar type date format.
- Universal Dashboard - Option to select multiple energy data points and generate dashboard on the fly for any user defined date range.


EMS shall provide an interface for ad-hoc data trending option for up to 30 days in daily and hourly resolution for any point of choice of the user through selections on the UI screen

In addition EMS shall represent the facility meter distribution tree dynamically with associated details namely the distribution feeder, Rated KW for the feeder, etc.

- **Dashboard – Chillers & Plant performance:**

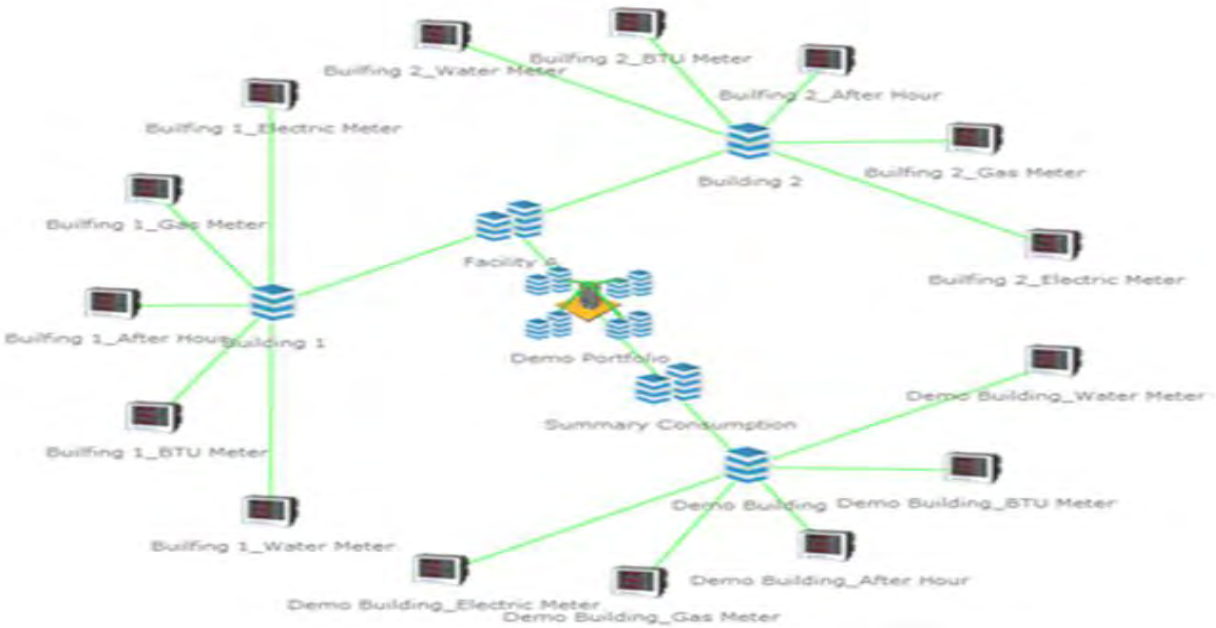
EMS software shall generate the following dashboards but not limited to

- Plant Efficiency
- Chiller Efficiency against design/benchmark.
- Cooling tower Efficiency.
- Cooling Load profile.
- Universal Dashboard - Option to select multiple data points and generate dashboard on the fly for any user defined date range.

- **Visualization – Site meter and controller architecture**

EMS software shall be able to visualize and represent the actual site meter and controller architecture based on site definitions.

User shall be able to drill down from the facility view to individual buildings and asset view and down to individual meters and controllers.




- **Reporting Services:**

  Report Scheduling - The reporting package should have the option trigger reports automatically based on periodic or time-based schedule.

  Report Targets - The reporting package should have the option to send the generated reports to the following targets at a minimum:
  - Printer
  - Fax
  - Email report as attachment
  - Publish directly as HTML page on the web.
  - Generate PDF file
  - Generate report in editable format in Excel
  - User should be to create on demand web reports available in multiple formats (excel, pdf etc)

  Report Template - User shall have the option to select, configure and store the parameters used in the report as a predefined template for fast report generation at a later date. User should also be able to edit the saved templates at a later time.

- **Standard Reports – Energy Performance:**

  The Report program shall be a user-friendly web-based application. The program shall allow the facility managers to configure the facility in terms of its working day/ weekend/ holidays/ operating hour, analyse and document the building energy data, monthly consumption, amend tariff rates and associated administrative functions. The energy performance reports shall contain the following but not limited to

  - Monthly Energy Consumption report: This report shall detail the daily energy consumption (KWh), demand (KW), maximum demand (kVA), and power

factor (PF) information for the month with indication of the Maximum/ Minimum consumption & demand instances during the report period. For ease of analysis the report shall also indicate day wise weekly comparison of both consumption and demand.

- Energy Consumption & Demand Comparison report: For analysis purpose, there shall be simple user interface for the user to generate a report comparing the energy consumption and demand value on the following

  - Year-on-Year
  - Month-on-Month
  - Week-by-Week.
  - Date by date
  - Hour-by-hour for a selected date
  - User defined time periods

- Meter wise consumption report: User shall be able to select a set of meters and generate the report for meter reading for the selected dates, and the subsequent consumption.
- Yearly & Monthly Consumption report for other utilities. EMS shall be capable of generating consumption of other utilities namely Gas, Water, Btu etc.
- Energy comparison for two different groups of meters: User shall be able to select groups of energy meters that could be compared for time range of choice – year, month, date range, day by hours.

| **Report Format : Energy Performance** | | | |
|---|---|---|---|
| **Report** | **Time Resolution** | **Units of the points** | **Report for** |
| Demand Profile Comparison | Year – Month – Week | Electrical Demand | Comparison for selected meter in line format. Along with chart table<br>Relative reading and average reading meter wise |
| Consumption Profile Comparison | Year – Month – Week | Electrical Consumption | Comparison for selected meter in line format. Along with chart table<br>Relative reading and Total reading meter wise |
| Energy Consumption | Monthly | Electrical demand, consumption, power factor | Demand and KVA for each day of month.<br>Consumption On peak and Off peak wise.<br>Show cost as per defined rate. |
| Utility wise Consumption | Yearly - Monthly | Utility (non-electric) consumption | Consumption (Water, Gas and Cooling)in chart and table format for selected period |
| Date-wise Comparison | Daily/Hourly | All consumption units (electricity, water, gas BTU) | Compare hourly consumption on two different dates for a group of meters |
| Month-wise Comparison | Date Range | All consumption units (electricity, water, gas BTU) | compare energy data for a group of meters over two different date ranges<br>Information should split by consumption by respective months from within the date range |
| Grouped Meter Comparison | Yearly, Monthly, Date Range, Daily, Hourly | All consumption units (electricity, water, gas BTU) | compare consumption for two different groups of meter(s) over the same time range |

- **Standard Reports – Chillers / Plant Performance:**

The system shall support a flexible reporting package to allow easy generation of report data. The reports provided should include pre-configured standard reports for common requirements such as Alarm Event reports and custom report generation facilities that are configurable by the user.

| **Report Format : Plant Room & Equipment** | | | |
|---|---|---|---|
| **Report** | **Time Resolution** | **Units of the points** | **About the Report** |
| Plant Room Efficiency Report | Daily / Hourly | Chiller Efficiency | Shows the daily trend (for a particular month) and hourly trend (for a particular date) chart and table, with option to show average value for the points selected |
| Temperature Report | Daily / Hourly | Temperature | |
| Tonnage Report | Daily / Hourly | Chiller Tonnage | |
| Demand Report | Daily / Hourly | Electric Demand | |
| Excel Export Data | Raw data/ hourly/ daily/ monthly/ yearly | Any unit | Export data for multiple points (of any unit) in time resolution of hourly / daily / monthly / yearly format in excel format |

- **Tenant/User/Department wise Utility Billing:**

The Tenant / User / Department Utility Billing Report programme shall be an integral part of the EMS. This programme will help in the proper management of the tenant / Department energy usage. The software shall automatically generate bills covering all utilities namely electricity, gas, water, BTU etc including tenants / Users afterhours usage

EMS software shall be capable to provide the following at the minimum:

- Tenant/User based Setup on the location of occupied space in the building/floor/ zone.
- Tenant/User account management. Personalize account details including contact information, meter device assignment, support for multiple meters, billing rate assignment and billing cycles.
- Ability to define tenant /User billing rates by time of day and consumption slabs.
- Ability to define multiple tenant /User billing rates by type of meter meters, by duration and by type of day.
- Ability to assign multiple tenants/Users to the same meter by applying pre-rate meter sharing factors as required on site.
- Scheduled generation of bills and automatic e-mail to the tenant e-mail addresses as pdf.
- Dashboard showing billing summary (both in energy units and amount) for all tenants/User, month wise for managerial review.
- A separate tenant / /User portal from the EMS log-in page (controlled by user roles and rights) that shall provide snapshot of current utility usage, past

consumption history and an archive of previous tenant utility bills. The portal shall also be used as tenant /User communication window with the facility management team.

- Afterhours (request for extended use of utilities like Air-conditioning etc. beyond normal operating hours) service request facility shall be provided on tenant/User web portal. Request can be placed / schedule for any day on the month. The software shall have the ability to repeat the request on daily/weekly/monthly basis.

The system is to be programmed to record after hours for each tenant/User. Hours are to be accumulated on a daily basis and configured to be reportable as daily or the accumulated total between user defined rates. Recorded run hours are to be recorded separately as “normal” hours and “after” hour operation.

After hours air-conditioning requests are to be recorded including the following information:

- Start date and time.
- Duration of the request or the requested stop date and time.
- The origin of the request (user or specifically defined after hours switch)
- The tenancy/Users requesting after-hours operation.

Reports are to include all of the above information and the accumulated run time for each request. Reporting is to group requests by tenancy providing in historical sequence, each request and an accumulated total for each tenancy on a monthly basis. Reports are also to be available base on operator request between operator defined dates.

The facility team (with adequate user roles and rights) shall be able to browse the tenant/User portal without a separate log-in process. EMS shall allow the admin user to override any after-hours request.

| **Report Format : Tenant Utility Billing** | | | |
|---|---|---|---|
| **Report** | **Selection** | **Units of the points** | **About the Report** |
| Tenant Billing Report | Year – Month – Tenant | All consumption units (electricity, water, gas BTU) | Electricity bill, after hour Air-conditioning usage and total utility bill detailing report will generate |
| Summary Billing | Monthly | Local Currency or Standard Currency | Report detailing cost for different utility types for all tenant will appear for selected month |
| After Hour Summary | Monthly | Hours and currency | Report detailing monthly consumption will appear with demand and KVA for each day of month. Daily and Monthly Consumption will be appearing showing consumption On peak and Off peak wise. Also provide cost as per defined rate. |
| Consumption Summary | Monthly | Hours and currency | Report detailing consumption for different utility types for all tenant will appear for selected month |

Approved Make - Johnson Metasys/Siemens Desigo / Honeywell (Comfort Point)

## i ENERGY INFORMATION KIOSK:

### i Scope:

1. The Energy Information Kiosk shall be web-based application software complete with all necessary associated databases and other software that may be required for its complete and in scope functionality to meet the intent of the particular fitting specification.

2. The EIK shall collect the data from Building Management System (BMS) and shall provide comprehensive data visualization capabilities in terms of dashboards and reports for monitoring and analysing;

   - Electricity consumption
   - Water consumption
   - Gas consumption
   - Carbon footprint
   - Weather Information via Internet Feeds

3. The EIK shall have the option to be configured to display real-time feeds from popular news sites, display public announcements and provide option for users to give feedback using social networking sites.

4. The EIK should be able to display weather conditions using graphic images.

5. The EIK should be able to display graphics showing the facility and floor layouts.

   The work shall include design, manufacture, works testing, supply, delivery to site, installation, site testing, commissioning, data validation with Building Automation system (BMS) and making good any bugs/defects that occur during the defect liability period. The successful bidder shall be providing a complete user manual document for trouble free operation of EIK during the Operation and Maintenance of the facility.

### ii Hardware/ Server requirement:

1. Server shall be a standard unmodified digital computer of modular design currently being manufactured. Server hardware shall meet the following minimum requirements:
   - Processor – Minimum 3 GHz Quad Core
   - Random Access Memory (RAM) – Minimum of 6 GB of DDR3 expandable up to 192GB
   - Hard drives and Controller: Controller and drives shall provide at least 100GB usable disk space with an average seek time of 7 ms or less with Raid 0/1 redundancy.
   - Support information display on a 19 inch touch screen for an integrated KIOSK, or support display on 46-60” LCD/LED monitors.
   - Dual Network Interface Card (NIC): Integrated 1000Base-T Ethernet NIC with an RJ45 connectors.
   - Operating system shall be Microsoft Windows Server 2008.
   - Browser supporting Flash.
   - DVD-RW Optical Drive for Backup.
   - Thermal Efficient Server Tower Case.

### iii Energy Information Kiosk Software features:

1. The Energy Information Kiosk software shall be built on the following

- Operating System – The Kiosk shall operate on Windows Server 2003, Windows Server 2008 (32 bit & 64bit), Windows XP, Windows7 or Windows8.
- Web Browser support – EIK shall be accessed using any of the standard web browser namely Internet Explorer 9 and above, Google Chrome (v 38 and above), Mozilla Firefox (v31 and above).
- Backend- Microsoft .NET (version 4.0 and higher) technology.
- Front End User Interface - The front end user interface shall be built on rich user interface namely Adobe Flash version 3.0 or higher or HTML 5.
- Database – MS SQL Server 2008 R2 and above with SQL Management Studio.
- Dashboard – Standard Flash / HTML 5 components.

### iv Energy Information Kiosk Software Functional features:

#### 1. Data Collection

EIK shall collect the data from Building Automation Systems by any of the following methodologies.

- Open Database connectivity namely SQL, MS-Access etc.
- Real Time connectivity to the BMS through standard protocols like BACnet IP, MODBUS IP, SNMP, OPC.
- Web Services.
- Any other custom data sources.
- The EIK software on a single server installation shall be able to collect the data from multiple BMS/ control system instances on any permutation of the data sources mentioned above. There should be a simple user interface to select the data source and mapping of points to the EIK.
- When connected to an Open Database source of BMS/other control and monitoring systems, the EIK software shall have the capability to fetch historical records from the BMS/Other control & monitoring systems up to previous 1 (one) years at a minimum.

#### 2. Data Normalization:

- EIK shall be able to normalize the data fetched from single/multiple systems as per the user definable nomenclature (parameter name and corresponding unit of measure).

### *3.* Data Storage/ Management

- The BMS/other control system parameters mapped to the EIK shall be stored in a Microsoft SQL database MS SQL 2008 R2 and above. The data shall be stored for a period of 5 years from the date of implementation. There shall be adequate provision for back-up/ restoration of the EIK database.

- Provide database for the storage of equipment parameters data, run hours, point data (temperature, pressure etc.), events, alarm etc which should be stored in a system database. This database should be an industry standard supporting SQL.

- The database should be scalable and shall continue to operate efficiently with at least 500 controllers connected to the systems.

- The database should also store data in efficient manner to minimise total space consumed by the database. Repetition of data within or across the tables should be avoided.

- The database should be able to store calculated data for different types of source data, including.
  - Instantaneous data points
  - Incremental data points
  - Status data points
  - Trigger points
  - Totalization points

- The historical database shall also provide tables for definition of number of parameters that shall be entered manually or imported. These parameters shall include (but not limited to):
  - Building and tenancy area.
  - Energy cost parameters
  - Weather data using Web Services from weather information feeds
  - Energy and power specifications for connected equipment.
  - Coefficient for greenhouse gas equivalents

  These parameters shall be used to drive values for energy related data displays.

- Taking backup of the EIS database using standard SQL backup options should be allowed. The operator should be able to generate backup anytime using standard Microsoft SQL database backup options on the following criteria:
  - A quantity of records
  - A date range

  The operator should be able to manually select the storage location for the archived files such as network drives, CD, DVD or removable hard disk.

### 4. Data Verification & Alerts:

- EIK software shall be able to identify ‘bad’ data at the source during the data collection process from BMS/other control systems and will reject such instances. There should be provision to define acceptable values. Integrity of source data is critical to the facility and EIK software that uses manipulation of source data during the data verification process shall not be acceptable.

- EIK should be able to automatically handle the below site data issue scenarios:
  - Site meter resets

- Data spikes
- Able to average out missing meter data for a duration of up to 120 hours
- Site network failure and ensuing data loss for a duration of up to 120 hours at a time.

**5. Secure User Access:**

- The software shall feature at a minimum of Windows NT® integrated security framework and related User access flow. There will be an Admin account and various User accounts. Only registered users or groups with access rights may view, execute, and manage data displays.

- Furthermore, standard SQL authentication techniques for database access must be compulsorily used. The software should encrypt all database call queries from the application to protect the SQL access credentials. All passwords within the application UI and within the software database must be viewed / stored in protected (hashed) format.

**6. User Interface (UI):**

- The UI shall be rich, intuitive and user friendly. It should include graphical display. Auto rotation of the custom defined graphics should be possible. EIK should also have capability to have user defined Navigation.

- The display shall be capable of showing both static images and dynamic data from the field. Dynamic data shall be capable of being updated once every 15 minutes or less.

- The dynamic data should be able to display in the form of text, animated dials, trend charts. GUI display shall clearly provide the following forms of data:


7. **Data Visualization**: EIK shall be capable of the following Charting & Data Visualization features at the minimum:

- User selectable facility/building dashboard in a multiple building/facility environment.
- Floor wise comparison of similar parameters / KPI
- Pre-defined dashboards types with the ability to classify them for display of specific equipment's consumption
- Multiple chart types namely Horizontal & vertical bar charts, Line chart, Pie Chart and dial gauge.
- Provision of multiple Y-axis (for line/Bar charts) for different parameter types
- Automatically update of the dashboard when new data is delivered.

**8. Overview / Introduction:**

- EIK software shall display the following information:

  - View of the building with 360 degree view
  - Brief description of the building
  - Summary of Power consumption, Water consumption and Gas consumption for the facility
  - Space for display of public announcements
  - Weather information with appropriate graphical display
  - Display of customer logo, news feed and current date/time

**9. Energy module:**

- EIK software shall display the following information:

  - Digital display of Electrical energy consumed by different HVAC equipment in the facility.
  - Energy consumption and/or cost display in digital format/bar charts/gauge for Lighting, Small power, Ventilation, Plug in, Heating, Elevators. These categories and corresponding graphics should be completely configurable by the Administrator.
  - Display Energy saving tips, which should be configurable by the Administrator
  - Display data for current day, current week, current month and current year
  - Provide benchmark comparison against the best and worst performance in the history of the facility
  - Have ability to provide floor/zone wise displays if desired by the Administrator.

**10. Water Module: EIK software shall display the following information:**

- Digital display of Water consumption in the facility

- Water consumption and/or cost display in digital format/bar charts/gauge for Hot water, Cold water, Flushing water, Domestic water, Municipality water, etc. These categories and corresponding graphics should be completely configurable by the Administrator.

- Display Water saving tips, which should be configurable by the Administrator.

- Display data for current day, current week, current month and current year.
-

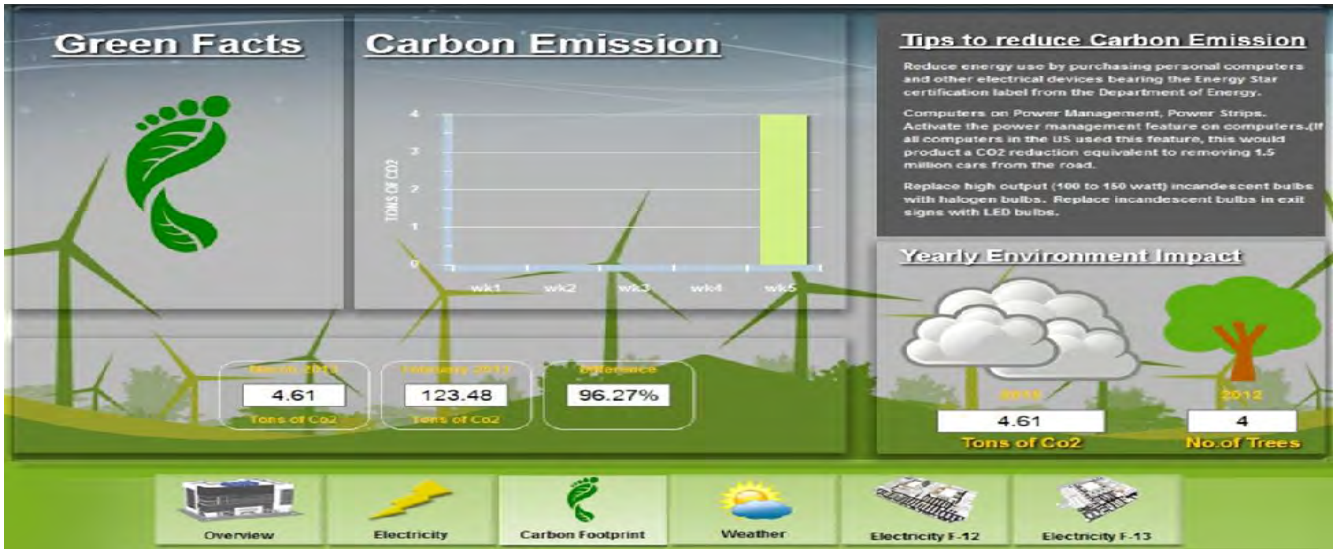
- Provide benchmark comparison against the best and worst performance in the history of the facility.
- Have ability to provide floor/zone wise displays if desired by the Administrator

**11. Gas Module: EIK software shall display the following information:**

- Digital display of Gas consumption in the facility.
- Gas consumption and/or cost display in digital format/bar charts/gauge format
- Display data for current day, current week, current month and current year
- Provide benchmark comparison against the best and worst performance in the history of the facility
- Have ability to provide floor/zone wise displays if desired by the Administrator

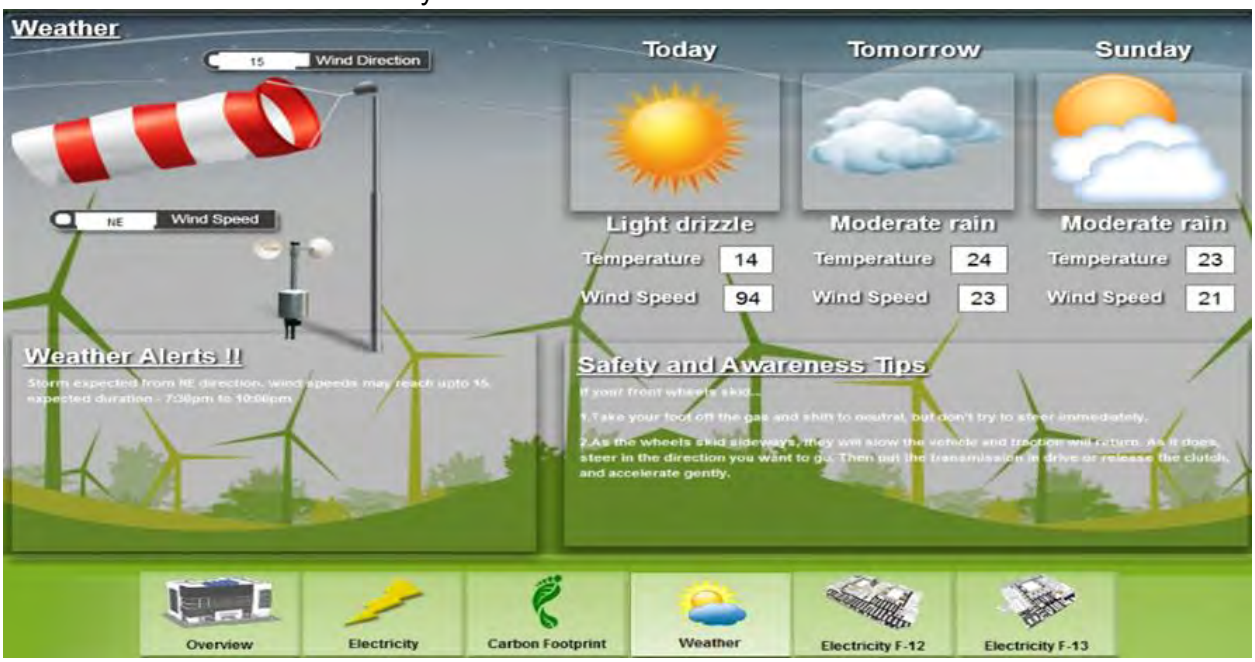
**12. Carbon Footprint: EIK software shall display the following information:**

- Digital display of Carbon emission in the facility
- Carbon emission display in digital format. The CO2 conversion factor should be completely configurable by the Administrator
- Display tips (defined by user) for reducing carbon emission, which should be configurable by the Administrator
- Display impact on environment in terms of number of trees, cars, etc
- Display month on month change (positive or negative) in carbon emission
- Have ability to provide floor/zone wise displays if desired by the Administrator



**13. Weather Display: EIK software shall display the following information:**

- Digital display of weather data – temperature and humidity for current day, next day and the day after that. Corresponding weather graphics should be included.
- Wind speed and direction should be displayed.
- Weather alerts should be displayed
- Safety and Awareness tips should be displayed. The content for this should be configurable by the Administrator.
- All the graphics on this page needs to be very dynamic and attractive from a user experience perspective
- Any weather data not available from the site should be retrieved using a popular weather service available on the Internet. Any licensing agreement for this must be notified in advance by the vendor.




**14. Green Facts:**

EIK software shall display the following information:

- Display of green facts that could include suggestions defined by User on saving energy, increasing energy and green building knowledge among viewers, provide an avenue to advertise green initiatives being undertaken by the property/building owner.
- All the text content, trend graphs and graphics should be completely configurable by the Administrator

**15. Notifications/Public Announcements:**

- Any public announcements and notifications from the facility management team through the Kiosk should be supported across all modules. The Administrator should have the option to enable voice notifications as well.

**16. Screen navigation:**

- All screens should support user interaction through active click option on various tabs and content.
- Inactivity on the Kiosk for a configurable time limit should automatically navigate the application back to the Overview/Introduction screen.
- System should support a configurable time limit (in seconds or minutes) after which the application will automatically navigate to the next module.
- Any static text content exceeding the available display window should auto-scroll at a suitable speed to allow users to read through the content

Approved Make - Johnson Metasys/Siemens Desigo / Honeywell (Comfort Point)

**j NETWORK / SUPERVISORY CONTROLLER:**

i The Network / Supervisory Controller shall be a fully user-programmable, supervisory controller. The Supervisory Controller shall monitor the network of distributed application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Supervisory Controllers.

ii Automation network – The Supervisory Controller shall reside on the automation network and shall support a subnet of system controllers.

iii User Interface – Each Supervisory Controller shall have the ability to deliver a web based User Interface (UI) as previously described. All computers connected physically or virtually to the automation network shall have access to the web based UI.

1. The web based UI software shall be imbedded in the Supervisory Controller. Systems that require a local copy of the system database on the user's personal computer are not acceptable.
2. The Supervisory Controller shall support a minimum of two (2) concurrent users.
3. The web based user shall have the capability to access all system data through one Supervisory Controller.
4. Remote users connected to the network through an Internet Service Provider (ISP) or telephone dial up shall also have total system access through one Supervisory Controller.
5. Systems that require the user to address more than one Supervisory Controller to access all system information are not acceptable.
6. The Supervisory Controller shall have the capability of generating web based UI graphics. The graphics capability shall be imbedded in the Supervisory Controller.
7. Systems that support UI Graphics from a central database or require the graphics to reside on the user's personal computer are not acceptable.
8. The web based UI shall support the following functions using a standard version of Microsoft Internet Explorer:
   - Configuration
   - Commissioning
   - Data Archiving

- Monitoring
- Commanding
- System Diagnostics

9. Systems that require workstation software or modified web browsers are not acceptable.
10. The Supervisory Controller shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems.

iv Processor – The Supervisory Controller shall be microprocessor-based with a minimum word size of 32 bits. The Supervisory Controller shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. Supervisory Controller size and capability shall be sufficient to fully meet the requirements of this Specification.

v Memory – Each Supervisory Controller shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.

vi Hardware Real Time Clock – The Supervisory Controller shall include an integrated, hardware-Based, real-time clock.

vii The Supervisory Controller shall include troubleshooting LED indicators to identify the following conditions:

1. Power - On/Off
2. Ethernet Traffic – Ethernet Traffic/No Ethernet Traffic
3. Ethernet Connection Speed – 10 Mbps/100 Mbps
4. FC Bus – Normal Communications/No Field Communications
5. Peer Communication – Data Traffic between Supervisory Controller Devices
6. Run – Supervisory Controller Running/ Supervisory Controller in Startup/ Supervisory Controller Shutting Down/Software Not Running
7. Bat Fault – Battery Defective, Data Protection Battery Not Installed
8. Fault – General Fault

viii Communications Ports – The Supervisory Controller shall provide the following ports for operation of operator Input/ Output (I/O) devices, such as industry-standard computers, modems, and portable operator's terminals.

1. USB port
2. RS-232 serial data communication port
3. RS-485 port
4. Ethernet port

ix Diagnostics – The Supervisory Controller shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The Network Controller shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.

x Power Failure – In the event of the loss of normal power, The Supervisory Controller shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.

1. During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.
2. Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.

xi Certification – The Supervisory Controller shall be listed by Underwriters Laboratories (UL).

iv Controller network – The Supervisory Controller shall support all three (3) the following communication protocols on the controller network:

1. The Supervisory Controller shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.

- The Supervisory Controller shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
- The Supervisory Controller shall be tested and certified as a BACnet Building Controller (B-BC).
- A BACnet Protocol Implementation Conformance Statement shall be provided for the Supervisory Controller.
- The Conformance Statements shall be submitted 10 days prior to bidding.
- The Supervisory Controller shall support a minimum of 100 control devices.

2. The Supervisory Controller shall support LonWorks enabled devices using the Free Topology Transceiver FTT10.
   - All LonWorks controls devices shall be LonMark certified.
   - The Supervisory Controller shall support a minimum of 127 LonWorks enabled control devices.
3. The Supervisory Controller shall support the Field Bus.
   - The Supervisory Controller shall support a minimum of 100 control devices.
   - The Bus shall conform to Electronic Industry Alliance (EIA) Standard RS-485.
   - The Bus shall employ a master/slave protocol where the Supervisory Controller is the master.
   - The Bus shall employ a four (4) level priority system for polling frequency.
   - The Bus shall be optically isolated from the Supervisory Controller.
   - The Bus shall support the BMS System Integrator to the System.

## K INTEGRATION CONTROLLER FOR 3RD PARTY SYSTEM:

i The Network Integrator Controller shall be a fully user-programmable, supervisory controller. The Integration Controller shall monitor the network of distributed application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Supervisory Controller.

ii Network Integration for Third-Party Device and Equipment - Integration Controller shall able to integrate power and energy meters, lighting, HVAC, security, access control, and many proprietary systems that communicate over Modbus, M-Bus (EN1434-3) and KNX Bus.

iii Integration Controller shall leverage standard building management communication technologies, including:

1. BACnet® protocol – The Integration Controller shall support the BACnet services and objects typically used by a workstation and a field controller device, including:
   - BACnet alarm
   - Scheduling
   - Trend
   - Event services.
2. MS/TP FC Bus – The BACnet MS/TP Field Controller (FC) Bus is a standard peer-to-peer, multiple-master protocol in which each master device takes turns originating messages to pass to any device on the bus.
3. LONWORKS® protocol – Integration Controller shall able to supervise LONWORKS devices if:
   - The network interface follows current LONMARK® guidelines
   - Uses the Free Topology Transceiver (FTT10).
4. N2 Bus protocol –Integration Controller shall able to supervise N2 Bus as well.
5. Modbus® – Integration Controller shall support both Modbus RTU (RS-485, RS-232) and Modbus TCP/IP connectivity.
6. M-Bus (EN 1434-3) M-Bus (Meter Bus) is a European standard (EN 1434-3) that applies to heat meters.
7. KNX protocol – KNX Bus is used to control lighting, blinds and shutters, heating, and attendance systems.

- KNX (KONNEX) was created from the EIB (European Installation Bus), BatiBUS, and EHS (European Home System) protocols.
- A KNX IP Gateway is required to connect an Integration Controller to a KNX network.

iv User Interface – Each Integration Controller shall have the ability to deliver a web based User Interface (UI) as previously described. All computers connected physically or virtually to the automation network shall have access to the web based UI.

1. The web based UI software shall be imbedded in the Integration Controller. Systems that require a local copy of the system database on the user's personal computer are not acceptable.
2. The Integration Controller shall support a minimum of two (2) concurrent users.
3. The Integration Controller shall have the capability of generating web based UI graphics. The graphics capability shall be imbedded in the Integration Controller.
4. Systems that support UI Graphics from a central database or require the graphics to reside on the user's personal computer are not acceptable.
5. The web based UI shall support the following functions using a standard version of Microsoft Internet Explorer:
   - Configuration
   - Commissioning
   - Data Archiving
   - Monitoring
   - Commanding
   - System Diagnostics
6. Systems that require workstation software or modified web browsers are not acceptable.

v The Integration Controller shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems.

1. The Integration Controller shall employ a finite state control engine to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.
2. The Integration Controller shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only, shall not be acceptable.
3. The Integration Controller shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.

## I DDC SYSTEM CONTROLLERS

### i FIELD DDC CONTROLLER

1. The DDC Controller shall be a fully user-programmable, digital controller that communicates via BACnet MS/TP protocol.
   - The DDC Controller shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.
     - The DDC Controller shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
     - The DDC Controller shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
     - A BACnet Protocol Implementation Conformance Statement shall be provided for the DDC Controller.
     - The Conformance Statement shall be submitted 10 days prior to bidding.
2. The DDC Controller shall employ a finite state control engine to eliminate unnecessary conflicts between control functions at crossover points in their operational

sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.

3. Controllers shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable. The DDC Controller shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.
4. The DDC Controller shall include troubleshooting LED indicators to identify the following conditions:
   - Power On
   - Power Off
   - Download or Startup in progress, not ready for normal operation
   - No Faults
   - Device Fault
   - Field Controller Bus - Normal Data Transmission
   - Field Controller Bus - No Data Transmission
   - Field Controller Bus - No Communication
   - Sensor-Actuator Bus - Normal Data Transmission
   - Sensor-Actuator Bus - No Data Transmission
   - Sensor-Actuator Bus - No Communication
5. The DDC Controller shall accommodate the direct wiring of analog and binary I/O field points.
6. The DDC Controller shall support the following types of inputs and outputs:
   - Universal Inputs - shall be configured to monitor any of the following:
     - Analog Input, Voltage Mode
     - Analog Input, Current Mode
     - Analog Input, Resistive Mode
     - Binary Input, Dry Contact Maintained Mode
     - Binary Input, Pulse Counter Mode
   - Binary Inputs - shall be configured to monitor either of the following:
     - Dry Contact Maintained Mode
     - Pulse Counter Mode
   - Analog Outputs - shall be configured to output either of the following
     - Analog Output, Voltage Mode
     - Analog Output, current Mode
   - Binary Outputs - shall output the following:
     - 24 VAC Triac
   - Configurable Outputs - shall be capable of the following:
     - Analog Output, Voltage Mode
     - Binary Output Mode
7. The DDC Controller shall have the ability to reside on a Field Controller Bus (FC Bus).
   - The FC Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard protocol SSPC-135, Clause 9.
   - The FC Bus shall support communications between the DDC Controller and the Supervisory Controller.
   - The FC Bus shall also support Input/ Output Module communications with the DDC Controller and with the Supervisory Contoller.
   - The FC Bus shall support a minimum of 100 IOMs and DDC Controllers in any combination.
   - The FC Bus shall operate at a maximum distance of 15,000 Ft. between the DDC Controller and the furthest connected device.
8. The DDC Controller shall have the ability to monitor and control a network of sensors and actuators over a Sensor-Actuator Bus (SA Bus).

- The SA Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard Protocol SSPC-135, Clause 9.
- The SA Bus shall support a minimum of 10 devices per trunk.
- The SA Bus shall operate at a maximum distance of 1,200 Ft. between the DDC Controller and the furthest connected device.

9. The DDC Controller shall have the capability to execute complex control sequences involving direct wired I/O points as well as input and output devices communicating over the FC Bus or the SA Bus.
10. The DDC Controller shall support, but not be limited to, the following applications:
    - Chilled water/central plant optimization applications including but not limited to:
        - Selection and sequencing of up to eight chillers of different sizes
        - Selection and sequencing of up to eight (each) primary and secondary chilled water pumps of varying pumping capacities
        - Selection and sequencing of up to eight condenser water pumps
        - Selection and sequencing of cooling towers and bypass valve, including single speed, multi-speed, and Vernier control
        - Selection and sequencing of up to four heat exchangers, of different capacities
        - A proven and documented central cooling plant optimization program that incorporates custom equipment efficiency profiles, without rewriting software code, in order to meet the building load using the least amount of energy as calculated.
        - The use of advanced control algorithms that apply equipment specific parameters, including operational limits and efficiency profiles, in order to determine equipment start and runtime preferences
        - Identification of the most efficient equipment combination and automatic control of state and speed of all necessary equipment to balance runtime, optimize timing and sequencing and ensure the efficiency and stability of the central cooling plant
        - Control definition for the chiller plant in a single DDC Controller, as supported by available memory and point Input/ Output (I/O), or capable of being split across multiple DDC Controllers
    - Heating central plant applications
    - Built-up air handling units for special applications
    - Terminal & package units
    - Special programs as required for systems control

11. **BMS vendor shall furnish quantity for each type of controller (DDC/Supervisory Controller/Third party Integrator) considered.**

12. The DDC panel shall be a vandal proof, lockable & secure MS powder coated Cabinets.

13. For Outdoor installations DDC panel should be IP65 rated weather proof housing

14. All Controller shall run on the UPS Power provided by Electrical Contractor as per design & instruction of BMS Contractor.

## m SENSORS & FIELD DEVICES:

### i Temperature Sensors:

#### 1. General Requirements:

- Sensors and transmitters shall be provided, as outlined in the input/output summary and sequence of operations.
- The temperature sensor shall be of the resistance type, and shall be either two-wire 1000 ohm nickel RTD, or two-wire 1000 ohm platinum RTD.

- The following point types (and the accuracy of each) are required, and their associated accuracy values include errors associated with the sensor, lead wire, and A to D conversion:

| ***Point Type*** | ***Accuracy*** |
|---|---|
| *Chilled Water* | *+ .5°F.* |
| *Room Temp* | *+ .5°F.* |
| *Duct Temperature* | *+ .5°F.* |
| *All Others* | *+ .75°F.* |

Temperature Sensor enclosure/ cover should meet UL 1995 plenum requirements if applicable.

**2. Room Temperature Sensors:**

- Room sensors shall be constructed for either surface or wall box mounting.
- Room sensors shall have the following options when specified:
  - Set-point warmer/cooler dial or reset slide switch providing a +3 degree (adjustable) range.
  - Individual heating/cooling set-point slide switches.
  - A momentary override request push button for activation of after-hours operation.
  - Analog thermometer.

**3. Thermo-wells**

- Thermo-well manufacturer shall have models available in stainless steel, brass body, and copper bulb.
- When thermos-wells are required, the sensor and well shall be supplied as a complete assembly, including wellhead and sensor.
- Thermo-wells shall be pressure rated and constructed in accordance with the system working pressure.
- Thermo-wells and sensors shall be mounted in a direct mount (no adapter) offering faster installation or 1/2” NFT saddle and allow easy access to the sensor for repair or replacement.
- Thermo-wells constructed of 316 stainless steel shall comply with Canadian Registration Number (CRN) pressure vessel rating.

4. **Immersion Temperature Sensors:**

- Immersion sensors shall be provided with a separable corrosion protected stainless steel well. Pressure rating of well is to be consistent with the system pressure in which it is to be installed.
- Operating conditions shall be -50 to 220 deg F; pressure rating shall be min. PN 16, IP 54 protection, 1000 ohms platinum at 0 deg. C. To meet UL 1995 plenum requirements if necessary. Accuracy to ±0.73F° at 70°F (±0.41C° at 21°C), DIN Class B

**5. Duct Temperature & Humidity Sensors:**

- Duct sensors shall be provided with a sampling chamber. Duct probe material should comply with 94-5V flammability rated per UL 94 standard.

- The Sensor shall tested and calibrated with equipment certified to be in compliance with National Institute of Standards and Technology (NIST) guidelines.

- 14-30 VDC or 20-30VAC @ 50Hz power supply, ambient temperature rating of 50 deg. C, protection class 65 and Pt 1000 sensing element.

- All Polymer Humidity Sensor shall provide Humidity Element accuracy better or equal to ±3% RH for 20 to ±80% RH at 77 deg F.

- The Sensor shall also provide Temperature accuracy of ±0.34 deg F at 70 Deg F or better.
- Survival Operating Conditions range for the sensor shall -20 deg F to 140 deg F & 0-100% RH, 85 Deg F – Max Dew Point. Whether Ambient Range shall be 32 deg F to 140 deg F & 0-100% RH, 85 Deg F – Max Dew Point.

6. **Space Temperature & Humidity & Occupancy Sensors:**
   - The Space Sensor shall comply BTL 135-2004 BACnet Listing for BACnet / MSTP protocol communication and for Energy Management UL 916 Listing. The Network Sensor shall be constructed for either surface or wall box mounting.

   - The Network Sensor shall be monitoring Room Temperature, Zone Humidity & occupancy on passive infrared with occupancy over-ride button.

   - Current Consumption 17mA (non-transmitting).

   - The Ambient Storage range shall -40 to 158°F; 5 to 95% RH, Non-condensing, while the ambient Operating range shall 32 Deg F to 104 Deg F ; 10 to 90% RH, Non-condensing; 85°F (29°C) maximum Dew Point.

   - Network Sensor accuracy shall be for Temp Element ±1.0F° at 70°F & Humidity Element Accuracy ±3% RH for 20 to 80% RH; ±6% RH for 10 to 20% and 80 to 90% RH.

   - PIR Sensing shall have Minimum 94 Angular Degrees up to a Distance of 4 m.

7. **Outside air temperature & humidity sensors:**
   - The Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield.

   - Sensors exposed to wind velocity pressures shall be shielded by a perforated plate that surrounds the sensor.

   - Temperature transmitters shall be of NEMA 3R (IP54) or NEMA 4 (IP65) construction and rated for ambient temperatures

   - The outdoor sensor can be easily mounted on a roof, pole or side of a building utilizing its already assembled mounting bracket.

   - Outside Relative Humidity sensors 0-100% full range of accurate measurement. Operating temperature -4 to 140F (-20 to 60C).

   - Outside temperature sensors operating temperature range is -40 to 140F, +/- .55F (+/- .3C).

- Sensors shall be mounted on the North wall to minimize solar radiant heat impact or located in a continuous intake flow adequate to monitor outside air conditions accurately.

- Sensors shall be installed with a rain proof, perforated cover

**ii Humidity sensor**

1. The sensor shall be a solid-state type, relative humidity sensor of the Thin Film Capacitance or Bulk Polymer Design. The sensor element shall resist service contamination.

2. The humidity transmitter shall be equipped with non-interactive span and zero adjustments, a 2-wire isolated loop powered, 4-20 mA, 0-100% linear proportional output.

3. The humidity transmitter shall meet the following overall accuracy, including lead loss and Analog to Digital conversion. 3% between 20% and 80% RH @ 77 Deg F unless specified elsewhere.

4. Duct type sensing probes shall be constructed of 304 stainless steel, and shall be equipped with a neoprene grommet, bushings, and a mounting bracket

**iii Differential pressure switch for blowers & filters:**

1. IP 54 rated DP Switch shall cover in Polycarbonate housing with Glass reinforced polycarbonate case. The Diaphragm with Nitrile butadiene rubber & Switch shall be of Brass, Phosphor bronze, and Silver nickel material.

2. The DP Switch shall senses a change in the (differential) pressure (either velocity pressure or pressure drop across a restriction) as the airflow changes.

3. Pressure Set Point range should 10mbar with the differential of 0.5 mbar shall sustain on maximum continuous overpressure of 300mbar.

4. Storage Temperature range -35 to 40 Deg C & Humidity range 10 to 95% RH, non-condensing.

**iv WATER FLOW Switches:**

1. Flow-proving switches shall be either paddle or differential pressure type, as shown.

2. Paddle type switches (water service only) shall be UL / CE listed, SPDT snap-acting with pilot duty rating (125 VA minimum). Adjustable sensitivity with IP55Type enclosure unless otherwise specified. Pressure rating: 1.5MPa, fluid temperature: -25 to 110 deg.C.

3. Differential pressure type switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum), NEMA 1 Type enclosure, with scale range and differential suitable for intended application, or as specified.

**v Liquid level switch:**

1. IP 66 UL Listed Liquid Level Switch shall have NEMA Type-1, .95mm cold drawn Stainless steel case with minimum 2.5 ft High Density polyethylene cable & must have weights of phenolic with Epoxy Seal.
2. The Switch shall have Double Pole / Single Through, Fixed mounting bracket.
3. The Assembly should have sustainability at 140 Deg F for Switch & 150 Deg F for Cable.

**vi CO2 Sensor:**

1. CO2 Sensor shall have ABS plastic housing & UL Listing &Duct Probe Meets Plenum Rating Requirements of UL 1995.
2. The Sensor shall have on Silicon-based CARBOCAP® Design &CARBOCAP Silicon, Micro-machined Construction for Duct environment. The Sensor shall also consist diffusion-aspirated, single-beam, dual-wavelength.
3. The sensor shall have Measuring Range of 0 to 2,000 ppm CO2 &Accuracy at 77°F < ± 30 ppm CO2 + 2.0% of reading.
4. The sensor shall have Response Time (0 to 63%) of 1 Minute &Warm-up Time< 5 minutes. The Sensor shall workable at Airflow Range 0 to 7,500 ft/Minute.
5. C02 sensors shall have the following features:
   - Jumper selectable: 0-20mA, 4-20mA & 0-10VDC output
   - Liquid Crystal Display
6. The C02 sensors shall have the ability to monitor and output the following variables as required by the systems sequence of operations:
   - Zone carbon-dioxide

**vii Current Relays:**

1. Control relays shall be UL listed plug-in type with retaining springs or clips & dust cover. Contact rating, configuration, and coil voltage suitable for application.

2. Time delay relays shall be UL listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable plus or minus 200% (minimum) from set-point shown on plans. Contact rating, configuration, and coil voltage suitable for application. Provide NEMA 1 Type enclosure when not installed in local control panel.

3. DPDT, 3PDT, or 4PDT relays shall be provided, as appropriate for application.

4. Contacts shall be rated for 10 amps at 120VAC.

**viii Water Pressure Transmitter:**

1. UL / CE Listed Water Pressure Transmitter shall be made of 17-4PH stainless steel construction Pressure Port & 40% glass-filled Polyetherimide (PEI) Packard Connector.

2. The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:

   - -1.00 to +1.00 w.c. input differential pressure ranges. (Select range appropriate for system application)
   - 4-20 mA output.
   - Maintain accuracy up to 20 to 1 ratio turndown.
   - Reference Accuracy: +0.2% of full span.

3. The Accuracy shall be ±1% Full Span (maximum) over compensated temperature range.

**ix STATIC PRESSURE Sensors:**

1. Sensor shall have linear output signal. Zero and span shall be field-adjustable.

2. Sensor sensing elements shall withstand continuous operating conditions plus or minus 50% greater than calibrated span without damage.

3. Water pressure sensor shall have stainless steel diaphragm construction, proof pressure of 150psi minimum. Sensor shall be complete with 4-20 ma output, required mounting brackets, and block and bleed valves. Mount in location accessible for service.

4. Water differential pressure sensor shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Over-range limit (DP) and maximum static pressure shall be 3,000 psi. Transmitter shall be complete with 4-20 ma output, required mounting brackets, and five-valve manifold. Mount in a location accessible for service.

**x WATER FLOW METER – ULTRASONIC TYPE:**

1. The Water flow meter shall have Ultrasonic Type and inside the IP65 - NEMA 4X weather-resistant enclosure & consist LCD Display. The Flow Meter Shall have isolated RS-485 interface with power surge protection & must supports the MODBUS protocol.

2. Abundant input /output , isolated 4-20mA output , relay, pulse output , alarm-output.

3. The Assembly should include flow totalizers, batch controller and scheduler.

4. Shall maintain the accuracy of □1% of reading, plus □0.006m/s (□0.02ft/s) in velocity & Velocity -16 ~ +16m/s (-52 ~ +52 ft/s), bi-directional.

5. Should have the Response Time of 0.5s and configurable between 0.5s and 99s.

6. Operating Liquid Temperature -40°C ~ 100°C or -40°C ~ 155°C, depending on transducer type.

**xi PH ANALYZER:**

1. The PH Analyzer shall have DIN Rail Mounted with LCD Display with Plastic housing construction to safeguard from corrosion.

2. Shall have Input of pH electrode Pt100 & output 4/20 mA dc isolated.

3. Operating range of 0/14.00 pH -10.0/120.0 °C

4. Power Supply - 10/30 Vdc

5. Shall incorporate the Zero and Sensitivity (span) calibration adjustments.

**xii TDS ANALYZER:**

1. DIN Rail Mounted TDS Analyser shall have Alpha-numeric backlit display.
2. Operating range 0-4,000 mg/lt of PSL & 9/999 - 99/9,999 mg/l of SiO2
3. The Zero of the probe 0.0/10.0 % f.s. and Sensitivity 80.0/120.0 %.
4. Response Time 10 s for 98% of input & Relay Delay 0.0/99.9 s.

**xiii Water Hardness Analyzer:**

1. CE/EN Certified Water hardness Analyzer shall be incorporated in IP 67 rated housing made of Polycarbonate + ABS. Water hardness Analyzer shall consist LCD Display
2. The Analysis of Water hardness shall be able to determine by photometric measurement method with embedded microprocessor.
3. On-line real time automatic analysis and display.
4. The Analyzer Alert alarm in the event of abnormal analysis & Auto Calibration (Option).
5. Operating Range 0.5 – 10 mg / ltr and Operating Pressure 1-6 bar g. The Sample flow should be 30-700ml/min.
6. The Accuracy shall be ±0.5 mg/Ltr and response time 3 min.
7. Data Communication shall be at RS-485 & MODBus RTU Protocol.
8. The Communication cable length between network devices can go up to 1500Mtrs with repeater at 22AWG conductor size.

**xiv Transducers for electrical services**

1. Electrical transducers shall be integrated electronic type and rack mounted on the field. These shall work on 230 V supply with the output being standard type i.e. 4-20 mA, 0-10 Volts etc.
2. Power factor, Voltage, Current, Frequency and Kilowatt transducers shall have standard output signal for measurement for the specified variable.
3. Kilowatt-Hour metering (if any) shall be poly-phase; three- element with current transformer (CT) operated type. The metering shall feature high accuracy with no more than +/- 1% error over the expected load range. The coils shall be totally encapsulated against high impulse levels.

**xv THREE WAY Motorized VALVES**

1. Butterfly Valves, High Performance 2-1/2 through 16 in.
   - Butterfly Valves shall have bodies manufactured from Carbon Steel, ASTM A216 GR WCB/A516 GR 70 and shall be fully lugged per ASME Class 150 or ASME Class 300.
   - Butterfly Valves seat assembly shall be RPTFE (reinforced polytetrafluoroethylene) and the seat retainer shall be Carbon Steel, ASTM A516 GR 70

- Butterfly Valve disk shall be Stainless Steel, ASTM A 351 GR CF8M
- Butterfly Valve stems shall be 17-4 PH Stainless Steel, ASTM A564-Type 630
- Butterfly Valve Stem Seals shall be One Carbon Fiber Ring and Three TFE Rings
- Flow Characteristics shall be equal percentage up to 70° of disk rotation.
- All valves shall be rated for service with hot water, chilled water, 50% glycol solutions and 50 psig saturated steam in modulating service or 150 psig saturated steam in two position service.
- Butterfly Valves shall meet the performance requirements of ASME Class 150 or Class 300.
- Valves shall be maintenance free.
- Valves shall be provided with a 3 year warranty.
- Valve electric actuators shall be UL-recognized or CSA-certified.

**xvi Duct Static Pressure Sensor**

| Parameter | Technical Specification | Vendor Confirmation |
|---|---|---|
| Type | Electronic Pressure Sensor or 3 Wire | |
| Sensor | Piezo-Resistive / Solid state capacitance | |
| Range | 0 to 350 pascals | |
| Output | Two Wire , 0-10VDC corresponding to 0-10Kg/cm2 | |
| Mounting | Duct Mounted | |
| Voltage operation | 15/24 VAC , 50 Hz or 15/24 VDC | |
| Accuracy | 1% of span | |
| Ambient Temp. & RH conditions | Temp. 10 to 55 Deg C and upto 90% RH non- condensing, | |
| Housing | ABS plastic Box / polycarbonate IP 55 | |
| Make & Model offered | Vendor to Furnish complete code | |

**xvii CO sensor:**

1. The CO sensor should be suitable for 24V AC & DC power supply and should able to provide Analogue output signal of 4 to 20mA & 2 to 10V. The CO sensor range should be 0 to 250PPM. The sensor should be semiconductor type and should cover minimum area of 450m2 or more. The degree of protection of the Co sensor should be IP30. The CO sensor should produce the output signal of either 2-10VDC or 4-20m Amps.

**xviii Cabling & Conduiting**

**1. SIGNAL CABLE**

- The cable running between DDC controllers to the field devices shall be termed as signal cabling. This Armored cable along shall be lay on I/O point mentioned in Data

Point Summary basis. The Signal cable of 2C x 1Sqmm, 4C x 1Sqmm & 8C x 1Sqmm cable shall be of the following specifications:

| | |
|---|---|
| Wire: | Annealed Tinned Copper |
| Size: | Minimum 1 sq. mm |
| No. of conductors: | Two (One pair), Four (two pair), Eight (Four Pair) |
| Jacket: | Chrome PVC |
| Nominal DCR: | 17.6 ohm/km for conductor 57.0 ohm/km for shield |
| Nominal capacitance: | 130 pF/m between conductors |

**2. POWER CABLE:**

- The cable running to Power DDC controller / Panel / Integrator shall be termed as Power cabling. The Armored Power cable of 3C x 1.5 Sq.mm cable shall be of the following specifications:

| | |
|---|---|
| Wire: | Annealed Tinned Copper |
| Size: | Minimum 1.5 sq. mm |
| No. of conductors: | Three (3) |
| Jacket: | Chrome PVC |
| Nominal DCR: | 17.6 ohm/km for conductor, 57.0 ohm/km for shield |
| Nominal capacitance: | 130 pF/m between conductors |

**3. COMMUNICATION CABLE:**

- The cabling running between the system integration units to the DDC controllers & Sensors, Valves EM etc. This Armored cable shall be lay on I/O point mentioned in Data Point Summary basis. The Communication Cable of 3C x 1Sqmm cable shall be of the following specifications:

| | |
|---|---|
| Wire: | Annealed Tinned Copper |
| Size: | Minimum 24 AWG stranded |
| No. of conductors: | Three (3 conductor) |
| Shielding: | Overall beld foil Aluminum polyester shield. |
| Jacket: | Chrome PVC |
| Nominal DCR: | 78.7 ohm/km for conductor ohm/km for shield |
| Nominal capacitance: | 131 pF/m between conductor |

**4. CAT-6 UTP CABLE:**

- Cables should be dressed and terminated in accordance with the manufacturer's recommendations and/or best industry practices
- Pair untwist at the termination should not exceed one-half an inch.
- Bend radius of the cable in the termination area should not be less than 4 times the outside diameter of the cable.
- The cable jacket should be maintained as close as possible to the termination point.
- Cables should be neatly bundled and dressed to their respective panels or blocks. Each panel or block should be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
- The distance between UTP data cable and any power cable should be more than 4 inches.
- Each cable should be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view should not be acceptable.
- Cables should be installed in continuous lengths from origin to destination (no splices).

**5. HEAVY DUTY CONDUITS:**

- Conduit & accessories shall confirm to relevant Indian Standard.
- All rigid conduit pipes shall be of Heavy Duty PVC and be ISI marked. The wall thickness shall be not less than 2 mm for conduit up to 25 mm dia.
- The maximum number of PVC insulated cables / wires conforming o ISI: 694-1990 that can be drawn in one conduit as per standard norms. Conduit sizes shall be selected accordingly in each room.
- No conduit less than 20 mm in diameter shall be used. Flexible conduits will only be permitted for interconnections between switchgear, DB's and conduit terminations in wall.

**6. List of Drawings.**

- Building management system supplier or Contractor shall submit following document for approval *before* actual installation of system on site.
  - Control Schematics Diagram of major equipment
  - BMS Network Architecture
  - Chiller Plant Network diagram

**7. List of Document Required**

- Building management system supplier or Contractor shall submit following document for approval before actual installation of system on site.
  - System P&ID
  - System write up
  - Control Schemes/Control logics with write up
  - Final I/O List
  - DDC & DDC Panel Schedule
  - Cable schedule
  - Data Sheet along with catalogue of manufacturer's for all field instrument and equipment supplied by

- Maintenance during defect Liability period (DLP)
  - The Contractor shall be responsible for replacing the Item/commodity related to BMS as per defect liability mentioned in main contract document.
- Operation requirement including DLP
  - The expert representative from OEMs or BMS sub-contractors shall be required on site as per the requirement for the operation during DLP.
- System Uptime Requirement
  - The OEM or BMS contractor shall submit a complete schedule on uptime requirement for the approval of engineer In charge.

# 13.4. ANNEXURE I – I/O SUMMARY

**SOUTH ASIAN UNIVERSITY, MAIDANGARHI, NEW DELHI - BMS DATA POINT SUMMARY**

| Sr. No. | Description / Ranges | Function | Qty | AI | DI | AO | DO | SI | Monitor | Control | Alarm | By BMS provider | By respective service providers | Benefit / purpose |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **HVAC SYSTEM - HIGH SIDE** | | | | | | | | | | | | |
| **A** | | **AC PLANT ROOM** | | | | | | | | | | | | |
| **1** | | **COMFORT CHILLING MACHINE (6 Nos)** | **6** | | | | | | | | | | | |
| i | Start/ Stop | Chillers - ON / OFF | | | | | 6 | | * | * | | Potential Free Contact from BMS to Chiller panel | Wiring & termination at Chiller microprocessor accepting (2 amp.) remote start / stop | For automatic Chiller Operation based on schedule / condition - optimises energy consumption |
| ii | Normal / Tripped | Chillers Trip / Fault | | | 6 | | | | * | | * | Potential Free Contact to BMS from Chiller | Wiring & termination from Potential Free contact at the Chiller microprocessor panel | Monitoring / Alarm information, also utilised in Chiller sequencing |
| iii | On / Off | Chiller run status | | | 6 | | | | * | | * | Potential Free Contact to BMS from Chiller | Wiring & termination from Potential Free contact at the Chiller microprocessor panel | Input information for command functions & interlocks |
| iv | Auto-Manual | Chiller Auto / Manual switch | | | 6 | | | | * | | * | Potential Free Contact to BMS from Chiller | Wiring & termination from Potential Free contact at the Chiller microprocessor panel | Monitoring / Alarm information, also utilised in Chiller sequencing |
| v | Deg C | CHW supply temperature | | 6 | | | | | * | | | Immersion temperature sensor with thermowell & wiring | Providing of suitably sized socket in the chilled water supply line | Derive tonnage information |
| vi | Deg C | CHW return temperature | | 6 | | | | | * | | | Immersion temperature sensor with thermowell & wiring | Providing of suitably sized socket in the chilled water return line | Derive cooling demand of the building |
| vii | Deg C | CDW supply temperature | | 6 | | | | | * | | | Immersion temperature sensor with thermowell & wiring | Providing of suitably sized socket in the condenser water supply line | Monitoring |
| viii | Deg C | CDW return temperature | | 6 | | | | | * | | | Immersion temperature sensor with thermowell & wiring | Providing of suitably sized socket in the condenser water return line | Monitoring |
| ix | Deg C | Common Header CHW supply / return temp. | | 2 | | | | | * | | | Immersion temperature sensor with thermowell & wiring | Providing of suitably sized socket in the chilled water return line | Derive cooling demand of the building with flow & header temp. |
| x | Open / Close | CHW isolation Mortised valves ON/OFF command | | | | | 6 | | | * | | Potential Free Contact from BMS to motorised butter fly valve with limit switch for Command. | Supply & installation of motorised butterfly valve at CHW line & accepting 1 SPDT for opening and closing of valves. | For sequencing (or isolation) in case of multiple chiller system - Major energy saving feature |
| xi | Open / Close | CHW isolation Mortised valves ON/OFF Status | | | 12 | | | | * | | | Potential Free Contact from BMS to motorised butter fly valve with limit switch for position status. | Potential Free Contact from motorised butter fly valve actuator to BMS | Input information for command functions & interlocks |
| xii | Open / Close | CDW isolation Mortised valves ON/OFF command | | | | | 6 | | | * | | Potential Free Contact from BMS to motorised butter fly valve with limit switch for Command. | Supply & installation of motorised butterfly valve at CDW line & accepting 1 SPDT for opening and closing of valves. | For sequencing (or isolation) in case of multiple chiller system - Major energy saving feature |
| xiii | Open / Close | CDW isolation Mortised valves ON/OFF Status | | | 12 | | | | * | | | Potential Free Contact from BMS to motorised butter fly valve with limit switch for position status. | Potential Free Contact from motorised butter fly valve actuator to BMS | Input information for command functions & interlocks |
| xiv | Flow Meter | Chilled Water Supply Flow Measurent | | 1 | | | | | | | | Water Flow Meter | Providing of suitably sized Flanges in the chilled water Supply line | To obtain KW / TR |
| xv | Pressure | Differential Pressure between Chilled Water Return & Supply line | | 12 | | | | | | | | Water Pressure Transmitter | Providing of suitably sized Socket in the chilled water return & Supply line | To detect Scaling across chiller |

| Sr. No. | Description / Ranges | Function | Qty | AI | DI | AO | DO | SI | Monitor | Control | Alarm | By BMS provider | By respective service providers | Benefit / purpose |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| xvi | Information | Chiller Plant Manager microprocessor (software) integration for Chiller-intrinsic parameter monitoring including IN/Out CHW Temp, CDW Temp, % Loading, Various Faults and other parameters as per BACnet Point List | | | | | | X | * | * | * | INTEGRATOR UNIT / Software connectivity | Networked Chiller microprocessors releasing information at one port on Open protocol [BACnet/Modbus] with built-in interface & communication cards | Provide comprehensive Chiller information on BMS user interface, perform trend & archive functions |
| xvii | Open / Close | Chiller headers isolation Mortised valves ON/OFF command | | | | | 2 | | | * | | Potential Free Contact from BMS to motorised butter fly valve with limit switch for position status. | Supply & installation of motorised butterfly valve between Chiller Headers ( cenrtifugal & Screw )line & accepting 1 SPDT for opening and closing of valves. | Isolation |
| xviii | C/RH | Outside Temp and RH Sensor | | 2 | | | | | * | * | | Outdoor Temp & RH Sensor | Installation provision for Outdoor temp & Humidity sensor & Wiring | Ambient Information |
| | | | | | | | | | | | | | | |
| | | **Sub Total for Chillers** | | **41** | **42** | **0** | **20** | | | | | | | |
| | | | | | | | | | | | | | | |
| **2** | | **Chilled Water Pumps** | | | | | | | | | | | | |
| **a** | | **Primary Chilled Water Pumps (6 Nos)** | **6** | | | | | | | | | | | |
| i | Start/ Stop | Primary Chilled Water Pump on / off command | | | | | 6 | | | * | | Relay output @ 2 amp, 230 V and wiring from MCC | Wiring and termination of potential free contact in auto mode in the control circuit of Pump Panel | For automatic pump Operation based on schedule / condition - (ensures equal run-time) |
| ii | Auto-Manual | Primary Chilled Water Pump auto manual status | | | 6 | | | | * | | * | Wiring from Auto/ Manual Switch | Wiring & termination at auxiliary potential free contact of auto manual switch of Pump Panel | Input information for command functions & interlocks |
| iii | On / Off Status | Primary Chilled water Pump run Status | | | 6 | | | | * | | | Current relay & Wiring | Wiring & Installation of current relay in MCC panel (cable alley) | Proof of pump running - interlock function |
| iv | Normal / Tripped | Primary Chilled water Pump trip Status | | | 6 | | | | * | | * | Wiring from MCC | Wiring & termination at auxiliary potential free contact of the over load relay of Pump Panel | Monitoring & Alarm information - other alerts |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| **b** | | **Secondary Chilled Water Pump (6 Nos)** | **6** | | | | | | | | | | | |
| i | Start/ Stop | Secondary Chilled Water Pump on / off command | | | | | 6 | | | * | | Relay output @ 2 amp, 230 V and wiring from MCC | Wiring and termination of potential free contact in auto mode in the control circuit of Pump Panel | For automatic pump Operation based on schedule / condition - (ensures equal run-time) |
| ii | Auto-Manual | Secondary Chilled Water Pump auto manual status | | | 6 | | | | * | | * | Wiring from Auto/ Manual Switch | Wiring & termination at auxiliary potential free contact of auto manual switch of Pump Panel | Input information for command functions & interlocks |
| iii | On / Off Status | Secondary Chilled water Pump run Status | | | 6 | | | | * | | | Current relay & Wiring | Wiring & Installation of current relay in MCC panel (cable alley) | Proof of pump running - interlock function |
| iv | Normal / Tripped | Secondary Chilled water Pump trip Status | | | 6 | | | | * | | * | Wiring from MCC | Wiring & termination at auxiliary potential free contact of the over load relay of Pump Panel | Monitoring & Alarm information - other alerts |
| v | Control | Pump VFD control | | | | 6 | | x | | * | | Wiring for 0-10 V DC or 4-20 ma output from BMS to VFD | VFD releasing information at one port on Open protocol [BACnet/Modbus] with built-in interface & communication cards | Monitoring & Controlling |
| vi | Monitor | VFD Pump operation | | | | | | X | * | | * | INTEGRATOR UNIT / Software connectivity | Primary pumping system information on open protocol [BACnet/Modbus] with built-in interface & communication cards. | Provide comprehensive secondary system information on BMS user interface, perform trend & archive functions |
| | | | | | | | | | | | | | | |
| **3** | | **Condenser Water Pumps (6 Nos)** | **6** | | | | | | | | | | | |
| i | Start/ Stop | Condenser Water Pump on / off command | | | | | 6 | | | * | | Relay output @ 2 amp, 230 V and wiring from MCC | Wiring and termination of potential free contact in auto mode in the control circuit of Pump Panel | For automatic pump Operation based on schedule / condition - (ensures equal run-time) |

| Sr. No. | Description / Ranges | Function | Qty | AI | DI | AO | DO | SI | Monitor | Control | Alarm | By BMS provider | By respective service providers | Benefit / purpose |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ii | Auto-Manual | Condenser Water Pump auto manual status | | | 6 | | | | * | | * | Wiring from Auto/ Manual Switch | Wiring & termination at auxiliary potential free contact of auto manual switch of Pump Panel | Input information for command functions & interlocks |
| iii | On / Off Status | Condenser water Pump run Status | | | 6 | | | | * | | | Water Differential Pressure switch & Wiring | installation of Suitable Socket in Pipe | Proof of pump running - interlock function |
| iv | Normal / Tripped | Condenser water Pump trip Status | | | 6 | | | | * | | * | Wiring from MCC | Wiring & termination at auxiliary potential free contact of the over load relay of Pump Panel | Monitoring & Alarm information - other alerts |
| | | **Sub Total for Pump** | | **0** | **54** | **6** | **18** | | | | | | | |
| | | | | | | | | | | | | | | |
| **4** | | **Hot Water Generator (5 Nos)** | **5** | | | | | | | | | | | |
| i | Start / Stop | Hot water generator - ON / OFF Command | | | | | 5 | | | * | | Relay output @ 2 amp, 230 V and wiring from MCC | Wiring and termination of potential free contact in auto mode in the control circuit of Pump Panel | For automatic pump Operation based on schedule / condition - (ensures equal run-time) |
| ii | Auto-Manual | Hot water generator Auto / Manual switch status | | | 5 | | | | * | | * | Wiring from Auto/ Manual Switch | Wiring & termination at auxiliary potential free contact of auto manual switch of Pump Panel | Input information for command functions & interlocks |
| iii | On / Off Status | Hot water generator run status | | | 5 | | | | * | | | Water Differential Pressure switch & Wiring | installation of Suitable Socket in Pipe | Proof of pump running - interlock function |
| iv | Normal / Tripped | Hot water generator Trip status | | | 5 | | | | * | | * | Wiring from MCC | Wiring & termination at auxiliary potential free contact of the over load relay of Pump Panel | Monitoring & Alarm information - other alerts |
| v | Deg C | HW Supply/Return temp | | 10 | | | | | * | | | Immersion temperature sensor with thermowell & wiring | Providing of suitably sized socket in the Hot water Supply / return line | Derive Tonnage & Heeting demand of the building. |
| vi | Deg C | Common Header HW supply temp | | 1 | | | | | * | | | Immersion temperature sensor with thermowell & wiring | Providing of suitably sized socket in the Hot water Supply / return line | Derive demand of the building with flow & header temp. |
| vii | Control | Supply Header Isolation valve control | | | | | 2 | | | | * | Output signal from the DDC Controller & wiring to valve actuator | Supply & Installation of motorised tow way control valves including necessary nipples / mating flanges in the pipeline | Major energy saving feature - optimises CHW consumption |
| viii | Position | Valves status | | | 4 | | | | * | * | | Wiring from Valve Actuator | Two way valve with desired output | Input information for command functions |
| | | **Sub Total for HWG & Pump** | | **11** | **19** | **0** | **7** | | | | | | | |
| | | | | | | | | | | | | | | |
| **6** | | **Cooling Tower System (4 Nos)** | **4** | | | | | | | | | | | |
| i | Start/ Stop | Cooling Tower fan ON/OFF command. | | | | | 4 | | | * | | Relay output @ 2 amp, 230 V and wiring from MCC | Wiring and termination of potential free contact in auto mode in the control circuit of Elec Panel | For automatic CTOperation based on schedule / condition - (ensures equal run-time) |
| ii | Auto-Manual | Cooling Tower fan Auto/ Manual status. | | | 4 | | | | * | | * | Wiring from MCC | Wiring & termination at auxiliary potential free contact of auto manual switch of Elec Panel | Input information for command functions & interlocks |
| iii | On / Off | Cooling Tower fan ON/OFF Status | | | 4 | | | | * | | | Current relay & Wiring | Wiring & Installation of current relay in MCC panel (cable alley) | Proof of CT running - interlock function |
| iv | Control | CT Fan VFD control | | | | 4 | | X | | * | | Wiring for 0-10 V DC or 4-20 ma output from BMS to VFD | VFD releasing information at one port on Open protocol [BACnet/Modbus] with built-in interface & communication cards | Monitoring & Controlling |
| v | Monitor | VFD CT Fan operation | | | | | | X | * | | * | INTEGRATOR UNIT / Software connectivity | Primary pumping system information on open protocol [BACnet/Modbus] with built-in interface & communication cards. | Provide comprehensive secondary system information on BMS user interface, perform trend & archive functions |
| vi | Normal / Tripped | Cooling Tower fan trip status. | | | 4 | | | | * | | * | | Potential free contact from respective MCC Panel | Monitoring & Alarm information - other alerts |
| vii | Level | Cooling Tower Sump level monitoring low | | | 4 | | | | * | | * | Level Switch & field wiring | Provision of suitably sized socket for installation of level switch | Monitoring & Alarm information - other alerts / interlock functions |

| Sr. No. | Description / Ranges | Function | Qty | AI | DI | AO | DO | SI | Monitor | Control | Alarm | By BMS provider | By respective service providers | Benefit / purpose |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| viii | Open / Close | Cooling tower inlet isolation valves open / close command | | | | | 4 | | | * | | Relay output (1 SPDT for open and close) @ 2 amp, 230 V & wiring from Valves Actuator. | Supply & installation of motorised butterfly valve at Cooling tower inlet & accepting 1 SPDT for opening and closing of valves. | For sequencing (or isolation) in case of multiple CT system - Major energy saving feature |
| ix | Open / Close | Cooling tower inlet isolation valves open / close status | | | 8 | | | | * | * | | Wiring from Valve Actuator | Potential Free Contact from motorised isolation valve actuator to BMS | Input information for command functions & interlocks |
| x | Deg C | Condenser water outlet temperature from the Cooling tower | | 4 | | | | | * | | | Immersion temperature sensor with thermowell & wiring | Providing of suitably sized socket in the condenser water line | information |
| xi | Deg C | Header Temp from Cooling Tower Outlet | | 1 | | | | | * | | | Immersion temperature sensor with thermowell & wiring | Providing of suitably sized socket in the condenser water line | VFD Control |
| xii | Measurment | Hardness Analyser for cooling tower makeup water | | 1 | | | | | | | | Hardness Analyser | Wiring and termination from Hardness Analyser for Graphical Presentation & Analysys | Monitoring of Water Hardness |
| xiii | Measurment | PH Monitoring | | 1 | | | | | | | | PH Analyser | Wiring and termination from PH Transmitter | Water Quality Measurment |
| xiv | Measurment | CT - Water TDS | | 1 | | | | | | | | TDS Analyser | Wiring and termination from TDS Transmitter | Water Quality Measurment |
| | | **Sub Total for Cooling Tower** | | **8** | **24** | **4** | **8** | | | | | | | |
| | | **Sub Total for Pump, HWG & Cooling towers** | | **19** | **97** | **10** | **33** | | | | | | | |
| | | | | | | | | | | | | | | |
| | | **Sub Total for Plant with 15% spare** | | **69** | **160** | **12** | **61** | | | | | | | |
| | | | | | | | | | | | | | | |
| **B** | **FACULTY OF LIFE SCIENCE & EARTH SCIENCE** | | | | | | | | | | | | | |
| **B.1** | **AIR HANDLING UNITS - TYPE-1** | | **44** | | | | | | | | | | | |
| i | Start/ Stop | AHU on / off command | | | | | 44 | | | * | | Relay output @ 2 amp, 230 V & wiring from AHU MCC | Wiring & termination of potential free contact in auto mode in the control circuit of AHU MCC Panel | Automatic AHU Operation on schedule / condition - based controls |
| ii | Auto-Manual | AHU auto manual status | | | 44 | | | | * | | * | Wiring from AHU MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of AHU Panel | Input information for command functions & interlocks |
| iii | Clean / Clog | AHU Pre & Fine Filter status | | | 88 | | | | * | | * | Diff. Pressure Switch across filter & field wiring | Insertion provision for Installation of DP switch across Filter | Proof of AHU running - interlock function |
| iv | Normal / Trip | AHU Trip Status | | | 44 | | | | * | | * | Wiring from AHU MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of AHU Panel | Monitring & Alram Information & other Input |
| v | Run Status | AHU Run status | | | 44 | | | | * | | * | Diff. Pressure Switch across Blower & field wiring | Insertion provision for Installation of DP switch across Blower | Proof of AHU running - interlock function |
| vi | Deg C | Return Air Temperature & Humidity monitoring | | 88 | | | | | * | * | | Duct mount temp & Humidity sensor & field wiring | Installation provision for temp & Humidity sensor | Input information for valve command functions |
| vii | Deg C | Supply air temperature monitoring | | 44 | | | | | * | * | | Duct mount temp sensor & field wiring | Installation provision for temp. sensor | Input information for valve command functions |
| viii | Pressure | Supply Duct Pressure monitoring | | 44 | | | | | * | * | | Duct mount Diff Pressure Transmitter & field wiring | Installation provision for DPT | information & Flow Control |
| ix | % Open | 2-Way CHW valve modulating control | | | | 44 | | | | | * | Output signal from the DDC Controller & wiring to valve actuator | Supply & Installation of motorised tow way control valves including necessary nipples / mating flanges in the pipeline | Major energy saving feature - optimises CHW consumption |
| x | Position | Valves status | | 44 | | | | | * | * | | Wiring from Valve Actuator | Two way valve with desired output | Input information for command functions |
| xi | Deg C | On-Coil & Off-Coil Water temperature | | 88 | | | | | * | | | Immersion temperature sensor with thermowell & wiring | Providing of suitably sized socket in the condenser water line | information |
| xii | CO2 Sensor | CO2 Measurement in Return air | | 44 | | | | | | | | Duct type CO2 Sensor for return air for Each AHU | Installation provision for CO2 sensor | Ventillation Control |
| xiii | % Open | Motorised Fresh Air Damper Command & Status | | 44 | | 44 | | | | | * | Output signal from the DDC Controller & wiring to Damper actuator | Supply & Installation of motorised Damper Controller including necessary accessories | Major energy saving feature - optimises CHW consumption |

| Sr. No. | Description / Ranges | Function | Qty | AI | DI | AO | DO | SI | Monitor | Control | Alarm | By BMS provider | By respective service providers | Benefit / purpose |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| xiv | % Open | Motorised Bypass/ Return Damper Command | | 44 | | 44 | | | | | * | Output signal from the DDC Controller & wiring to Damper actuator | Supply & Installation of motorised Damper Controller including necessary accessories | Major energy saving feature - optimises CHW consumption |
| xv | Speed Modulation & Status | VFD Speed control, monitoring. Integration of VFDS, Frequency from VFD(0-10v/4-20mA) | | 22 | | 22 | | X | * | * | * | 0-10V feedback from VFD to DDC to monitor the frequency, Input signal (0-10V) to control the VFD frequency on return air basis. Soft integration with Integrator Unit | HVAC Vendor to provide the protocol & address details for integration & IBMS Vendor to integrate the same with necessary cabling and all required accessories. | Major energy saving feature - Input information for command functions & Monitoring Information |
| | | **Sub Total for AHU-Type-1** | | **462** | **220** | **154** | **44** | | | | | | | |
| | | | | | | | | | | | | | | |
| **B.2** | **DOAS UNITS -TYPE-2 - ANIMAL FLOOR** | | **16** | | | | | | | | | | | |
| i | Start/ Stop | DOAS on / off command | | | | | 16 | | | * | | Relay output @ 2 amp, 230 V & wiring from DOAS MCC | Wiring & termination of potential free contact in auto mode in the control circuit of DOAS MCC Panel | Automatic DOAS Operation on schedule / condition - based controls |
| ii | Auto-Manual | DOAS auto manual status | | | 16 | | | | * | | * | Wiring from DOAS MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of DOAS Panel | Input information for command functions & interlocks |
| iii | Clean / Clog | DOAS Pre-Fine Filter status | | | 32 | | | | * | | * | Diff. Pressure Switch across filter & field wiring | Insertion provision for Installation of DP switch across Filter | Proof of DOAS running - interlock function |
| iv | Clean / Clog | DOAS HEPA Filter status | | | 16 | | | | * | | * | Diff. Pressure Switch across filter & field wiring | Insertion provision for Installation of DP switch across Filter | Proof of DOAS running - interlock function |
| v | Normal / Trip | DOAS Trip Status | | | 16 | | | | * | | * | Wiring from DOAS MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of DOAS Panel | Monitring & Alram Information & other Input |
| vi | Run Status | DOAS Run status | | | 16 | | | | * | | * | Diff. Pressure Switch across Blower & field wiring | Insertion provision for Installation of DP switch across Blower | Proof of DOAS running - interlock function |
| vii | Deg C | Supply air temperature monitoring | | 16 | | | | | * | * | | Duct mount temp sensor & field wiring | Installation provision for temp. sensor | Input information for valve command functions |
| viii | % Open | 2-Way CHW valve modulating control | | | | 16 | | | | | * | Output signal from the DDC Controller & wiring to valve actuator | Supply & Installation of motorised tow way control valves including necessary nipples / mating flanges in the pipeline | Major energy saving feature - optimises CHW consumption |
| ix | Position | Valves status | | 16 | | | | | * | * | | Wiring from Valve Actuator | Two way valve with desired output | Input information for command functions |
| x | CO2 Sensor | CO2 Measurement in Return air | | 16 | | | | | | | | Duct type CO2 Sensor for return air for Each DOAS | Installation provision for CO2 sensor | Ventillation Control |
| xi | % Open | Motorised Fresh Air Damper Command & Status | | 16 | | 16 | | | | | * | Output signal from the DDC Controller & wiring to Damper actuator | Supply & Installation of motorised Damper Controller including necessary accessories | Major energy saving feature - optimises CHW consumption |
| xii | % Open | Motorised Bypass/ Return Damper Command | | 16 | | 16 | | | | | * | Output signal from the DDC Controller & wiring to Damper actuator | Supply & Installation of motorised Damper Controller including necessary accessories | Major energy saving feature - optimises CHW consumption |
| xiii | Speed Modulation & Status | VFD Speed control, monitoring. Integration of VFDS, Frequency from VFD(0-10v/4-20mA) | | 16 | | 16 | | X | * | * | * | 0-10V feedback from VFD to DDC to monitor the frequency, Input signal (0-10V) to control the VFD frequency on return air basis. Soft integration with Integrator Unit | HVAC Vendor to provide the protocol & address details for integration & IBMS Vendor to integrate the same with necessary cabling and all required accessories. | Major energy saving feature - Input information for command functions & Monitoring Information |
| xiv | Start/ Stop | Humidifier on / off command & Capacity | | | | 16 | 16 | | | * | | Relay output @ 2 amp, 230 V & wiring from Humidifier MCC | Wiring & termination of potential free contact in auto mode in the control circuit of Humidifier Panel | Automatic Operation on schedule / condition - based controls |
| xv | Auto-Manual | Humidifier auto manual status | | | 16 | | | | * | | * | Wiring from Humidifier MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of Humidifier Panel | Input information for command functions & interlocks |
| xvi | Normal / Trip | Humidifier Run Status | | | 16 | | | | * | | * | Wiring from Humidifier MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of Humidifier Panel | Monitring & Alram Information & other Input |
| | | **Sub Total for AHU-Type-2** | | **96** | **128** | **80** | **32** | | | | | | | |
| | | | | | | | | | | | | | | |
| **B.3** | **AIR HANDLING UNITS - TYPE-3** | | **21** | | | | | | | | | | | |

| Sr. No. | Description / Ranges | Function | Qty | AI | DI | AO | DO | SI | Monitor | Control | Alarm | By BMS provider | By respective service providers | Benefit / purpose |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| i | Start/ Stop | AHU on / off command | | | | | 21 | | | * | | Relay output @ 2 amp, 230 V & wiring from AHU MCC | Wiring & termination of potential free contact in auto mode in the control circuit of AHU MCC Panel | Automatic AHU Operation on schedule / condition - based controls |
| ii | Auto-Manual | AHU auto manual status | | | 21 | | | | * | | * | Wiring from AHU MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of AHU Panel | Input information for command functions & interlocks |
| iii | Clean / Clog | AHU Pre & Fine Filter status | | | 42 | | | | * | | * | Diff. Pressure Switch across filter & field wiring | Insertion provision for Installation of DP switch across Filter | Proof of AHU running - interlock function |
| iv | Normal / Trip | AHU Trip Status | | | 21 | | | | * | | * | Wiring from AHU MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of AHU Panel | Monitring & Alram Information & other Input |
| v | Run Status | AHU Run status | | | 21 | | | | * | | * | Diff. Pressure Switch across Blower & field wiring | Insertion provision for Installation of DP switch across Blower | Proof of AHU running - interlock function |
| vi | Deg C | Return Air Temperature & Humidity monitoring | | 42 | | | | | * | * | | Duct mount temp & Humidity sensor & field wiring | Installation provision for temp & Humidity sensor | Input information for valve command functions |
| vii | Deg C | Supply air temperature monitoring | | 21 | | | | | * | * | | Duct mount temp sensor & field wiring | Installation provision for temp. sensor | Input information for valve command functions |
| viii | % Open | 2-Way CHW valve modulating control | | | | 21 | | | | | * | Output signal from the DDC Controller & wiring to valve actuator | Supply & Installation of motorised tow way control valves including necessary nipples / mating flanges in the pipeline | Major energy saving feature - optimises CHW consumption |
| ix | Position | Valves status | | 21 | | | | | * | * | | Wiring from Valve Actuator | Two way valve with desired output | Input information for command functions |
| x | Deg C | On-Coil & Off-Coil Water temperature | | 42 | | | | | * | | | Immersion temperature sensor with thermowell & wiring | Providing of suitably sized socket in the condenser water line | information |
| xi | CO2 Sensor | CO2 Measurement in Return air | | 21 | | | | | | | | Duct type CO2 Sensor for return air for Each AHU | Installation provision for CO2 sensor | Ventillation Control |
| xii | % Open | Motorised Fresh Air Damper Command & Status | | 21 | | 21 | | | | | * | Output signal from the DDC Controller & wiring to Damper actuator | Supply & Installation of motorised Damper Controller including necessary accessories | Major energy saving feature - optimises CHW consumption |
| xiii | % Open | Motorised Bypass/ Return Damper Command | | 21 | | 21 | | | | | * | Output signal from the DDC Controller & wiring to Damper actuator | Supply & Installation of motorised Damper Controller including necessary accessories | Major energy saving feature - optimises CHW consumption |
| | | **Sub Total for AHU-Type-3** | | **189** | **105** | **63** | **21** | | | | | | | |
| | | | | | | | | | | | | | | |
| **B.4** | **HEAT RECOVERY WHEEL UNIT** | | **4** | | | | | | | | | | | |
| i | Start/ Stop | Heat Recovery Wheel ON/OFF Command | | | | | 4 | | | * | | Relay output @ 2 amp, 230 V & wiring from HRU MCC | Wiring & termination of potential free contact in auto mode in the control circuit of HRU MCC Panel | Automatic HRU Operation on schedule / condition - based controls |
| ii | Auto-Manual | Heat Recovery Wheel Auto / Manual status | | | 4 | | | | * | | * | Wiring from HRU MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of HRU Panel | Input information for command functions & interlocks |
| iii | Clean / Clog | Heat Recovery Unit filter status | | | 4 | | | | * | | * | Diff. Pressure Switch across filter & field wiring | Insertion provision for Installation of DP switch across Filter | Proof of HRU Fan running - interlock function |
| iv | Start/ Stop | Heat Recovery Wheel Air Flow status | | | 4 | | | | * | | * | Diff. Pressure Switch across FAN & field wiring | provision for Installation of DP switch across Fan | Proof of HRU Fan running |
| v | Deg C | Supply Air Temperature | | 4 | | | | | * | * | | Duct mount temp sensor & field wiring | Installation provision for temp. sensor | Input information for valve command functions |
| vi | Deg C | Return Air Temperature & Humidity monitoring | | 8 | | | | | * | * | | Duct mount temp & Humidity sensor & field wiring | Installation provision for temp & Humidity sensor | Input information for valve command functions |
| vii | Speed Modulation & Status | VFD Speed control, monitoring. Integration of VFDS, Frequency from VFD(0-10v/4-20mA) | | 4 | | 4 | | X | * | * | * | 0-10V feedback from VFD to DDC to monitor the frequency, Input signal (0-10V) to control the VFD frequency on return air basis. Soft integration with Integrator Unit | HVAC Vendor to provide the protocol & address details for integration & IBMS Vendor to integrate the same with necessary cabling and all required accessories. | Major energy saving feature - Input information for command functions & Monitoring Information |
| | | **Sub Total for HRW** | | **16** | **12** | **4** | **4** | | | | | | | |
| | | | | | | | | | | | | | | |
| **B.5** | | **Tertiary Chilled Water Pump** | **2** | | | | | | | | | | | |

| Sr. No. | Description / Ranges | Function | Qty | AI | DI | AO | DO | SI | Monitor | Control | Alarm | By BMS provider | By respective service providers | Benefit / purpose |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| i | Start/ Stop | Tertiary Chilled Water Pump on / off command | | | | | 2 | | | * | | Relay output @ 2 amp, 230 V and wiring from MCC | Wiring and termination of potential free contact in auto mode in the control circuit of Pump Panel | For automatic pump Operation based on schedule / condition - (ensures equal run-time) |
| ii | Auto-Manual | Tertiary Chilled Water Pump auto manual status | | | 2 | | | | * | | * | Wiring from Auto/ Manual Switch | Wiring & termination at auxiliary potential free contact of auto manual switch of Pump Panel | Input information for command functions & interlocks |
| iii | On / Off Status | Tertiary Chilled water Pump run Status | | | 2 | | | | * | | | Current relay & Wiring | Wiring & Installation of current relay in MCC panel (cable alley) | Proof of pump running - interlock function |
| iv | Normal / Tripped | Tertiary Chilled water Pump trip Status | | | 2 | | | | * | | * | Wiring from MCC | Wiring & termination at auxiliary potential free contact of the over load relay of Pump Panel | Monitoring & Alarm information - other alerts |
| v | Control | Pump VFD control | | | | 2 | | | | * | | Wiring for 0-10 V DC or 4-20 ma output from BMS to VFD | VFD releasing information at one port on Open protocol [BACnet/Modbus] with built-in interface & communication cards | Monitoring & Controlling |
| vi | Monitor | VFD Pump operation | | | | | | X | * | | * | INTEGRATOR UNIT / Software connectivity | Primary pumping system information on open protocol [BACnet/Modbus] with built-in interface & communication cards. | Provide comprehensive Tertiary system information on BMS user interface, perform trend & archive functions |
| | | **Sub Total for Tertiary Pump** | | **0** | **6** | **2** | **2** | | | | | | | |
| | | | | | | | | | | | | | | |
| **B.6** | | **VENTILLATION SYSTEM** | | | | | | | | | | | | |
| **i** | | **Lift Pressurization Fan (12 Nos)** | **12** | | | | | | | | | | | |
| i | Start/ Stop | Normal mode Exhaust Fan on / off command | | | | | 12 | | | * | | Relay output @ 2 amp, 230 V & wiring from Fan MCC | Wiring & termination of potential free contact in auto mode in the control circuit of Fan MCC Panel | Automatic Fan Operation on schedule / condition - based controls |
| ii | Auto-Manual | Normal mode Exhaust Fan auto manual status | | | 12 | | | | * | | * | Wiring from Fan MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of Fan MCC Panel | Input information for command functions & interlocks |
| iii | On / Off | Fan Air Flow status | | | 12 | | | | * | | * | Diff. Pressure Switch - Air & field wiring | Insertion provision for Installation of DP switch across blower | Proof of fan running - interlock function |
| | | | | | | | | | | | | | | |
| **ii** | | **Basement Ventillation (34 Nos)** | **34** | | | | | | | | | | | |
| i | Start/ Stop | Fan on / off command | | | | | 34 | | | * | | Relay output @ 2 amp, 230 V & wiring from Fan MCC | Wiring & termination of potential free contact in auto mode in the control circuit of Fan MCC Panel | Automatic Fan Operation on schedule / condition - based controls |
| ii | Auto-Manual | Fan auto manual status | | | 34 | | | | * | | * | Wiring from Fan MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of Fan MCC Panel | Input information for command functions & interlocks |
| iii | On / Off | Fan run status | | | 34 | | | | * | | * | Diff. Pressure Switch - Air & field wiring | Insertion provision for Installation of DP switch across blower | Proof of fan running - interlock function |
| iv | Normal / Trip | Fan Trip Status | | | 34 | | | | * | | * | Wiring from Fan MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of Fan MCC Panel | Monitring & Alram Information & other Input |
| v | Software mapping | Basement Parking CO monitoring | | 9 | | | | | * | | | CO sensor | Provision for installation of CO sensor in the parking area | Monitor of air quality and providing input information for fresh air & exhaust fans |
| vi | Speed Modulation & Status | VFD Speed control, monitoring. Integration of VFDS, Frequency from VFD(0-10v/4-20mA) | | 9 | | 9 | | X | * | * | * | 0-10V feedback from VFD to DDC to monitor the frequency & Input signal (0-10V) to control the VFD frequency. Soft integration with Integrator Unit | HVAC Vendor to provide the protocol & address details for integration & IBMS Vendor to integrate the same with necessary cabling and all required accessories. | Major energy saving feature - Input information for command functions & Monitoring Information |
| | | **Sub Total for Ventillation** | | **18** | **126** | **9** | **46** | | | | | | | |
| | | | | | | | | | | | | | | |
| | | **Sub Total for LSES Faculty** | | **781** | **597** | **312** | **149** | | | | | | | |
| | | | | | | | | | | | | | | |

| Sr. No. | Description / Ranges | Function | Qty | AI | DI | AO | DO | SI | Monitor | Control | Alarm | By BMS provider | By respective service providers | Benefit / purpose |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C | ADMINSTRATION BUILDING | | | | | | | | | | | | | |
| C.1 | AIR HANDLING UNITS | | 20 | | | | | | | | | | | |
| i | Start/ Stop | AHU on / off command | | | | | 20 | | | * | | Relay output @ 2 amp, 230 V & wiring from AHU MCC | Wiring & termination of potential free contact in auto mode in the control circuit of AHU MCC Panel | Automatic AHU Operation on schedule / condition - based controls |
| ii | Auto-Manual | AHU auto manual status | | | 20 | | | | * | | * | Wiring from AHU MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of AHU Panel | Input information for command functions & interlocks |
| iii | Clean / Clog | AHU Pre & Fine Filter status | | | 40 | | | | * | | * | Diff. Pressure Switch across filter & field wiring | Insertion provision for Installation of DP switch across Filter | Proof of AHU running - interlock function |
| iv | Normal / Trip | AHU Trip Status | | | 20 | | | | * | | * | Wiring from AHU MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of AHU Panel | Monitring & Alram Information & other Input |
| v | Run Status | AHU Run status | | | 20 | | | | * | | * | Diff. Pressure Switch across Blower & field wiring | Insertion provision for Installation of DP switch across Blower | Proof of AHU running - interlock function |
| vi | Deg C | Return Air Temperature & Humidity monitoring | | 40 | | | | | * | * | | Duct mount temp & Humidity sensor & field wiring | Installation provision for temp & Humidity sensor | Input information for valve command functions |
| vii | Deg C | Supply air temperature monitoring | | 20 | | | | | * | * | | Duct mount temp sensor & field wiring | Installation provision for temp. sensor | Input information for valve command functions |
| viii | Pressure | Supply Duct Pressure monitoring | | 20 | | | | | * | * | | Duct mount Diff Pressure Transmitter & field wiring | Installation provision for DPT | information & Flow Control |
| ix | % Open | 2-Way CHW valve modulating control | | | | 20 | | | | | * | Output signal from the DDC Controller & wiring to valve actuator | Supply & Installation of motorised tow way control valves including necessary nipples / mating flanges in the pipeline | Major energy saving feature - optimises CHW consumption |
| x | Position | Valves status | | 20 | | | | | * | * | | Wiring from Valve Actuator | Two way valve with desired output | Input information for command functions |
| xi | Deg C | On-Coil & Off-Coil Water temperature | | 40 | | | | | * | | | Immersion temperature sensor with thermowell & wiring | Providing of suitably sized socket in the condenser water line | information |
| xii | CO2 Sensor | CO2 Measurement in Return air | | 20 | | | | | | | | Duct type CO2 Sensor for return air for Each AHU | Installation provision for CO2 sensor | Ventillation Control |
| xiii | % Open | Motorised Fresh Air Damper Command & Status | | 20 | | 20 | | | | | * | Output signal from the DDC Controller & wiring to Damper actuator | Supply & Installation of motorised Damper Controller including necessary accessories | Major energy saving feature - optimises CHW consumption |
| xiv | % Open | Motorised Bypass/ Return Damper Command | | 20 | | 20 | | | | | * | Output signal from the DDC Controller & wiring to Damper actuator | Supply & Installation of motorised Damper Controller including necessary accessories | Major energy saving feature - optimises CHW consumption |
| xv | Speed Modulation & Status | VFD Speed control, monitoring. Integration of VFDS, Frequency from VFD(0-10v/4-20mA) | | 20 | | 20 | | X | * | * | * | 0-10V feedback from VFD to DDC to monitor the frequency, Input signal (0-10V) to control the VFD frequency on return air basis. Soft integration with Integrator Unit | HVAC Vendor to provide the protocol & address details for integration & IBMS Vendor to integrate the same with necessary cabling and all required accessories. | Major energy saving feature - Input information for command functions & Monitoring Information |
| | | **Sub Total for AHU** | | **220** | **100** | **80** | **20** | | | | | | | |
| | | | | | | | | | | | | | | |
| C.2 | HEAT RECOVERY WHEEL UNIT | | 4 | | | | | | | | | | | |
| i | Start/ Stop | Heat Recovery Wheel ON/OFF Command | | | | | 4 | | | * | | Relay output @ 2 amp, 230 V & wiring from HRU MCC | Wiring & termination of potential free contact in auto mode in the control circuit of HRU MCC Panel | Automatic HRU Operation on schedule / condition - based controls |
| ii | Auto-Manual | Heat Recovery Wheel Auto / Manual status | | | 4 | | | | * | | * | Wiring from HRU MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of HRU Panel | Input information for command functions & interlocks |
| iii | Clean / Clog | Heat Recovery Unit filter status | | | 4 | | | | * | | * | Diff. Pressure Switch across filter & field wiring | Insertion provision for Installation of DP switch across Filter | Proof of HRU Fan running - interlock function |
| iv | Start/ Stop | Heat Recovery Wheel Air Flow status | | | 4 | | | | * | | * | Diff. Pressure Switch across FAN & field wiring | provision for Installation of DP switch across Fan | Proof of HRU Fan running |
| v | Deg C | Supply Air Temperature | | 4 | | | | | * | * | | Duct mount temp sensor & field wiring | Installation provision for temp. sensor | Input information for valve command functions |
| vi | Deg C | Return Air Temperature & Humidity monitoring | | 8 | | | | | * | * | | Duct mount temp & Humidity sensor & field wiring | Installation provision for temp & Humidity sensor | Input information for valve command functions |

| Sr. No. | Description / Ranges | Function | Qty | AI | DI | AO | DO | SI | Monitor | Control | Alarm | By BMS provider | By respective service providers | Benefit / purpose |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| vii | Speed Modulation & Status | VFD Speed control, monitoring. Integration of VFDS, Frequency from VFD(0-10v/4-20mA) | | 4 | | 4 | | X | * | * | * | 0-10V feedback from VFD to DDC to monitor the frequency, Input signal (0-10V) to control the VFD frequency on return air basis. Soft integration with Integrator Unit | HVAC Vendor to provide the protocol & address details for integration & IBMS Vendor to integrate the same with necessary cabling and all required accessories. | Major energy saving feature - Input information for command functions & Monitoring Information |
| | | **Sub Total for HRW** | | **16** | **12** | **4** | **4** | | | | | | | |
| | | | | | | | | | | | | | | |
| **C.3** | | **Tertiary Chilled Water Pump** | **2** | | | | | | | | | | | |
| i | Start/ Stop | Tertiary Chilled Water Pump on / off command | | | | | 2 | | | * | | Relay output @ 2 amp, 230 V and wiring from MCC | Wiring and termination of potential free contact in auto mode in the control circuit of Pump Panel | For automatic pump Operation based on schedule / condition - (ensures equal run-time) |
| ii | Auto-Manual | Tertiary Chilled Water Pump auto manual status | | | 2 | | | | * | | * | Wiring from Auto/ Manual Switch | Wiring & termination at auxiliary potential free contact of auto manual switch of Pump Panel | Input information for command functions & interlocks |
| iii | On / Off Status | Tertiary Chilled water Pump run Status | | | 2 | | | | * | | | Current relay & Wiring | Wiring & Installation of current relay in MCC panel (cable alley) | Proof of pump running - interlock function |
| iv | Normal / Tripped | Tertiary Chilled water Pump trip Status | | | 2 | | | | * | | * | Wiring from MCC | Wiring & termination at auxiliary potential free contact of the over load relay of Pump Panel | Monitoring & Alarm information - other alerts |
| v | Control | Pump VFD control | | | | 2 | | | | * | | Wiring for 0-10 V DC or 4-20 ma output from BMS to VFD | VFD releasing information at one port on Open protocol [BACnet/Modbus] with built-in interface & communication cards | Monitoring & Controlling |
| vi | Monitor | VFD Pump operation | | | | | | X | * | | * | INTEGRATOR UNIT / Software connectivity | Primary pumping system information on open protocol [BACnet/Modbus] with built-in interface & communication cards. | Provide comprehensive Tertiary system information on BMS user interface, perform trend & archive functions |
| | | **Sub Total for Tertiary Pump** | | **0** | **6** | **2** | **2** | | | | | | | |
| | | | | | | | | | | | | | | |
| **C.4** | | **VENTILLATION SYSTEM** | | | | | | | | | | | | |
| **i** | | **Pressurization Fan (7 Nos)** | **7** | | | | | | | | | | | |
| i | Start/ Stop | Normal mode Exhaust Fan on / off command | | | | | 7 | | | * | | Relay output @ 2 amp, 230 V & wiring from Fan MCC | Wiring & termination of potential free contact in auto mode in the control circuit of Fan MCC Panel | Automatic Fan Operation on schedule / condition - based controls |
| ii | Auto-Manual | Normal mode Exhaust Fan auto manual status | | | 7 | | | | * | | * | Wiring from Fan MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of Fan MCC Panel | Input information for command functions & interlocks |
| iii | On / Off | Fan Air Flow status | | | 7 | | | | * | | * | Diff. Pressure Switch - Air & field wiring | Insertion provision for Installation of DP switch across blower | Proof of fan running - interlock function |
| | | | | | | | | | | | | | | |
| **ii** | | **Basement Ventillation (3 Nos)** | **3** | | | | | | | | | | | |
| i | Start/ Stop | Fan on / off command | | | | | 3 | | | * | | Relay output @ 2 amp, 230 V & wiring from Fan MCC | Wiring & termination of potential free contact in auto mode in the control circuit of Fan MCC Panel | Automatic Fan Operation on schedule / condition - based controls |
| ii | Auto-Manual | Fan auto manual status | | | 3 | | | | * | | * | Wiring from Fan MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of Fan MCC Panel | Input information for command functions & interlocks |
| iii | On / Off | Fan run status | | | 3 | | | | * | | * | Diff. Pressure Switch - Air & field wiring | Insertion provision for Installation of DP switch across blower | Proof of fan running - interlock function |
| iv | Speed Modulation & Status | VFD Speed control, monitoring. Integration of VFDS, Frequency from VFD(0-10v/4-20mA) | | 3 | | 3 | | X | * | * | * | 0-10V feedback from VFD to DDC to monitor the frequency & Input signal (0-10V) to control the VFD frequency. Soft integration with Integrator Unit | HVAC Vendor to provide the protocol & address details for integration & IBMS Vendor to integrate the same with necessary cabling and all required accessories. | Major energy saving feature - Input information for command functions & Monitoring Information |
| | | **Sub Total for Ventillation** | | **3** | **20** | **3** | **10** | | | | | | | |
| | | | | | | | | | | | | | | |

| Sr. No. | Description / Ranges | Function | Qty | AI | DI | AO | DO | SI | Monitor | Control | Alarm | By BMS provider | By respective service providers | Benefit / purpose |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Sub Total for Admin Building** | | **239** | **138** | **89** | **36** | | | | | | | |
| | | | | | | | | | | | | | | |
| **D** | **PHYSICS CHEMISTRY & MATHS-IT FACULTY** | | | | | | | | | | | | | |
| **D.1** | **AIR HANDLING UNITS** | | **17** | | | | | | | | | | | |
| i | Start/ Stop | AHU on / off command | | | | | 17 | | | * | | Relay output @ 2 amp, 230 V & wiring from AHU MCC | Wiring & termination of potential free contact in auto mode in the control circuit of AHU MCC Panel | Automatic AHU Operation on schedule / condition - based controls |
| ii | Auto-Manual | AHU auto manual status | | | 17 | | | | * | | * | Wiring from AHU MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of AHU Panel | Input information for command functions & interlocks |
| iii | Clean / Clog | AHU Pre & Fine Filter status | | | 34 | | | | * | | * | Diff. Pressure Switch across filter & field wiring | Insertion provision for Installation of DP switch across Filter | Proof of AHU running - interlock function |
| iv | Normal / Trip | AHU Trip Status | | | 17 | | | | * | | * | Wiring from AHU MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of AHU Panel | Monitring & Alram Information & other Input |
| v | Run Status | AHU Run status | | | 17 | | | | * | | * | Diff. Pressure Switch across Blower & field wiring | Insertion provision for Installation of DP switch across Blower | Proof of AHU running - interlock function |
| vi | Deg C | Return Air Temperature & Humidity monitoring | | 34 | | | | | * | * | | Duct mount temp & Humidity sensor & field wiring | Installation provision for temp & Humidity sensor | Input information for valve command functions |
| vii | Deg C | Supply air temperature monitoring | | 17 | | | | | * | * | | Duct mount temp sensor & field wiring | Installation provision for temp. sensor | Input information for valve command functions |
| viii | Pressure | Supply Duct Pressure monitoring | | 17 | | | | | * | * | | Duct mount Diff Pressure Transmitter & field wiring | Installation provision for DPT | information & Flow Control |
| ix | % Open | 2-Way CHW valve modulating control | | | | 17 | | | | | * | Output signal from the DDC Controller & wiring to valve actuator | Supply & Installation of motorised tow way control valves including necessary nipples / mating flanges in the pipeline | Major energy saving feature - optimises CHW consumption |
| x | Position | Valves status | | 17 | | | | | * | * | | Wiring from Valve Actuator | Two way valve with desired output | Input information for command functions |
| xi | Deg C | On-Coil & Off-Coil Water temperature | | 34 | | | | | * | | | Immersion temperature sensor with thermowell & wiring | Providing of suitably sized socket in the condenser water line | information |
| xii | CO2 Sensor | CO2 Measurement in Return air | | 17 | | | | | | | | Duct type CO2 Sensor for return air for Each AHU | Installation provision for CO2 sensor | Ventillation Control |
| xiii | % Open | Motorised Fresh Air Damper Command & Status | | 17 | | 17 | | | | | * | Output signal from the DDC Controller & wiring to Damper actuator | Supply & Installation of motorised Damper Controller including necessary accessories | Major energy saving feature - optimises CHW consumption |
| xiv | % Open | Motorised Bypass/ Return Damper Command | | 17 | | 17 | | | | | * | Output signal from the DDC Controller & wiring to Damper actuator | Supply & Installation of motorised Damper Controller including necessary accessories | Major energy saving feature - optimises CHW consumption |
| xv | Speed Modulation & Status | VFD Speed control, monitoring. Integration of VFDS, Frequency from VFD(0-10v/4-20mA) | | 17 | | 17 | | X | * | * | * | 0-10V feedback from VFD to DDC to monitor the frequency, Input signal (0-10V) to control the VFD frequency on return air basis. Soft integration with Integrator Unit | HVAC Vendor to provide the protocol & address details for integration & IBMS Vendor to integrate the same with necessary cabling and all required accessories. | Major energy saving feature - Input information for command functions & Monitoring Information |
| | | **Sub Total for AHU** | | **187** | **85** | **68** | **17** | | | | | | | |
| | | | | | | | | | | | | | | |
| **D.2** | **HEAT RECOVERY WHEEL UNIT** | | **4** | | | | | | | | | | | |
| i | Start/ Stop | Heat Recovery Wheel ON/OFF Command | | | | | 4 | | | * | | Relay output @ 2 amp, 230 V & wiring from HRU MCC | Wiring & termination of potential free contact in auto mode in the control circuit of HRU MCC Panel | Automatic HRU Operation on schedule / condition - based controls |
| ii | Auto-Manual | Heat Recovery Wheel Auto / Manual status | | | 4 | | | | * | | * | Wiring from HRU MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of HRU Panel | Input information for command functions & interlocks |
| iii | Clean / Clog | Heat Recovery Unit filter status | | | 4 | | | | * | | * | Diff. Pressure Switch across filter & field wiring | Insertion provision for Installation of DP switch across Filter | Proof of HRU Fan running - interlock function |
| iv | Start/ Stop | Heat Recovery Wheel Air Flow status | | | 4 | | | | * | | * | Diff. Pressure Switch across FAN & field wiring | provision for Installation of DP switch across Fan | Proof of HRU Fan running |
| v | Deg C | Supply Air Temperature | | 4 | | | | | * | * | | Duct mount temp sensor & field wiring | Installation provision for temp. sensor | Input information for valve command functions |

| Sr. No. | Description / Ranges | Function | Qty | AI | DI | AO | DO | SI | Monitor | Control | Alarm | By BMS provider | By respective service providers | Benefit / purpose |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| vi | Deg C | Return Air Temperature & Humidity monitoring | | 8 | | | | | * | * | | Duct mount temp & Humidity sensor & field wiring | Installation provision for temp & Humidity sensor | Input information for valve command functions |
| vii | Speed Modulation & Status | VFD Speed control, monitoring. Integration of VFDS, Frequency from VFD(0-10v/4-20mA) | | 4 | | 4 | | X | * | * | * | 0-10V feedback from VFD to DDC to monitor the frequency, Input signal (0-10V) to control the VFD frequency on return air basis. Soft integration with Integrator Unit | HVAC Vendor to provide the protocol & address details for integration & IBMS Vendor to integrate the same with necessary cabling and all required accessories. | Major energy saving feature - Input information for command functions & Monitoring Information |
| | | **Sub Total for HRW** | | **16** | **12** | **4** | **4** | | | | | | | |
| | | | | | | | | | | | | | | |
| **D.3** | | **Tertiary Chilled Water Pump** | **2** | | | | | | | | | | | |
| i | Start/ Stop | Tertiary Chilled Water Pump on / off command | | | | | 2 | | | * | | Relay output @ 2 amp, 230 V and wiring from MCC | Wiring and termination of potential free contact in auto mode in the control circuit of Pump Panel | For automatic pump Operation based on schedule / condition - (ensures equal run-time) |
| ii | Auto-Manual | Tertiary Chilled Water Pump auto manual status | | | 2 | | | | * | | * | Wiring from Auto/ Manual Switch | Wiring & termination at auxiliary potential free contact of auto manual switch of Pump Panel | Input information for command functions & interlocks |
| iii | On / Off Status | Tertiary Chilled water Pump run Status | | | 2 | | | | * | | | Current relay & Wiring | Wiring & Installation of current relay in MCC panel (cable alley) | Proof of pump running - interlock function |
| iv | Normal / Tripped | Tertiary Chilled water Pump trip Status | | | 2 | | | | * | | * | Wiring from MCC | Wiring & termination at auxiliary potential free contact of the over load relay of Pump Panel | Monitoring & Alarm information - other alerts |
| v | Control | Pump VFD control | | | | 2 | | | | * | | Wiring for 0-10 V DC or 4-20 ma output from BMS to VFD | VFD releasing information at one port on Open protocol [BACnet/Modbus] with built-in interface & communication cards | Monitoring & Controlling |
| vi | Monitor | VFD Pump operation | | | | | | X | * | | * | INTEGRATOR UNIT / Software connectivity | Primary pumping system information on open protocol [BACnet/Modbus] with built-in interface & communication cards. | Provide comprehensive Tertiary system information on BMS user interface, perform trend & archive functions |
| | | **Sub Total for Tertiary Pump** | | **0** | **6** | **2** | **2** | | | | | | | |
| | | | | | | | | | | | | | | |
| **D.4** | | **VENTILLATION SYSTEM** | | | | | | | | | | | | |
| **i** | | **Pressurization Fan (10 Nos)** | **10** | | | | | | | | | | | |
| i | Start/ Stop | Normal mode Exhaust Fan on / off command | | | | | 10 | | | * | | Relay output @ 2 amp, 230 V & wiring from Fan MCC | Wiring & termination of potential free contact in auto mode in the control circuit of Fan MCC Panel | Automatic Fan Operation on schedule / condition - based controls |
| ii | Auto-Manual | Normal mode Exhaust Fan auto manual status | | | 10 | | | | * | | * | Wiring from Fan MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of Fan MCC Panel | Input information for command functions & interlocks |
| iii | On / Off | Fan Air Flow status | | | 10 | | | | * | | * | Diff. Pressure Switch - Air & field wiring | Insertion provision for Installation of DP switch across blower | Proof of fan running - interlock function |
| | | | | | | | | | | | | | | |
| **ii** | | **Basement Ventillation (7 Nos)** | **7** | | | | | | | | | | | |
| i | Start/ Stop | Fan on / off command | | | | | 7 | | | * | | Relay output @ 2 amp, 230 V & wiring from Fan MCC | Wiring & termination of potential free contact in auto mode in the control circuit of Fan MCC Panel | Automatic Fan Operation on schedule / condition - based controls |
| ii | Auto-Manual | Fan auto manual status | | | 7 | | | | * | | * | Wiring from Fan MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of Fan MCC Panel | Input information for command functions & interlocks |
| iii | On / Off | Fan run status | | | 7 | | | | * | | * | Diff. Pressure Switch - Air & field wiring | Insertion provision for Installation of DP switch across blower | Proof of fan running - interlock function |
| iv | Speed Modulation & Status | VFD Speed control, monitoring. Integration of VFDS, Frequency from VFD(0-10v/4-20mA) | | 7 | | 7 | | X | * | * | * | 0-10V feedback from VFD to DDC to monitor the frequency & Input signal (0-10V) to control the VFD frequency. Soft integration with Integrator Unit | HVAC Vendor to provide the protocol & address details for integration & IBMS Vendor to integrate the same with necessary cabling and all required accessories. | Major energy saving feature - Input information for command functions & Monitoring Information |
| | | **Sub Total for Ventillation** | | **7** | **34** | **7** | **17** | | | | | | | |

| Sr. No. | Description / Ranges | Function | Qty | AI | DI | AO | DO | SI | Monitor | Control | Alarm | By BMS provider | By respective service providers | Benefit / purpose |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | |
| | | **Sub Total for PCM & IT Faculty** | | **210** | **137** | **81** | **40** | | | | | | | |
| | | | | | | | | | | | | | | |
| **E** | **FACULTY OF ART & CONVENTION CENTER** | | | | | | | | | | | | | |
| **E.1** | **AIR HANDLING UNITS** | | **17** | | | | | | | | | | | |
| i | Start/ Stop | AHU on / off command | | | | | 17 | | | * | | Relay output @ 2 amp, 230 V & wiring from AHU MCC | Wiring & termination of potential free contact in auto mode in the control circuit of AHU MCC Panel | Automatic AHU Operation on schedule / condition - based controls |
| ii | Auto-Manual | AHU auto manual status | | | 17 | | | | * | | * | Wiring from AHU MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of AHU Panel | Input information for command functions & interlocks |
| iii | Clean / Clog | AHU Pre & Fine Filter status | | | 34 | | | | * | | * | Diff. Pressure Switch across filter & field wiring | Insertion provision for Installation of DP switch across Filter | Proof of AHU running - interlock function |
| iv | Normal / Trip | AHU Trip Status | | | 17 | | | | * | | * | Wiring from AHU MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of AHU Panel | Monitring & Alram Information & other Input |
| v | Run Status | AHU Run status | | | 17 | | | | * | | * | Diff. Pressure Switch across Blower & field wiring | Insertion provision for Installation of DP switch across Blower | Proof of AHU running - interlock function |
| vi | Deg C | Return Air Temperature & Humidity monitoring | | 34 | | | | | * | * | | Duct mount temp & Humidity sensor & field wiring | Installation provision for temp & Humidity sensor | Input information for valve command functions |
| vii | Deg C | Supply air temperature monitoring | | 17 | | | | | * | * | | Duct mount temp sensor & field wiring | Installation provision for temp. sensor | Input information for valve command functions |
| viii | Pressure | Supply Duct Pressure monitoring | | 17 | | | | | * | * | | Duct mount Diff Pressure Transmitter & field wiring | Installation provision for DPT | information & Flow Control |
| ix | % Open | 2-Way CHW valve modulating control | | | | 17 | | | | | * | Output signal from the DDC Controller & wiring to valve actuator | Supply & Installation of motorised tow way control valves including necessary nipples / mating flanges in the pipeline | Major energy saving feature - optimises CHW consumption |
| x | Position | Valves status | | 17 | | | | | * | * | | Wiring from Valve Actuator | Two way valve with desired output | Input information for command functions |
| xi | Deg C | On-Coil & Off-Coil Water temperature | | 34 | | | | | * | | | Immersion temperature sensor with thermowell & wiring | Providing of suitably sized socket in the condenser water line | information |
| xii | CO2 Sensor | CO2 Measurement in Return air | | 17 | | | | | | | | Duct type CO2 Sensor for return air for Each AHU | Installation provision for CO2 sensor | Ventillation Control |
| xiii | % Open | Motorised Fresh Air Damper Command & Status | | 17 | | 17 | | | | | * | Output signal from the DDC Controller & wiring to Damper actuator | Supply & Installation of motorised Damper Controller including necessary accessories | Major energy saving feature - optimises CHW consumption |
| xiv | % Open | Motorised Bypass/ Return Damper Command | | 17 | | 17 | | | | | * | Output signal from the DDC Controller & wiring to Damper actuator | Supply & Installation of motorised Damper Controller including necessary accessories | Major energy saving feature - optimises CHW consumption |
| xv | Speed Modulation & Status | VFD Speed control, monitoring. Integration of VFDS, Frequency from VFD(0-10v/4-20mA) | | 17 | | 17 | | X | * | * | * | 0-10V feedback from VFD to DDC to monitor the frequency, Input signal (0-10V) to control the VFD frequency on return air basis. Soft integration with Integrator Unit | HVAC Vendor to provide the protocol & address details for integration & IBMS Vendor to integrate the same with necessary cabling and all required accessories. | Major energy saving feature - Input information for command functions & Monitoring Information |
| | | **Sub Total for AHU** | | **187** | **85** | **68** | **17** | | | | | | | |
| | | | | | | | | | | | | | | |
| **E.2** | **HEAT RECOVERY WHEEL UNIT** | | **4** | | | | | | | | | | | |
| i | Start/ Stop | Heat Recovery Wheel ON/OFF Command | | | | | 4 | | | * | | Relay output @ 2 amp, 230 V & wiring from HRU MCC | Wiring & termination of potential free contact in auto mode in the control circuit of HRU MCC Panel | Automatic HRU Operation on schedule / condition - based controls |
| ii | Auto-Manual | Heat Recovery Wheel Auto / Manual status | | | 4 | | | | * | | * | Wiring from HRU MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of HRU Panel | Input information for command functions & interlocks |
| iii | Clean / Clog | Heat Recovery Unit filter status | | | 4 | | | | * | | * | Diff. Pressure Switch across filter & field wiring | Insertion provision for Installation of DP switch across Filter | Proof of HRU Fan running - interlock function |
| iv | Start/ Stop | Heat Recovery Wheel Air Flow status | | | 4 | | | | * | | * | Diff. Pressure Switch across FAN & field wiring | provision for Installation of DP switch across Fan | Proof of HRU Fan running |
| v | Deg C | Supply Air Temperature | | 4 | | | | | * | * | | Duct mount temp sensor & field wiring | Installation provision for temp. sensor | Input information for valve command functions |

| Sr. No. | Description / Ranges | Function | Qty | AI | DI | AO | DO | SI | Monitor | Control | Alarm | By BMS provider | By respective service providers | Benefit / purpose |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| vi | Deg C | Return Air Temperature & Humidity monitoring | | 8 | | | | | * | * | | Duct mount temp & Humidity sensor & field wiring | Installation provision for temp & Humidity sensor | Input information for valve command functions |
| vii | Speed Modulation & Status | VFD Speed control, monitoring. Integration of VFDS, Frequency from VFD(0-10v/4-20mA) | | 4 | | 4 | | X | * | * | * | 0-10V feedback from VFD to DDC to monitor the frequency, Input signal (0-10V) to control the VFD frequency on return air basis. Soft integration with Integrator Unit | HVAC Vendor to provide the protocol & address details for integration & IBMS Vendor to integrate the same with necessary cabling and all required accessories. | Major energy saving feature - Input information for command functions & Monitoring Information |
| | | **Sub Total for HRW** | | **16** | **12** | **4** | **4** | | | | | | | |
| | | | | | | | | | | | | | | |
| **E.3** | | **Tertiary Chilled Water Pump** | **2** | | | | | | | | | | | |
| i | Start/ Stop | Tertiary Chilled Water Pump on / off command | | | | | 2 | | | * | | Relay output @ 2 amp, 230 V and wiring from MCC | Wiring and termination of potential free contact in auto mode in the control circuit of Pump Panel | For automatic pump Operation based on schedule / condition - (ensures equal run-time) |
| ii | Auto-Manual | Tertiary Chilled Water Pump auto manual status | | | 2 | | | | * | | * | Wiring from Auto/ Manual Switch | Wiring & termination at auxiliary potential free contact of auto manual switch of Pump Panel | Input information for command functions & interlocks |
| iii | On / Off Status | Tertiary Chilled water Pump run Status | | | 2 | | | | * | | | Current relay & Wiring | Wiring & Installation of current relay in MCC panel (cable alley) | Proof of pump running - interlock function |
| iv | Normal / Tripped | Tertiary Chilled water Pump trip Status | | | 2 | | | | * | | * | Wiring from MCC | Wiring & termination at auxiliary potential free contact of the over load relay of Pump Panel | Monitoring & Alarm information - other alerts |
| v | Control | Pump VFD control | | | | 2 | | | | * | | Wiring for 0-10 V DC or 4-20 ma output from BMS to VFD | VFD releasing information at one port on Open protocol [BACnet/Modbus] with built-in interface & communication cards | Monitoring & Controlling |
| vi | Monitor | VFD Pump operation | | | | | | X | * | | * | INTEGRATOR UNIT / Software connectivity | Primary pumping system information on open protocol [BACnet/Modbus] with built-in interface & communication cards. | Provide comprehensive Tertiary system information on BMS user interface, perform trend & archive functions |
| | | **Sub Total for Tertiary Pump** | | **0** | **6** | **2** | **2** | | | | | | | |
| | | | | | | | | | | | | | | |
| **E.4** | | **TFA (2 Nos)** | **2** | | | | | | | | | | | |
| i | Start/ Stop | Treated Fresh Air unit on / off command | | | | | 2 | | | * | | Relay output @ 2 amp, 230 V & wiring from TFA MCC | Wiring & termination of potential free contact in auto mode in the control circuit of TFA MCC Panel | Automatic TFA Operation on schedule / condition - based controls |
| ii | Auto-Manual | Treated Fresh Air unit Auto-manual status | | | 2 | | | | * | | * | Wiring from TFA MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of TFA Panel | Input information for command functions & interlocks |
| iii | Clean / Clog | Treated Fresh Air Unit filter status | | | 2 | | | | * | | * | Diff. Pressure Switch across filter & field wiring | Insertion provision for Installation of DP switch across Filter | Proof of TFA Fan running - interlock function |
| iv | Start/ Stop | Treated Fresh Air Fans Air Flow status | | | 2 | | | | * | | * | Diff. Pressure Switch across FAN & field wiring | provision for Installation of DP switch across Fan | Proof of TFA Fan running |
| v | Deg C | Supply Air Temperature | | 2 | | | | | * | * | | Duct mount temp sensor & field wiring | Installation provision for temp. sensor | Input information for valve command functions |
| vi | % Open | 2-Way CHW valve modulating control | | | | 2 | | | | | * | Output signal from the DDC Controller & wiring to valve actuator | Supply & Installation of motorised tow way control valves including necessary nipples / mating flanges in the pipeline | Major energy saving feature - optimises CHW consumption |
| vii | Position | Valves status | | 2 | | | | | * | * | | Wiring from Valve Actuator | Two way valve with desired output | Input information for command functions |
| | | **Sub Total for TFA** | | **4** | **6** | **2** | **2** | | | | | | | |
| | | | | | | | | | | | | | | |
| **E.5** | | **VENTILLATION SYSTEM** | | | | | | | | | | | | |
| **i** | | **Pressurization Fan (38 Nos)** | **38** | | | | | | | | | | | |
| i | Start/ Stop | Normal mode Exhaust Fan on / off command | | | | | 38 | | | * | | Relay output @ 2 amp, 230 V & wiring from Fan MCC | Wiring & termination of potential free contact in auto mode in the control circuit of Fan MCC Panel | Automatic Fan Operation on schedule / condition - based controls |

| Sr. No. | Description / Ranges | Function | Qty | AI | DI | AO | DO | SI | Monitor | Control | Alarm | By BMS provider | By respective service providers | Benefit / purpose |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ii | Auto-Manual | Normal mode Exhaust Fan auto manual status | | | 38 | | | | * | | * | Wiring from Fan MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of Fan MCC Panel | Input information for command functions & interlocks |
| iii | On / Off | Fan Air Flow status | | | 38 | | | | * | | * | Diff. Pressure Switch - Air & field wiring | Insertion provision for Installation of DP switch across blower | Proof of fan running - interlock function |
| | | | | | | | | | | | | | | |
| **ii** | | **Basement Ventillation (8 Nos)** | **8** | | | | | | | | | | | |
| i | Start/ Stop | Fan on / off command | | | | | 8 | | | * | | Relay output @ 2 amp, 230 V & wiring from Fan MCC | Wiring & termination of potential free contact in auto mode in the control circuit of Fan MCC Panel | Automatic Fan Operation on schedule / condition - based controls |
| ii | Auto-Manual | Fan auto manual status | | | 8 | | | | * | | * | Wiring from Fan MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of Fan MCC Panel | Input information for command functions & interlocks |
| iii | On / Off | Fan run status | | | 8 | | | | * | | * | Diff. Pressure Switch - Air & field wiring | Insertion provision for Installation of DP switch across blower | Proof of fan running - interlock function |
| iv | Speed Modulation & Status | VFD Speed control, monitoring. Integration of VFDS, Frequency from VFD(0-10v/4-20mA) | | 8 | | 8 | | X | * | * | * | 0-10V feedback from VFD to DDC to monitor the frequency & Input signal (0-10V) to control the VFD frequency. Soft integration with Integrator Unit | HVAC Vendor to provide the protocol & address details for integration & IBMS Vendor to integrate the same with necessary cabling and all required accessories. | Major energy saving feature - Input information for command functions & Monitoring Information |
| | | **Sub Total for Ventillation** | | **8** | **92** | **8** | **46** | | | | | | | |
| | | | | | | | | | | | | | | |
| | | **Sub Total for Faculty of Art & Design & Convention Centre** | | **215** | **201** | **84** | **71** | | | | | | | |
| | | | | | | | | | | | | | | |
| **F** | **FACULTY OF LEGAL STUDIES & HUMANITIES** | | | | | | | | | | | | | |
| **F.1** | **AIR HANDLING UNITS** | | **14** | | | | | | | | | | | |
| i | Start/ Stop | AHU on / off command | | | | | 14 | | | * | | Relay output @ 2 amp, 230 V & wiring from AHU MCC | Wiring & termination of potential free contact in auto mode in the control circuit of AHU MCC Panel | Automatic AHU Operation on schedule / condition - based controls |
| ii | Auto-Manual | AHU auto manual status | | | 14 | | | | * | | * | Wiring from AHU MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of AHU Panel | Input information for command functions & interlocks |
| iii | Clean / Clog | AHU Pre & Fine Filter status | | | 28 | | | | * | | * | Diff. Pressure Switch across filter & field wiring | Insertion provision for Installation of DP switch across Filter | Proof of AHU running - interlock function |
| iv | Normal / Trip | AHU Trip Status | | | 14 | | | | * | | * | Wiring from AHU MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of AHU Panel | Monitring & Alram Information & other Input |
| v | Run Status | AHU Run status | | | 14 | | | | * | | * | Diff. Pressure Switch across Blower & field wiring | Insertion provision for Installation of DP switch across Blower | Proof of AHU running - interlock function |
| vi | Deg C | Return Air Temperature & Humidity monitoring | | 28 | | | | | * | * | | Duct mount temp & Humidity sensor & field wiring | Installation provision for temp & Humidity sensor | Input information for valve command functions |
| vii | Deg C | Supply air temperature monitoring | | 14 | | | | | * | * | | Duct mount temp sensor & field wiring | Installation provision for temp. sensor | Input information for valve command functions |
| viii | Pressure | Supply Duct Pressure monitoring | | 14 | | | | | * | * | | Duct mount Diff Pressure Transmitter & field wiring | Installation provision for DPT | information & Flow Control |
| ix | % Open | 2-Way CHW valve modulating control | | | | 14 | | | | | * | Output signal from the DDC Controller & wiring to valve actuator | Supply & Installation of motorised tow way control valves including necessary nipples / mating flanges in the pipeline | Major energy saving feature - optimises CHW consumption |
| x | Position | Valves status | | 14 | | | | | * | * | | Wiring from Valve Actuator | Two way valve with desired output | Input information for command functions |
| xi | Deg C | On-Coil & Off-Coil Water temperature | | 28 | | | | | * | | | Immersion temperature sensor with thermowell & wiring | Providing of suitably sized socket in the condenser water line | information |
| xii | CO2 Sensor | CO2 Measurement in Return air | | 14 | | | | | | | | Duct type CO2 Sensor for return air for Each AHU | Installation provision for CO2 sensor | Ventillation Control |
| xiii | % Open | Motorised Fresh Air Damper Command & Status | | 14 | | 14 | | | | | * | Output signal from the DDC Controller & wiring to Damper actuator | Supply & Installation of motorised Damper Controller including necessary accessories | Major energy saving feature - optimises CHW consumption |

| Sr. No. | Description / Ranges | Function | Qty | AI | DI | AO | DO | SI | Monitor | Control | Alarm | By BMS provider | By respective service providers | Benefit / purpose |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| xiv | % Open | Motorised Bypass/ Return Damper Command | | 14 | | 14 | | | | | * | Output signal from the DDC Controller & wiring to Damper actuator | Supply & Installation of motorised Damper Controller including necessary accessories | Major energy saving feature - optimises CHW consumption |
| xv | Speed Modulation & Status | VFD Speed control, monitoring. Integration of VFDS, Frequency from VFD(0-10v/4-20mA) | | 14 | | 14 | | X | * | * | * | 0-10V feedback from VFD to DDC to monitor the frequency, Input signal (0-10V) to control the VFD frequency on return air basis. Soft integration with Integrator Unit | HVAC Vendor to provide the protocol & address details for integration & IBMS Vendor to integrate the same with necessary cabling and all required accessories. | Major energy saving feature - Input information for command functions & Monitoring Information |
| | | **Sub Total for AHU** | | **154** | **70** | **56** | **14** | | | | | | | |
| | | | | | | | | | | | | | | |
| **F.2** | **HEAT RECOVERY WHEEL UNIT** | | **4** | | | | | | | | | | | |
| i | Start/ Stop | Heat Recovery Wheel ON/OFF Command | | | | | 4 | | | * | | Relay output @ 2 amp, 230 V & wiring from HRU MCC | Wiring & termination of potential free contact in auto mode in the control circuit of HRU MCC Panel | Automatic HRU Operation on schedule / condition - based controls |
| ii | Auto-Manual | Heat Recovery Wheel Auto / Manual status | | | 4 | | | | * | | * | Wiring from HRU MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of HRU Panel | Input information for command functions & interlocks |
| iii | Clean / Clog | Heat Recovery Unit filter status | | | 4 | | | | * | | * | Diff. Pressure Switch across filter & field wiring | Insertion provision for Installation of DP switch across Filter | Proof of HRU Fan running - interlock function |
| iv | Start/ Stop | Heat Recovery Wheel Air Flow status | | | 4 | | | | * | | * | Diff. Pressure Switch across FAN & field wiring | provision for Installation of DP switch across Fan | Proof of HRU Fan running |
| v | Deg C | Supply Air Temperature | | 4 | | | | | * | * | | Duct mount temp sensor & field wiring | Installation provision for temp. sensor | Input information for valve command functions |
| vi | Deg C | Return Air Temperature & Humidity monitoring | | 8 | | | | | * | * | | Duct mount temp & Humidity sensor & field wiring | Installation provision for temp & Humidity sensor | Input information for valve command functions |
| vii | Speed Modulation & Status | VFD Speed control, monitoring. Integration of VFDS, Frequency from VFD(0-10v/4-20mA) | | 4 | | 4 | | X | * | * | * | 0-10V feedback from VFD to DDC to monitor the frequency, Input signal (0-10V) to control the VFD frequency on return air basis. Soft integration with Integrator Unit | HVAC Vendor to provide the protocol & address details for integration & IBMS Vendor to integrate the same with necessary cabling and all required accessories. | Major energy saving feature - Input information for command functions & Monitoring Information |
| | | **Sub Total for HRW** | | **16** | **12** | **4** | **4** | | | | | | | |
| | | | | | | | | | | | | | | |
| **F.3** | | **Tertiary Chilled Water Pump** | **2** | | | | | | | | | | | |
| i | Start/ Stop | Tertiary Chilled Water Pump on / off command | | | | | 2 | | | * | | Relay output @ 2 amp, 230 V and wiring from MCC | Wiring and termination of potential free contact in auto mode in the control circuit of Pump Panel | For automatic pump Operation based on schedule / condition - (ensures equal run-time) |
| ii | Auto-Manual | Tertiary Chilled Water Pump auto manual status | | | 2 | | | | * | | * | Wiring from Auto/ Manual Switch | Wiring & termination at auxiliary potential free contact of auto manual switch of Pump Panel | Input information for command functions & interlocks |
| iii | On / Off Status | Tertiary Chilled water Pump run Status | | | 2 | | | | * | | | Current relay & Wiring | Wiring & Installation of current relay in MCC panel (cable alley) | Proof of pump running - interlock function |
| iv | Normal / Tripped | Tertiary Chilled water Pump trip Status | | | 2 | | | | * | | * | Wiring from MCC | Wiring & termination at auxiliary potential free contact of the over load relay of Pump Panel | Monitoring & Alarm information - other alerts |
| v | Control | Pump VFD control | | | | 2 | | | | * | | Wiring for 0-10 V DC or 4-20 ma output from BMS to VFD | VFD releasing information at one port on Open protocol [BACnet/Modbus] with built-in interface & communication cards | Monitoring & Controlling |
| vi | Monitor | VFD Pump operation | | | | | | X | * | | * | INTEGRATOR UNIT / Software connectivity | Primary pumping system information on open protocol [BACnet/Modbus] with built-in interface & communication cards. | Provide comprehensive Tertiary system information on BMS user interface, perform trend & archive functions |
| | | **Sub Total for Tertiary Pump** | | **0** | **6** | **2** | **2** | | | | | | | |
| | | | | | | | | | | | | | | |
| **F.4** | | **TFA (4 Nos)** | **4** | | | | | | | | | | | |

| Sr. No. | Description / Ranges | Function | Qty | AI | DI | AO | DO | SI | Monitor | Control | Alarm | By BMS provider | By respective service providers | Benefit / purpose |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| i | Start/ Stop | Treated Fresh Air unit on / off command | | | | | 4 | | | * | | Relay output @ 2 amp, 230 V & wiring from TFA MCC | Wiring & termination of potential free contact in auto mode in the control circuit of TFA MCC Panel | Automatic TFA Operation on schedule / condition - based controls |
| ii | Auto-Manual | Treated Fresh Air unit Auto-manual status | | | 4 | | | | * | | * | Wiring from TFA MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of TFA Panel | Input information for command functions & interlocks |
| iii | Clean / Clog | Treated Fresh Air Unit filter status | | | 4 | | | | * | | * | Diff. Pressure Switch across filter & field wiring | Insertion provision for Installation of DP switch across Filter | Proof of TFA Fan running - interlock function |
| iv | Start/ Stop | Treated Fresh Air Fans Air Flow status | | | 4 | | | | * | | * | Diff. Pressure Switch across FAN & field wiring | provision for Installation of DP switch across Fan | Proof of TFA Fan running |
| v | Deg C | Supply Air Temperature | | 4 | | | | | * | * | | Duct mount temp sensor & field wiring | Installation provision for temp. sensor | Input information for valve command functions |
| vi | % Open | 2-Way CHW valve modulating control | | | | 4 | | | | | * | Output signal from the DDC Controller & wiring to valve actuator | Supply & Installation of motorised tow way control valves including necessary nipples / mating flanges in the pipeline | Major energy saving feature - optimises CHW consumption |
| vii | Position | Valves status | | 4 | | | | | * | * | | Wiring from Valve Actuator | Two way valve with desired output | Input information for command functions |
| | | **Sub Total for TFA** | | **8** | **12** | **4** | **4** | | | | | | | |
| | | | | | | | | | | | | | | |
| **F.3** | | **VENTILLATION SYSTEM** | | | | | | | | | | | | |
| **i** | | **Pressurization Fan (10 Nos)** | **10** | | | | | | | | | | | |
| i | Start/ Stop | Normal mode Exhaust Fan on / off command | | | | | 10 | | | * | | Relay output @ 2 amp, 230 V & wiring from Fan MCC | Wiring & termination of potential free contact in auto mode in the control circuit of Fan MCC Panel | Automatic Fan Operation on schedule / condition - based controls |
| ii | Auto-Manual | Normal mode Exhaust Fan auto manual status | | | 10 | | | | * | | * | Wiring from Fan MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of Fan MCC Panel | Input information for command functions & interlocks |
| iii | On / Off | Fan Air Flow status | | | 10 | | | | * | | * | Diff. Pressure Switch - Air & field wiring | Insertion provision for Installation of DP switch across blower | Proof of fan running - interlock function |
| | | | | | | | | | | | | | | |
| **ii** | | **Basement Ventillation (7 Nos)** | **7** | | | | | | | | | | | |
| i | Start/ Stop | Fan on / off command | | | | | 7 | | | * | | Relay output @ 2 amp, 230 V & wiring from Fan MCC | Wiring & termination of potential free contact in auto mode in the control circuit of Fan MCC Panel | Automatic Fan Operation on schedule / condition - based controls |
| ii | Auto-Manual | Fan auto manual status | | | 7 | | | | * | | * | Wiring from Fan MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of Fan MCC Panel | Input information for command functions & interlocks |
| iii | On / Off | Fan run status | | | 7 | | | | * | | * | Diff. Pressure Switch - Air & field wiring | Insertion provision for Installation of DP switch across blower | Proof of fan running - interlock function |
| iv | Speed Modulation & Status | VFD Speed control, monitoring. Integration of VFDS, Frequency from VFD(0-10v/4-20mA) | | 7 | | 7 | | X | * | * | * | 0-10V feedback from VFD to DDC to monitor the frequency & Input signal (0-10V) to control the VFD frequency. Soft integration with Integrator Unit | HVAC Vendor to provide the protocol & address details for integration & IBMS Vendor to integrate the same with necessary cabling and all required accessories. | Major energy saving feature - Input information for command functions & Monitoring Information |
| | | **Sub Total for Ventillation** | | **7** | **34** | **7** | **17** | | | | | | | |
| | | | | | | | | | | | | | | |
| | | **Sub Total for Legal & Humanity Faculty** | | **185** | **134** | **73** | **41** | | | | | | | |
| | | | | | | | | | | | | | | |
| **G** | **SAARC HAAT** | | | | | | | | | | | | | |
| **G.1** | **AIR HANDLING UNITS** | | **10** | | | | | | | | | | | |
| i | Start/ Stop | AHU on / off command | | | | | 10 | | | * | | Relay output @ 2 amp, 230 V & wiring from AHU MCC | Wiring & termination of potential free contact in auto mode in the control circuit of AHU MCC Panel | Automatic AHU Operation on schedule / condition - based controls |
| ii | Auto-Manual | AHU auto manual status | | | 10 | | | | * | | * | Wiring from AHU MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of AHU Panel | Input information for command functions & interlocks |

| Sr. No. | Description / Ranges | Function | Qty | AI | DI | AO | DO | SI | Monitor | Control | Alarm | By BMS provider | By respective service providers | Benefit / purpose |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| iii | Clean / Clog | AHU Pre & Fine Filter status | | | 20 | | | | * | | * | Diff. Pressure Switch across filter & field wiring | Insertion provision for Installation of DP switch across Filter | Proof of AHU running - interlock function |
| iv | Normal / Trip | AHU Trip Status | | | 10 | | | | * | | * | Wiring from AHU MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of AHU Panel | Monitring & Alram Information & other Input |
| v | Run Status | AHU Run status | | | 10 | | | | * | | * | Diff. Pressure Switch across Blower & field wiring | Insertion provision for Installation of DP switch across Blower | Proof of AHU running - interlock function |
| vi | Deg C | Return Air Temperature & Humidity monitoring | | 20 | | | | | * | * | | Duct mount temp & Humidity sensor & field wiring | Installation provision for temp & Humidity sensor | Input information for valve command functions |
| vii | Deg C | Supply air temperature monitoring | | 10 | | | | | * | * | | Duct mount temp sensor & field wiring | Installation provision for temp. sensor | Input information for valve command functions |
| viii | Pressure | Supply Duct Pressure monitoring | | 10 | | | | | * | * | | Duct mount Diff Pressure Transmitter & field wiring | Installation provision for DPT | information & Flow Control |
| ix | % Open | 2-Way CHW valve modulating control | | | | 10 | | | | | * | Output signal from the DDC Controller & wiring to valve actuator | Supply & Installation of motorised tow way control valves including necessary nipples / mating flanges in the pipeline | Major energy saving feature - optimises CHW consumption |
| x | Position | Valves status | | 10 | | | | | * | * | | Wiring from Valve Actuator | Two way valve with desired output | Input information for command functions |
| xi | Deg C | On-Coil Water temperature | | 20 | | | | | * | | | Immersion temperature sensor with thermowell & wiring | Providing of suitably sized socket in the condenser water line | information |
| xii | CO2 Sensor | CO2 Measurement in Return air | | 10 | | | | | | | | Duct type CO2 Sensor for return air for Each AHU | Installation provision for CO2 sensor | Ventillation Control |
| xiii | % Open | Motorised Fresh Air Damper Command & Status | | 10 | | 10 | | | | | * | Output signal from the DDC Controller & wiring to Damper actuator | Supply & Installation of motorised Damper Controller including necessary accessories | Major energy saving feature - optimises CHW consumption |
| xiv | % Open | Motorised Bypass/ Return Damper Command | | 10 | | 10 | | | | | * | Output signal from the DDC Controller & wiring to Damper actuator | Supply & Installation of motorised Damper Controller including necessary accessories | Major energy saving feature - optimises CHW consumption |
| xv | Speed Modulation & Status | VFD Speed control, monitoring. Integration of VFDS, Frequency from VFD(0-10v/4-20mA) | | 10 | | 10 | | X | * | * | * | 0-10V feedback from VFD to DDC to monitor the frequency, Input signal (0-10V) to control the VFD frequency on return air basis. Soft integration with Integrator Unit | HVAC Vendor to provide the protocol & address details for integration & IBMS Vendor to integrate the same with necessary cabling and all required accessories. | Major energy saving feature - Input information for command functions & Monitoring Information |
| | | **Sub Total for AHU** | | **110** | **50** | **40** | **10** | | | | | | | |
| | | | | | | | | | | | | | | |
| **G.2** | **HEAT RECOVERY WHEEL UNIT** | | **4** | | | | | | | | | | | |
| i | Start/ Stop | Heat Recovery Wheel ON/OFF Command | | | | | 4 | | | * | | Relay output @ 2 amp, 230 V & wiring from HRU MCC | Wiring & termination of potential free contact in auto mode in the control circuit of HRU MCC Panel | Automatic HRU Operation on schedule / condition - based controls |
| ii | Auto-Manual | Heat Recovery Wheel Auto / Manual status | | | 4 | | | | * | | * | Wiring from HRU MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of HRU Panel | Input information for command functions & interlocks |
| iii | Clean / Clog | Heat Recovery Unit filter status | | | 4 | | | | * | | * | Diff. Pressure Switch across filter & field wiring | Insertion provision for Installation of DP switch across Filter | Proof of HRU Fan running - interlock function |
| iv | Start/ Stop | Heat Recovery Wheel Air Flow status | | | 4 | | | | * | | * | Diff. Pressure Switch across FAN & field wiring | provision for Installation of DP switch across Fan | Proof of HRU Fan running |
| v | Deg C | Supply Air Temperature | | 4 | | | | | * | * | | Duct mount temp sensor & field wiring | Installation provision for temp. sensor | Input information for valve command functions |
| vi | Deg C | Return Air Temperature & Humidity monitoring | | 8 | | | | | * | * | | Duct mount temp & Humidity sensor & field wiring | Installation provision for temp & Humidity sensor | Input information for valve command functions |
| vii | Speed Modulation & Status | VFD Speed control, monitoring. Integration of VFDS, Frequency from VFD(0-10v/4-20mA) | | 4 | | 4 | | X | * | * | * | 0-10V feedback from VFD to DDC to monitor the frequency, Input signal (0-10V) to control the VFD frequency on return air basis. Soft integration with Integrator Unit | HVAC Vendor to provide the protocol & address details for integration & IBMS Vendor to integrate the same with necessary cabling and all required accessories. | Major energy saving feature - Input information for command functions & Monitoring Information |
| | | **Sub Total for HRW** | | **16** | **12** | **4** | **4** | | | | | | | |
| | | | | | | | | | | | | | | |
| **G.3** | | **Tertiary Chilled Water Pump** | **2** | | | | | | | | | | | |

| Sr. No. | Description / Ranges | Function | Qty | AI | DI | AO | DO | SI | Monitor | Control | Alarm | By BMS provider | By respective service providers | Benefit / purpose |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| i | Start/ Stop | Tertiary Chilled Water Pump on / off command | | | | | 2 | | | * | | Relay output @ 2 amp, 230 V and wiring from MCC | Wiring and termination of potential free contact in auto mode in the control circuit of Pump Panel | For automatic pump Operation based on schedule / condition - (ensures equal run-time) |
| ii | Auto-Manual | Tertiary Chilled Water Pump auto manual status | | | 2 | | | | * | | * | Wiring from Auto/ Manual Switch | Wiring & termination at auxiliary potential free contact of auto manual switch of Pump Panel | Input information for command functions & interlocks |
| iii | On / Off Status | Tertiary Chilled water Pump run Status | | | 2 | | | | * | | | Current relay & Wiring | Wiring & Installation of current relay in MCC panel (cable alley) | Proof of pump running - interlock function |
| iv | Normal / Tripped | Tertiary Chilled water Pump trip Status | | | 2 | | | | * | | * | Wiring from MCC | Wiring & termination at auxiliary potential free contact of the over load relay of Pump Panel | Monitoring & Alarm information - other alerts |
| v | Control | Pump VFD control | | | | 2 | | | | * | | Wiring for 0-10 V DC or 4-20 ma output from BMS to VFD | VFD releasing information at one port on Open protocol [BACnet/Modbus] with built-in interface & communication cards | Monitoring & Controlling |
| vi | Monitor | VFD Pump operation | | | | | | X | * | | * | INTEGRATOR UNIT / Software connectivity | Primary pumping system information on open protocol [BACnet/Modbus] with built-in interface & communication cards. | Provide comprehensive Tertiary system information on BMS user interface, perform trend & archive functions |
| | | **Sub Total for Tertiary Pump** | | **0** | **6** | **2** | **2** | | | | | | | |
| | | | | | | | | | | | | | | |
| **G.4** | | **TFA (2 Nos)** | **2** | | | | | | | | | | | |
| i | Start/ Stop | Treated Fresh Air unit on / off command | | | | | 2 | | | * | | Relay output @ 2 amp, 230 V & wiring from TFA MCC | Wiring & termination of potential free contact in auto mode in the control circuit of TFA MCC Panel | Automatic TFA Operation on schedule / condition - based controls |
| ii | Auto-Manual | Treated Fresh Air unit Auto-manual status | | | 2 | | | | * | | * | Wiring from TFA MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of TFA Panel | Input information for command functions & interlocks |
| iii | Clean / Clog | Treated Fresh Air Unit filter status | | | 2 | | | | * | | * | Diff. Pressure Switch across filter & field wiring | Insertion provision for Installation of DP switch across Filter | Proof of TFA Fan running - interlock function |
| iv | Start/ Stop | Treated Fresh Air Fans Air Flow status | | | 2 | | | | * | | * | Diff. Pressure Switch across FAN & field wiring | provision for Installation of DP switch across Fan | Proof of TFA Fan running |
| v | Deg C | Supply Air Temperature | | 2 | | | | | * | * | | Duct mount temp sensor & field wiring | Installation provision for temp. sensor | Input information for valve command functions |
| vi | % Open | 2-Way CHW valve modulating control | | | | 2 | | | | | * | Output signal from the DDC Controller & wiring to valve actuator | Supply & Installation of motorised tow way control valves including necessary nipples / mating flanges in the pipeline | Major energy saving feature - optimises CHW consumption |
| vii | Position | Valves status | | 2 | | | | | * | * | | Wiring from Valve Actuator | Two way valve with desired output | Input information for command functions |
| | | **Sub Total for TFA** | | **4** | **6** | **2** | **2** | | | | | | | |
| | | | | | | | | | | | | | | |
| **G.3** | | **VENTILLATION SYSTEM** | | | | | | | | | | | | |
| **i** | | **Pressurization Fan (6 Nos)** | **6** | | | | | | | | | | | |
| i | Start/ Stop | Normal mode Exhaust Fan on / off command | | | | | 6 | | | * | | Relay output @ 2 amp, 230 V & wiring from Fan MCC | Wiring & termination of potential free contact in auto mode in the control circuit of Fan MCC Panel | Automatic Fan Operation on schedule / condition - based controls |
| ii | Auto-Manual | Normal mode Exhaust Fan auto manual status | | | 6 | | | | * | | * | Wiring from Fan MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of Fan MCC Panel | Input information for command functions & interlocks |
| iii | On / Off | Fan Air Flow status | | | 6 | | | | * | | * | Diff. Pressure Switch - Air & field wiring | Insertion provision for Installation of DP switch across blower | Proof of fan running - interlock function |
| | | | | | | | | | | | | | | |
| **ii** | | **Basement Ventillation (10 Nos)** | **10** | | | | | | | | | | | |
| i | Start/ Stop | Fan on / off command | | | | | 10 | | | * | | Relay output @ 2 amp, 230 V & wiring from Fan MCC | Wiring & termination of potential free contact in auto mode in the control circuit of Fan MCC Panel | Automatic Fan Operation on schedule / condition - based controls |

| Sr. No. | Description / Ranges | Function | Qty | AI | DI | AO | DO | SI | Monitor | Control | Alarm | By BMS provider | By respective service providers | Benefit / purpose |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ii | Auto-Manual | Fan auto manual status | | | 10 | | | | * | | * | Wiring from Fan MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of Fan MCC Panel | Input information for command functions & interlocks |
| iii | On / Off | Fan run status | | | 10 | | | | * | | * | Diff. Pressure Switch - Air & field wiring | Insertion provision for Installation of DP switch across blower | Proof of fan running - interlock function |
| iv | Speed Modulation & Status | VFD Speed control, monitoring. Integration of VFDS, Frequency from VFD(0-10v/4-20mA) | | 10 | | 10 | | X | * | * | * | 0-10V feedback from VFD to DDC to monitor the frequency & Input signal (0-10V) to control the VFD frequency. Soft integration with Integrator Unit | HVAC Vendor to provide the protocol & address details for integration & IBMS Vendor to integrate the same with necessary cabling and all required accessories. | Major energy saving feature - Input information for command functions & Monitoring Information |
| | | **Sub Total for Ventillation** | | **10** | **32** | **10** | **16** | | | | | | | |
| | | | | | | | | | | | | | | |
| | | **Sub Total for SAARC Haat** | | **140** | **106** | **58** | **34** | | | | | | | |
| | | | | | | | | | | | | | | |
| **H** | **LIBRARY** | | | | | | | | | | | | | |
| **H.1** | **AIR HANDLING UNITS** | | **18** | | | | | | | | | | | |
| i | Start/ Stop | AHU on / off command | | | | | 18 | | | * | | Relay output @ 2 amp, 230 V & wiring from AHU MCC | Wiring & termination of potential free contact in auto mode in the control circuit of AHU MCC Panel | Automatic AHU Operation on schedule / condition - based controls |
| ii | Auto-Manual | AHU auto manual status | | | 18 | | | | * | | * | Wiring from AHU MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of AHU Panel | Input information for command functions & interlocks |
| iii | Clean / Clog | AHU Pre & Fine Filter status | | | 36 | | | | * | | * | Diff. Pressure Switch across filter & field wiring | Insertion provision for Installation of DP switch across Filter | Proof of AHU running - interlock function |
| iv | Normal / Trip | AHU Trip Status | | | 18 | | | | * | | * | Wiring from AHU MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of AHU Panel | Monitring & Alram Information & other Input |
| v | Run Status | AHU Run status | | | 18 | | | | * | | * | Diff. Pressure Switch across Blower & field wiring | Insertion provision for Installation of DP switch across Blower | Proof of AHU running - interlock function |
| vi | Deg C | Return Air Temperature & Humidity monitoring | | 36 | | | | | * | * | | Duct mount temp & Humidity sensor & field wiring | Installation provision for temp & Humidity sensor | Input information for valve command functions |
| vii | Deg C | Supply air temperature monitoring | | 18 | | | | | * | * | | Duct mount temp sensor & field wiring | Installation provision for temp. sensor | Input information for valve command functions |
| viii | Pressure | Supply Duct Pressure monitoring | | 18 | | | | | * | * | | Duct mount Diff Pressure Transmitter & field wiring | Installation provision for DPT | information & Flow Control |
| ix | % Open | 2-Way CHW valve modulating control | | | | 18 | | | | | * | Output signal from the DDC Controller & wiring to valve actuator | Supply & Installation of motorised tow way control valves including necessary nipples / mating flanges in the pipeline | Major energy saving feature - optimises CHW consumption |
| x | Position | Valves status | | 18 | | | | | * | * | | Wiring from Valve Actuator | Two way valve with desired output | Input information for command functions |
| xi | Deg C | On-Coil & Off-Coil Water temperature | | 36 | | | | | * | | | Immersion temperature sensor with thermowell & wiring | Providing of suitably sized socket in the condenser water line | information |
| xii | CO2 Sensor | CO2 Measurement in Return air | | 18 | | | | | | | | Duct type CO2 Sensor for return air for Each AHU | Installation provision for CO2 sensor | Ventillation Control |
| xiii | % Open | Motorised Fresh Air Damper Command & Status | | 18 | | 18 | | | | | * | Output signal from the DDC Controller & wiring to Damper actuator | Supply & Installation of motorised Damper Controller including necessary accessories | Major energy saving feature - optimises CHW consumption |
| xiv | % Open | Motorised Bypass/ Return Damper Command | | 18 | | 18 | | | | | * | Output signal from the DDC Controller & wiring to Damper actuator | Supply & Installation of motorised Damper Controller including necessary accessories | Major energy saving feature - optimises CHW consumption |
| xv | Speed Modulation & Status | VFD Speed control, monitoring. Integration of VFDS, Frequency from VFD(0-10v/4-20mA) | | 18 | | 18 | | X | * | * | * | 0-10V feedback from VFD to DDC to monitor the frequency, Input signal (0-10V) to control the VFD frequency on return air basis. Soft integration with Integrator Unit | HVAC Vendor to provide the protocol & address details for integration & IBMS Vendor to integrate the same with necessary cabling and all required accessories. | Major energy saving feature - Input information for command functions & Monitoring Information |
| | | **Sub Total for AHU** | | **198** | **90** | **72** | **18** | | | | | | | |
| | | | | | | | | | | | | | | |
| **H.2** | **HEAT RECOVERY WHEEL UNIT** | | **4** | | | | | | | | | | | |

| Sr. No. | Description / Ranges | Function | Qty | AI | DI | AO | DO | SI | Monitor | Control | Alarm | By BMS provider | By respective service providers | Benefit / purpose |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| i | Start/ Stop | Heat Recovery Wheel ON/OFF Command | | | | | 4 | | | * | | Relay output @ 2 amp, 230 V & wiring from HRU MCC | Wiring & termination of potential free contact in auto mode in the control circuit of HRU MCC Panel | Automatic HRU Operation on schedule / condition - based controls |
| ii | Auto-Manual | Heat Recovery Wheel Auto / Manual status | | | 4 | | | | * | | * | Wiring from HRU MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of HRU Panel | Input information for command functions & interlocks |
| iii | Clean / Clog | Heat Recovery Unit filter status | | | 4 | | | | * | | * | Diff. Pressure Switch across filter & field wiring | Insertion provision for Installation of DP switch across Filter | Proof of HRU Fan running - interlock function |
| iv | Start/ Stop | Heat Recovery Wheel Air Flow status | | | 4 | | | | * | | * | Diff. Pressure Switch across FAN & field wiring | provision for Installation of DP switch across Fan | Proof of HRU Fan running |
| v | Deg C | Supply Air Temperature | | 4 | | | | | * | * | | Duct mount temp sensor & field wiring | Installation provision for temp. sensor | Input information for valve command functions |
| vi | Deg C | Return Air Temperature & Humidity monitoring | | 8 | | | | | * | * | | Duct mount temp & Humidity sensor & field wiring | Installation provision for temp & Humidity sensor | Input information for valve command functions |
| vii | Speed Modulation & Status | VFD Speed control, monitoring. Integration of VFDS, Frequency from VFD(0-10v/4-20mA) | | 4 | | 4 | | X | * | * | * | 0-10V feedback from VFD to DDC to monitor the frequency, Input signal (0-10V) to control the VFD frequency on return air basis. Soft integration with Integrator Unit | HVAC Vendor to provide the protocol & address details for integration & IBMS Vendor to integrate the same with necessary cabling and all required accessories. | Major energy saving feature - Input information for command functions & Monitoring Information |
| | | **Sub Total for HRW** | | **16** | **12** | **4** | **4** | | | | | | | |
| | | | | | | | | | | | | | | |
| **H.3** | | **Tertiary Chilled Water Pump** | **2** | | | | | | | | | | | |
| i | Start/ Stop | Tertiary Chilled Water Pump on / off command | | | | | 2 | | | * | | Relay output @ 2 amp, 230 V and wiring from MCC | Wiring and termination of potential free contact in auto mode in the control circuit of Pump Panel | For automatic pump Operation based on schedule / condition - (ensures equal run-time) |
| ii | Auto-Manual | Tertiary Chilled Water Pump auto manual status | | | 2 | | | | * | | * | Wiring from Auto/ Manual Switch | Wiring & termination at auxiliary potential free contact of auto manual switch of Pump Panel | Input information for command functions & interlocks |
| iii | On / Off Status | Tertiary Chilled water Pump run Status | | | 2 | | | | * | | | Current relay & Wiring | Wiring & Installation of current relay in MCC panel (cable alley) | Proof of pump running - interlock function |
| iv | Normal / Tripped | Tertiary Chilled water Pump trip Status | | | 2 | | | | * | | * | Wiring from MCC | Wiring & termination at auxiliary potential free contact of the over load relay of Pump Panel | Monitoring & Alarm information - other alerts |
| v | Control | Pump VFD control | | | | 2 | | | | * | | Wiring for 0-10 V DC or 4-20 ma output from BMS to VFD | VFD releasing information at one port on Open protocol [BACnet/Modbus] with built-in interface & communication cards | Monitoring & Controlling |
| vi | Monitor | VFD Pump operation | | | | | | X | * | | * | INTEGRATOR UNIT / Software connectivity | Primary pumping system information on open protocol [BACnet/Modbus] with built-in interface & communication cards. | Provide comprehensive Tertiary system information on BMS user interface, perform trend & archive functions |
| | | **Sub Total for Tertiary Pump** | | **0** | **6** | **2** | **2** | | | | | | | |
| | | | | | | | | | | | | | | |
| **H.4** | | **TFA (3 Nos)** | **3** | | | | | | | | | | | |
| i | Start/ Stop | Treated Fresh Air unit on / off command | | | | | 3 | | | * | | Relay output @ 2 amp, 230 V & wiring from TFA MCC | Wiring & termination of potential free contact in auto mode in the control circuit of TFA MCC Panel | Automatic TFA Operation on schedule / condition - based controls |
| ii | Auto-Manual | Treated Fresh Air unit Auto-manual status | | | 3 | | | | * | | * | Wiring from TFA MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of TFA Panel | Input information for command functions & interlocks |
| iii | Clean / Clog | Treated Fresh Air Unit filter status | | | 3 | | | | * | | * | Diff. Pressure Switch across filter & field wiring | Insertion provision for Installation of DP switch across Filter | Proof of TFA Fan running - interlock function |
| iv | Start/ Stop | Treated Fresh Air Fans Air Flow status | | | 3 | | | | * | | * | Diff. Pressure Switch across FAN & field wiring | provision for Installation of DP switch across Fan | Proof of TFA Fan running |
| v | Deg C | Supply Air Temperature | | 3 | | | | | * | * | | Duct mount temp sensor & field wiring | Installation provision for temp. sensor | Input information for valve command functions |

| Sr. No. | Description / Ranges | Function | Qty | AI | DI | AO | DO | SI | Monitor | Control | Alarm | By BMS provider | By respective service providers | Benefit / purpose |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| vi | % Open | 2-Way CHW valve modulating control | | | | 3 | | | | | * | Output signal from the DDC Controller & wiring to valve actuator | Supply & Installation of motorised tow way control valves including necessary nipples / mating flanges in the pipeline | Major energy saving feature - optimises CHW consumption |
| vii | Position | Valves status | | 3 | | | | | * | * | | Wiring from Valve Actuator | Two way valve with desired output | Input information for command functions |
| | | **Sub Total for TFA** | | **6** | **9** | **3** | **3** | | | | | | | |
| | | | | | | | | | | | | | | |
| **H.5** | | **VENTILLATION SYSTEM** | | | | | | | | | | | | |
| **i** | | **Pressurization Fan (5 Nos)** | **5** | | | | | | | | | | | |
| i | Start/ Stop | Normal mode Exhaust Fan on / off command | | | | | 5 | | | * | | Relay output @ 2 amp, 230 V & wiring from Fan MCC | Wiring & termination of potential free contact in auto mode in the control circuit of Fan MCC Panel | Automatic Fan Operation on schedule / condition - based controls |
| ii | Auto-Manual | Normal mode Exhaust Fan auto manual status | | | 5 | | | | * | | * | Wiring from Fan MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of Fan MCC Panel | Input information for command functions & interlocks |
| iii | On / Off | Fan Air Flow status | | | 5 | | | | * | | * | Diff. Pressure Switch - Air & field wiring | Insertion provision for Installation of DP switch across blower | Proof of fan running - interlock function |
| | | | | | | | | | | | | | | |
| **ii** | | **Basement Ventillation (4 Nos)** | **4** | | | | | | | | | | | |
| i | Start/ Stop | Fan on / off command | | | | | 4 | | | * | | Relay output @ 2 amp, 230 V & wiring from Fan MCC | Wiring & termination of potential free contact in auto mode in the control circuit of Fan MCC Panel | Automatic Fan Operation on schedule / condition - based controls |
| ii | Auto-Manual | Fan auto manual status | | | 4 | | | | * | | * | Wiring from Fan MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of Fan MCC Panel | Input information for command functions & interlocks |
| iii | On / Off | Fan run status | | | 4 | | | | * | | * | Diff. Pressure Switch - Air & field wiring | Insertion provision for Installation of DP switch across blower | Proof of fan running - interlock function |
| iv | Speed Modulation & Status | VFD Speed control, monitoring. Integration of VFDS, Frequency from VFD(0-10v/4-20mA) | | 4 | | 4 | | X | * | * | * | 0-10V feedback from VFD to DDC to monitor the frequency & Input signal (0-10V) to control the VFD frequency. Soft integration with Integrator Unit | HVAC Vendor to provide the protocol & address details for integration & IBMS Vendor to integrate the same with necessary cabling and all required accessories. | Major energy saving feature - Input information for command functions & Monitoring Information |
| | | **Sub Total for Ventillation** | | **4** | **18** | **4** | **9** | | | | | | | |
| | | | | | | | | | | | | | | |
| | | **Sub Total for Library** | | **224** | **135** | **85** | **36** | | | | | | | |
| | | | | | | | | | | | | | | |
| **I** | | **VENTILLATION SYSTEM - Faculty Housing & Hostels** | | | | | | | | | | | | |
| **I.1** | | **Air washers / Scrubber (1+1 Nos)** | **2** | | | | | | | | | | | |
| i | Start/ Stop | Air washer / Scrubber on / off command | | | | | 2 | | | * | | Relay output @ 2 amp, 230 V & wiring from AHU MCC | Wiring & termination of potential free contact in auto mode in the control circuit of AHU MCC Panel | Automatic AHU Operation on schedule / condition - based controls |
| ii | Auto-Manual | Air washer / Scrubber auto manual status | | | 2 | | | | * | | * | Wiring from AHU MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of AHU Panel | Input information for command functions & interlocks |
| iii | On / Off | Air washer / Scrubber air flow status | | | 2 | | | | * | | * | Diff. Pressure Switch - Air & field wiring | Insertion provision for Installation of DP switch across blower | Proof of AHU running - interlock function |
| iv | Dirty / Clean | Air washer / Scrubber filter status | | | 2 | | | | x | | * | Diff. Pressure Switch - Air & field wiring | Insertion provision for Installation of DP switch across filter | Maintenance alert for filter cleaning |
| v | Start/ Stop | Pump on / off command | | | | | 2 | | * | | | Relay output @ 2 amp, 230 V and wiring from MCC | Wiring and termination of potential free contact in auto mode in the control circuit of Pump Panel | For automatic pump Operation based on schedule / condition - (ensures equal run-time) |
| vi | Auto-Manual | Pump auto manual status | | | 2 | | | * | | * | | Wiring from MCC | Wiring & termination at auxiliary potential free contact of auto manual switch of Pump Panel | Input information for command functions & interlocks |
| vii | On / Off | Pump run Status | | | 2 | | | | * | | | Water Differential Pressure switch & Wiring | Installation provision of DP Switch across the pumps | Proof of pump running - interlock function |

| Sr. No. | Description / Ranges | Function | Qty | AI | DI | AO | DO | SI | Monitor | Control | Alarm | By BMS provider | By respective service providers | Benefit / purpose |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| viii | Normal / Tripped | Pump trip Status | | | 2 | | | * | | * | | Wiring from MCC | Wiring & termination at auxiliary potential free contact of the over load relay of Pump Panel | Monitoring & Alarm information - other alerts |
| | | | | | | | | | | | | | | |
| **I.2** | | **Basement Ventillation (30 Nos)** | **30** | | | | | | | | | | | |
| i | Start/ Stop | Fan on / off command | | | | | 30 | | | * | | Relay output @ 2 amp, 230 V & wiring from Fan MCC | Wiring & termination of potential free contact in auto mode in the control circuit of Fan MCC Panel | Automatic Fan Operation on schedule / condition - based controls |
| ii | Auto-Manual | Fan auto manual status | | | 30 | | | | * | | * | Wiring from Fan MCC | Wiring & termination of auxiliary potential free contact of auto manual switch of Fan MCC Panel | Input information for command functions & interlocks |
| iii | On / Off | Fan run status | | | 30 | | | | * | | * | Diff. Pressure Switch - Air & field wiring | Insertion provision for Installation of DP switch across blower | Proof of fan running - interlock function |
| v | Speed Modulation & Status | VFD Speed control, monitoring. Integration of VFDS, Frequency from VFD(0-10v/4-20mA) | | 30 | | 30 | | X | * | * | * | 0-10V feedback from VFD to DDC to monitor the frequency & Input signal (0-10V) to control the VFD frequency. Soft integration with Integrator Unit | HVAC Vendor to provide the protocol & address details for integration & IBMS Vendor to integrate the same with necessary cabling and all required accessories. | Major energy saving feature - Input information for command functions & Monitoring Information |
| | | **Sub Total for Faculty Housing & Hostels** | | **30** | **72** | **30** | **34** | | | | | | | |
| | | | | | | | | | | | | | | |
| **L** | | **Fire Fighting Pump** | **10** | | | | | | | | | | | |
| i | Start/ Stop | Jocky / Sprinkler / hydrent Pump on / off command | | | | | 10 | | * | | | Relay output @ 2 amp, 230 V and wiring from MCC | Wiring and termination of potential free contact in auto mode in the control circuit of Pump Panel | For automatic pump Operation based on schedule / condition - (ensures equal run-time) |
| ii | Auto-Manual | Jocky / Sprinkler / hydrent Pump auto manual status | | | 10 | | | * | | * | | Wiring from MCC | Wiring & termination at auxiliary potential free contact of auto manual switch of Pump Panel | Input information for command functions & interlocks |
| iii | On / Off | Pump run Status (Electrically Driven) | | | 10 | | | | * | | | Current relay & Wiring | Provision for Installation of current relay in the pump pannel | Proof of pump running - interlock function |
| iv | Normal / Tripped | Pump trip Status (Electrically Driven) | | | 10 | | | * | | * | | Wiring from MCC | Wiring & termination at auxiliary potential free contact of the over load relay of Pump Panel | Monitoring & Alarm information - other alerts |
| v | On / Off | Pump run Status (Diesel Driven) | | | 2 | | | | * | | | Current relay & Wiring | Provision for Installation of current relay in the pump pannel | Proof of pump running - interlock function |
| vi | Normal / Tripped | Pump trip Status (Diesel Driven) | | | 2 | | | * | | * | | Wiring from MCC | Wiring & termination at auxiliary potential free contact of the over load relay of Pump Panel | Monitoring & Alarm information - other alerts |
| vii | Status | Hydrant pressure monitroing | | 9 | | | | | | | | Water Pressure Transmitter | Wiring & termination from Pressure Switch of Pump Panel | Monitoring & Alarm information - other alerts |
| viii | Status | Sprinkler pressure monitroing | | 9 | | | | | | | | Water Pressure Transmitter | Wiring & termination from Pressure Switch of Pump Panel | Monitoring & Alarm information - other alerts |
| | | | | | | | | | | | | | | |
| **M** | | **Plumbing / Domestic / Raw Water Pump** | **18** | | | | | | | | | | | |
| i | Start/ Stop | Pump on / off command | | | | | 18 | | * | | | Relay output @ 2 amp, 230 V and wiring from MCC | Wiring and termination of potential free contact in auto mode in the control circuit of Pump Panel | For automatic pump Operation based on schedule / condition - (ensures equal run-time) |
| ii | Auto-Manual | Pump auto manual status | | | 18 | | | * | | * | | Wiring from MCC | Wiring & termination at auxiliary potential free contact of auto manual switch of Pump Panel | Input information for command functions & interlocks |
| iii | On / Off | Pump run Status | | | 18 | | | | * | | | Current relay & Wiring | Provision for Installation of current relay in the pump pannel | Proof of pump running - interlock function |
| iv | Normal / Tripped | Pump trip Status | | | 18 | | | * | | * | | Wiring from MCC | Wiring & termination at auxiliary potential free contact of the over load relay of Pump Panel | Monitoring & Alarm information - other alerts |

| Sr. No. | Description / Ranges | Function | Qty | AI | DI | AO | DO | SI | Monitor | Control | Alarm | By BMS provider | By respective service providers | Benefit / purpose |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v | High / Low | Overhead Tank Water level monitoring low/High (5 Nos) | | | 10 | | | | * | | * | Level Switch & field wiring | Provision of suitably sized socket for installation of level switch | Monitoring & Alarm information - other alerts / interlock functions |
| vi | High / Low | Undeground Tank Water level monitoring low (8 Nos) | | | 8 | | | | * | | * | Level Switch & field wiring | Provision of suitably sized socket for installation of level switch | Monitoring & Alarm information - other alerts / interlock functions |
| | | | | | | | | | | | | | | |
| **O** | | **WTP Panel Mapping** | | | | | | | | | | | | |
| i | Software mapping | WTP Panel Monitoring / Soft Integration | | | | | | X | * | | * | INTEGRATOR UNIT / Software connectivity | WTP Panle providing Output on Open Protocol BACnet / Modbus RTU | information |
| | | | | | | | | | | | | | | |
| **P** | | **STP Panel Mapping** | | | | | | | | | | | | |
| i | Software mapping | STP Panel Monitoring / Soft Integration | | | | | | X | * | | * | INTEGRATOR UNIT / Software connectivity | WTP Panle providing Output on Open Protocol BACnet / Modbus RTU | information |
| | | | | | | | | | | | | | | |
| **Q** | | **Fire Fighting Panel Mapping** | | | | | | | | | | | | |
| i | Software mapping | FF Panel Monitoring / Soft Integration | | | | | | X | * | | * | INTEGRATOR UNIT / Software connectivity | FF Panle providing Output on Open Protocol BACnet / Modbus RTU | information |
| | | | | | | | | | | | | | | |
| **R** | | **VAV Box** | | | | | | | | | | | | |
| i | Software mapping | VAV BOX Parameters Monitoring / Soft Integration (245 Nos) | | | | | | X | * | | * | INTEGRATOR UNIT / Software connectivity | VAV Box providing Output on Open Protocol BACnet / Modbus RTU | information |
| | | | | | | | | | | | | | | |
| **S** | | **BTU Meter** | | | | | | | | | | | | |
| i | Software mapping | BTU Meter Monitoring / Soft Integration (15 Nos) | | | | | | X | * | | * | INTEGRATOR UNIT / Software connectivity | BTU Meters providing Output on Open Protocol BACnet / Modbus RTU | information |
| | | | | | | | | | | | | | | |
| **T** | | **FIRE DETECTION SYSTEM** | | | | | | | | | | | | |
| i | Software mapping | Complete monitoring of common area Addressable Fire Detection System Control Panel (for 10000 Soft Points) | | | | | | X | * | | * | Software integration of all the parameters from Main Addressable Fire Detection Panel on BMS | Addressable Fire Detection Panel communicating on open protocol [BACnet/Modbus] at one point | Monitor and record information from Addressable Fire Detection System |
| | | | | | | | | | | | | | | |
| **U** | | **Elevator System** | **60** | | | | | | | | | | | |
| i | Normal / Alarm | Lift alarm connectivity | | | 60 | | | | * | | * | Wiring from Lift panel (Separate for all towers) | Potential free contact from lift panel | Monitoring / Alarm function |
| ii | Normal / Tripped | Lift trip status | | | 60 | | | | * | | * | Wiring from Lift panel (Separate for all towers) | Potential free contact from lift panel | Monitoring / Alarm function |
| iii | Normal / Alarm | Push Button Alarm Monitoring | | | 60 | | | | | | | Wiring from Lift panel (Separate for all towers) | Potential free contact from lift panel | Monitoring / Alarm function |
| v | Software mapping | Lift Panel Monitoring / Soft Integration | | | | | | X | * | | * | Integrator Unit / Software Connectivity & Harwired Connectivity | Lift Panle providing Output on Open Protocol BACnet / Modbus RTU | Monitoring & Alarm information - other alerts / interlock functions |
| | | **SUB Total - Other Services** | | **18** | **286** | **0** | **28** | | | | | | | |
| | | | | | | | | | | | | | | |
| | | **GRAND TOTAL** | | **2111** | **1966** | **824** | **530** | | | | | | | |
| | | **SPARE I/O 15%** | | **317** | **295** | **124** | **80** | | | | | | | |
| | | **GRAND TOTAL WITH SPARE DATA POINTS** | | **2428** | **2261** | **948** | **610** | | | | | | | |

# 13.5. ANNEXURE II – DDR FOR BMS WORKS

## 13.5. ANNEXURE 2 – DDR FOR BMS SYSTEM

### 13.5.1. Introduction:

a South Asian University is an International level educational campus proposed to be located at Maidan Garhi, New Delhi. The university includes Academic blocks, Library, Hostels, Residences, Gymnasiums, Health center etc. The Overall campus has a total plot area of 95.7 acres.

**b Site Location:**

| | | |
|---|---|---|
| i | Site Location | : New Delhi |
| ii | Geographic Location | : 28.38°N, 77.13°E |
| iii | Altitude | : 216 m above mean sea level |

### 13.5.2. Scope of Document:

a The Document covers the proposal for Building Management Solution requirement & its implementation at South Asian University at Maidan garhi, New Delhi Campus for below mentioned locations for the current phase requirement;

b Faculty of Art, Design & convention Center – This Building includes Amphitheater, Art Gallery, Cafeteria, Dean's Room & official's sitting, Mini-theater, Class Rooms, Convention Center Auditorium, Design Studios etc. Building consists of a basement + Ground Floor + 4 Floors.

c Faculty of Life Science & Earth science Building - This building includes Laboratories, Lecture hall, Lounge, PI room, specialized room, Animal holding & central Instrumentation room, Cafeteria etc .Building consists of a basement + Lower Ground + 6 Floors and a service floor on the top and a total built-up area of 44781.67 Sq. Mtr.

d Faculty of Physics Chemistry & Maths-IT –This Building includes Dean's & Official's Sitting, Class Rooms, various labs, conference Rooms, Department Library, Cafeteria, Meeting Rooms & Faculty Sitting etc. Building consists of a Basement + Ground Floor + 3 Floors divided in to 2 Zones.

e Faculty of Legal Studies & Humanities –This Building includes Dean's & Official's Sitting, Class Rooms, Multiple Halls , conference Rooms, Cafeteria, Meeting Rooms & Faculty Sitting etc. Building consists of a Basement + Ground Floor + 3 Floors.

f Administration Building – This Building includes Facilitation Center, Exhibition Center, Conference Room, Cafeteria, Director's, officials & General Admin sitting. Building consists of a Basement + Ground Floor + 5 Floors.

g Library – This Building includes General Reading Area, Book Storage, Cafeteria, officials & General Admin sitting, Meeting Rooms etc. Building consists of a Basement + Ground Floor + 5 Floors.

h SAARC Haat –Building consists of a Basement + Ground Floor + 4 Floors.

i Faculty club and Guest House - This Building includes Dining halls, Banquet hall, Guest rooms, Gym, Aerobics room, Yoga room, etc. The Overall Faculty Club and Guest House has a total built-up area of 2140 Sq. Mtr.

j Faculty & Staff Housing Building – The Building includes flats for faculty having living, dining room, toilets, kitchen and bathroom. Three of these blocks are to be constructed in this phase. Each Faculty & Staff Housing block consists of 6 tower and a basement & having total built-up area of 19822 Sq. Mtr.

**BMS System Architecture& Codes:**

The Building Management System (BMS) shall use an open architecture and fully support a multi-vendor environment. To accomplish this effectively, the BMS shall support open communication protocol standards and integrate a wide variety of third-party devices and applications. The system shall be designed for use on the Internet, or intranets using off the shelf, industry standard technology compatible with other owner provided networks. The BMS shall work on following protocols;

a BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9.
b All Controllers should BACnet Testing Labs (BTL) certified and carry the BTL Label.
c Lon-Works enabled devices using the Free Topology Transceiver (FTT-10a).
d The system shall comply with NFPA 90A Air Conditioning and 90B Warm Air Heating, Air conditioning standard.
e System devices used for smoke control shall have UL864 (UUKL smoke control).

Including the above the System shall fulfil the requirement as per mentioned in HVAC Design report for ASHREA, ECBC, and GRIHA etc. to meet the indoor Environment conditions & shall follow the sequence mentioned for individual component there.

**13.5.3. The Utilities Scope and Integration -**

a The proposed Building Management System should be capable of controlling / monitoring of following major significant building utilities:

i Heating, ventilation & air-conditioning (HVAC) system
ii Lighting
iii Electrical Power Distribution System
iv Backup DG power system
v UPS power system
vi Fire detection and Fire Fighting System
vii Lift/Elevators
viii Water Treatment and Management/Plumbing

b The BMS system shall also able to map the other **third party System via integration for control and monitoring purpose,** wherever possible as per current Mechanical Electrical and plumbing Services. Few are listed below;
i Chillers
ii VFD's for pumps & AHU
iii Electrical systems (DG sets & Energy Meters)
iv Mechanical ventilation
v Fire Detection & Alarm System
vi Water management & treatment
vii Hot water and solar power generation.
viii UPS
ix Energy Meters
x Elevators etc.

c The Intelligent Building Management System software package shall equipped with minimum requirements as per mentioned below;

i Complete system operation software.
ii Active graphics software.
iii Energy management system software.
iv Alarm indication software.
v Enterprise Assets Solution
vi Energy Usage Consumption both electrical and thermal(Monthly, Daily)

vii Equipment Efficiency monitor (transformer)
viii Chiller System COP (KW/TR) with benchmarking & equipment performance indicators.
ix DG SEGR (KW/Ltrs)
x Monthly CO 2 Emission.

**d System operation (BMS) software:**

i The Software should be able to manage the collection and presentation of large amounts of trend data, event messages, operator transactions, and system configuration data. Software should run on a server operating system to provide extended historical archiving and reporting capabilities.Software should be able to act as a Site Director which should provide secure communication to a network of Supervisory Controllers.

ii The BMS software should support the following features:
1 Support of IT Standards and Internet Technologies
2 Secure User Access
3 Flexible System Navigation and Dynamic User Graphics
4 Alarm and Event Management
5 Long-Term Trend Data Storage
6 Advanced Reporting System and Energy Management System for generating the energy reports.
7 Software should support Multiple Simultaneous Users

iii As the part of Energy Essentials software should offer the following seven reports:

1 **Big Picture Energy:** a single high-level report that includes normalized source energy use.

2 **Consumption:** similar to Big Picture Energy, a report that offers another level of detail on energy use in the default units of each energy type.
3 **Electrical Energy:** a report focused on electrical energy information, including usage, peak demand, reactive power, and power factor.

4 **Production:** a report focused on the energy that our site produces, including efficiency. For example, this report allows you to see the trueefficiency ofour chiller.

5 **Simple Energy Cost:** The packaged cost-based report, offering an easy-to-configure high-level view of energy costs. This report is notintended as a billing validation report.

6 **Load Profile:** a report focused on the daily demand profile, containing key information for developing strategies to minimize and/or deferpeaks.

7 **Equipment Runtime:** a report dedicated to the hours of runtime for equipment that typically is a large percentage of overall usage; the reportalso includes the number of equipment starts for the reporting period

**13.5.4. Minimum server requirement for BMS Software**

**a Server Platform:**
i I7 Processor or Equivalent Server PC with 4MB Cache with 4 GB RAM
ii 2.0 GHz processor with 1 TB hard disk Space
iii 500 GB free space on the hard disk after installing the prerequisite software
iv Minimum 1 GB Graphic Card
v 100/1000 Mbps NIC for Network connection and anti-virus software
vi Windows OS and SQL Server software
vii 22" color graphics monitor

**b Supported Operating Systems and Database Software:**

i Microsoft Windows Server 2008 or advance
ii Supports Microsoft SQL Server™ 2008 R2 Standard and Enterprise software

**13.5.5. Energy management system software:**

a The Energy Software should be able to fetch the energy data from the BMS and store the data into separate application database for analysis. Energy data is the information coming from meters and contains data related to metered consumption and also other power quality related parameters like voltage, peak load, power factor.

b This data is processed and validated in the application database and further used for the dashboards and reports creation. The application database is an SQL database (server/ express based) and stores all the data i.e. user information, configuration information and point/tag data for the application. This tool should also provide the facility to send the email or SMS alerts to the respective users.

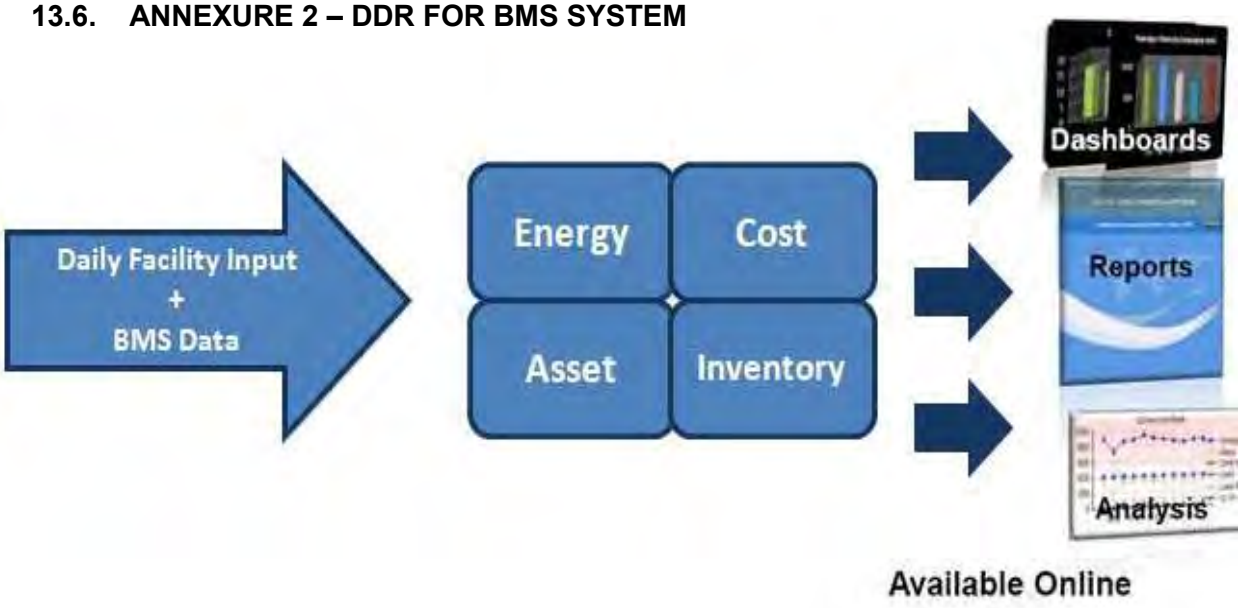
c The Software should have the following key features:

i Segmentation of energy information at a glance.
ii Customizable energy dash-board.
iii Energy report generation against selection of time and frequency.
iv Co2 emission calculation and reporting.
v Web based tool. No additional software required.
vi E-mail / SMS option available
vii Multiple database sources / site can be integrated.

**d Enterprise Assets Solution**

Screens to be available for on-line monitoring of Energy (Electricity, Fuel, Water)

## 13.6. ANNEXURE 2 – DDR FOR BMS SYSTEM




| Module | Ready Report & Dash Board |
|---|---|
| Energy Utilities & Management | • Month on month KWH per Sq. Ft.<br>• Month on month Carbon Emission<br>• Trend of energy cost per Sq. Ft. per unit<br>• Trend of diesel cost per Sq. Ft. per unit<br>• Benchmark Vs actual |
| Cost Management | • Cost Index per Sq. Ft.<br>• Month on month comparison & Trend |
| Asset & Maintenance management | • PPM Status (due, done & pending)<br>• Uptime- Grid Power, UPS Power, Backup Power.<br>• DG & UPS availability in % |
| Inventory Management (Engineering HK, Pantry) | • Low Stock level of Key Inventory |

### 13.6.1. Screens to be available for on-line monitoring

a **Overview Dashboards:** Overview dashboards should provide the bird's eye view of the entire portfolio / facility to the user from energy perspective.

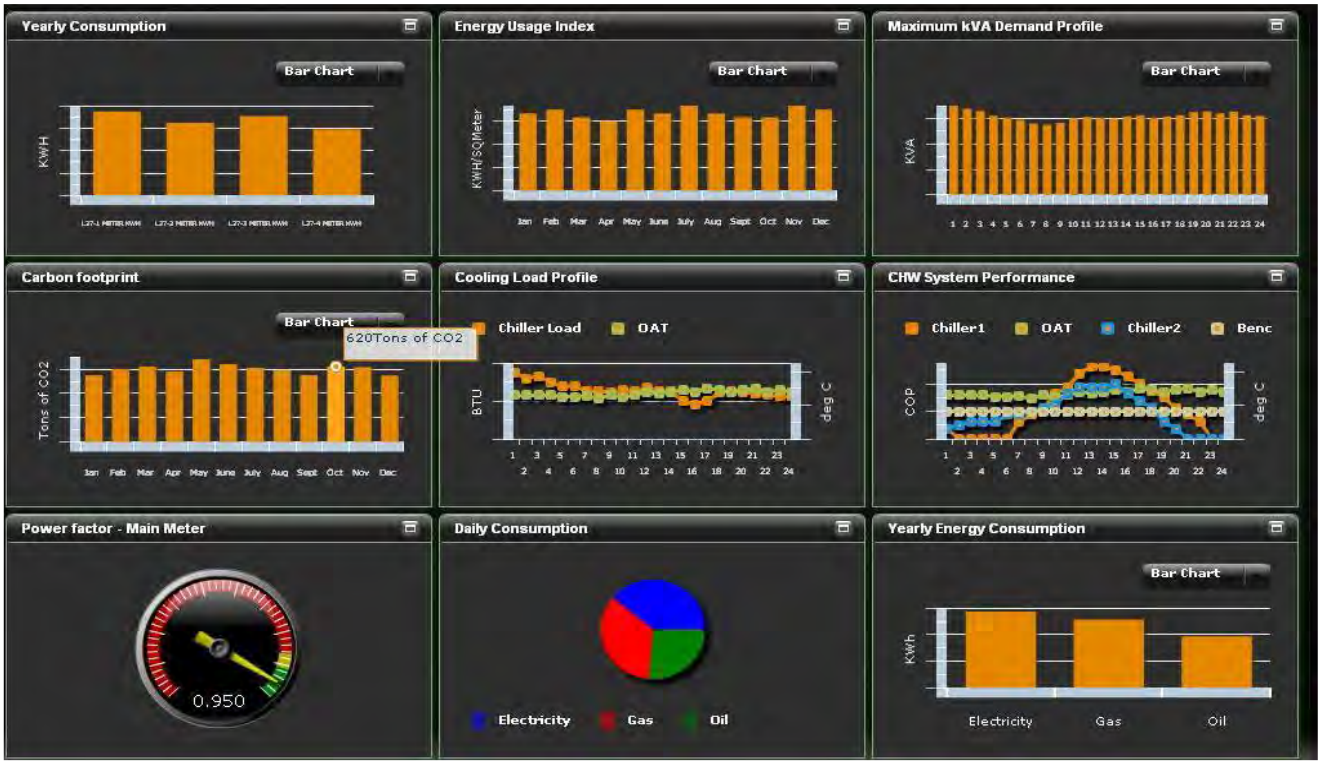
The standard dashboard provided in **this** module should be as below:

i Portfolio performance dashboard.
ii Yearly energy consumption of the facility / Building.

iii Month wise energy usage index of the facility / building.
iv KVA demand profile. 5. Carbon footprints.
v Cooling load profile.
vi Chilled water system performance.
vii Power factor.
viii Daily energy consumption.
ix Yearly energy consumption.

Standard reports include following:

i Portfolio details report.
ii Portfolio scorecard report.
iii Total consumption report.
iv Energy consumption report




b **Asset Dashboards:** The asset module should capture necessary details on the assets in the facility / building. The standard asset dashboards that must be provided in this module are as below:

i AC / Chiller plant dashboard. 2, Air Handling Unit dashboard. Emergency generator Dashboard.

The standard asset reports included in this module are as below:

i Asset list report.
ii Asset distribution architecture report.
iii AC/Chiller plant performance report.
iv Air Handling unit performance report.
v Emergency generator performance report.


c **Energy Dashboards:** Energy module should track all the energy and utility meters in the facility and generate necessary dashboards and reports.

The **Standard Dashboard** should include:

i Average daily consumption (YOY).
ii Daily Min – Avg – Max demand.
iii Utility wise demand analysis.
iv Energy scorecard.
v Monthly energy profile analysis.
vi Yearly energy consumption analysis.

The **Standard Reports** include:

i Meter distribution architecture.
ii Monthly energy scorecard.
iii Meter wise consumption report.
iv Monthly demand analysis report.
v Utility wise energy analysis report.
vi Demand profile comparison report.
vii Consumption profile comparison report.

**d Manage your portfolio:** MONITOR MULTIPLE FACILITIES FROM ANY LOCATION

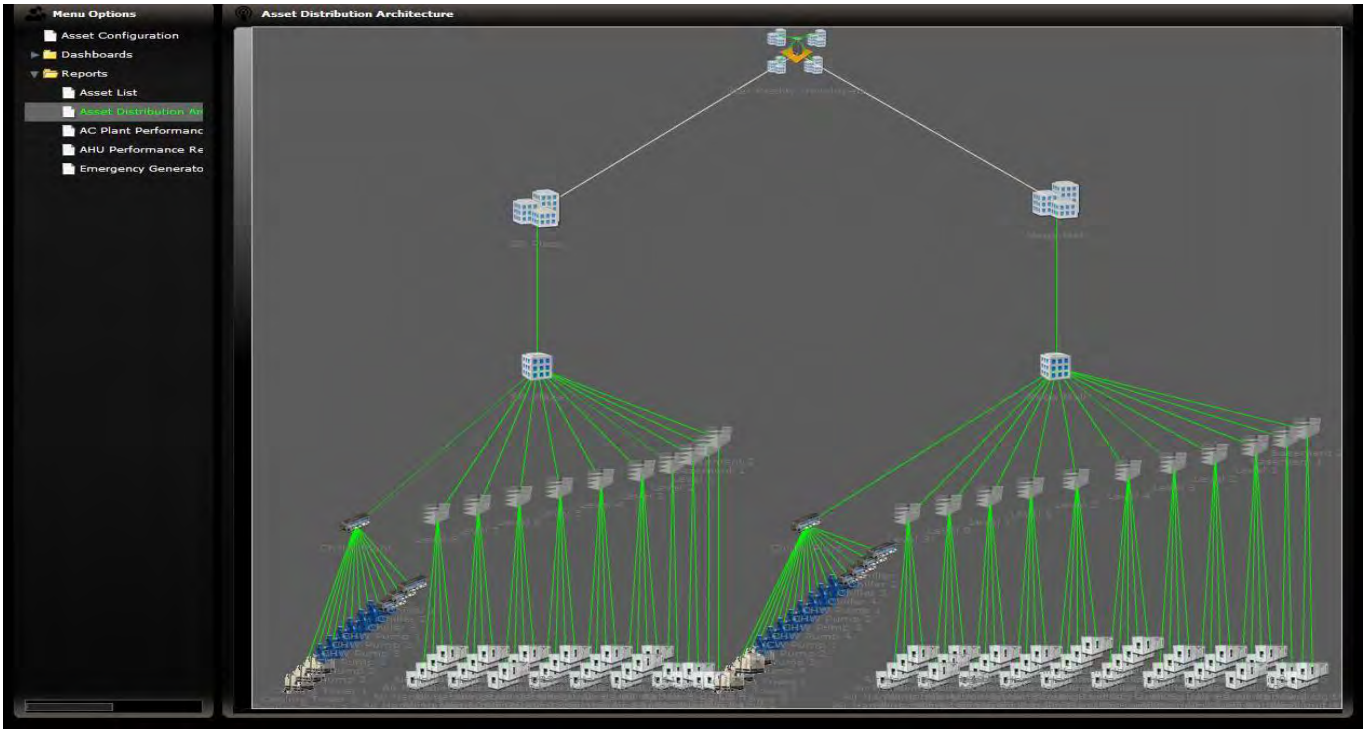
i Monitor, Compare and analyze our facility from any location. Do a year on year comparison between the facilities. Take a quick overview of individual facility on a click of a button.

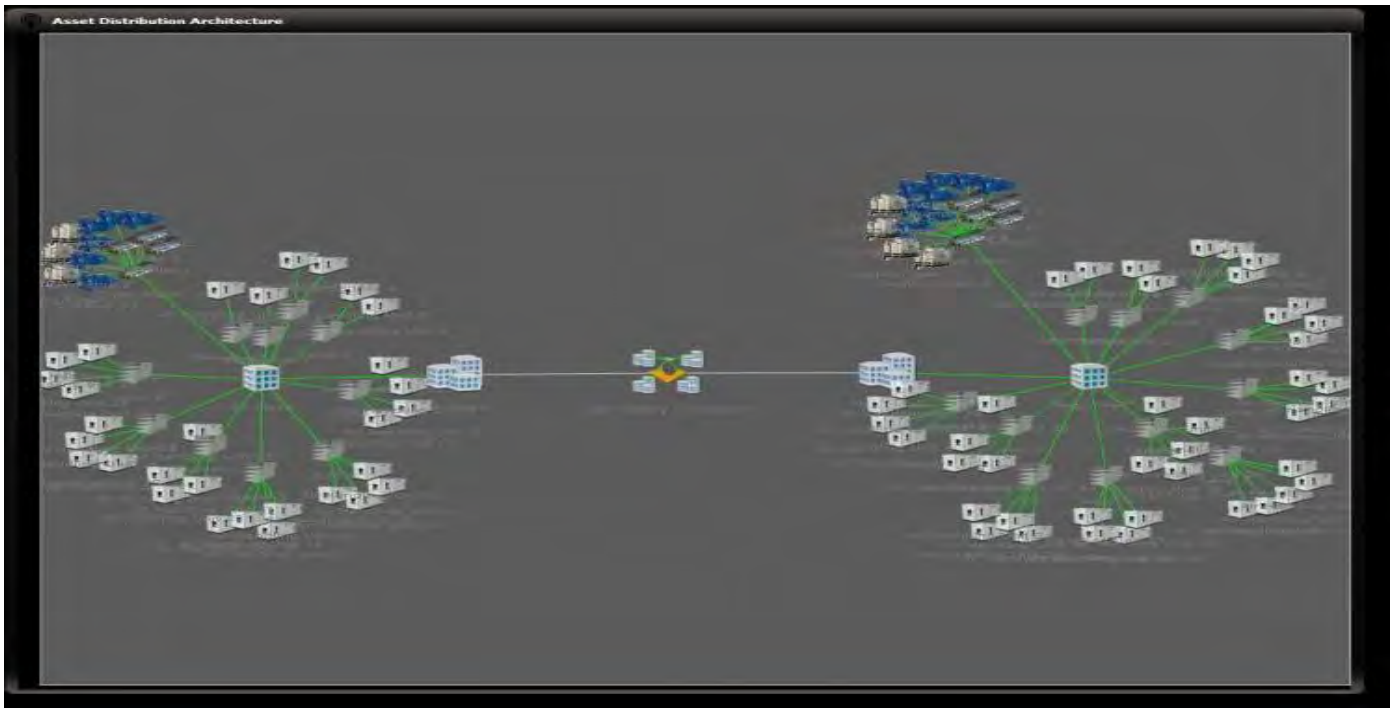
**e Visualize the charts in bar or line**

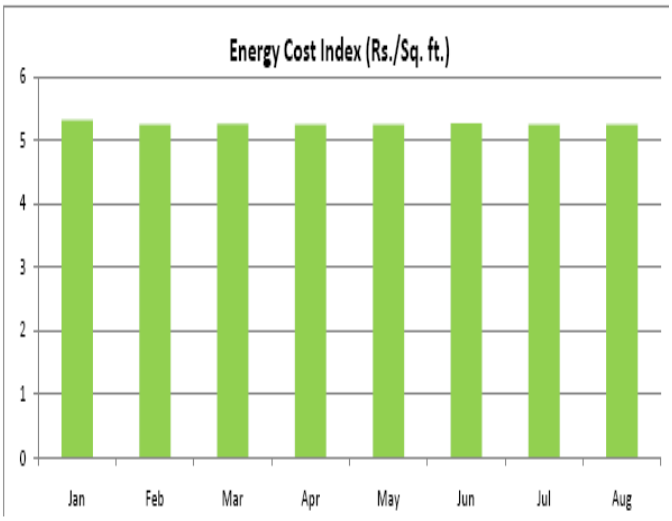
**ii** Software should provide the complete flexibility to view the chart as required. The same chart should change from bar chart to line chart.

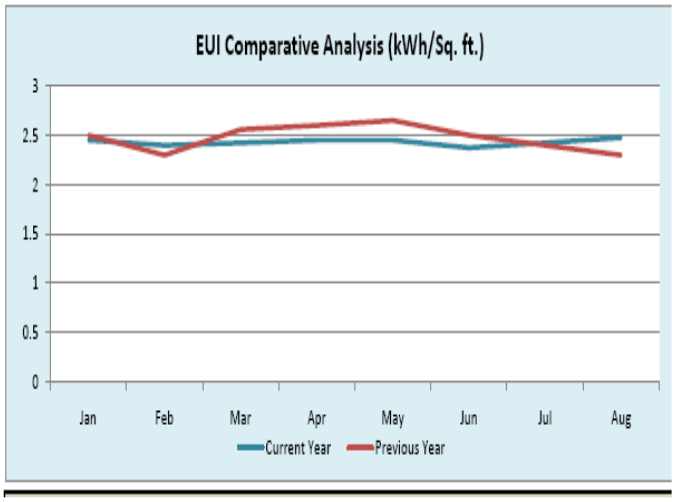
**f Asset Architecture**

iii The Software should be able to manage & track the assets by creating its own asset architecture. Details of the asset like Make, Model, Asset ID, Manufacturing date, Installation date, Capacity etc are available on tool tip for quick and easy reference.


Menu Options
Asset Configuration
Dashboards
Reports
Asset List
Asset Distribution Ar
AC Plant Performanc
AHU Performance Re
Emergency Generato
Asset Distribution Architecture


Asset Distribution Architecture




3. Diesel Consumption

| Tank Name | Tank Capacity (Ltrs) | Diesel Received (Ltrs) | Diesel Consumed (Ltrs) | Balance Stock (Ltrs) |
|---|---|---|---|---|
| UGT-1 | | | | |
| UGT-2 | | | | |
| DOT-1 | | | | |
| DOT-2 | | | | |
| DOT-3 | | | | |
| Boiler (20 kL) | | | | |
| Boiler (15 kL) | | | | |

### 13.6.2. DATA POINTS COVERED BY INTELLIGENT BUILDING MANAGEMENT SYSTEM:-

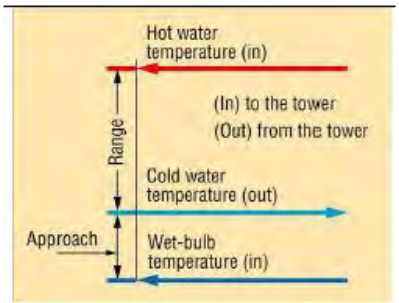
The Intelligent Building Management System software package shall be with minimum standard:

- Complete system operation software.
- Active graphics software.
- Energy management system software.
- Alarm indication software.
- Maintenance package
- Multiple simultaneous user software
- The data points against service equipment and area are elaborated as below:-

**a <u>CHILLER PLANTS</u>**

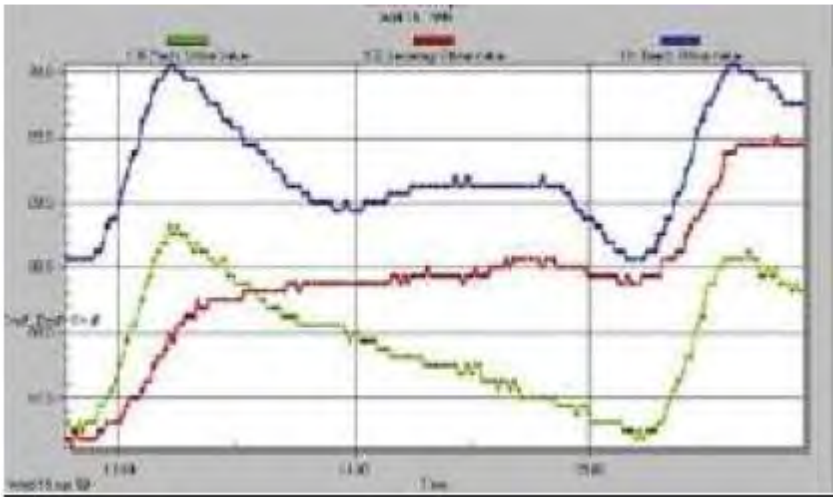
| Data Point Description | Control Philosophy |
|---|---|
| **<u>Water Chilling Machine (CENTRIFUGAL)</u>**<br>• Carry out software integration with the micro-processor panel of water chilling machine.<br>• All the points displayed on the chiller micro-processor panel shall be duplicated on the BMS screen.<br>• Isolate individual chiller at OUT and condenser at OUT through motorized butterfly valves..<br>• Enable and disable chilling machine.<br>• Carry out chilled water temperature reset with respect to chilled water valve position at the AHUs.<br>• Monitor chilled / condensing water supply temperature at the outlet of chilling machine.<br>• Monitor manual operation status.<br>• Monitor flow status through chiller/condenser of the machine.<br>• Automatic changeover of SUMMER and WINTER modes. | The correct amount of tonnage is calculated on-line and based on same the chillers quantity and their set points are enabled to maintain the load.<br>$TR = \frac{Q \cdot C_p \cdot (T_i - T_o)}{3024}$<br>**Q** is mass flow rate of chilled water inkg/hr<br>**Cp**is coolant specific heat in kCal/kg degC<br>**Ti**is inlet, temperature IN to evaporator (chiller) in $^0$C .<br>**To**is outlet temperature OUT from evaporator (chiller) in $^0$C |


| | |
|---|---|
| **Heat Pumps**<br>• Isolate Heat Pumps and Water Cooled Chillers header circuit throughMotorized Butterfly valves.<br>• Monitor Heat Pump Header IN and OUT temperature.<br>• Monitor individual Heat Pump OUT temperature.<br>• Monitor manual operation status.<br>• Monitor flow status through Heat Pumps. | |
| **Primary &Secondary Chilled Water pumps**<br>• Start-stop each pump in accordance with demand.<br>• Sequence each pump to maintain equally run time<br>• Monitor any pump being switched on a manual basis.<br>• Carry out software integration with secondary chilled water pumps for varying the speed in accordance with the load.<br>• Monitor status of pump<br>• Monitor energy consumption. | Sequencing the pumps along with the chillers and cooling towers based on demand and monitoring their status.<br><br>Run equal run time operation of pumps. |

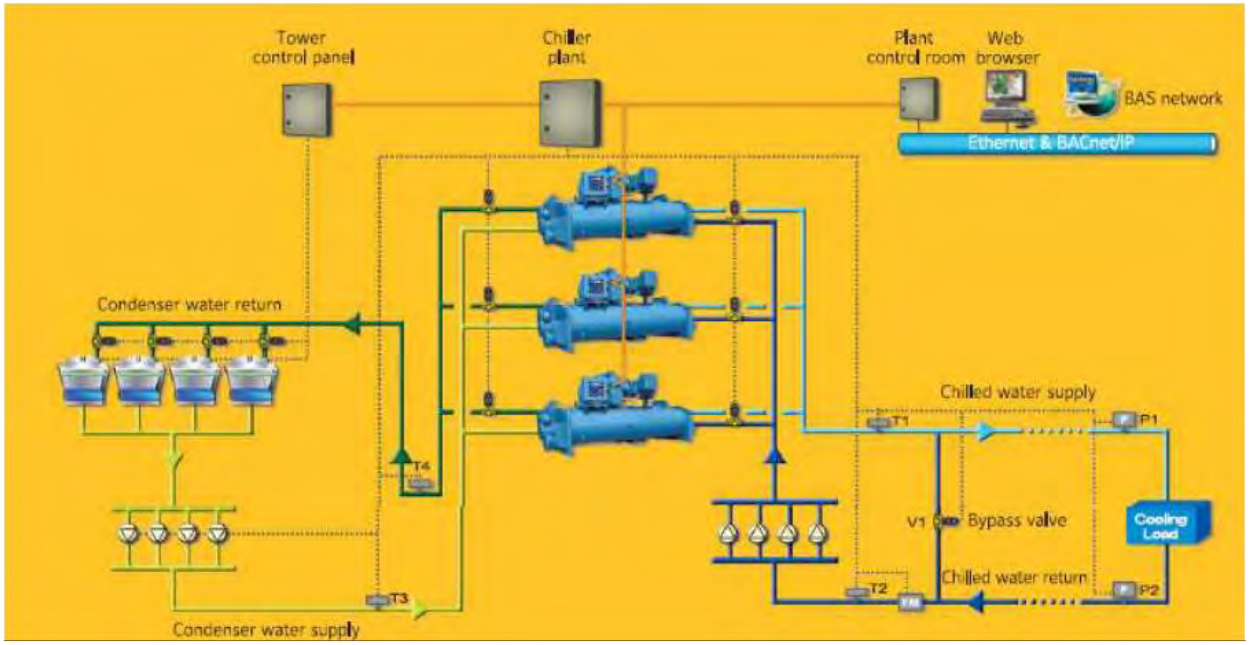
| | |
|---|---|
| **Cooling Towers**<br>• Isolate individual Cooling Towers at IN and OUT through motorized<br>• Butterfly valves.<br>• Monitor ambient wet bulb temperature.<br>• Switch on/off each cooling tower in accordance with the demand.<br>• Monitor status of the cooling tower fans.<br>• Monitor low water levels in each cooling tower.<br>• Control and monitor motorized butterfly valve provided at inlet & outletof the cooling tower.<br>• Monitor water outlet temperature at each cooling tower.<br>• Control RPM of CT fans based on the demand<br>• Sequence operation of cooling tower to maintain equal run time.<br>• Monitor energy consumption. |  <br>Maintain Cooling tower effectiveness which is =<br>Range / (Range + Approach). |
| **Header**<br>• Monitor common chilled water supply and return temperature in header.<br>• Monitor common condenser water and return temperature in header.<br>• Monitor chilled water flow rate in chilled water circuit.<br>• Monitor level in the chilled water expansion tank.<br>• Monitor outside air temperature and relative humidity.<br>• Monitor pressure in chilled water header.<br>• Monitor direction of flow in the de-coupler pipe of primary-secondary<br>• Pumping system.<br>• Monitor energy consumption (KWH and BTU) and work out Chiller System COP. | The specific power consumption for certain TR output would include:<br>Compressor kW/TR<br>Chilled water pump kW/TR<br>Condenser water pump kW/TR<br>Cooling tower fan kW/TR<br>The overall kW/TR is the sum ofthe above.<br>COP =Cooling effect (kW)__<br>{Power input to compressor (kW)} |
| **Condenser Water Pumps**<br>• Monitor the pump header pressure.<br>• Monitor tertiary circuit header temperatures IN and OUT.<br>• Start-stop each pump in accordance with demand.<br>• Sequence each pump to maintain equally run time<br>• Monitor any pump being switched on a manual basis.<br>• Monitor status of pump<br>• Monitor energy consumption. | Sequencing the pumps along with the load and monitoring their status.<br><br>Run equal run time operation of pumps. |

### 13.6.3. FEATURES OF BMS:

**a Trend Analysis**



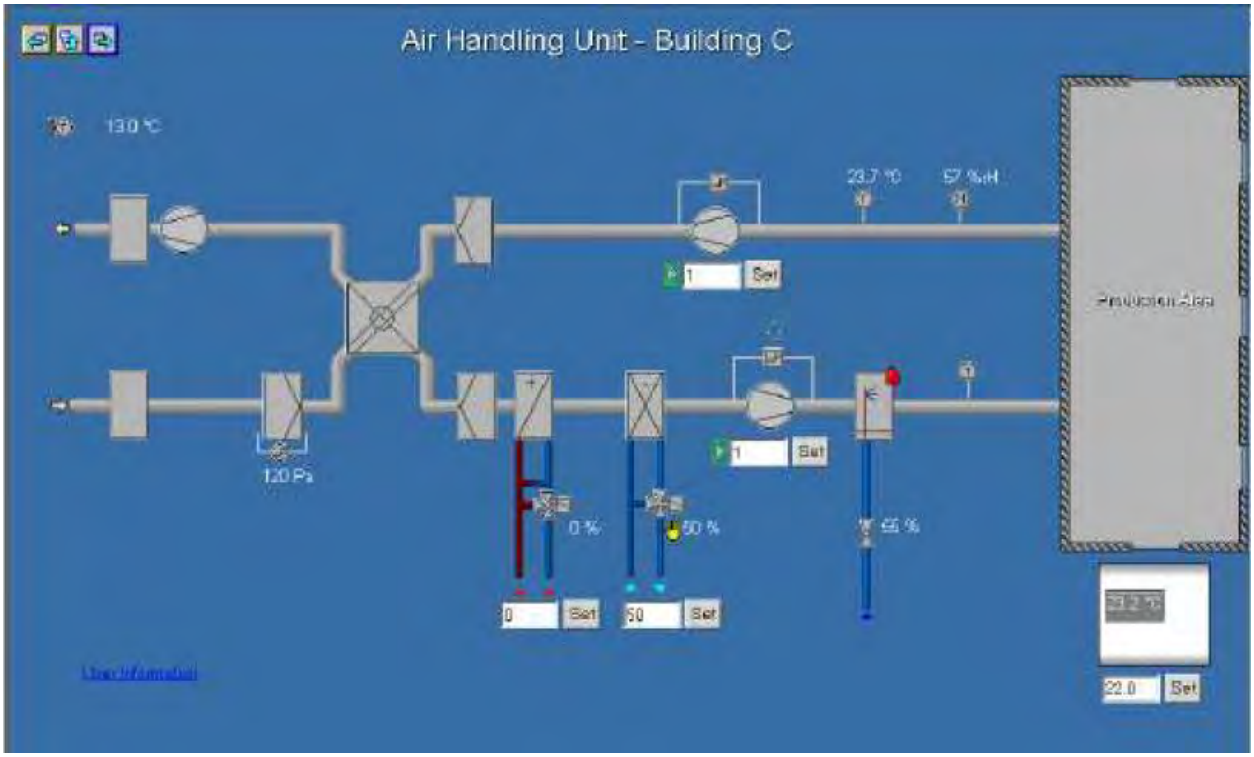
b **Chiller Plant Manager**- (BMS should be capable of scheduling the chiller plant room operations i.e. it should have the capability to act as chiller Plant manager along with other control and monitoring of equipment in the building. The only requirement for this is chiller should be capable of releasing its microprocessor information on Open Protocol (i.e. BACnet / Modbus RTU).



## i Air Handling Units

### Data Point Description & Control Philosophy

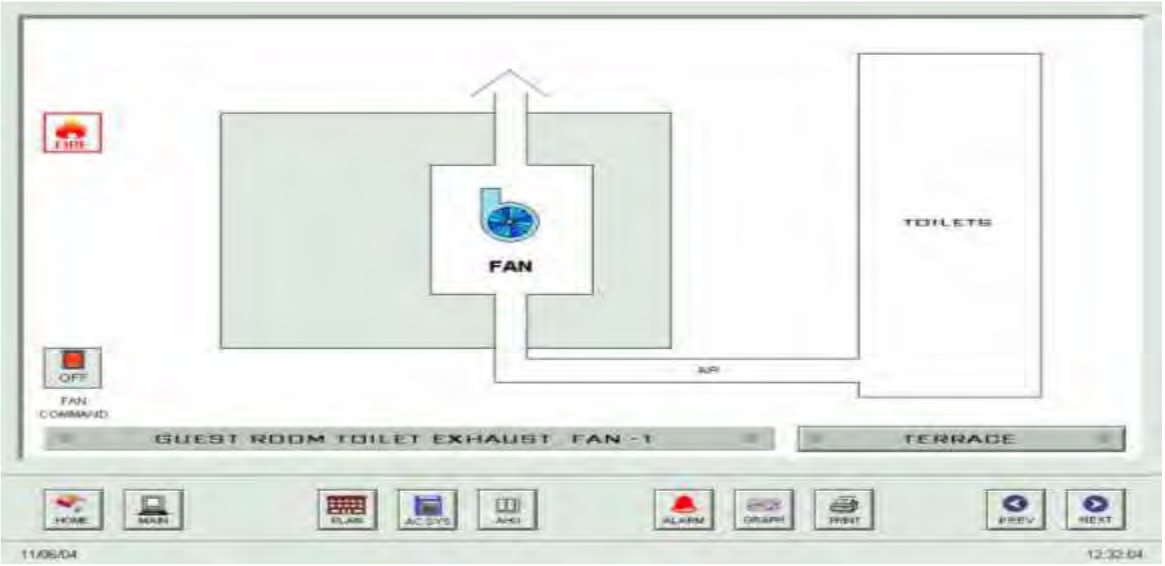
1. Program the start/stop of supply / return fan at each air handling unit and carry out the duty cycling (from AHU panel).
2. Monitor the running status of each blower fan through a differential pressure switch and keep a log of the number of hours run.
3. Monitor filter status of each AHU by a pressure differential switch & give an alarm in case the filter gets choked.
4. Monitor the supply and return air temperature & give an alarm for a high/low supply air temperature.
5. Control the chilled water-modulating valve, to maintain the room conditions.
6. Indicate any unit running in Manual mode.
7. Control RPM of supply and return air fans based on the demand.
8. Monitor CO2 levels in return air and modulate fresh air damper to ensure difference between outdoor and indoor CO2 level is maintained less than 530 ppm. If levels are not maintained, bring up an alarm if the values are higher than the maximum CO2 levels permitted in ASHRAE standards 60.1-2004.
9. Carry out software integration with VFD panel of supply / return air fan and display all electrical parameters.
10. Monitor energy consumption.



**ii Indoor Exhaust Fans, Emergency Exhaust and Toilet Exhaust Fans**

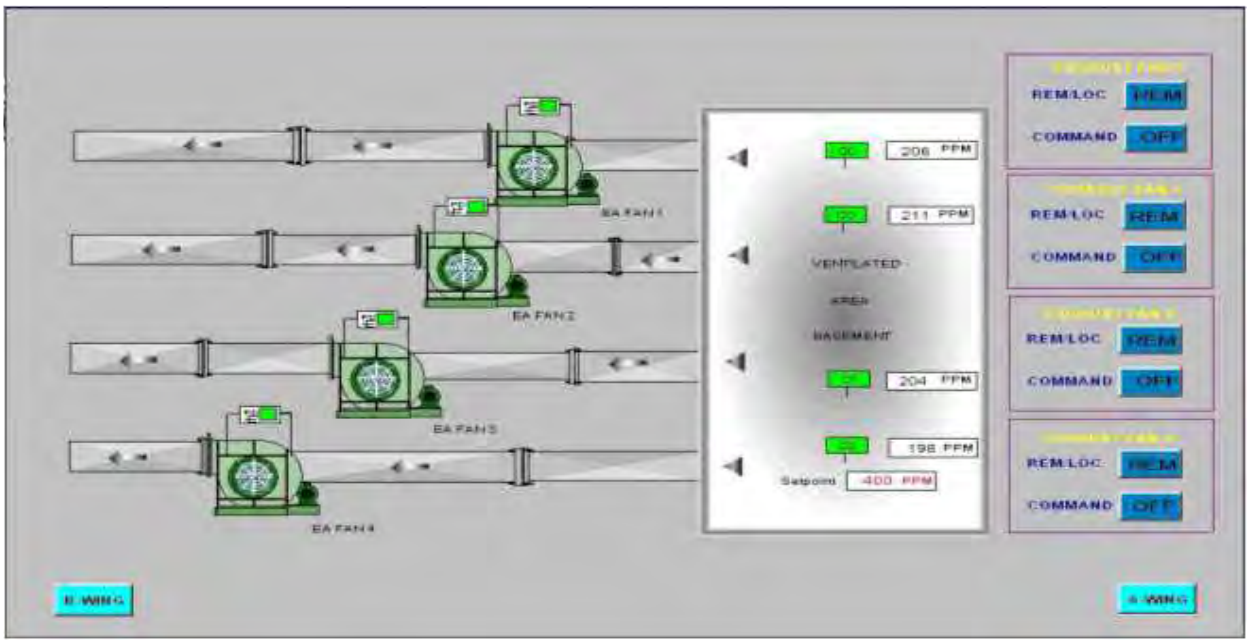
**Data Point Description & Control Philosophy**

1 Control start/stop of exhaust fans in integration with Fire Alarm System.
2 Monitor status of blower during emergency mode




**iii Basement Ventilation Fans:**

| Data Point Description | Control Philosophy | Remarks |
|---|---|---|
| CO sensor<br><br>Fan ON/OFF command<br><br>Fan A/M status<br><br>Fan run status | CO monitoring in the parking area covering approx. 4500 sq. Ft per sensor.<br><br>Based on ASHRAE standard of ventilation the Fans will start when CO level reaches >35ppm and stop when CO level is at 20 PPM. | ON-OFF System of Fresh Air &<br>Exhaust Fans ZONE wise automatically, to maintain the CO level.<br><br>EMERGENCY EXHUAT FANS In case of FIRE ALARM in the zones the Smoke Exhaust Fans shall be automatically switched ON by FAS control relay and in addition by BMS system. |




## iv Lighting:

### Data Point Description & Control Philosophy

1 Control of indoor lighting based on schedule in the above areas.
2 Monitoring of Outdoor Lux Level.
3 Schedule and Lux based lighting control for outdoor / perimeter lighting.

**v UPS:**

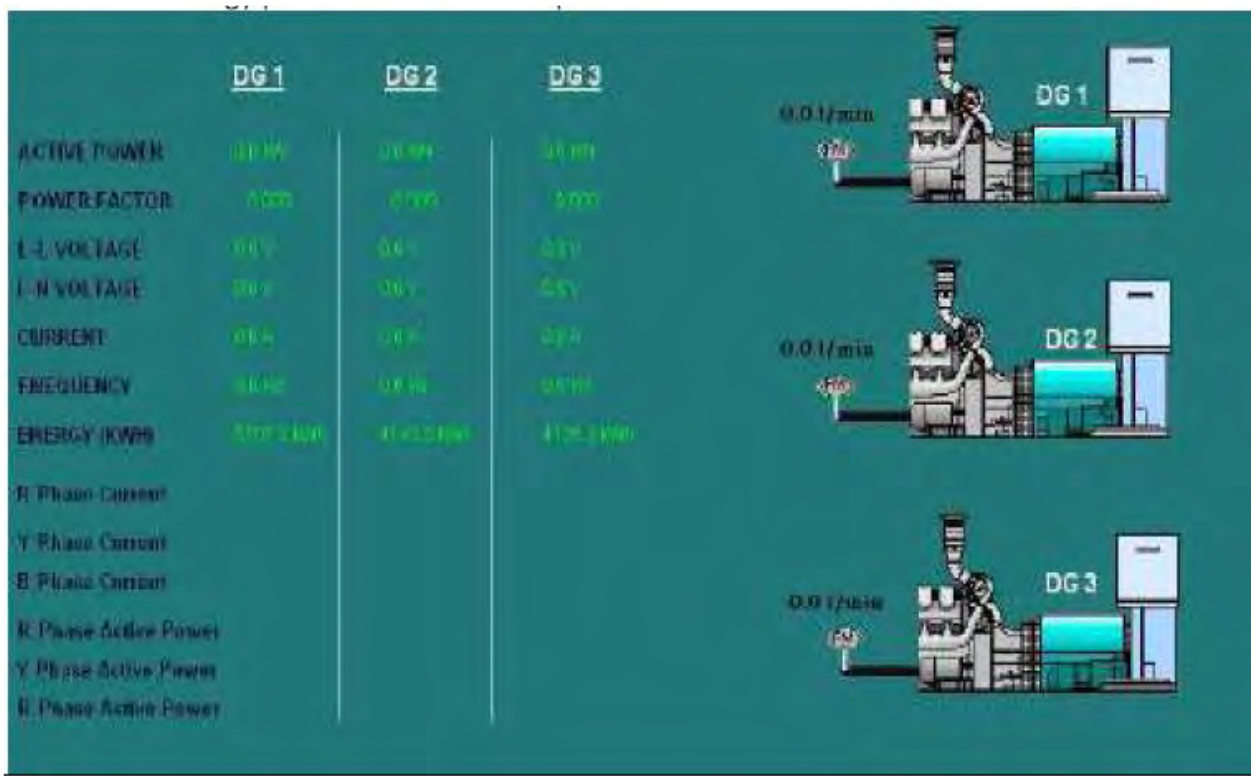
**Data Point Description & Control Philosophy**

1 Software integration with UPS monitoring system to duplicate the data being monitored by UPS monitoring system..
2 Monitoring temperature in UPS & Server Rooms.

**vi DG Sets:**

**Data Point Description & Control Philosophy**

1 Monitor DG status and keep log of run hours
2 Monitor DG battery voltage
3 Monitor high / low level in day oil tank.
4 Monitor electrical parameters of DG power
5 Control start-stop of DG cooling tower
6 Control start-stop of DG cooling tower pump through monitoring of water level in sump tank.
7 Monitor DG cooling tower fan status
8 Monitor low water level in DG cooling towers
9 Monitor energy production and other parameters.
10 Monitor oil transfer pump status



## vii Electrical Power Distribution Panels:

### Data Point Description & Control Philosophy

1 Provide Static Power Meter and Data Logger at incoming power supply in the main electrical panels and MDB's and carry out software integration to monitor all electrical parameters.


## viii Lifts / Escalators:

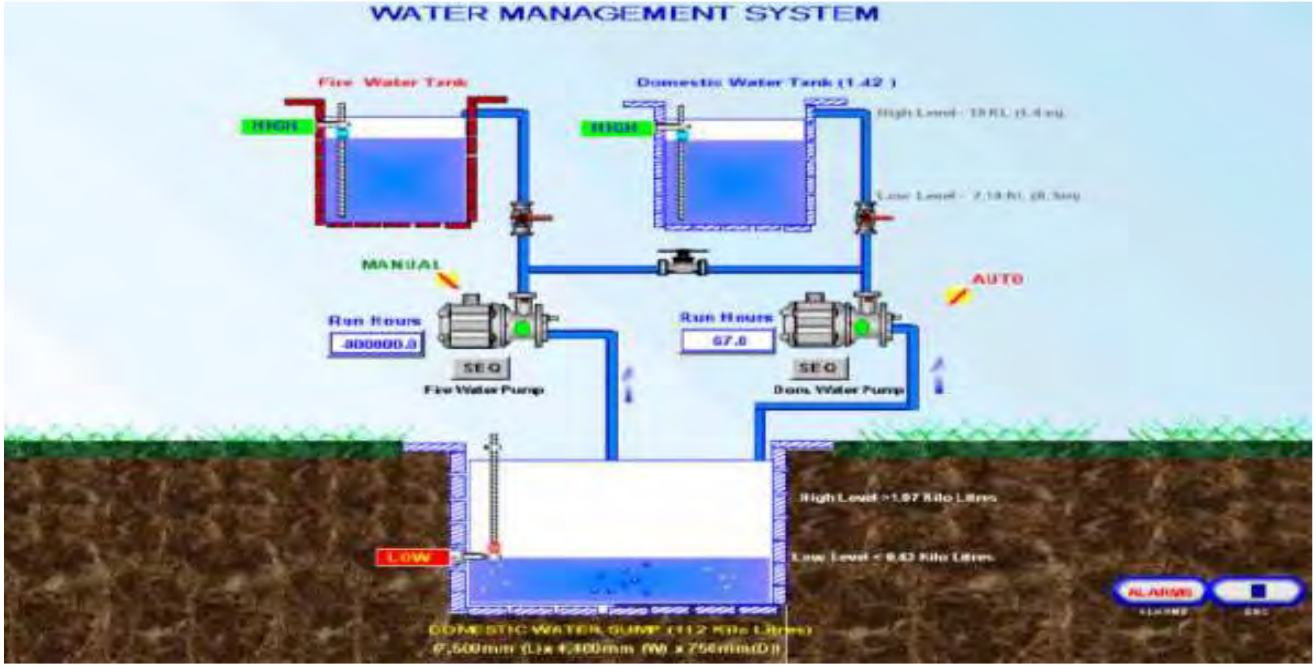
### Data Point Description & Control Philosophy

1 Software integration with elevator & escalator monitoring system to duplicate the data being monitored by elevator / escalator monitoring system.
2 Monitor battery voltage

## ix Fire Hydrant & Sprinkler System:

### Data Point Description & Control Philosophy

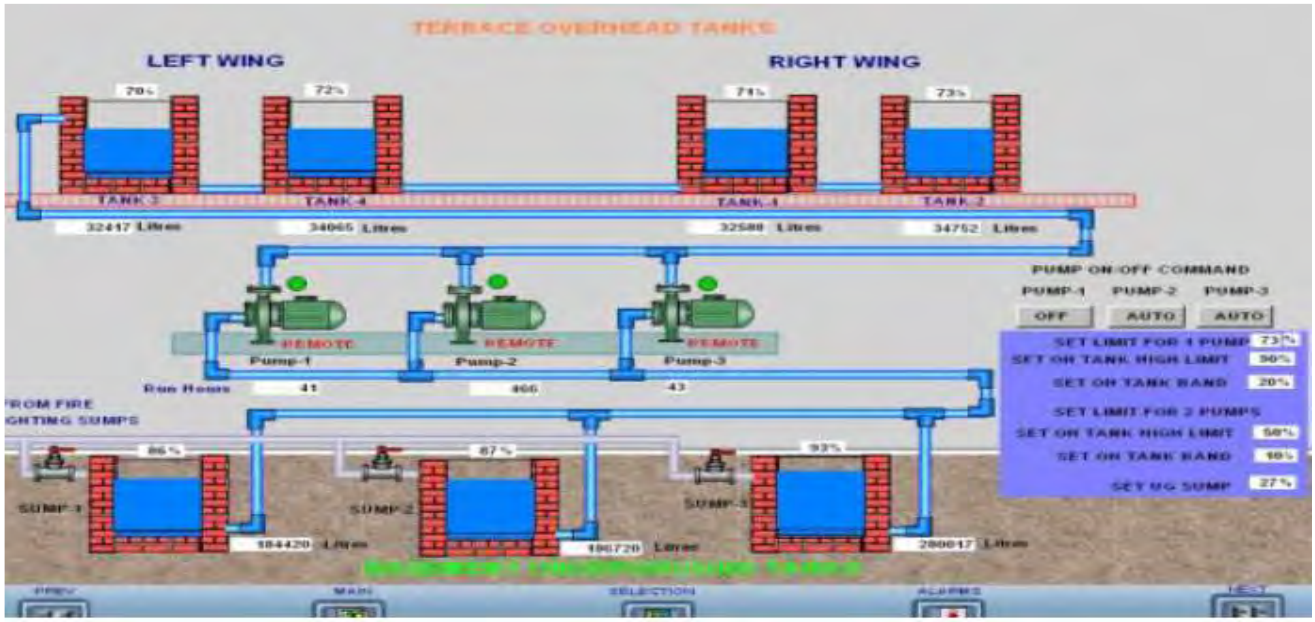
1 Monitor water level in tanks.
2 Monitor Hydrant pump / Jockey Pump status.
3 Monitor any item operating on manual basis.
4 Monitor pressure in the fire pipe network.
5 Monitor high/low level of diesel storage tank for diesel driven pump.
6 Monitor battery status of diesel driven fire pump.




x **Plumbing System:**

**Data Point Description & Control Philosophy**

1 Monitor water level in all underground and overhead tanks
2 Monitory pump status
3 Monitor any equipment operating on manual basis
4 Monitor pressure in the external fire pipe network

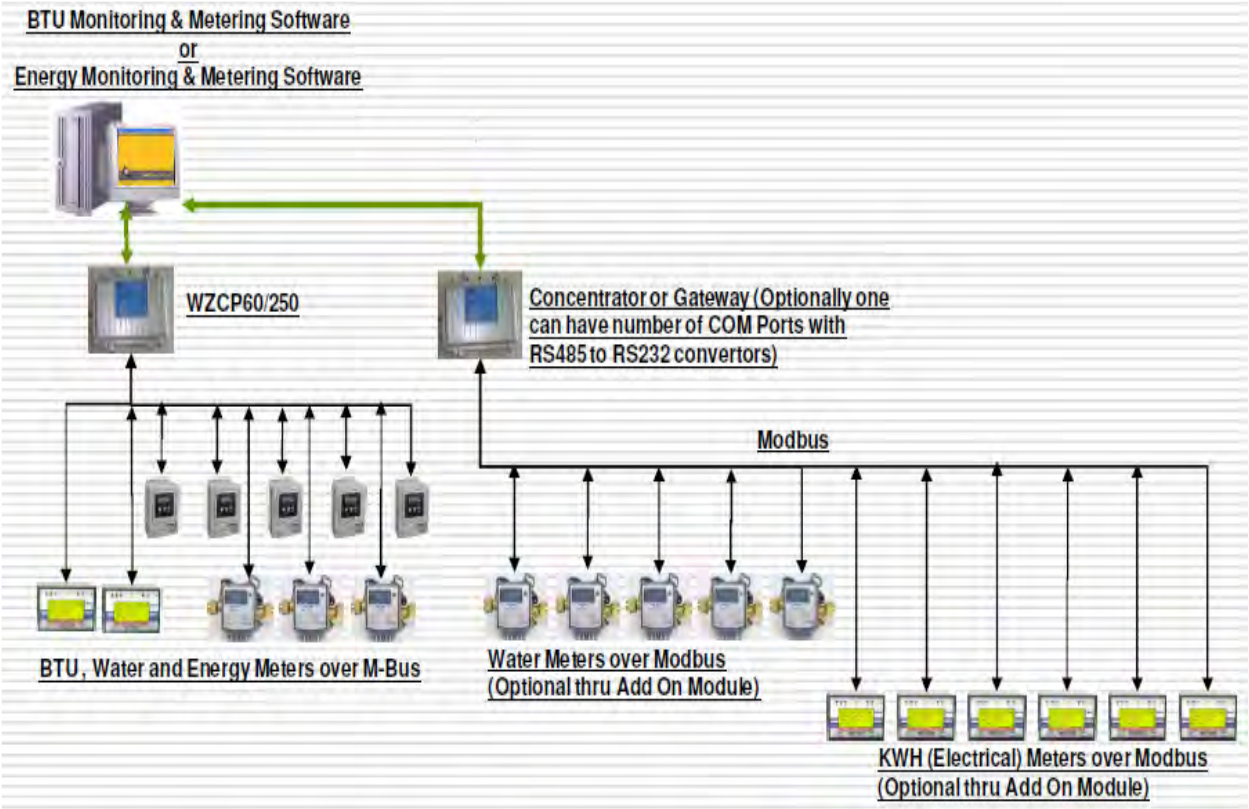


**xi BTU Metering System:**

1 View Data Dynamically
- Dynamic Energy , Temperature and Flow Data Tree View or Graphic View
- Role and Feature Based Security
- Define Users – Create different users for the system
- Administration to assign privileges and user configurations

2 Various Versions based on number of Meters connected (Tag Based) –
- Directly connected to the BTU / Energy Meters thru a Gateway
- Through BMS software History Block

3 Define Customers – Add various Tenants in a Multi-tenant Facility
- Define Meters
  - Assign and Allocate the Meter/s to users
  - Allocate Common Area Meters
- Allocate percentage distribution of common meters
- Generate Various Customized Reports – Dynamic, Historical, Monthly
- Define Tariffs and Costs for metering and billing



# 13.6. LIST OF APPROVED MAKES FOR BMS WORKS

## 13.6. LIST OF APPROVED MAKES FOR BMS WORKS:-

| APPROVED LIST OF MAKES FOR BUILDING MANAGEMENT SYSTEM | | | | | |
|---|---|---|---|---|---|
| **S.No.** | **ITEMS** | **Approved Makes** | | | |
| **1** | CENTRAL CONTROL STATION | Compaq | IBM | DELL | |
| **2** | BUILDING MANAGEMENT SYSTEM WEB-BASED SERVER SOFTWARE | Johnson Metasys | Siemens Apogee | Honeywell (Comfort Point) | |
| **3** | ENERGY MANAGEMENT SOFTWARE | Johnson Metasys | Siemens Apogee | Honeywell (Comfort Point) | |
| **4** | PROGRAMMABLE & APPLICATION SPECIFIC CONTROLLER (DDC) | Johnson Metasys | Siemens | Honeywell (Comfort Point) | |
| **5** | WEB SERVER ENGINES (NETWORK / SUPERVISORY CONTROLLERS) | Johnson Metasys | Siemens | Honeywell (Comfort Point) | |
| **6** | INTEGRATORS | Johnson Metasys | Siemens | Honeywell (Comfort Point) | |
| **7** | SENSORS AND FIELD DEVICES | | | | |
| **A** | Immersion type temperature sensors | Johnson Metasys | Siemens | Honeywell | |
| **B** | Differential Pressure Switch (blowers & Filters & Pump) | Johnson Metasys | Siemens | Honeywell | |
| **C** | Duct mount temperature & RH sensor | Johnson Metasys | Siemens | Honeywell | |
| **D** | Damper Actuator | Johnson Metasys | Siemens | Honeywell | |
| **E** | CO Sensor | Johnson Metasys | Siemens | Honeywell | Greystone |
| **F** | CO2 Sensor | Johnson Metasys | Siemens | Honeywell | MSR(Germany) |
| **G** | Current Relay | Johnson Metasys | Siemens | Honeywell | Kele |
| **H** | Water level Switch | Johnson Metasys | Siemens | Honeywell | Kele |
| **I** | Network Temp, RH & PIR Sensor | Johnson Metasys | Siemens | Honeywell | |
| **K** | Water Pressure Sensor | Johnson Metasys | Siemens | Honeywell | |
| **L** | Duct Static Pressure Sensor | Johnson Metasys | Siemens | Honeywell | |
| **M** | Water Flow Meters | Landis & Gyr | Kele | Sontay | ABB |
| **N** | Ultrasonic BTU Meters | Kamstrup | Sontay | Schenitech | Landis & Gyr |
| **O** | Hardness Analyzer | HACH | ABB | Kele | Schenitech |
| **P** | Ultrasonic water flow Meters | Kamstrup | Sontay | Schenitech | Landis & Gyr |
| **R** | 3 Way motorized Valves | Johnson Controls | Siemens | Honeywell | Belimo |
| **S** | Flameproof Level Switch | Kele | Vekeselor | Filpro | |
| **T** | Outside Air Temperature/ RH Sensor | Schneider | Honeywell | Invensys | Siemens |
| **U** | Voltage / Current / Power Factor Transducer | L&T | ABB | Honeywell | Johnson Controls |
| **V** | Room Temp. Sensor | Johnson Controls | Siemens | Honeywell | Sontay |
| **8** | **WIRING & CONDUITING** | | | | |
| **A** | Communication Cables / Signal Cable/ Control Cable | RR Cable | Teleflex | Skytone | Polycab |
| **B** | MS/GI/ PVC conduits | BEC | AKG | Precision | NIC |
| **C** | CAT 6 cable | Leviton | Amp | Panduit | Systemax |

# 14.0 TENDER DRAWINGS

## 14.1. LIST OF TENDER DRAWINGS (TOTAL 270 DRAWINGS)

| S.NO. | DRAWING NO. | DESCRIPTION |
|---|---|---|
| | | |
| **AD1 - ADMINISTRATION BUILDING** | | |
| | | |
| **A** | **ARCHITECTURE** | |
| 1 | AD1-A-2.0 | Basement Plan |
| 2 | AD1-A-2.1 | Ground Floor Plan |
| 3 | AD1-A-2.2 | First Floor Plan |
| 4 | AD1-A-2.6 | Fifth Floor Plan |
| 5 | AD1-A-2.7 | Terrace Plan |
| 6 | AD1-A-2.8 | Roof Plan |
| 7 | AD1-A-3.1 | Section AA' |
| 8 | AD1-A-3.2 | Section BB' |
| 9 | AD1-A-4.1 | Elevation A |
| 10 | AD1-A-4.2 | Elevation B |
| 11 | AD1-A-7.3.1 | Façade Details |
| | | |
| **B** | **STRUCTURE** | |
| 12 | AD1-ST-2.0.1 | Column & Wall Marking Layout & Details At Foundation Level |
| 13 | AD1-ST-2.0.2 | General Arrangement and detail at foundation level |
| 14 | AD1-ST-2.0.4.1 | Column Reinforcement Details (Sheet 1) |
| 15 | AD1-ST-2.0.5.1 | Shear Wall Reinforcement Details (Sheet 1 of 5) |
| 16 | AD1-ST-2.1 | General Arrangement layout Ground Floor framing plan |
| | | |
| **C** | **ELECTRICAL** | |
| 17 | AD1-EL-0.1 | Electrical System Single Line Diagram |
| 18 | AD1-EL-0.2 | Fire Alarm System - Schematic Diagram |
| 19 | AD1-EL-2.0(L) | Basement Plan – Lighting Layout |
| 20 | AD1-EL-2.0(LV) | Basement Plan – Fire Alarm, Access Control, PA & CCTV Layout |
| 21 | AD1-EL-2.0(P) | Basement Plan – Power, Cable Tray & LV Layout |
| 22 | AD1-EL-2.1(L) | Ground Floor Plan – Lighting Layout |
| 23 | AD1-EL-2.1(LV) | Ground Floor Plan – Fire Alarm, Access Control, PA & CCTV Layout |
| 24 | AD1-EL-2.1(P) | Ground Floor Plan – Power, Cable Tray & LV Layout |
| 25 | AD1-EL-2.7 | Terrace Plan – Electrical Layout |
| | | |
| **D** | **HVAC** | |
| 26 | AD1-AC-2.0 | HVAC System Layout: Basement Plan |
| 27 | AD1-AC-2.1 | HVAC System Layout: Ground Floor Plan |
| 28 | AD1-AC-4.0 | HVAC System Layout: Riser Diagram |
| 29 | AD1-AC-5.0 | HVAC System Layout: Sehedule |
| 30 | AD1-AC-6.0 | HVAC System: Typical Detail |
| | | |
| **E** | **PLUMBING** | |
| 31 | AD1-PH-0.1 | Plumbing Water Supply Schematic Diagram |
| 32 | AD1-PH-2.0 | Basement Floor Plan – Plumbing Layout |
| 33 | AD1-PH-2.1 | Ground Floor Plan – Plumbing Layout |
| 34 | AD1-PH-2.7 | Terrace Plan – Plumbing Layout |
| | | |
| **F** | **FIRE FIGHTING** | |
| 35 | AD1-FF-0.1 | Fire fighting Schematic Diagram |
| 36 | AD1-FF-2.0 | Basement Floor Plan - Fire Fighting layout |
| 37 | AD1-FF-2.1 | Ground Floor Plan - Fire Fighting layout |
| 38 | AD1-FF-2.7 | Terrace Floor Plan - Fire Fighting layout |
| | | |
| **G** | **LANDSCAPE** | |
| 39 | AD1-LA-1.1 | Landscape Plan |
| | | |
| **L1-LIBRARY BUILDING** | | |
| | | |
| **A** | **ARCHITECTURE** | |
| 1 | L1-A-2.0 | Basement Plan |

| S.NO. | DRAWING NO. | DESCRIPTION |
|---|---|---|
| 2 | L1-A-2.1 | Ground Floor Plan |
| 3 | L1-A-2.2 | First Floor Plan |
| 4 | L1-A-2.8 | Mumty Floor Plan |
| 5 | L1-A-3.1 | Section 1 |
| 6 | L1-A-3.2 | Section 2 |
| 7 | L1-A-4.1 | Elevations A |
| 8 | L1-A-4.2 | Elevations B |
| 9 | L1-A-7.2.1 | Facade Details |
| | | |
| **B** | **STRUCTURE** | |
| 10 | L1-ST-2.0.1 | Column & Wall Marking Layout |
| 11 | L1-ST-2.0.2 | General arrangement layout at Foundation level |
| 12 | L1-ST-5.1 | Beam Schedule at Ground Floor Level |
| | | |
| **C** | **ELECTRICAL** | |
| 13 | L1-EL-0.1 | Electrical System SLD |
| 14 | L1-EL-0.2 | Fire Alarm System Schematic Diagram |
| 15 | L1-EL-2.0(L) | Basement Floor Plan - Lighting Layout |
| 16 | L1-EL-2.0(LV) | Basement Floor Plan - Fire Alarm, Access Control, PA & CCTV Layout |
| 17 | L1-EL-2.0(P) | Basement Plan - Power, Cable Tray & LV Layout |
| 18 | L1-EL-2.1(L) | Ground Floor Plan - Lighting Layout |
| 19 | L1-EL-2.1(LV) | Ground Floor Plan - Fire Alarm, Access Control, PA & CCTV Layout |
| 20 | L1-EL-2.1(P) | Ground Floor Plan - Power, Cable Tray & LV Layout |
| 21 | L1-EL-2.7 | Terrace Plan - Electrical Layout |
| | | |
| **D** | **HVAC** | |
| 22 | L1-AC-0.1 | HVAC System Layout: Riser Diagram |
| 23 | L1-AC-2.0 | HVAC System Layout: Basement Plan |
| 24 | L1-AC-2.1 | HVAC System Layout: Ground Floor Plan |
| 25 | L1-AC-2.7 | HVAC System Layout: Roof Floor Plan |
| 26 | L1-AC-5.0 | HVAC System Layout: Schedules |
| | | |
| **E** | **PLUMBING** | |
| 27 | L1–PH-0.1 | Plumbing Water Supply Schematic Diagram |
| 28 | L1-PH-2.0 | Basement Floor Plan - Plumbing Layout |
| 29 | L1- PH-2.1 | Ground Floor Plan - Plumbing Layout |
| 30 | L1- PH-2.7 | Terrace Floor Plan - Plumbing layout |
| 31 | L1- PH-2.8 | Mumty Floor - Plumbing Layout |
| | | |
| **F** | **FIRE FIGHTING** | |
| 32 | L1-FF-0.1 | Fire Fighting Schematic Diagram |
| 33 | L1-FF-2.0 | Basement Floor Plan - Fire Fighting Layout |
| 34 | L1-FF-2.1 | Ground Floor Plan - Fire Fighting Layout |
| 35 | L1-FF-2.7 | Terrace Floor Plan - Fire Fighting Layout |
| | | |
| **AC9 - INSTITUTE OF SAARC STUDIES** | | |
| | | |
| **A** | **ARCHITECTURE** | |
| 1 | AC9-A-2.0. | Basement Plan |
| 2 | AC9-A-2.1 | Ground Floor Plan |
| 3 | AC9-A-2.7 | Terrace Plan & Roof Plan |
| 4 | AC9-A-3.1 | Section AA' |
| 5 | AC9-A-3.2 | Section BB' |
| 6 | AC9-A-4.1 | Elevation 1 |
| 7 | AC9-A-4.2 | Elevation 2 |
| 8 | AC9-A-6.3 | Staircase Detail (STC-03) |
| 9 | AC9-A-7.2.1 | Façade Detail |
| | | |
| **B** | **STRUCTURE** | |
| 10 | AC9-ST-2.0.1 | Column & Wall Marking Layout At Foundation Level |
| | | |
| **C** | **ELECTRICAL** | |
| 11 | AC9-EL-0.1 | Electrical System – SLD |

| S.NO. | DRAWING NO. | DESCRIPTION |
|---|---|---|
| 12 | AC9-EL-0.2 | Fire Alarm System - Schematic Diagram |
| 13 | AC9-EL-2.0(L) | Basement Floor Plan – Lighting Layout |
| 14 | AC9-EL-2.0(LV) | Basement Floor Plan – Fire alarm, Access control, PA & CCTV Layout |
| 15 | AC9-EL-2.0(P) | Basement Plan – (Power, Cable Tray & LV Layout) |
| 16 | AC9-EL-2.1(L) | Ground Floor Plan – Lighting Layout |
| 17 | AC9-EL-2.1(LV) | Ground Floor Plan – Fire alarm, Access control, PA & CCTV Layout |
| 18 | AC9-EL-2.1(P) | Ground Floor plan – (Power, Cable Tray & LV Layout) |
| 19 | AC9-EL-2.7 | Terrace Plan – Electric Layout |
| | | |
| **D** | **HVAC** | |
| 20 | AC9-AC-2.0 | HVAC System Layout: Basement Floor Plan |
| 21 | AC9-AC-2.1 | HVAC System Layout: Ground Floor Plan |
| 22 | AC9-AC-2.9 | HVAC System Layout: Roof Floor Plan |
| 23 | AC9-AC-4.0 | HVAC System Layout: Riser Diagram |
| 24 | AC9-AC-5.0 | HVAC System Layout: Schedule |
| | | |
| **E** | **PLUMBING** | |
| 25 | AC9-PH-0.1 | Plumbing Water Supply Schematic Diagram |
| 26 | AC9-PH-2.0 | Basement Floor Plan Plumbing Drainage Layout |
| 27 | AC9-PH-2.1 | Ground Floor Plan Plumbing Layout |
| 28 | AC9-PH-2.7 | Terrace Floor Plan Plumbing Layout |
| | | |
| **F** | **FIRE FIGHITING** | |
| 29 | AC9-FF-0.1 | Schematic Fire Fighting Layout |
| 30 | AC9-FF-2.0 | Basement Plan - Fire Fighting Layout |
| 31 | AC9-FF-2.1 | Ground Floor - Fire Fighting Layout |
| 32 | AC9-FF-2.7 | Terrace Floor - Fire Fighting Layout |
| | | |
| **G** | **LANDSCAPE** | |
| 33 | AC9/L1-LA-1.1 | Landscape Plan |
| | | |
| | **U1 -UTILITY BUILDING** | |
| | | |
| **A** | **ARCHITECTURE** | |
| 1 | U1-A-2.1 | Ground Floor Plan |
| 2 | U1-A-2.2 | Basement, First & Terrace Floor Plan |
| 3 | U1-A-3.1 | Section AA' & BB' |
| 4 | U1-A-4.1 | Elevation 1,2 & 3 |
| 5 | U1-A-4.2 | Elevation 4,5,6 & 7 |
| 6 | U1-A-7.1 | Facade Details A, B, C, D |
| 7 | U1-A-10.1 | Door Window Schedule |
| | | |
| **B** | **STRUCTURE** | |
| 8 | U1-ST-2.0.1 | Column & Wall Marking Plan |
| 9 | U1-ST-2.0.2 | Framing plan at foundation level Plan |
| | | |
| **C** | **ELECTRICAL** | |
| 10 | U1-EL-0.1 | Electrical System – SLD |
| 11 | U1-EL-8.1(EL) | Electrical Layout Ground Floor Plan |
| 12 | U1-EL-8.1(LV) | LV Layout Ground Floor Plan |
| 13 | U1-EL-8.2(EL) | Electrical Layout Basement, First & Terrace Floor Plan |
| 14 | U1-EL-8.2(LV) | LV Layout Basement, First & Terrace Floor Plan |
| | | |
| **D** | **HVAC** | |
| 15 | U1-AC-1.1 | HVAC System Layout: Plant Room-Basement |
| 16 | U1-AC-1.2 | HVAC System Layout: Plant Room-Ground Floor |
| 17 | U1-AC-4.0 | HVAC System Layout: Single Line Diagram |
| | | |
| **E** | **PLUMBING** | |
| 18 | U1-PH-0.1 | Plumbing Water Supply Diagram |
| 19 | U1-PH 2.1 | Ground Floor Plumbing Layout |
| 20 | U1-PH 2.2 | First & Terrace Plumbing Layout |
| | | |

| S.NO. | DRAWING NO. | DESCRIPTION |
|---|---|---|
| **F** | **FIRE FIGHITING** | |
| 21 | U1- FF 2.1 | Ground Floor Plan Fire Fighting Layout |
| 22 | U1- FF 2.2 | First Floor plan Fire Fighting Layout |
| | | |
| **AC3 - FACULTY OF PHYSICS- CHEMISTRY & MATHS - IT** | | |
| | | |
| **A** | **ARCHITECTURE** | |
| 1 | AC3-A-2.0 | Plan : Basement Floor |
| 2 | AC3-A-2.1 | Plan : Ground Floor |
| 3 | AC3-A-2.5 | Plan : Fourth Floor |
| 4 | AC3-A-2.6 | Plan : Terrace Floor |
| 5 | AC3-A-2.7 | Plan : Roof Floor |
| 6 | AC3-A-3.1 | Section : AA' & CC' |
| 7 | AC3-A-4.1 | Elevation A & B |
| 8 | AC3/AC4-A-7.1 | Façade Detail |
| | | |
| **B** | **STRUCTURE** | |
| 9 | AC3-ST-2.0.1 | Column and wall marking plan and detail at foundation level |
| 10 | AC3-ST-2.0.2 | Foundation plan and details |
| | | |
| **C** | **ELECTRICAL** | |
| 11 | AC3-EL-0.1 | Electrical System SLD |
| 12 | AC3-EL-0.2 | Fire Alarm System Schematic Diagram |
| 13 | AC3-EL-2.0(L) | Plan : Basement Floor Lighting Layout |
| 14 | AC3-EL-2.0(LV) | Plan : Basement Floor LV Layout |
| 15 | AC3-EL-2.0(P) | Plan : Basement Floor Power Layout |
| 16 | AC3-EL-2.1(L) | Plan : Ground Floor Lighting Layout |
| 17 | AC3-EL-2.1(LV) | Plan : Ground Floor LV Layout |
| 18 | AC3-EL-2.1(P) | Plan : Ground Floor Power Layout |
| 19 | AC3-EL-2.6 | Plan : Terrace Floor Electrical Layout |
| | | |
| **D** | **HVAC** | |
| 20 | AC3-AC-2.0 | HVAC System Layout: Basement Floor Plan |
| 21 | AC3-AC-2.1 | HVAC System Layout: Ground Floor Plan |
| 22 | AC3-AC-2.6 | HVAC System Layout: Roof Plan |
| 23 | AC3-AC-4.0 | HVAC System Layout: Riser Diagram |
| 24 | AC3-AC-5.0 | HVAC System Layout: Schedules |
| | | |
| **E** | **PLUMBING** | |
| 25 | AC3-PH-0.1 | Plumbing Water Supply Schematic Diagram |
| 26 | AC3- PH -2.0 | Basement Floor Plan Plumbing Layout |
| 27 | AC3- PH -2.1 | Ground Floor Plan Plumbing Layout |
| 28 | AC3- PH -2.6 | Terrace Floor Plan Plumbing Layout |
| | | |
| **F** | **FIRE FIGHITING** | |
| 29 | AC3-FF-0.1 | Fire Fighiting- Schematic Diagram |
| 30 | AC3-FF-2.0 | Basement Floor Plan Fire Fighting Layout |
| 31 | AC3-FF-2.1 | Ground Floor Plan Fire Fighting Layout |
| 32 | AC3-FF-2.5 | Fourth Floor Plan Fire Fighting Layout |
| | | |
| **G** | **LANDSCAPE** | |
| 33 | AC3-LA-1.1 | Landscape Area Plan |
| | | |
| **AC4 - FACULTY OF LAW AND HUMANITIES** | | |
| | | |
| **A** | **ARCHITECTURE** | |
| 1 | AC4-A-2.0 | Plan : Basement Floor |
| 2 | AC4-A-2.1 | Plan : Ground floor |
| 3 | AC4-A-2.5 | Plan : Terrace Floor |
| 4 | AC4-A-2.6 | Plan : Mumty Floor |
| 5 | AC4-A-3.1 | Section : AA' & CC' |
| 6 | AC4-A-4.1 | Elevation : A & B |

| S.NO. | DRAWING NO. | DESCRIPTION |
|---|---|---|
| | | |
| **B** | **STRUCTURE** | |
| 7 | AC4-ST-2.0.1 | Column and wall marking layout and detail at Foundation level |
| 8 | AC4-ST-2.0.2 | Foundation plan and details |
| | | |
| **C** | **ELECTRICAL** | |
| 9 | AC4-EL-0.1 | Electrical System SLD |
| 10 | AC4-EL-0.2 | Plan : Ground Floor Fire Alarm System Schematic Diagram |
| 11 | AC4-EL-2.0(L) | Plan : Basement Floor Lighting Layout |
| 12 | AC4-EL-2.0(LV) | Plan : Basement Floor LV Layout |
| 13 | AC4-EL-2.0(P) | Plan : Basement Floor Power Layout |
| 14 | AC4-EL-2.1(L) | Plan : Ground Floor Lighting Layout |
| 15 | AC4-EL-2.1(LV) | Plan : Ground Floor LV Layout |
| 16 | AC4-EL-2.1(P) | Plan : Ground Floor Power Layout |
| 17 | AC4-EL-2.5 | Plan : Terrace Floor Electrical Layout |
| 18 | AC4-EL-4.0.1 | Plan : Ground Floor Data System Schematic Diagram |
| | | |
| **D** | **HVAC** | |
| 19 | AC4-AC-2.0 | HVAC System Layout: Basement Floor Plan |
| 20 | AC4-AC-2.1 | HVAC System Layout: Ground Floor Plan |
| 21 | AC4-AC-2.5 | HVAC System Layout: Roof Plan |
| 22 | AC4-AC-4.0 | HVAC System Layout: Riser Diagram |
| 23 | AC4-AC-5.0 | HVAC System Layout: Schedules |
| | | |
| **E** | **PLUMBING** | |
| 24 | AC4-PH-0.1 | Plumbing water supply Schematic Diagram |
| 25 | AC4- PH -2.0 | Basement Floor Plan Plumbing Layout |
| 26 | AC4- PH -2.1 | Ground Floor Plan Plumbing Layout |
| 27 | AC4- PH -2.5 | Terrace Floor Plan Plumbing Layout |
| | | |
| **F** | **FIRE FIGHTING** | |
| 28 | AC4-FF-0.1 | Fire Fighiting Schematic Diagram |
| 29 | AC4-FF-2.0 | Basement Floor Plan Fire Fighiting Layout |
| 30 | AC4-FF-2.1 | Ground Floor Plan Fire Fighiting Layout |
| 31 | AC4-FF-2.5 | Terrace Floor Plan Fire Fighiting Layout |
| | | |
| **G** | **LANDSCAPE** | |
| 32 | AC4-LA-1.1 | Landscape Area Plan |
| | | |
| **AC1_C1 - ART & DESIGN AND CONVENTION CENTRE** | | |
| | | |
| **A** | **ARCHITECTURE** | |
| 1 | AC1-A-2.0.1 | Plan: Basement 02 |
| 2 | AC1-A-2.0.2 | Plan: Basement 01 |
| 3 | AC1-A-2.1 | Plan: Ground Floor |
| 4 | AC1-A-2.2 | Plan: First Floor |
| 5 | AC1-A-2.6 | Plan: Terrace 1 |
| 6 | AC1-A-3.1 | Section 'AA' |
| 7 | AC1-A-4.1 | Elevation AA & BB |
| 8 | AC1-A-7.1 | Art and Design Centre Façade Detail |
| 9 | AC1-A-7.2 | Convention Centre Façade Detail |
| | | |
| **B** | **STRUCTURE** | |
| 10 | AC1-ST-2.0.1(SH-01) | Column and Wall marking layout |
| 11 | AC1-ST-2.0.2(SH-01) | Foundation Plan |
| 12 | AC1-ST-2.0.4 | Basement 1- Framing Plan |
| 13 | AC1-ST-2.1(SH-01) | Ground Floor- Framing Plan |
| 14 | AC1-ST-2.6 | Terrace Floor Framing Plan, details and Truss detail |
| | | |
| **C** | **ELECTRICAL** | |
| 15 | AC1-EL-0.1 | Electrical System SLD |
| 16 | AC1-EL-0.2 | Fire Alarm System Schematic Diagram |
| 17 | AC1-EL-2.0.1(L) | Plan: Basement 2 Lighting Layout |

| S.NO. | DRAWING NO. | DESCRIPTION |
|---|---|---|
| 18 | AC1-EL-2.0.1(LV) | Plan: Basement 2 LV Layout |
| 19 | AC1-EL-2.0.1(P) | Plan: Basement 2 Power Layout |
| 20 | AC1-EL-2.0.2(L) | Plan: Basement 1 Lighting Layout |
| 21 | AC1-EL-2.0.2(LV) | Plan: Basement 1 LV Layout |
| 22 | AC1-EL-2.0.2(P) | Plan: Basement 1 Power Layout |
| 23 | AC1-EL-2.1(L) | Plan: Ground Floor Lighting Layout |
| 24 | AC1-EL-2.1(LV) | Plan: Ground Floor LV Layout |
| 25 | AC1-EL-2.1(P) | Plan: Ground Floor Power Layout |
| 26 | AC1-EL-2.6 | Plan: Terrace Electrical Layout |
| | | |
| **D** | **HVAC** | |
| 27 | AC1-AC-2.0 | HVAC System Layout: Basement Floor Plan |
| 28 | AC1-AC-2.1 | HVAC System Layout: Lower Ground Floor Plan |
| 29 | AC1-AC-2.2 | HVAC System Layout: Ground Floor Plan |
| 30 | AC1-AC-4.0 | HVAC System Layout: Chilled Water Riser Diagram |
| 31 | AC1-AC-5.0 | HVAC System Layout: Schedules |
| 32 | AC1-AC-6.0 | HVAC System Layout: Typical Detail |
| | | |
| **E** | **PLUMBING** | |
| 33 | AC1-PH-0.1 | Plumbing Water Supply Schematic Diagram |
| 34 | AC1-PH-2.0.1 | Basement 2 Floor: Plumbing Layout |
| 35 | AC1-PH-2.0.2 (A) | Basement 1 Water Supply Plumbing Layout |
| 36 | AC1-PH-2.1 | Ground Floor: Plumbing Floor Plan Layout |
| 37 | AC1-PH-2.6 | Terrace Floor Plumbing Plan Layout |
| | | |
| **F** | **FIRE FIGHITING** | |
| 38 | AC1-FF-0.1 | Fire Fighting- Schematic Diagram |
| 39 | AC1-FF-2.0.2 | Basement 1 Plan - Fire Fighting Layout |
| 40 | AC1-FF-2.0.1 | Basement 2 Plan - Fire Fighting Layout |
| 41 | AC1-FF-2.1 | Ground Floor Plan - Fire Fighting Layout |
| 42 | AC1-FF-2.6 | Terrace Plan - Fire Fighting Layout |
| | | |
| **G** | **LANDSCAPE** | |
| 43 | AC1-LA-1.1 | Landscape Area Plan |
| | | |
| | **EXTERNAL DEVELOPMENT** | |
| | | |
| **A** | **LANDSCAPE** | |
| 1 | LA-A-1.1 | Layout Plan (Grading, Northing & Easting) |
| 2 | LA-LP-3.0 | Landscape Common Details |
| 3 | LA-LP-3.1 | Academic Spine Part Plan, Sections and Detail |
| 4 | LA-LP-3.2 | 27M ROW (12 M WIDE ROAD): Part Plan, Sections and Detail |
| 5 | LA-LP-3.3 | Peripheral road (Near PCM-IT Building): Part Plan, Sections and Detail |
| 6 | LA-LP-4.1 | Rain Water Harvesting Pit (Annexure:5) |
| | | |
| **B** | **ELECTRICAL** | |
| 7 | LP-EL-1.0 | Site Plan : HT/LT cable routing& ESS locations Layout |
| 8 | LP-EL-1.0A | Site Plan : Extra low voltage & cable routing layout |
| 9 | LP-EL-1.0B | Earthing Pit Detail |
| 10 | LP-EL-1.0C | Block diagram for access, CCTV, Data, Voice & EM System with fibre optic cable routing |
| 11 | LP-EL-1.1 | Main Electrical System SLD |
| 12 | LP-EL-1.1A | ESS 1 Electrical System SLD |
| 13 | LP-EL-1.1B | ESS 2 Electrical System SLD |
| 14 | LP-EL-1.1C | ESS 3 Electrical System SLD |
| 15 | LP-EL-1.1D | ESS 4 Electrical System SLD |
| 16 | LP-EL-1.1E | P&I Diagram Of HSD Fuel System For DG Set |
| 17 | LP-EL-1.2 | Site Plan: External Lighting Layout |
| 18 | LP-EL-1.3 | SCADA System Architectural |
| 19 | LP-EL-3.1 | Main Receiving Station & Earthing Layout Ground Floor Plan |
| 20 | LP-EL-3.2 | HSD Yard Tank Typical DetailL 15000 Ltrs. |
| | | |

| S.NO. | DRAWING NO. | DESCRIPTION |
|---|---|---|
| **C** | **HVAC** | |
| 21 | LP-AC-2.1 | CHW Pipe site plan & routing |
| | | |
| **D** | **PLUMBING** | |
| 22 | LP-PH-1.1 | Plumbing Sewer Layout - Site Plan |
| 23 | LP-PH-1.1 A | Plumbing Storm Water Layout - Site Plan |
| 24 | LP-PH-1.1 B | Plumbing Water Supply Layout - Site Plan |
| 25 | LP-PH-3.1 | Sewer Treatment Plant: Schematic |
| 26 | LP-PH-3.2 | Water Treatment Plant: Schematic |
| | | |
| **F** | **FF** | |
| 27 | LP-FF-1.1 | Fire Fighting Layout - Site Plan |
| | | |
| **COMMON DRAWINGS** | | |
| | | |
| **A** | **ARCHITECTURE** | |
| 1 | AD1/L1/AC9/AC3/AC4/AC1/C1-A-7.4.1 | Miscellaneous Details |
| 2 | AD1/L1/AC9/AC3/AC4/AC1/C1-A-7.4.2 | Toilet, Lift Core & Stair Case Details |
| | | |
| **B** | **STRUCTURE** | |
| 3 | AC3/AC4/AC1-ST-6.1 | Precast and fins detail |
| | | |
| **C** | **HVAC** | |
| 4 | AD1/L1/AC9/U1/AC3/AC4/AC1/C1-A-1.0 | HVAC System Layout: General Notes, Mechanical Notes, Symbols and Abbreviation |
| | | |
| **D** | **BMS** | |
| 5 | BMS-1.0 | BMS Network Architecture |
| 6 | BMS-2.0 | Typical control schematic diagram for circulator AHU |

# SOUTH ASIAN UNIVERSITY

Akbar Bhawan, Chanakyapuri, New Delhi

**Construction of South Asian University Campus at Maidan Garhi, New Delhi. Package-III: (i) Administration Building (ii) Library Building (iii) Institute of South Asian Studies and Interdisciplinary Research (iv) Faculty of Law and Humanities (v) Faculty of Physics, Chemistry, Maths and I.T. (vi) Faculty of Art & Design and Convention Centre (vii) Utility Building: Including Basements, Superstructures, Interior Finishes, Internal Water Supply, Sanitary Installations, Drainage, Internal Electrical Installations, HVAC, Lifts, Fire Fighting System, Low Voltage System ; PA System, Solar Water Heating System etc. External Site Development and Infrastructure; Roads, Street Lighting, Sewerage, Storm Water Drainage, STP, WTP, Water Supply, HT & LT Power Distribution, Electrical Substation, Chiller Plant, Pump House, D.G. Sets, Rainwater Harvesting, Hardscaping etc.**

**Percentage Rate Tender for Works**

**PART A**
**Technical / Eligibility Bid**
**Notice Inviting Tender, Eligibility Criteria,**
**General Conditions of Contract**

**PART B**
**Special Conditions and Particular Specifications**
**and Tender Drawings**

**PART C**
**Financial Bid**

**September 2016**

## SUMMARY OF SCHEDULE

### OVERALL SUMMARY OF SCHEDULES A, B, C & D

| S.No. | Description of Work | Amount (Rs.) |
|---|---|---|
| 1 | SCHEDULE A - DSR 2014 ITEMS | 3,744,762,475 |
| 2 | SCHEDULE B - NON DSR ITEMS | 2,414,884,096 |
| 3 | SCHEDULE C - BUILDING MANAGEMENT SYSTEM | 59,617,766 |
| 4 | SCHEDULE D - OPERATION & MAINTENANCE WORKS | 169,654,000 |
| | TOTAL | 6,388,918,337 |

| SCHEDULE A SUMMARY - DSR 2014 ITEMS | | |
|---|---|---|
| Tenderer has to quote % above/below/at Par for the following Group of Items | | |
| | | |
| **S.No.** | **Description of Work** | **Amount (Rs.) DSR** |
| | **CIVIL WORKS** | |
| A. | EARTH WORK | 69,466,933 |
| B. | PLAIN CEMENT CONCRETE | 167,315,580 |
| C. | REINFORCED CEMENT CONCRETE | 1,844,237,852 |
| D. | BRICK WORK | 151,755,404 |
| E. | SAND STONE | 247,513,004 |
| F. | MARBLE & GRANITE WORK | 211,312,345 |
| G. | WOOD & PVC WORK | 1,006,466 |
| H. | STEEL WORK | 33,130,937 |
| I. | FLOORING | 119,463,634 |
| J. | ROOFING | 97,978,664 |
| K. | FINISHING | 94,200,839 |
| L. | ROAD WORK | 171,628,770 |
| M. | DOORS, WINDOWS & ALUMINIUM WORKS | 33,904,880 |
| N. | WATER PROOFING | 38,811,777 |
| O. | MISCELLANEOUS ITEMS | - |
| P. | RAIN WATER HARVESTING & RECHARGE WELLS | 38,480,710 |
| | **PLUMBING & SANITARY WORKS** | |
| A. | SANITARY INSTALLATIONS | 1,550,004 |
| B. | INTERNAL DRAINAGE | 18,282,675 |
| C. | WATER-SUPPLY (INTERNAL) | 8,662,877 |
| D. | WATER-SUPPLY (EXTERNAL) | 22,266,136 |
| E. | EXTERNAL SEWERAGE SYSTEM | 16,627,903 |
| F. | EXTERNAL STORM WATER DRAINAGE | 25,052,001 |
| G. | GARDEN IRRIGATION SYSTEM | 50,832 |
| H. | SEWAGE TREATEMENT PLANT | - |
| I. | WATER TREATMENT PLANT | - |
| J. | SOLAR HOT WATER SYSTEM FOR HOT WATER GENERATION | - |
| | **FIRE FIGHTING** | |
| A. | FIRE PUMPS, EQUIPMENT, PIPING, VALVES & ACCESSORIES : | 2,089,956 |
| B. | FIRE HYDRANT SYSTEM (INTERNAL) | 21,914,031 |
| C. | FIRE HYDRANT SYSTEM (EXTERNAL) | 15,199,012 |
| D. | SPRINKLER SYSTEM | 25,224,428 |
| F. | FIRE EXTINGUISHERS | - |
| G. | GAS SUPPRESSION SYSTEM FOR ADMIN BLOCK SERVER FLOOR (3RD FL) | - |

| S.No. | Description of Work | Amount (Rs.) DSR |
|---|---|---|
| H. | FIRE SUPPRESSION SYSTEM FOR ELECTRICAL PANELS | - |
| | **ELECTRICAL** | |
| A. | POINT WIRING AND SUBMAINS | 79,736,456 |
| B. | CABLES & CABLE TRAYS | 11,068,885 |
| C. | DISTRIBUTION BOARDS | 5,787,588 |
| D. | LIGHTING FIXTURES AND FANS | 696,032 |
| E. | CONDUITING & CABLEING FOR TELEPHONE, DATA & MATV SYSTEM | 30,030,732 |
| F. | FIRE DETECTION, ALARM AND PA SYSTEM | 22,776,650 |
| G. | CONDUITING FOR CCTV SYSTEM | 2,869,750 |
| H. | ACCESS CONTROL SYSTEM | 494,190 |
| I. | CIVIL WORKS | 2,253,338 |
| J. | EARTHING SYSTEM | 1,917,038 |
| K. | HT CABLES AND TERMINATIONS | 1,934,760 |
| L. | MISCELLANEOUS ITEMS | 11,855,010 |
| | **HVAC WORKS** | |
| A | HIGH SIDE EQUIPMENT | 1,114,410 |
| B | AIR CONDITIONING EQUIPMENTS: | - |
| C | VENTILATION SYSTEM: | - |
| D | AIR DISTRIBUTION SYSTEM: | 67,441,383 |
| E | PIPING & ACCESSORIES | 22,391,532 |
| F | ELECTRICAL WORKS | 5,267,072 |
| | | |
| | **TOTAL** | **3,744,762,475** |
| | **Percentage quoted by the tenderer above/below/at Par of the Total Amount (in %) in figures** | |
| | **Percentage quoted by the tenderer above/below/at Par of the Total Amount (in %) in words** | |
| | **Total Quoted Amount in Figures (in Rs.)** | |
| | **Total Quoted Amount in Words** | |

| SCHEDULE B - SUMMARY NON DSR ITEMS | | |
|---|---|---|
| Tenderer has to quote % above/below/at Par for the following Group of Items | | |
| | | |
| **S.No.** | **Description of Work** | **Amount (Rs.) NDSR** |
| | | |
| | **CIVIL WORKS** | |
| A. | EARTH WORK | - |
| B. | PLAIN CEMENT CONCRETE | - |
| C. | REINFORCED CEMENT CONCRETE | 10,972,572 |
| D. | BRICK WORK | - |
| E. | SAND STONE | 54,646,650 |
| F. | MARBLE & GRANITE WORK | - |
| G. | WOOD & PVC WORK | 18,088,983 |
| H. | STEEL WORK | 88,690,900 |
| I. | FLOORING | 46,490,915 |
| J. | ROOFING | 81,489,702 |
| K. | FINISHING | 12,070,350 |
| L. | ROAD WORK | 26,230,385 |
| M. | DOORS, WINDOWS & ALUMINIUM WORKS | 337,135,404 |
| N. | WATER PROOFING | 71,098,640 |
| O. | MISCELLANEOUS ITEMS | 62,946,866 |
| P. | RAIN WATER HARVESTING & RECHARGE WELLS | - |
| | | |
| | **PLUMBING & SANITARY WORKS** | |
| A. | SANITARY INSTALLATIONS | 39,846,239 |
| B. | INTERNAL DRAINAGE | 8,712,425 |
| C. | WATER-SUPPLY (INTERNAL) | 25,836,769 |
| D. | WATER-SUPPLY (EXTERNAL) | 3,823,568 |
| E. | EXTERNAL SEWERAGE SYSTEM | 2,786,246 |
| F. | EXTERNAL STORM WATER DRAINAGE | 6,624,206 |
| G. | GARDEN IRRIGATION SYSTEM | 2,447,291 |
| H. | SEWAGE TREATEMENT PLANT | 36,655,000 |
| I. | WATER TREATMENT PLANT | 7,320,000 |
| J. | SOLAR HOT WATER SYSTEM FOR HOT WATER GENERATION | 1,097,250 |
| | | |
| | **FIRE FIGHTING** | |
| A. | FIRE PUMPS, EQUIPMENT, PIPING, VALVES & ACCESSORIES : | 5,741,649 |
| B. | FIRE HYDRANT SYSTEM (INTERNAL) | 20,296,948 |
| C. | FIRE HYDRANT SYSTEM (EXTERNAL) | 7,572,955 |
| D. | SPRINKLER SYSTEM | 31,881,108 |
| F. | FIRE EXTINGUISHERS | 10,637,249 |

| S.No. | Description of Work | Amount (Rs.) NDSR |
|---|---|---|
| G. | GAS SUPPRESSION SYSTEM FOR ADMIN BLOCK SERVER FLOOR (3RD FL) | 34,628,427 |
| H. | FIRE SUPPRESSION SYSTEM FOR ELECTRICAL PANELS | 8,982,560 |
| | | |
| | **ELECTRICAL** | |
| A | POINT WIRING AND SUBMAINS | 10,161,133 |
| B | CABLES & CABLE TRAYS | 69,191,277 |
| C | DISTRIBUTION BOARDS | 985,044 |
| D | LIGHTING FIXTURES AND FANS | 159,270,281 |
| E | UPS SYSTEM | 49,806,667 |
| F | EARTHING SYSTEM | 4,766,944 |
| G | LIGHTNING PROTECTION SYSTEM | 3,973,770 |
| H | ELEVATORS | 84,810,000 |
| I | MATV SYSTEM | 54,207,777 |
| J | FIRE DETECTION, ALARM AND PA SYSTEM | 79,439,615 |
| K | CONDUITING FOR CCTV SYSTEM | 3,434,678 |
| L | ACCESS CONTROL SYSTEM | 6,829,352 |
| M | BUS DUCT (IN SANDWICH CONSTRUCTION) | 1,924,650 |
| N | DISTRIBUTION BOARDS & PANELS | 47,745,399 |
| O | POWER AND DISTRIBUTION TRANSFORMERS & COMPACT SUB STATION | 65,621,177 |
| P | 66 KV GIS SWITCHGEARS , 11 KV MAIN HT PANEL & DG SYNCH. PANEL | 53,917,445 |
| Q | ISOLATOR PANEL BOARDS (INDOOR & OUTDOOR TYPE) | 71,297,831 |
| R | DG SETS AND EXHAUST PIPING SYSTEM | 45,020,531 |
| S | HSD STORAGE AND SUPPLY SYSTEM | 2,548,975 |
| T | EXTERNAL LIGHTING FIXTURES: | 23,036,200 |
| U | SAFETY AND FIRE PROTECTION EQUIPMENTS | 1,874,430 |
| V | HT CABLES AND TERMINATIONS | 15,051,117 |
| W | SCADA SYSTEM | 8,400,000 |
| X | NITROGEN INJECTION FIRE PREVENTION AND EXTINGUISHING SYSTEM | 2,200,000 |
| Y | ENERGY MANAGEMENT SYSTEM | 3,771,787 |
| Z | MISCELLANEOUS ITEMS | 1,017,718 |
| | | |
| | **HVAC WORKS** | |
| A | HIGH SIDE EQUIPMENT | 209,224,164 |
| B | AIR CONDITIONING EQUIPMENTS: | 109,775,215 |
| C | VENTILATION SYSTEM: | 24,943,699 |

| S.No. | Description of Work | Amount (Rs.) NDSR |
|---|---|---|
| D | AIR DISTRIBUTION SYSTEM: | 53,012,612 |
| E | PIPING & ACCESSORIES | 39,534,032 |
| F | ELECTRICAL WORKS | 43,339,318 |
| | | |
| | **TOTAL** | **2,414,884,096** |
| | **Percentage quoted by the tenderer above/below/at Par of the Total Amount (in %) in figures** | |
| | **Percentage quoted by the tenderer above/below/at Par of the Total Amount (in %) in words** | |
| | **Total Quoted Amount in Figures (in Rs.)** | |
| | **Total Quoted Amount in Words** | |

| SCHEDULE C - SUMMARY BMS WORKS | | |
|---|---|---|
| Tenderer has to quote % above/below/at Par for the following Group of Items | | |
| **S.No.** | **Description of Work** | **Amount (Rs.) NDSR** |
| | | |
| A | BMS SYSTEM | 59,617,766 |
| | | |
| | **TOTAL** | **59,617,766** |
| **Percentage quoted by the tenderer above/below/at Par of the Total Amount (in %) in figures** | | |
| **Percentage quoted by the tenderer above/below/at Par of the Total Amount (in %) in words** | | |
| **Total Quoted Amount in Figures (in Rs.)** | | |
| **Total Quoted Amount in Words** | | |

| | | |
|---|---|---|
| **SCHEDULE D - SUMMARY OF OPERATION & MAINTENANCE WORKS** | | |
| **Tenderer has to quote % above/below/at Par for the following Group of Items** | | |
| | | |
| **S.No.** | **Description of Work** | **Amount (Rs.) DSR** |
| | | |
| A | OPERATION & MAINTENANCE FOR E & M WORKS | 169,654,000 |
| | | |
| | | |
| | **TOTAL** | **169,654,000** |
| | **Percentage quoted by the tenderer above/below/at Par of the Total Amount (in %) in figures** | |
| | **Percentage quoted by the tenderer above/below/at Par of the Total Amount (in %) in words** | |
| | **Total Quoted Amount in Figures (in Rs.)** | |
| | **Total Quoted Amount in Words** | |

# SUMMARY OF CIVIL WORKS

| S.No. | DESCRIPTION OF WORKS | Amount (Rs.) DSR | Amount (Rs.) Non DSR |
|---|---|---|---|
| A. | EARTH WORK | 69,466,933 | - |
| B. | PLAIN CEMENT CONCRETE | 167,315,580 | - |
| C. | REINFORCED CEMENT CONCRETE | 1,844,237,852 | 10,972,572 |
| D. | BRICK WORK | 151,755,404 | - |
| E. | SAND STONE | 247,513,004 | 54,646,650 |
| F. | MARBLE & GRANITE WORK | 211,312,345 | - |
| G. | WOOD & PVC WORK | 1,006,466 | 18,088,983 |
| H. | STEEL WORK | 33,130,937 | 88,690,900 |
| I. | FLOORING | 119,463,634 | 46,490,915 |
| J. | ROOFING | 97,978,664 | 81,489,702 |
| K. | FINISHING | 94,200,839 | 12,070,350 |
| L. | ROAD WORK | 171,628,770 | 26,230,385 |
| M. | DOORS, WINDOWS & ALUMINIUM WORKS | 33,904,880 | 337,135,404 |
| N. | WATER PROOFING | 38,811,777 | 71,098,640 |
| O. | MISCELLANEOUS ITEMS | - | 62,946,866 |
| P | RAIN WATER HARVESTING & RECHARGE WELLS | 38,480,710 | - |
| | TOTAL | 3,320,207,794 | 809,861,367 |
| | | | |
| | GRAND TOTAL | | 4,130,069,161 |

| CIVIL WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| | | | | | | |
| **A** | | **EARTH WORK** | | | | |
| 1.0 | **1.1.2** | Carriage of material by mechanical transport including loading, unloading and stacking for all leads and lift. **(The disposal of Malba shall be outside the area of SAU anywhere permissible by local authority)** | | | | |
| 1.1 | **a)** | Earth/Malba | **Cum** | 210.77 | 1000 | 210,770 |
| 1.2 | **979** | Credit for surplus excavated earth removed by contractor from the site for his own use including all loading unloading in all leads and lifts and transportation etc. complete as per direction of engineer-in-charge. | **Cum** | -45 | 119915 | -5396175 |
| 2.0 | **1157** | Credit for taking away the excavated hard rocks from site of work as per the direction of engineer incharge | **Cum** | -900 | 10683 | -9614700 |
| 3.0 | **2.6** | Earth work in excavation by mechanical means (Hydraulic excavator )/ manual means over areas (exceeding 30cm in depth. 1.5m in width as well as 10 sqm on plan) including disposal of excavated earth, lead upto 50m and lift upto 1.5m, disposed earth to be leveled and neatly dressed. **(In case, earth work in excavation is done by mechanical means, no additional lift shall be applicable and nothing shall be paid extra on this account)** | | | | |
| 3.1 | **2.6.1** | All kinds of soil | **Cum** | 155.60 | 187637 | 29,196,317 |
| 4.0 | **2.7** | Earth work in excavation by mechanical means (Hydraulic excavator) / manual means over areas (exceeding 30 cm in depth, 1.5 m in width as well as 10 sqm on plan) including disposal of excavated earth, lead upto 50 m and lift upto 1.5 m, disposed earth to be levelled and neatly dressed. **(In case, earth work in excavation is done by mechanical means, no additional lift shall be applicable and nothing shall be paid extra on this account)** | | | | |
| 4.1 | **2.7.1** | Ordinary rock | **Cum** | 244.60 | 11265 | 2,755,419 |
| 4.2 | **2.7.3** | Hard rock **(blasting prohibited)** | **Cum** | 618.10 | 11265 | 6,962,897 |
| | | | | | | |
| 5.0 | **2.8** | Earth work in excavation by mechanical means (Hydraulic excavator) / manual means in foundation trenches or drains (not exceeding 1.5 m in width or 10 sqm on plan), including dressing of sides and ramming of bottoms, lift upto 1.5 m, including getting out the excavated soil and disposal of surplus excavated soil as directed, within a lead of 50 m. **(In case, earth work in excavation is done by mechanical means, no additional lift shall be applicable and nothing shall be paid extra on this account)** | | | | |
| 5.1 | **2.8.1** | All kinds of soil. | **Cum** | 157.50 | 47229 | 7,438,568 |

| CIVIL WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| 6.0 | **2.9** | Excavation work by mechanical means (Hydraulic excavator) / manual means in foundation trenches or drains (not exceeding 1.5m in width or 10 sqm on plan), including dressing of sides and ramming of bottoms, lift upto 1.5 m, including getting out the excavated soil and disposal of surplus excavated soils as directed, within a lead of 50 m. **(In case, earth work in excavation is done by mechanical means, no additional lift shall be applicable and nothing shall be paid extra on this account)** | | | | |
| 6.1 | **2.9.1** | Ordinary rock | **Cum** | 263.50 | 12001 | 3,162,264 |
| 6.2 | **2.9.3** | Hard rock (blasting prohibited) | **Cum** | 620.55 | 607 | 376,674 |
| 7.0 | **2.25** | Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering. (Lead and lift can be from anywhere within the site, nothing shall be paid extra.) | **Cum** | 112.40 | 92352 | 10,380,365 |
| 8.0 | **2.26** | Extra for every additional lift of 1.5 m or part thereof in excavation / banking excavated or stacked materials. | | | | |
| 8.1 | **2.26.1** | All kinds of soil up to 1.5m | **Cum** | 46.25 | 60395 | 2,793,269 |
| 8.2 | **2.26.2** | All kinds of soil up to 3m to 4.5m | **Cum** | 82.95 | 60389 | 5,009,268 |
| 8.3 | | Extra for additional lift exceeding 4.5 mtr but not exceeding 6 mtr. | Cum | 129.20 | 22873 | 2,955,192 |
| 8.4 | | Extra for additional lift exceeding 6 mtr but not exceeding 7.5 mtr. | Cum | 175.45 | 22873 | 4,013,068 |
| 8.5 | | Extra for additional lift exceeding 7.5 mtr but not exceeding 9 mtr. | Cum | 221.70 | 14867 | 3,296,014 |
| 9.0 | **2.27** | Supplying and filling in plinth with Jamuna / local sand under floors, including watering, ramming, consolidating and dressing complete. | **Cum** | 910.25 | 1535 | 1,397,234 |
| 10.0 | **2.34** | Supplying chemical emulsion in sealed containers including delivery as specified. | | | | |
| 11.0 | **2.34.1** | Chlorpyriphos/ Lindane emulsifiable concentrate of 20% | **Ltr.** | 185.95 | 23145 | 4,303,813 |
| 12.0 | **2.35** | Diluting and injecting chemical emulsion for POSTCONSTRUCTIONAL anti-termite treatment (excluding the cost of chemical emulsion) : | | | | |
| 13.0 | **2.35.1** | Along external wall where the apron is not provided using chemical emulsion @ 7.5 litres / sqm of the vertical surface of the substructure to a depth of 300 mm including excavation channel along the wall & rodding etc. complete: | | | | |
| 13.1 | **2.35.1.1** | With Chlorpyriphos/ Lindane E.C. 20% with 1% concentration | **Metre** | 15.40 | 2083 | 32,078 |
| 14.0 | **2.35.2** | Along the external wall below concrete or masonry apron using chemical emulsion @ 2.25 litres per linear metre including drilling and plugging holes etc.: | | | | |
| 14.1 | **2.35.2.1** | With Chlorpyriphos/ Lindane E.C. 20% with 1% concentration | **Metre** | 22.70 | 2083 | 47,284 |

| CIVIL WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| 15.0 | **2.35.3** | Treatment of soil under existing floors using chemical emulsion @ one litre per hole, 300 mm apart including drilling 12 mm diameter holes and plugging with cement mortar 1 :2 (1 cement : 2 Coarse sand) to match the existing floor : | | | | |
| 15.1 | **2.35.3.1** | With Chlorpyriphos/Lindane E.C. 20% with 1% concentration | **Sqm** | 118.90 | 1239 | 147,317 |
| | | **Total of Earth Work Carried Over to Summary** | | | | **69,466,933** |
| | | | | | | |
| **B** | | **CONCRETE WORK** | | | | |
| 1.0 | **4.1** | Providing and laying in position machine mixed/ready plain cement concrete, using PPC cement content as per NOMINAL mix given in IS 456:2000 (Table 9 page 23 and manufactured in fully autmatic batching plant and transported to the site of work in transit mixer for all leads, having continuous agitated mixer as per direction of Engineer-in-carge (all works upto plinth level) | | | | |
| 1.1 | **4.1.3** | M-15 grade plain cement concrete (1:2:4, 1-cement: 2-Coarse sand: 4-graded stone aggregate 10mm) This item shall be used as a protective layer above APP membrane. | **Cum** | 5,466.30 | 6501 | 35,536,416 |
| 1.2 | **4.1.5** | M-10 grade plain cement concrete (1:3:6) 20mm nominal size | **Cum** | 4,834.30 | 4732 | 22,875,908 |
| 1.3 | **4.1.8** | M-7.5 grade plain cement concrete (1:4:8) 40mm nominal size | **Cum** | 4,301.15 | 4054 | 17,436,862 |
| 2.0 | **4.2** | Providing and laying in position machine mixed/ready plain cement concrete, using PPC cement content as per NOMINAL mix given in IS 456:2000 (Table 9 page 23 and manufactured in fully autmatic batching plant and transported to the site of work in transit mixer for all leads, having continuous agitated mixer as per direction of Engineer-in-carge (upto floor V Level) | | | | |
| 2.1 | **4.2.3** | M-15 grade plain cement concrete (1:2:4, 1-cement: 2-Coarse sand: 4-graded stone aggregate 10mm). | **Cum** | 6,450.00 | 8496 | 54,799,200 |
| 3.0 | **4.11** | Providing and laying damp-proof course 50mm thick with cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20mm nominal size). | **Sqm** | 314.85 | 310 | 97,604 |
| 4.0 | **4.12** | Extra for providing and mixing water proofing material in cement concrete work in doses by weight of cement as per manufacturer's specification. | **Per 50 KG Cement** | 48.15 | 150 | 7,223 |
| 5.0 | **4.18** | Extra for addition of synthetic Polyester triangular fibre of length 12mm, effective diameter 10-40 microns and specific gravity of 1.34 to 1.40 in cement concrete / RCC / Flooring /water retaining structures by using 125gms of synthetic Polyester triangular fibre for 50 Kg cement used as per directions of Engineer-in-Charge. | **Per Bag of 50 Kg of cement** | 53.00 | 750 | 39,750 |

| CIVIL WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| 6.0 | **4.20** | Providing and laying in position ready mixed plain cement concrete, with cement content as per approved design mix and manufactured in fully automatic batching plant and transported to site of work in transit mixer for all leads, having continuous agitated mixer, manufactured as per mix design of specified grade for plain cement concrete work, including pumping of R.M.C. from transit mixer to site of laying and curing, excluding the cost of centering, shuttering and finishing, including cost of curing, admixtures in recommended proportions as per IS : 9103 to accelerate/ retard setting of concrete, improve workability without impairing strength and durability as per direction of the Engineer-in-charge. | | | | |
| | | **Note: Based on the design criterion mentioned in the contract, the agency will get the design mix prepared from the approved laboratory. The Rate of concrete shall be inclusive of all constitutents including extra cement over the minimum, admixture, micro silica and other additives wherever required. Nothing extra shall be paid on this account.** | | | | |
| 6.1 | **4.20.1** | All works upto plinth level : | | | | |
| 6.1.1 | **4.20.1.1** | M-15 grade plain cement concrete | **Cum** | 5,996.70 | 100 | 599,670 |
| 6.1.2 | **4.20.1.2** | M-10 grade plain cement concrete | **Cum** | 5,843.75 | 5926 | 34,630,063 |
| 6.2 | **4.20.2** | All works above plinth and upto floor V level : | | | | |
| 6.2.1 | **4.20.2.1** | M-15 grade plain cement concrete. | **Cum** | 6,540.90 | 100 | 654,090 |
| 6.2.2 | **4.20.2.2** | M-10 grade plain cement concrete | **Cum** | 6,387.95 | 100 | 638,795 |
| | | | | | | |
| | | **Total of PCC Carried Over to Summary** | | | | 167,315,580 |
| | | | | | | |
| **C** | | **REINFORCED CEMENT CONCRETE** | | | | |
| 1.0 | **5.9** | Centering and shuttering including strutting, propping etc. and removal of form for : | | | | |
| 1.1 | **5.9.1** | Foundations, footings, bases of columns, etc. for mass concrete. | **Sqm** | 196.45 | 17076 | 3,354,580 |
| 1.2 | **5.9.2** | Walls (any thickness) including attached pilasters, butteresses, plinth and string courses etc. | **Sqm** | 360.80 | 78615 | 28,364,292 |
| 1.3 | **5.9.3** | Suspended floors, roofs, landings, balconies and access platform. | **Sqm** | 401.65 | 127495 | 51,208,367 |
| 1.4 | **5.9.4** | Shelves (Cast in situ) | **Sqm** | 401.65 | 9264 | 3,720,886 |
| 1.5 | **5.9.5** | Lintels, beams, plinth beams, girders, bressumers and cantilevers. | **Sqm** | 332.15 | 40918 | 13,590,914 |
| 1.6 | **5.9.6** | Columns, Pillars, Piers, Abutments, Posts and Struts. | **Sqm** | 453.35 | 38746 | 17,565,499 |
| 1.7 | **5.9.7** | Stairs, (excluding landings) except spiral-staircases | **Sqm** | 395.65 | 17685 | 6,997,070 |
| 1.8 | **5.9.13** | Vertical and horizontal fins individually or forming box louvers band, facias and eaves boards | **Sqm** | 587.35 | 100 | 58,735 |
| 1.9 | **5.9.16** | Edges of slabs and breaks in floors and walls | | | | |
| 1.9.1 | **5.9.16.1** | Under 20 cm wide | **Metre** | 116.40 | 100 | 11,640 |
| 1.9.2 | **5.9.16.2** | Above 20 cm wide | **Sqm** | 508.55 | 100 | 50,855 |
| 1.10 | **5.9.18** | Small surfaces such as cantilever ends, brackets and ends of steps, caps and bases to pilasters and columns and the like | **Sqm** | 483.70 | 100 | 48,370 |

| CIVIL WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| 2.0 | **5.11** | Extra for additional height in centering, shuttering where ever required with adequate bracing, propping etc., including cost of de-shuttering and decentering at all levels, over a height of 3.5 m, for every additional height of 1 metre or part thereof (Plan area to be measured). | | | | |
| 2.1 | **5.11.1** | Suspended floors, roofs, landing, beams and balconies (Plan area to be measured) | **Sqm** | 159.05 | 25498 | 4,055,457 |
| 3.0 | **5.13** | Providing, hoisting and fixing up to floor five level precast reinforced cement concrete in small lintels not exceeding 1.5 m clear span up to floor five level, including the cost of required centering, shuttering but excluding the cost of reinforcement, with 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size). | **Cum** | 8,797.80 | 383 | 3,369,557 |
| 4.0 | **5.17** | Providing, hoisting and fixing up to floor five level precast reinforced cement concrete in vertical & horizontal fins, individually or forming box louvers, setting in cement mortar 1:2 (1 cement : 2 coarse sand), including the cost of required centering, shuttering but excluding the cost of reinforcement, with 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size). | **Cum** | 7,177.85 | 803 | 5,763,814 |
| 5.0 | **5.22** | Reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete. Upto plinth level. | | | | |
| 5.1 | **5.22.6** | Thermo-Mechanically Treated bars. | **Kg** | 68.10 | 455821 | 31,041,410 |
| 6.0 | **5.22A** | Steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete above plinth level. | | | | |
| 6.1 | **5.22A.6** | Thermo-Mechanically Treated bars. | **Kg** | 68.10 | 15068060 | 1,026,134,886 |
| 7.0 | **5.33** | Providing and laying in position machine batched and machine mixed design mix M-25 grade cement concrete for reinforced cement concrete work, using cement content as per approved design mix, including pumping of concrete to site of laying but excluding the cost of centering, shuttering, finishing and reinforcement, including admixtures in recommended proportions as per IS: 9103 to accelerate, retard setting of concrete, improve workability without impairing strength and durability as per direction of Engineer-in-charge. | | | | |
| | | **Note: Based on the design criterion mentioned in the contract, the agency will get the design mix prepared from the approved laboratory. The Rate of concrete shall be inclusive of all constitutents including extra cement over the minimum, admixture, micro silica and other additives wherever required. Nothing extra shall be paid on this account.** | | | | |
| 7.1 | **5.33.1** | All works upto plinth level | **Cum** | 6,296.15 | 38883 | 244,813,200 |
| 7.2 | **5.33.2** | All works above plinth level upto floor V level | **Cum** | 7,014.55 | 53228 | 373,370,467 |
| 8.0 | **5.34** | Extra for providing richer mixes at all floor levels. | | | | |
| 8.1 | **5.34.1** | Extra for providing M-30 grade concrete instead of M-25 grade BMC/ RMC. | **Cum** | 76.50 | 26788 | 2,049,282 |

| CIVIL WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| 8.2 | **5.34.2** | Extra for providing M-35 grade concrete instead of M-25 grade BMC / RMC. | **Cum** | 152.95 | 1000 | 152,950 |
| 8.3 | **5.34.3** | Extra for providing M-40 grade concrete instead of M-25 grade BMC / RMC | **Cum** | 229.45 | 44297 | 10,163,947 |
| 8.4 | | Extra for providing M-60 grade concrete instead of M-25 grade BMC / RMC. | **Cum** | 520.00 | 16188 | 8,417,760 |
| 9.1 | **Derived from 5.35** | Add for using extra white cement in the items of design mix over and above the specified cement content therein. | **Quintel** | 1,637.00 | 4048 | 6,626,576 |
| 10.0 | **5.44** | Providing and fixing of expansion joint system related with floor location as per drawings and direction of Engineer-In-Charge. The joints system will be of extruded aluminum base members, self aligning / self centering arrangement and support plates etc. as per ASTM B221-02. The system shall be such that it provides floor to floor /floor to wall expansion control system for various vertical localtion in load application areas that accommodates multi directional seismic movement without stress to it's components. System shall consist of metal profiles with a universal aluminum base member designed to accommodate various project conditions and finish floor treatments.<br><br>The cover plate shall be designed of width and thickness required to satisfy projects movement and loading requirements and secured to base members by utilizing manufacturer's pre-engineered self-centering arrangement that freely rotates / moves in all directions. The Self – centering arrangement shall exhibit circular sphere ends that lock and slide inside the corresponding aluminum extrusion cavity to allow freedom of movement and flexure in all directions including vertical displacement. Provision of Moisture Barrier Membrane in the Joint System to have watertight joint is mandatory requirement all as per the manufactures design and as approved by Engineer -in- Charge . (Material shall confirm to ASTM 6063.) | | | | - |
| 10.1 | **5.44.1** | Floor joint of 100 mm gap | **Metre** | 6,358.55 | 298 | 1,894,848 |

| CIVIL WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| 11.0 | **5.45** | Providing and fixing of expansion joint system related with wall joint (internal/ external) location as per drawings and direction of Engineer-In-Charge.The joints shall be of extruded aluminum base members, self aligning / centering arrangement and support plates as per ASTM B221- 02. The material shall be such that it provides an Expansion Joints System suitable for vertical wall to wall/ wall to corner application, both new and existing construction in office Buildings & complexes with no slipping down tendency amongst the components of the Joint System. The Joint System shall utilize light weight aluminum profiles exhibiting minimal exposed aluminum surfaces mechanically snap locking the multicellular to facilitat movement. (Material shall confirm to ASTM 6063.) | | | | |
| 11.1 | **5.45.1** | Wall Joint of 100 mm gap | **Metre** | 5,080.90 | 278 | 1,412,490 |
| | | **Total of Reinforced Cement Concrete Carried Over to Summary** | | | | **1,844,237,852** |
| | | | | | | |
| **D** | | **BRICK WORK** | | | | |
| 1.0 | **6.1** | Brick work with common burnt clay F.P.S (non modular) bricks of class designation 7.5 in foundation and plinth | | | | |
| 1.1 | **6.1.1** | Cement mortar 1:4 (1 cement : 4 coarse sand) | **Cum** | 4,918.65 | 4907 | 24,135,816 |
| 2.0 | **6.4** | Brick work with common burnt clay F.P.S (non modular) bricks of class designation 7.5 in superstructure above plinth level up to floor V level in all shapes and size in : | | | | |
| 2.1 | **6.4.2** | Cement mortar 1:6 (1 cement : 6 coarse sand) | **Cum** | 5,426.15 | 1766 | 9,582,581 |
| 3.0 | **6.5** | Extra for brick work / AAC block masonry / Tile brick masonry in superstructure above floor V level, for each four floors or part thereof by mechanical means. | **Cum** | 289.05 | 1569 | 453,519 |
| 4.0 | **6.12** | Half brick masonry with common burnt clay F.P.S (non modular) bricks of class designation 7.5 in foundationand plinth | | | | |
| 4.1 | **6.12.2** | Cement mortar 1:4 (1 cement : 4 coarse sand ) | **Sqm** | 584.75 | 500 | 292,375 |
| 5.0 | **6.13** | Half brick masonry with common burnt clay F.P.S (non modular) bricks of class designation 7.5 in superstructure above plinth level up to floor V level | | | | |
| 5.1 | **6.13.2** | Cement mortar 1:4 (1 cement : 4 coarse sand ) | **Sqm** | 665.80 | 500 | 332,900 |
| 6.0 | **6.32** | Brick work with clay flyash F.P.S. (non modular) brick of class designation 7.5 in superstructure above plinth level up to floor five level in : | | | | |
| 6.1 | **6.32.1** | Cement mortar 1:4 (1 cement : 4 coarse sand) | **Cum** | 5,697.25 | 500 | 2,848,625 |
| 7.0 | **6.38** | Providing and laying autoclaved aerated cement blocks masonry with 100 mm thick AAC blocks in super structure above plinth level up to floor V level in cement mortar 1:4 (1 cement : 4 coarse sand ). The rate includes providing and placing in position 2 Nos 6 mm dia M.S. bars at every third course of masonry work. | **Cum** | 6,386.95 | 387 | 2,471,750 |

| CIVIL WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| 7.1 | **Derived from 6.38** | Providing and laying autoclaved aerated cement blocks masonry with 200 mm thick AAC blocks in super structure above plinth level up to floor V level in cement mortar 1:4 (1 cement : 4 coarse sand ). | **Cum** | 5,529.58 | 19670 | 108,766,839 |
| 7.2 | **Derived from 6.38** | Providing and laying autoclaved aerated lightweight filling in sunken portions of slab, loosely laid inclusive of ramming, compaction etc. all complete as per directions of the Engineer-in-Charge. | **Cum** | 2,871.00 | 1000 | 2,871,000 |
| | | **Total of Brick Work Carried Over to Summary** | | | | **151,755,404** |
| | | | | | | |
| **E** | | **SAND STONE** | | | | |
| 1.0 | **7.1** | Random rubble masonry with hard stone in foundation and plinth including leveling up with cement concrete 1:6:12 (1 cement : 6 coarse sand : 12 graded stone aggregate 20mm nominal size) at plinth level with : | | | | |
| 1.1 | **7.1.1** | Cement mortar 1:6 (1 cement : 6 coarse sand) | **Cum** | 3,918.10 | 303 | 1,187,184 |
| 2.0 | **7.2** | Random rubble masonry with hard stone in superstructure above plinth level and upto floor five level, including leveling up with cement concrete 1:6:12 (1 cement : 6 coarse sand : 12 graded stone aggregate 20mm nominal size) at window sills, ceiling level and the like. | | | | |
| 2.1 | **7.2.1** | Cement mortar 1:6 (1 cement : 6 coarse sand). | **Cum** | 4,664.85 | 42 | 195,924 |
| 3.0 | **7.23** | Stone work (machine cut edges) for wall lining etc. (veneer work) upto 10 metre height, backing filled with a grout of average 12mm thick cement mortar 1:3 (1 cement : 3 coarse sand ) including pointing in white cement mortar 1:2 (1 white cement : 2stone dust ) with an admixture of pigment matching the stone shade: (To be secured to the backing and the sides by means of cramps and pins which shall be paid for separately. | | | | |
| 3.1 | **7.23.2** | Red sand stone - Exposed face machine cut and table rubbed with rough backing. | | | | |
| 3.1.1 | **7.23.2.5** | 30 mm thick | **Sqm** | 3,036.60 | 9726 | 29,533,972 |
| 4.0 | **7.25** | Providing and fixing stainless steel cramps of required size and shape for anchoring stone wall lining to the backing or securing adjacent stones in stone wall lining in cement mortar 1:2 (1 cement : 2 coarse sand), including making the necessary chases in stone and holes in walls wherever required | **Kg** | 574.65 | 77808 | 44,712,367 |
| 5.0 | **7.32** | Stone work, plain in copings, cornices, string courses and plinth courses, upto 75 mm thick in Cement mortar 1:6 (1 cement : 6 coarse sand), including pointing with white cement mortar 1:2 (1 white cement : 2 stone dust) with an admixture of pigment matching the stone shade. | | | | |
| 5.1 | **7.32.1** | Red sand stone | **Cum** | 38,249.00 | 248 | 9,485,752 |
| 6.0 | **7.39** | Extra for Stone Work for Wall Lining on exterior walls of height more than 10m from ground level for every additional height of 3m or part thereoff. | **Sqm** | 83.35 | 28671 | 2,389,728 |

| CIVIL WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| 7.0 | **7.40** | Providing and fixing dry cladding upto 10 metre heights with 30 mm thick gang saw cut stone with (machine cut edges) of uniform colour and size upto 1mx1m, fixed to structural steel frame work and/ or with the help of cramps, pins etc. and sealing the joints with approved weather sealant as per Architectural drawing and direction of Engineer-in-charge.(The steel frame work, stainless steel cramps and pins etc. shall be paid for separately). | | | | |
| 7.1 | **7.40.1** | Red sand stone | **Sqm** | 2,486.30 | 23362 | 58,084,941 |
| 7.2 | **7.40.2** | White sand stone | **Sqm** | 2,520.00 | 1112 | 2,802,240 |
| 8.0 | **7.41** | Providing and fixing structural steel frame (for dry cladding with 30 mm thick gang saw cut with machine cut edges sand stone) on walls at all heights using M.S. square/ rectangular tube in the required pattern as per architectural drawing, including cost of cutting, bending, welding etc. The frame work shall be fixed to the wall with the help of M.S. brackets/ lugs of angle iron/ flats etc. which shall be welded to the frame and embedded in brick wall with cement concrete block 1:2:4 (1 cement :2 coarse sand :4 graded stone aggregate 20 mm nominal size) of size 300x230x300 mm, including cost of necessary centring and shuttering and with approved expansion hold fasteners on CC/RCC surface, including drilling necessary holes. | **Kg** | 143.55 | 339017 | 48,665,890 |
| | | Approved cramps/ pins etc. shall be welded to the frame work to support stone cladding, the steel work will be given a priming coat of Zinc primer as approved by Engineerin-charge and painted with two or more coats of epoxy paint (Shop drawings shall be submitted by the contractor to the Engineer-in-charge for approval before execution). The frame work shall be fixed in true horizontal & vertical lines/planes. (Only structural steel frame work shall be measured for the purpose of payment, stainless steel cramps shall be paid for separately and nothing extra shall be paid). The walls are made of AAC blocks instead of brick, the contractor shall quote accordingly and nothing to be paid extra on this account. | | | | |
| 9.0 | **7.42** | Providing and fixing adjustable stainless steel cramps of approved quality, required shape and size, adjustable with stainless steel nuts, bolts and washer (total weight not less than 260 gms), for dry stone cladding fixed on frame work at suitable location, including making necessary recesses in stone slab, drilling required holes etc complete as per direction of the Engineer-in-charge. | **Each** | 206.15 | 244749 | 50,455,006 |
| | | **Total of Sand Stone Carried Over to Summary** | | | | **247,513,004** |
| | | | | | | |
| **F** | | **MARBLE & GRANITE WORK** | | | | |

| CIVIL WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| 1.0 | **Derived from DSR item No. 8.1** | Granite work gang saw cut (polished and machine cut) of thickness 18 mm for wall lining (veneer work), backing filled with a grout of average 12 mm thick in cement mortar 1:3 (1 cement : 3 coarse sand), including pointing with white cement mortar 1:2 (1 white cement : 2 marble dust) with an admixture of pigment to match the marble shade (To be secured to the backing by means of cramps, which shall be paid for separately). | | | | |
| 1.1 | **8.1.1** | Granite stone | | | | |
| 1.1.1 | **8.1.1.1** | Area of slab upto 0.50 sqm (Basic Rate of Granite - Rs. 1900 per Sq. M.) | **Sqm** | 4,520.00 | 243 | 1,098,360 |
| 1.1.2 | **8.1.1.2** | Area of slab over 0.50 sqm (Basic Rate of Granite - Rs. 1900 per Sq. M.) | **Sqm** | 4,659.00 | 243 | 1,132,137 |
| 2.0 | **8.2** | Providing and fixing 18 mm thick gang saw cut, mirror polished, premoulded and prepolished, machine cut for kitchen platforms, vanity counters, window sills , facias and similar locations of required size, approved shade, colour and texture laid over 20 mm thick base cement mortar 1:4 (1 cement : 4 coarse sand), joints treated with white cement, mixed with matching pigment, epoxy touch ups, including rubbing, curing, moulding and polishing to edges to give high gloss finish etc. complete at all levels. | | | | |
| 2.1 | **8.2.2** | Granite of any colour and shade | | | | |
| 2.1.2 | **8.2.2.2** | Area of slab over 0.50 sqm | **Sqm** | 3,907.40 | 504 | 1,969,330 |
| 3.0 | **8.3** | Providing edge moulding to 18 mm thick marble stone counters, Vanities etc., including machine polishing to edge to give high gloss finish etc. complete as per design approved by Engineer-in-Charge. | | | | |
| 3.1 | **8.3.2** | Granite work | **Metre** | 230.55 | 874 | 201,501 |
| 4.0 | **8.4** | Extra for fixing marble /granite stone, over and above corresponding basic item, in facia and drops of width upto 150 mm with epoxy resin based adhesive, including cleaning etc. complete. | **Metre** | 247.40 | 1314 | 325,084 |
| 5.0 | **8.5** | Extra for providing opening of required size & shape for wash basin/ kitchen sink in kitchen platform, vanity counter and similar location in marble/Granite/stone work, including necessary holes for pillar taps etc. including moulding, rubbing and polishing of cut edges etc. complete. | **Each** | 386.60 | 341 | 131,831 |
| 6.0 | **8.10** | Providing and fixing stone slab with table rubbed, edges rounded and polished, of size 75x50 cm deep and 1.8 cm thick, fixed in urinal partitions by cutting a chase of appropriate width with chase cutter and embedding the stone in the chase with epoxy grout or with cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 6 mm nominal size) as per direction of Engineer-in-charge and finished smooth. | | | | |
| 6.1 | **8.10.2** | Granite Stone of approved shade | **Sqm** | 3,263.50 | 42 | 137,067 |

| CIVIL WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| 7.0 | **8.12** | Providing and laying flamed finish Granite stone flooring in required design and patterns, in linear as well as curvilinear portions of the building all complete as per the architectural drawings with 18 mm thick stone slab over 20 mm (average) thick base of cement mortar 1:4 (1 cement : 4 coarse sand) laid and jointed with cement slurry and pointing with white cement slurry admixed with pigment of matching shade including rubbing , curing and polishing etc. all complete as specified and as directed by the Engineer-in-Charge: | | | | |
| | | (A) Flamed finish granite stone slab Jet Black, Cherry Red, Elite Brown, Cat Eye or equivalent. | **Sqm** | 3,244.35 | 57730 | 187,296,326 |
| 8.0 | **Difference between DSR 11.27 and DSR 11.26.1 added to DSR 8.12** | Providing and Fixing Granite Stone Skirting in required design complete as per architectural drawings with 18mm thk. Stone Slab over 12mm (average) thk. Base of cement mortar 1:3 (1 Cement: 3 Coarse Sand) laid and jointed with cement slurry and pointing with white cement slurry admixed with pigment of matching shade including rubbing, curing, polishing etc. all complete as specified and as directed by the Engineer in Charge | | | | |
| | | (A) Granite stone slab Jet Black, Cherry Red, Elite Brown, Cat Eye or equivalent. | **Sqm** | 3,294.20 | 5774 | 19,020,711 |
| | | | | | | |
| | | **Total of Marble and Granite Work Carried Over to Summary** | | | | **211,312,345** |
| | | | | | | |
| **G** | | **WOOD & PVC WORK** | | | | |
| 1.0 | **9.1** | Providing wood work in frames of doors, windows, clerestory windows and other frames, wrought framed and fixed in position with hold fast lugs or with dash fasteners of required dia & length ( hold fast lugs or dash fastener shall be paid for separately). | | | | |
| 1.1 | **9.1.1** | Second class teak wood | **Cum** | 91,496.90 | **10** | **914,933** |
| **1.2** | **9.53** | **Providing 40x5 mm flat iron hold fast 40 cm long including fixing to frame with 10 mm diameter bolts, nuts and wooden plugs and embedding in cement concrete block 30x10x15cm 1:3:6 mix (1 cement : 3 coarse sand: 6 graded stone aggregate 20mm nominal size).** | **Each** | **117.35** | **780** | **91,533** |
| | | | | | | |
| | | **Total of Wood & PVC Work Carried Over to Summary** | | | | **1,006,466** |
| | | | | | | |
| **H** | | **STEEL WORK** | | | | |
| 1.0 | **10.1** | Structural steel work in single section, fixed with or without connecting plate, including cutting, hoisting, fixing in position and applying a priming coat of approved steel primer all complete. | **Kg** | 67.70 | 4373 | 296,052 |

| CIVIL WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| 2.0 | **10.2** | Structural steel work riveted, bolted or welded in built up sections, trusses and framed work, including cutting, hoisting, fixing in position and applying a priming coat of approved steel primer all complete. | **Kg** | 73.95 | 32481 | 2,401,970 |
| 3.0 | **10.25** | Steel work welded in built up sections/ framed work, including cutting, hoisting, fixing in position and applying a priming coat of approved steel primer using structural steel etc. as required. | | | | |
| 3.1 | **10.25.2** | In gratings, frames, guard bar, ladder, railings, brackets, gates and similar works | **Kg** | 90.10 | 36651 | 3,302,255 |
| 4.0 | **10.26** | Providing and fixing hand rail of approved size by welding etc. to steel ladder railing, balcony railing, staircase railing and similar works, including applying primary coat of approved steel primer. | | | | |
| 4.1 | **10.26.1** | M.S tube | **Kg** | 104.70 | 500 | 52,350 |
| 5.0 | **10.28** | Providing and fixing stainless steel ( Grade 304) railing made of Hollow tubes, channels, plates etc., including welding, grinding, buffing, polishing and making curvature (wherever required) and fitting the same with necessary stainless steel nuts and bolts complete, i/c fixing the railing with necessary accessories & stainless steel dash fasteners , stainless steel bolts etc., of required size, on the top of the floor or the side of waist slab with suitable arrangement as per approval of Engineer-in-charge, (for payment purpose only weight of stainless steel members shall be considered excluding fixing accessories such as nuts, bolts, fasteners etc.). | **Kg** | 619.40 | 43717 | 27,078,310 |
| | | **Total of Steel Work Carried Over to Summary** | | | | **33,130,937** |
| | | | | | | |
| **I** | | **FLOORING** | | | | |
| 1.0 | **11.4** | 52 mm thick cement concrete flooring with concrete hardener topping, under layer 40 mm thick cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) and top layer 12 mm thick cement hardener consisting of mix 1:2 (1 cement hardener mix : 2 graded stone aggregate 6 mm nominal size) by volume, hardening compound mixed @ 2 litre per 50 kg of cement or as per manufacturer's specifications. This includes cost of cement slurry, but excluding the cost of nosing of steps etc. complete. | **Sqm** | 535.25 | 14336 | 7,673,344 |
| 2.0 | **11.6** | Cement plaster skirting up to 30 cm height, with cement mortar 1:3 (1 cement : 3 coarse sand), finished with a floating coat of neat cement. | | | | |
| 2.1 | **11.6.1** | 18 mm thick | **Sqm** | 377.25 | 1687 | 636,421 |
| 3.0 | **11.20** | Chequerred precast cement concrete tiles 22 mm thick in footpath & courtyard, jointed with neat cement slurry mixed with pigment to matchthe shade of tiles, including rubbing and cleaning etc. complete, on 20 mm thick bed of cement mortar 1:4 (1 cement: 4 coarse sand). | | | | |
| 3.1 | **11.20.3** | Dark shade pigment using ordinary cement | **Sqm** | 695.95 | 3375 | 2,348,831 |

| CIVIL WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| 4.0 | **11.26** | Kota stone slab flooring over 20 mm (average) thick base laid over and jointed with grey cement slurry mixed with pigment to match the shade of the slab, including rubbing and polishing complete with base of cement mortar 1 : 4 (1 cement : 4 coarse sand) : | | | | |
| 4.1 | **11.26.1** | 25 mm thick | **Sqm** | 1,141.40 | 2663 | 3,039,548 |
| 5.0 | **11.27** | Kota stone slabs 20 mm thick in risers of steps, skirting, dado and pillars laid on 12 mm (average) thick cement mortar 1:3 (1 cement : 3 coarse sand) and jointed with grey cement slurry mixed with pigment to match the shade of the slabs, including rubbing and polishing complete. | **Sqm** | 1,191.25 | 677 | 806,476 |
| 6.0 | **11.29** | 40 mm thick fine dressed stone flooring over 20 mm (average) thick base of cement mortar 1:5 (1 cement : 5 coarse sand), including pointing with cement mortar 1:2 (1 cement : 2 stone dust) with an admixture of pigment to match the shade of stone. | | | | |
| 6.1 | **11.29.1** | Red sand stone | **Sqm** | 686.45 | 1078 | 739,993 |
| 7.0 | **11.30** | 40 mm thick rubbed stone flooring over 20 mm (average) thick base of cement mortar 1:5 (1 cement :5 coarse sand) with joints 3 mm thick, side buttered with cement mortar 1:2 (1 cement : 2 stone dust) admixed with pigment to match the shade of stone and pointing with same mortar | | | | |
| 7.1 | **11.30.1** | Red sand stone | **Sqm** | 752.65 | 1000 | 752,650 |
| 8.0 | **11.31** | Extra for pre finished nosing in treads of steps of Kota stone/ sand stone slab. | **Rmt.** | 75.80 | 3371 | 255,522 |
| 9.0 | **11.32** | Extra for Kota stone/ sand stone in treads of steps and risers using single upto 1.05 metre. | **Sqm** | 16.90 | 1871 | 31,620 |
| 10.0 | **11.36** | Providing and fixing Ist quality ceramic glazed wall tiles conforming to IS: 15622 (thickness to be specified by the manufacturer), of approved make, in all colours, shades except burgundy, bottle green, black of any size as approved by Engineer-in-Charge, in skirting, risers of steps and dados, over 12 mm thick bed of cement mortar 1:3 (1 cement : 3 coarse sand) and jointing with grey cement slurry @ 3.3kg per sqm, including pointing in white cement mixed with pigment of matching shade complete. | **Sqm** | 836.65 | 6408 | 5,361,253 |
| 11.0 | **11.37** | Providing and laying Ceramic glazed floor tiles of size 300x300 mm (thickness to be specified by the manufacturer) of 1st quality conforming to IS : 15622 of approved make in colours such as White, Ivory, Grey, Fume Red Brown, laid on 20 mm thick cement mortar 1:4 (1 Cement : 4 Coarse sand), including pointing the joints with white cement and matching pigment etc, complete. | **Sqm** | 785.40 | 2214 | 1,738,876 |

| CIVIL WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| 12.0 | **11.41** | Providing and laying vitrified floor tiles in different sizes (thickness to be specified by the manufacturer) with water absorption less than 0.08% and conforming to IS : 15622, of approved make, in all colours and shades, laid on 20mm thick cement mortar 1:4 (1 cement : 4 coarse sand), including grouting the joints with white cement and matching pigments etc., complete. | | | | |
| 12.1 | **11.41.2** | Tile 600x600 mm | **Sqm** | 1,405.95 | 32283 | 45,388,284 |
| 13.0 | **11.46** | Providing and laying Vitrified tiles in different sizes (thickness to be specified by manufacturer), with water absorption less than 0.08 % and conforming to I.S. 15622, of approved make, in all colours & shade, in skirting, riser of steps, over 12 mm thick bed of cement mortar 1:3 (1 cement: 3 coarse sand), including grouting the joint with white cement & matching pigments etc. complete. | | | | |
| 13.1 | **11.46.2** | Size of Tile 600x600 mm | **Sqm** | 1,415.40 | 3228 | 4,568,911 |
| 14.0 | **11.48** | Grouting the joints of flooring tiles having joints of 3 mm width, using epoxy grout mix of 0.70 kg of organic coated filler of desired shade (0.10 kg of hardener and 0.20 kg of resin per kg), including filling / grouting and finishing complete as per direction of Engineer-in-charge. | | | | |
| 14.1 | **11.48.2** | Size of Tile 600x600 mm | **Sqm** | 187.95 | 32283 | 6,067,590 |
| 15.0 | **11.53** | Providing and fixing Glass mossaic tiles at finished plain wall surface of size 20 mm x 20 mm x 4 mm in all colour, design , fixing in customize design as per direction of Engineer-in- Charge. The glass mosaic tiles to be fixed on the wall surface with the help of approved adhesive applied at the rate of 2.5 kg per sqm and grouting of the same. The rate is inclusive of all operation, material and required pattern approved by Engineer-in-Charge: | **Sqm** | 1,752.60 | 19267 | 33,767,344 |
| 16.0 | **11.54** | Providing and fixing removable raised/false access flooring with system and its components of approved make for different plenum height with possible height adjustment upto 50 mm, comprising of modular load bearing floor panels supported on G.I. rectangular stinger frame work and G.I. Pedestal etc. all complete, as per the architectural drawings, as specified and as directed by Engineer-in-charge consisting of: : | | | | - |

| CIVIL WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item | Description of Work | Unit | Rate | Total Quantity | Total Amount |
| | | a) P roviding at required spacing to form modular framework, pedestals made out of GI tube of thickness minimum 2 mm and 25 mm outer diameter, fully welded on to the G.I. Base plate of size 100mm x 100mm x 3mm at the bottom of the pedestal tube, G.I. pedestal head of size 75mmx75mmx3.5 mm welded with GI fully threaded stud 16mm outer diameter with two GI Check nuts screwed on the stud for level adjustment upto 50mm, locking and stabilizing the pedestal head in position at the required level. The pedestals shall be fixed to the subfloor (base) through base plate using epoxy based adhesive of approved make or the machine screw with rawl plug. | | | | |
| | | b) S tringers system in all steel construction hot dipped galvanized of rectangular size 570x20x30x0.80mm thick having holes at both ends for securing the stringers on to the pedestal head using fully threaded screws ensuring maximum lateral stability in all directions, the gridformed d by the pedestal and stringer assembly shall receive the floor panel, this system shall provide adequate solid, rigid support for access floor panel, the system shall provide a minimum clear uninterrupted clearance between the bottom of the floor for electrical conduits and wiring etc. all complete as per the architectural drawings, as specified and as directed by the Engineer- in- charge. | | | | |
| | | c) Providing and fixing Access Floor panel of 600x600x32 mm medium grade Filled Steel anti static high pressure Lamination of 800H grade (FS800H). Access loor panel shall be steel welded construction with an enclosed bottom pan with uniform pattern of 64 hemispherical cones. The top and bottom plates of Steel Gauges: top 0.6 mm and bottom 0.7 mm fused spot welded together (minimum 64 welds in each dome and 20 welds along each flange). The panel should be Corroresist epoxy coated for lifetime rust protection and cavity formed by the top and bottom plate is filled with Pyrogrip noncombustible | | | | |

| CIVIL WORKS - DSR | | | | | | |
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| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| | | Portland cementitious core mixed with lightweight foaming compound. The access floor shall be factory finished with Anti-static High Pressure laminate with Non Warp technology upto 1mm thickness for superior adhesion and Surface flatness within .75mm.The panel is to withstand a Concentrated Load of 363 kgs applied on area 25mm x 25mm without collapse in the centre of the panel which is placed on four steel blocks. The panel will withstand and Uniformly Distributed Load (UDL) minimum 1250 kg/sqm and an impact load of 50kg all complete as per the approved manufacturers specification and as per the direction of Engineer- in- charge. All specification must be printed on the side of the panel to ensure the quality of the product. | | | | |
| 16.1 | **11.54.1** | 300 mm Finished Floor Height (FFH) | **Sqm** | 3,999.55 | 29 | 115,987 |
| 16.2 | **11.54.2** | 450 mm Finished Floor Height (FFH) | **Sqm** | 3,983.85 | 1549 | 6,170,984 |
| | | | | | | |
| | | **Total of Flooring Carried Over to Summary** | | | | **119,463,634** |
| | | | | | | |
| **J** | | **ROOFING** | | | | |
| 1.0 | **12.22** | Making khurras 45x45 cm with average minimum thickness of 5 cm cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate of 20 mm nominal size) over P.V.C. sheet 1 m x1 m x 400 micron, finished with 12 mm cement plaster 1:3 (1 cement : 3 coarse sand) and a coat of neat cement, rounding the edges and making and finishing the outlet complete. | **Each** | 186.65 | 134 | 25,011 |
| 2.0 | **12.41** | Providing and fixing on wall face unplasticised Rigid PVC rain water pipes conforming to IS : 13592 Type A, including jointing with seal ring conforming to IS : 5382, leaving 10 mm gap for thermal expansion, (i) Single socketed pipes. | **Rmt** | | | |
| **2.1** | **12.41.1** | **75 mm diameter** | **Rmt** | **145.70** | **14552** | **2,120,234** |
| 3.0 | **12.45** | Providing and fixing false ceiling at all height including providing and fixing of frame work made of special sections, power pressed from M.S. sheets and galvanized with zinc coating of 120 gms/sqm (both side inclusive) as per IS : 277 and consisting of angle cleats of size 25 mm wide x 1.6 mm thick with flanges of 27 mm and 37mm, at 1200 mm centre to centre, one flange fixed to the ceiling with dash fastener 12.5 mm dia x 50mm long with 6mm dia bolts, other flange of cleat fixed to the angle hangers of 25x10x0.50 mm of required length with nuts & bolts of required size and other end of angle hanger fixed with intermediate G.I. channels 45x15x0.9 mm running at the spacing of 1200 mm centre to centre, to which the ceiling section 0.5 mm thick bottom wedge of 80 mm | | | | |

| CIVIL WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| | | with tapered flanges of 26 mm each having lips of 10.5 mm, at 450 mm centre to centre, shall be fixed in a direction Perpendicular to G.I. intermediate channel with connecting clips made out of 2.64 mm dia x 230 mm long G.I. wire at every junction, including fixing perimeter channels 0.5 mm thick 27 mm high having flanges of 20 mm and 30 mm long, the perimeter of ceiling fixed to wall/partition with the help of rawl plugs at 450 mm centre, with 25mm long dry wall screws @ 230 mm interval, including fixing of gypsum board to ceiling section and perimeter channel with the help of dry wall screws of size 3.5 x 25 mm a 230 mm c/c, including jointing and finishing | | | | |
| | | to a flush finish of tapered and square edges of the board with recommended jointing compound , jointing tapes , with jointing compound in 3 layers covering upto 150 mm on both sides of joint and two coats of primer suitable for board, all as per manufacturer's specification and also including the cost of making openings for light fittings, grills, diffusers, cutouts made with frame of perimeter channels suitably fixed, all complete as per drawings, specification and direction of the Engineer in Charge but excluding the cost of painting with : | | | | |
| 3.1 | **12.45.3** | 12.5 mm thick tapered edge gypsum moisture resistant board | **Sqm** | 1,059.50 | 46938 | 49,730,811 |
| 4.0 | **12.55** | Providing and fixing Heat Resistant Terrace Tiles (300 mm x 300 mm x 20 mm) with SRI (solar refractive index) > 78, solar reflection > 0.70 and initial emittance > 0.75 on waterproof and sloped surface of terrace, laid on 20 mm thick cement sand mortar in the ratio of 1:4 (1 cement : 4 coarse sand) and grouting the joints with mix of white cement & marble powder in ratio of 1:1, including rubbing and polishing of the surface | **Sqm** | 1,133.85 | 20428 | 23,162,288 |
| | | upto 3 cuts complete, including providing skirting upto 150 mm height along the parapet walls in the same manner. | | | | |
| 4.1 | **Derived from 12.56** | Providing and laying roof insulation with 60 mm thick impervious sprayed, closed cell free Rigid Polyurethane foam over deck insulation conforming to IS - 12432 Pt. III (density of foam being 40-45 kg/cum), over a coat of polyurethane primer applied @ 6-8 sqm per litre, all complete as per 'direction of Engineer-in-Charge. | **Sqm** | 1,076.00 | 21320 | 22,940,320 |
| | | **Total of Roofing Carried Over to Summary** | | | | **97,978,664** |
| | | | | | | |
| **K** | | **FINISHING** | | | | |
| 1.0 | **13.1** | 12 mm cement plaster of mix : | | | | |
| 1.1 | **13.1.1** | 1:4 (1 cement : 4 fine sand) | **Sqm** | 163.35 | 87272 | 14,255,881 |
| 2.0 | **13.2** | 15 mm cement plaster on the rough side of single or half brick wall of mix : | | | | |
| 2.1 | **13.2.1** | 1:4 (1 cement : 4 fine sand) | **Sqm** | 189.40 | 9697 | 1,836,612 |

| CIVIL WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| 3.0 | **13.12** | 18 mm cement plaster in two coats under layer 12 mm thick cement plaster 1:5 (1 cement: 5 coarse sand) and a top layer 6 mm thick cement plaster 1:3 (1 cement : 3 coarse sand) finished rough with sponge. | **Sqm** | 258.90 | 38080 | 9,858,912 |
| 4.0 | **13.21** | Extra for providing and mixing water proofing material in cement plaster work in proportion recommended by the manufacturers. | **per bag of 50 kg cement used in Mix** | 50.65 | 4770 | 241,601 |
| 5.0 | **13.22** | Extra for plastering exterior walls of height more than 10 m from ground level for every additional height of 3 m or part thereof. | | | | |
| 5.1 | | 10m to less than 13m | **Sqm** | 75.90 | 3911 | 296,845 |
| 5.2 | | 13m to less than 16m | **Sqm** | 113.85 | 3911 | 445,267 |
| 5.3 | | 16m to less than 19m | **Sqm** | 151.80 | 3911 | 593,690 |
| 5.4 | | 19m to less than 22m | **Sqm** | 189.75 | 3911 | 742,112 |
| 5.5 | | 22m to less than 25m | **Sqm** | 227.70 | 2993 | 681,506 |
| 5.6 | | 25m to less than 28m | **Sqm** | 265.65 | 2993 | 795,090 |
| 5.7 | | 28m to less than 31m | **Sqm** | 303.60 | 1286 | 390,430 |
| 5.8 | | 31m to less than 34m | **Sqm** | 341.55 | 462 | 157,796 |
| 5.9 | | 34m to less than 37m | **Sqm** | 379.50 | 462 | 175,329 |
| 6.0 | **13.33** | Pointing on stone work with cement mortar 1:3 (1 cement : 3 fine sand) : | | | | |
| 6.1 | **13.33.1** | Flush/ Ruled pointing | **Sqm** | 152.85 | 100 | 15,285 |
| 7.0 | **13.45** | Finishing walls with textured exterior paint of required shade : | | | | |
| 7.1 | **13.45.1** | New work (Two or more coats applied @ 3.28 ltr/10 sqm) over and including priming coat of exterior primer applied @ 2.20kg/10 sqm | **Sqm** | 146.45 | 38080 | 5,576,816 |
| 8.0 | **13.52** | Finishing with Epoxy paint (two or more coats) at all locations prepared and applied as per manufacturer's specifications including appropriate priming coat, preparation of surface, etc. complete. | | | | |
| 8.1 | **13.52.1** | On steel work | **Sqm** | 116.55 | 2476 | 288,578 |
| 8.2 | **13.52.2** | On concrete work | **Sqm** | 121.15 | 5159 | 625,013 |
| 9.0 | **13.78** | Providing and applying 12 mm thick (average) premixed formulated one coat gypsum lightweight plaster having additives and light weight aggregates as vermiculite/ perlite respectively conforming to IS: 2547 (Part - 1 & II) 1976, applied on hacked / uneven background such as bare brick/ block/ RCC work on walls & ceiling at all floors and locations, finished in smooth line and level etc. complete. | **Sqm** | 244.35 | 96971 | 23,694,864 |
| 10.0 | **13.80** | Providing and applying white cement based putty of average thickness 1 mm, of approved brand and manufacturer, over the plastered wall surface to prepare the surface even and smooth complete. | **Sqm** | 89.65 | 96969 | 8,693,271 |

| CIVIL WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| 11.0 | **13.83** | Wall painting with premium acrylic emulsion paint of interior grade, having VOC (Volatile Organic Compound ) content less than 50 grams/ litre, of approved brand and manufacture, including appying additional coats wherever required, to achieve even shade and colour. | | | | |
| 11.1 | **13.83.2** | Two or more coats | **Sqm** | 75.35 | 222659 | 16,777,356 |
| 12.0 | **13.85** | Applying priming coats with primer of approved brand and manufacture, having low VOC (Volatile Organic Compound ) content. | | | | |
| 12.1 | **13.85.2** | With ready mixed red oxide zinc chromatic on steel / iron works having VOC content less than 250 grams/ litre | **Sqm** | 30.80 | 2476 | 76,261 |
| 12.2 | **13.85.3** | With water thinnable cement primer on wall surface having VOC content less than 50 grams/litre | **Sqm** | 35.85 | 222659 | 7,982,325 |
| | | | | | | |
| | | **Total of Finishing Carried Over to Summary** | | | | **94,200,839** |
| | | | | | | |
| **L** | | **ROAD WORK** | | | | |
| 1.0 | **16.1** | Preparation and consolidation of sub grade with power road roller of 8 to 12 tonne capacity after excavating earth to an average of 22.5 cm depth, dressing to camber and consolidating with road roller including making good the undulations etc. and re-rolling the sub grade and disposal of surplus earth with lead upto 50 metres. (This item shall be paid only where the road is being prepared on the natural ground or in cutting.) | **Sqm** | 81.29 | 57387 | 4,664,989 |
| 2.0 | **2.3** | Banking excavated earth in layers not exceeding 20 cm in depth, breaking clods, watering, rolling each layer with ½ tonne roller, or wooden of steel rammers, and rolling every 3rd and top-most layer with power roller of minimum 8 tonnes and dressing up, in embankments for roads, flood banks, marginal banks, and guide banks etc., lead upto 50 m and lift upto 1.5 m : | | | | |
| 2.1 | **2.3.1** | All kinds of soil | **Cum** | 241.70 | 500 | 120,850 |
| 3.0 | **16.2** | Extra for compaction of earth work in embankment under optimum moisture conditions to give at least 95% of the maximum dry density (proctor density). | **Cum** | 10.15 | 1618 | 16,423 |
| 4.0 | **16.11** | Dry stone pitching 22.5 cm thick including supply of stones and preparing surface complete. | **Sqm** | 422.80 | 4548 | 1,922,894 |
| 5.0 | **16.43** | Providing and laying design mix cement concrete of M-30 grade, in roads/taxi tracks/ runways, using cement content as per design mix, using coarse sand and graded stone aggregate of 40 mm nominal size in appropriate proportions as per approved & specified design criteria, providing dowel bars with sleeve/ tie bars wherever required, laying at site, spreading and compacting mechanically by using needle and surface vibrators, levelling to required slope/ camber, finishing with required texture, including steel form work with sturdy | | | | - |

| CIVIL WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| | | M.S. channel sections, curing, making provision for contraction/ expansion, construction & longitudinal joints ( 10 mm wide x 50 mm deep) by groove cutting machine, providing and filling joints with approved joint filler and sealants, complete all as per direction of Engineer-in-charge (Item of joint fillers, sealants, dowel bars with sleeve/ tie bars to be paid separately).<br>**Note: Based on the design criterion mentioned in the contract, the agency will get the design mix prepared from the approved laboratory. The Rate of concrete shall be inclusive of all constitutents including extra cement over the minimum, admixture, micro silica and other additives wherever required. Nothing extra shall be paid on this account.** | | | | |
| 5.1 | **16.43.1** | Cement concrete prepared with batch mixing machine | **Cum** | 6,795.00 | 5425 | 36,862,875 |
| 6.0 | **16.44** | Extra for providing and mixing hardening compound of approved quality as per manufacturer's specification in cement concrete. | **litre** | 46.45 | 11935 | 554,381 |
| 7.0 | **16.45** | Providing and fixing in position pre-moulded joint filler in expansion joints. | **per cm depth per cm width per m length** | 2.45 | 22467 | 55,044 |
| 8.0 | **16.46** | Providing and laying in position bitumen hot sealing compound for expansion joints etc. | | | | |
| 8.1 | **16.46.1** | Using grade 'A' sealing compound. per cm | **per cm depth per cm width per m length** | 2.05 | 5312 | 10,890 |

| CIVIL WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| 9.0 | **16.50** | Providing and fixing Glow studs of size 100x20 mm made of heavy duty body shall be moulded ASA (Acrylic styrene Acryloretrite ) or HIP (High impact polystyrene) or ABS having electronically welded micro- prismatic lens with abrasion resistant coating as approved by Engineer in charge. The glow stud shall support a load of 13635 kg tested in accordance with ASTM D4280. The slope of retro-reflective surface shall be 35 (+/-5) degress to base .The reflective panels on both sides with at least 12 cm of reflective area up each side. The luminance intensity should be as per the specification and shall be tested as described in ASTM I: 809 as recommended in BS: 873 part 4 : 1973. The studs shall be fixed to the Road surface using the adhesive conforming to IS, as per procedure recommended by the manufacturer complete and as per direction of Engineer-in-charge. | **Each** | 243.00 | 14971 | 3,637,953 |
| | | | | | | |
| 10.0 | **16.69** | Providing and laying at or near ground level factory made kerb stone of M-25 grade cement concrete in position to the required line, level and curvature, jointed with cement mortar 1:3 (1 cement: 3 coarse sand), including making joints with or without grooves (thickness of joints except at sharp curve shall not to more than 5mm), including making drainage opening wherever required complete etc. as per direction of Engineer-in-charge (length of finished kerb edging shall be measured for payment). (Precast C.C. kerb stone shall be approved by Engineer-in-charge). | **Cum** | 5,295.90 | 567 | 3,002,775 |
| 11.0 | **16.70** | Providing and fixing G.I. chain link fabric fencing of required width in mesh size 50x50 mm including strengthening with 2 mm dia wire or nuts, bolts and washers as required complete as per the direction of Engineer-incharge. | | | | |
| 11.1 | **16.70.2** | Made of G.I. wire of dia. 4 mm, PVC coated to achieve outer dia not less than 5 mm in required colour and shade | **Sq. m.** | 577.05 | 388 | 223,895 |
| 12.0 | **16.75** | Providing and laying C.C. pavement of mix M-25 with ready mixed concrete from batching plant. The ready mixed concrete shall be laid and finished with screed board vibrator , vacuum dewatering process and finally finished by floating, brooming with wire brush etc. complete as per specifications and directions of Engineer-in- charge. (The panel shuttering work shall be paid for separately)<br><br>**Note: Based on the design criterion mentioned in the contract, the agency will get the design mix prepared from the approved laboratory. The Rate of concrete shall be inclusive of all constitutents including extra cement over the minimum, admixture, micro silica and other additives wherever required. Nothing extra shall be paid on this account.** | **Cum** | 6,848.85 | 1845 | 12,636,128 |

| CIVIL WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| 13.0 | **16.78** | Construction of granular sub-base by providing close graded Material conforming to specifications, mixing in a mechanical mix plant at OMC, carriage of mixed material by tippers to work site, for all leads & lifts, spreading in uniform layers of specified thickness with motor grader on prepared surface and compacting with vibratory power roller to achieve the desired density, complete as per specifications and directions of Engineer-in-Charge. | | | | |
| 13.1 | **16.78.2** | With material conforming to Grade-II (size range 53 mm to 0.075 mm ) having CBR Value-25 | **Cum** | 2,124.85 | 13528 | 28,744,971 |
| | | | | | | |
| 14.0 | **16.79** | Providing, laying, spreading and compacting graded stone aggregate (size range 53 mm to 0.075 mm ) to wet mix macadam (WMM) specification including premixing the material with water at OMC in for all leads & lifts, laying in uniform layers with mechanical paverfinisher in sub- base / base course on well prepared surface and compacting with vibratory roller of 8 to 10 tonne capacity to achievethe desired density, complete as per speci-fications and directions of Engineer-in-Charge. | **Cum.** | 2,119.75 | 550 | 1,165,863 |
| | | | | | | |
| 15.0 | **16.87** | Providing and laying gang saw cut 30 mm thick, mirror polished pre moulded and pre polished machine cut granite stone of required size and shape o f approved shade, colour and texture in footpath, flooring in road side plazas and similar locations, laid over 20mm thick base of cement mortar 1:4 (1cement : 4 coarse sand) including grouting the joints with white cement mixed with matching pigment, epoxy touch ups etc. complete as per direction of Engineer-in-Charge. | | | | |
| 16.0 | **16.87.1** | Area less than 0.50 sqm. | **Sqm** | 3,636.40 | 20031 | 72,840,728 |
| 17.0 | **16.90** | Providing and laying tactile tile (for vision impaired persons as per standards) of size 300x300x9.8mm having with water absorption less than 0.5% and conforming to IS: 15622 of approved make in all colours and shades in for outdoor floors such as footpath, court yard, multi modals location etc., laid on 20mm thick base of cement mortar 1:4 (1cement : 4 coarse sand) in all shapes & patterns including grouting the joints with white cement mixed with matching pigments etc. complete as per direction of Engineer-in-Charge. | **Sqm** | 1,439.35 | 1438 | 2,069,785 |
| 18.0 | **16.92** | Providing and fixing 10x10x7.50 cm Granite stone block hand cut and chisel dressed on top, for paving in floors, drains etc. laid over 20mm thick base mortar 1:4 (1cement:4 coarse sand) with joints 10mm wide filled with same mortar including ruled pointing etc. complete as per direction of engineer-in charge. | **Sqm** | 1,375.20 | 2253 | 3,098,326 |
| | | **Total of Road Work Carried Over to Summary** | | | | **171,628,770** |

| CIVIL WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| | | | | | | |
| **M** | | **DOORS, WINDOWS & ALUMINIUM WORKS** | | | | |
| 1.0 | **Derived From 21.8** | Filling the gap in between Stone work by providing weather silicon sealant over backer rod of approved quality as per architectural drawings and direction of Engineer-in-charge complete. | **Meter** | 128.00 | 150484 | 19,261,952 |
| | | Upto 6mm depth and 6 mm width | | | | |
| 2.0 | **Derived From DSR 26.1 & DSR 26.7** | **Metallic Louvre on Facades** | **Sqm** | 8,784.00 | 1667 | 14,642,928 |
| | | Designing, fabricating, testing, installing and fixing in position Metallic Louvres fabricated in aluminium extruded tubular sections as per the architectural drawings and approved shop drawings, the aluminium quality as per grade 6063 T5 or T6 as per BS 1474, including super durable powder coating of 60-80 microns conforming to AAMA 2604 of required colour and shade as approved by the Engineer-in-Charge. The tubular aluminum framework of 50mm x 50mm x 2.5mm thick Alumnium square sections shall be Clad with Aluminium Composite Panel Cladding, with open grooves for linear for all heights and all levels etc. including: | | | | |
| | | a) Structural analysis & design and preparation of shop drawings for pressure equalisation or rain screen principle as required, proper drainage of water to make it watertight including checking of all the structural and functional design. . | | | | |
| | | b) Providing, fabricating and supplying and fixing panels of aluminium composite panel cladding in pan shape in metalic colour of approved shades made out of 4mm thick aluminium composite panel material consisting of 3mm thick FR grade mineral core sandwiched between two Aluminium sheets (each 0.5mm thick). The aluminium composite panel cladding sheet shall be coil coated, with Kynar 500 based PVDF / Lumiflon based fluoropolymer resin coating of approved colour and shade on face # 1 and polymer (Service) coating on face # 2 as specified using stainless steel screws, nuts, bolts, washers, cleats, weather silicone sealant, backer rods etc | | | | |

| CIVIL WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| | | c) The fastening brackets of Aluminium alloy 6005 T5 / MS with Hot DipGalvanised with serrations and serrated washers to arrest the wind load movement, fasteners, SS 316 Pins and anchor bolts of approved make in SS 316, Nylon separators to prevent bi-metallic contacts all complete required to perform as per specification and drawing The item includescost of all material & labour component, the cost of all mock ups at site, cost of all samples of the individual components for testing in an approved laboratory, field tests on the assembled working curtain wall with aluminium composite panel cladding, cleaning and protection of the curtain wall with aluminium composite panel cladding till the handing over of the building for occupation. Base frame work for ACP cladding is payable under the relevant aluminium item.s s | | | | |
| | | The Contractor shall provide louvre with aluminium composite panel cladding, having all the performance characteristics all complete , as per the Architectural drawings, as per item description, as specified, as per the approved shop drawings and as directed by the Engineer-in-Charge. However, for the purpose of payment, only one face on the external face of the louver with Aluminum Composite Panel Cladding (including width of groove) shall be measured in sqm. up to two decimal places. | | | | |
| | | | | | | |
| | | **Total of Doors, Windows & Aluminium Works Carried Over to Summary** | | | | 33,904,880 |
| | | | | | | |
| **N** | | **WATER PROOFING** | | | | |
| | | **Note: Waterproofing will be done through system applicator approved by Engineer-in-Charge.** | | | | |
| 1.0 | **22.3** | Providing and laying water proofing treatment to vertical and horizontal surfaces of depressed portions of W.C., kitchen and the like consisting of: | **Sqm** | 522.90 | 8291 | 4,335,364 |
| | | (I) Ist course of applying cement slurry @ 4.4 kg/sqm mixed with water proofing compound conforming to IS 2645 in recommended proportions including rounding off junction of vertical and horizontal surface. | | | | |
| | | (II) IInd course of 20 mm cement plaster 1:3 (1 cement : 3 coarse sand) mixed with water proofing compound in recommended proportion including rounding off junction of vertical and horizontal surface. | | | | |
| | | (III) IIIrd course of applying blown or residual bitumen applied hot at 1.7 kg. per sqm of area. | | | | |
| | | (IV) IVth course of 400 micron thick PVC sheet. (Overlaps at joints of PVC sheet should be 100 mm wide and pasted to each other with bitumen @ 1.7 kg/sqm). | | | | |

| CIVIL WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| 2.0 | **22.6** | Providing and laying water proofing treatment on roofs of slabs by applying cement slurry mixed with water proofing cement compound consisting of applying: a) after surface preparation, first layer of slurry of cement @ 0.488 kg/sqm mixed with water proofing cement compound @ 0.253 kg/sqm. b) laying second layer of Fibre glass cloth when the first layer is still green. Overlaps of joints of fibre cloth should not be less than 10 cm. c) third layer of 1.5 mm thickness consisting of slurry of cement @ 1.289 kg/ sqm mixed with water proofing cement compound @ 0.670 kg/sqm and coarse sand @ 1.289 kg/sqm. This will be allowed to air cure for 4 hours followed by water curing for 48 hours.<br>The entire treatment will be taken upto 30 cm on parapet wall and tucked into groove in parapet all around. d) fourth and final layer of brick tiling with cement mortar (which will be paid for separately. For the purpose of measurement the entire treated surface will be measured. | **Sqm** | 390.35 | 25494 | 9,951,583 |
| 3.0 | **22.20** | Providing and laying APP (Atactic Polypropylene Polymer) modified prefabricated five layer 3 mm thick water proofing membrane, black finished reinforced with non-woven polyester matt consisting of a coat of bitumen primer for bitumen membrane @ 0.40 litre/sqm by the same membrane manufacture of density at 25°C, 0.87-0.89 kg/ litre and viscocity 70-160 cps. Over the primer coat the layer of membrane shall be laid using Butane Torch and sealing all joints etc, and preparing the surface complete. The vital physical and chemical parameters of the membrane shall be as under : Joint strength in longitudinal and transverse direction at 23°C as 650/ 450N/5cm. of the manufacturer of membrane :<br>Tear strength in longitudinal and transverse direction as 300/250N. Softening point of membrane not less than 150°C. Cold flexibility shall be upto -2°C when tested in accordance with ASTM, D - 5147. The laying of membrane shall be got done through the authorised applicator | | | | |
| 3.1 | **22.20.1** | 3mm thick | **Sqm** | 425.35 | 57658 | 24,524,830 |
| | | **Total of Water Proofing Carried Over to Summary** | | | | **38,811,777** |
| | | | | | | |
| **O** | | **RAIN WATER HARVESTING RECHARGE & WELLS** | | | | |

| CIVIL WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| 1.0 | Derived from DSR items | Construction of Rain Water Recharge pits with inside dimension as under, Constructed in Brick Masonary in cement mortar 1:4 ( 1 cement : 4 course sand) with class 75 designation bricks, over 100mm thick PCC (1:2:4) (1 Cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size). Brick masonry upto a depth of 1100 mm from top shall be in regular brick masonry wall 230mm thick , and below that will be 345mm thick brick masonary walls with provision of 100mm dia PVC sleevs in staghgered fashion (345 mm long) to allow percolation of water along the sides of the pit.<br><br>The pit thus constructed shall be filled with first layer (1200mm) - stone boulders 5cm to 20cm, second layer (600mm) 5-mm to 10 mm gravel topped with third layer (300mm) 1.5mm to 2mm sand encased (on all four sides and base) in two layers of 300 gsm geo textile. including cost of all labour, material etc complete. Cost also included cement sand plaster of ratio 1 : 4 at top of brick wall and sides upto 300mm from top internal and external both faces. Precast covers, Fliter media, PVC Sleeves, Boring and laying strainer pipe will be measured and paid seperately. | | | | |
| 1.1 | | With inside dimension 2160mm x 1360mm and depth 2100mm | No's | 30,667.89 | 235 | 7,206,954 |
| 1.2 | | with internal dimensions 5000mm x 900mm and depth 2100mm. | No's | 65,394.03 | 200 | 13,078,806 |
| 2.0 | 24.1.1.1 | Boring/drilling bore well of required dia for casing/ strainer pipe, by suitable method prescribed in IS: 2800 (part I), including collecting samples from different strata, preparing and submitting strata chart/ bore log, including hire & running charges of all equipments, tools, plants & machineries required for the job, all complete as per direction of Engineer - in-charge, upto 90 metre depth below ground level. | | | | |
| 2.1 | **24.1.1** | All types of soil | | | | |
| 2.2 | **24.1.1.1** | 300 mm dia metre | **RMT** | 407.10 | 8250 | 3,358,575 |
| 3.0 | **24.3.2** | Supplying, assembling, lowering and fixing in vertical position in bore well, unplasticized PVC medium well casing (CM) pipe of required dia, conforming to IS: 12818, including required hire and labour charges, fittings & accessories etc. all complete, for all depths, as per direction of Engineer -in-charge. 150 mm nominal size dia | **RMT** | 587.05 | 8250 | 4,843,163 |
| 4.0 | **24.5** | Supplying, filling, spreading & leveling stone boulders of size range 5 cm to 20 cm, in recharge pit, in the required thickness, for all leads & lifts, all complete as per direction of Engineer-in-charge. | **Cum** | 504.15 | 2755 | 1,388,933 |

| CIVIL WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| 5.0 | **24.6** | Supplying, filling, spreading & leveling gravels of size range 5 mm to 10 mm, in the recharge pit, over the existing layer of boulders, in required thickness, for all leads & lifts, all complete as per direction of Engineer-incharge. | **Cum** | 910.65 | 1390 | 1,265,804 |
| 6.0 | **24.7** | Supplying, filling, spreading & leveling coarse sand of size range 1.5 mm to 2 mm in recharge pit, in required thickness over gravel layer, for all leads & lifts, all complete as per direction of Engineer -in-charge. | **Cum** | 852.60 | 695 | 592,557 |
| 7.0 | Derived for DSR Item | Providing and placing in position upto 150 mm thick factory made machine batched & ma chine mixed Precast RCC Rectangular Covers on drains/ of footpath of various sizes,of M-25 grade cement concrete for RCC work, including cost of centering, shuttering, reinforcement of 8mm dia TMT bars of Fe 500 grade @ maximum 100mm c/c on both ways , neat cement punning on finished surface, properly finished on all edges and providing 2 Nos. 12 mm dia bar for hooks and bowl for lifting arrangement etc i/c cost of cartage ,all leads & lift, handling at site etc. all complete as per direction of Engineer-in-Charge . | **Cum** | 15,163.98 | 341 | 5,170,918 |
| 8.0 | **Derieved from 24.9** | Providing and fixing factory made precast RCC drain covers, having concrete of strength not less than M-25, of size 2000 x 450x75 mm, reinforced with 8 mm dia four nos longitudinal & 9 nos cross sectional T.M.T. hoop bars, including providing edge binding with M.S. flats of size 75 mm x 1.6 mm complete, all as per direction of Engineer-in-charge. | **Each** | 2,625.00 | 600 | 1,575,000 |
| | | | | | | |
| | | **Total of RAIN WATER HARVESTING & RECHARGE WELLS Carried Over to Summary** | | | | **38,480,710** |
| | | | | | | |
| | | **Total Carried over to Summary** | | | | **3,320,207,794** |

| CIVIL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **NON DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| | | | | | | |
| **C** | | **REINFORCED CEMENT CONCRETE** | | | | |
| | | | | | | |
| **1.0** | **NON DSR** | Providing structural connections wherever required as directed by Structural Engineers/ Project Managers, Work consisting of the following. | **Sqm** | 810.00 | 625 | 506,250 |
| | | i) Chipping of concrete cover and exposing the reinforcement bars. | | | | |
| | | ii) Welding necessary dowels to the existing exposed main reinforcement. Removing sag and cleaning the welded joint. | | | | |
| | | iii) Applying a bonding coat of epoxy resin (Araldite GY-250, Hardener HY 825, Hardener HY 830, Hardener HY 850) as per manufacturer's specifications on the substrate. | | | | |
| | | iv) Casting the joint along with new structural member within the pot lift of epoxy bonding coat. | | | | |
| | | Rate to include all the operations mentioned above. However, cost of RCC of connected member, formwork is payable under the relevant items. (Sqm of treated surface measured and paid for) | | | | |
| **2.0** | **NON DSR** | **Fire Sealing of Through Penetrations, with small to large size cut outs in Floors (Mixed Shafts).** | | | | |
| **2.1** | **NON DSR** | Providing Fire stop mortar system Hilti CP 636, with minimum 2 hours fire rating when tested in accordance with UL 1479 standards, for horizontal openings in fkloors or slabs after passing service lines like metal pipes, plastic pipes, metal duct etc. The mortar shall be light weight cementitious product and shall carry test certificate in accordance with IEC 60068-2-57: 1999-11 (Environmental testing) as per part 2-57: Test for vibration -Time - History method and VERTEQII for seismic zone 4. HILTI CP 602 acrylic firestop sealant, with minimum 2 Fire rating when tested in accordance with UL 1479 standards shall be used along the periphery of chiller pipe and ducts with insulation. | **Sqm** | 19,164.75 | 124 | 2,376,429 |
| | | Hilti FS One intumescent firestop sealant, with minimun 2Hour fire rating when tested in accordance with UL 1479 standards, shall be used along the periphery of chiller pipe and duct with insulation . | | | | |

| CIVIL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **NON DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| | | Hilti intumscent sealents FS One (for plastic pipe diameter <=2") intumscent Wraps CP 648 -E (for plastic pipe diameter > 2" & <=6") & intumescent collars CP 644 (or plastic pipe diameter >6" & <= 10") should be used around plastic pipes or conduits to provide minimum 2 hour fire rating when tested in accordance with UL 1479 standards. The product shall be age tested as per Dafstb and DIBT standards. The product shall carry test certificate for mould resistance rating of 0 as per determination by ASTM G21-96.<br>All products should confirm to LEED 2009. The products shall be UL listed & classified and shall bear the UL logo on the packing. Firestop installation should be done by Hilti trained applicators and in accordance with Hilti guidelines | | | | |
| **2.2** | **NON DSR** | PVC pipe diameter of 1" (FS One Firestop Sealant) | **Nos** | 814.21 | 156 | 127,017 |
| **2.3** | **NON DSR** | PVC pipe diameter of 2" (FS One Firestop Sealant) | **Nos** | 1,219.58 | 132 | 160,984 |
| **2.4** | **NON DSR** | PVC pipe diameter of 2.5" (CP 648 -E Firestop Wrap), Min. recommended hole dia. In wall /floor .92 mm | **Nos** | 1,593.58 | 20 | 31,872 |
| **2.5** | **NON DSR** | PVC pipe diameter of 3" (CP 648 -E Firestop Wrap), Min. recommended hole dia. In wall /floor 112 mm | **Nos** | 1,816.59 | 20 | 36,332 |
| **2.6** | **NON DSR** | PVC pipe diameter of 4" (CP 648 -E Firestop Wrap), Min. recommended hole dia. In wall /floor 132 mm | **Nos** | 2,270.73 | 237 | 538,164 |
| **2.7** | **NON DSR** | PVC pipe diameter of 5" (CP 648 -E Firestop Wrap), Min. recommended hole dia. In wall /floor 152 mm | **Nos** | 2,861.94 | 293 | 838,547 |
| **2.8** | **NON DSR** | PVC pipe diameter of 6" (CP 648 -E Firestop Wrap), Min. recommended hole dia. In wall /floor 202 mm | **Nos** | 3,405.52 | 530 | 1,804,925 |
| **3.0** | **NON DSR** | **Fire sealing of Through Penetrations, with small to large size cut outs, in Wall for passing various service lines like Cable Trays, Metal Pipes, Plastic Pipes, Metal Ducts etc.** | | | | |

| CIVIL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **NON DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| **4.0** | **NON DSR** | Providing Hilti Fire resistant Mineral Wool Board system with minimum 2 hours fire rating when tested in accordance with BS 476 part 20 for vertical openings in walls after passing service lines like electrical cables trays, metal pipes, Plastic Pipes, ducts etc. The fire resistant board system shall comprise of a mineral wool board coated with an ablative coating CP 670 at 0.7mm dft. on both sides. The mineral wool board shall be of min.160 kg/m3 density. All contact surfaces and cavities shall be sealed with a joint filler CP 606. Hilti intumescent sealants FS One (for pipe diameter <= 2") and Intumescent Wraps CP 648-E (for pipe diameter > 2" & <= 6") should be used around PVC Pipes or Conduits to provide minimum 2 hours fire rating when tested in accordance with UL 1479 standards. | **Sqm** | 21,487.75 | 103 | 2,213,238 |
| | | The products shall be age tested for as per Dafstb and DIBT standards. The products shall carry test certificate for mold resistance rating of 0 as determined by ASTM G21-96. All products should confirm to LEED 2009. Fire paint & Sealants shall be UL listed & classified and shall bear the UL and FM approval logo on the packing. Firestop installation should be done by Hilti trained applicators and in accordance with Hilti guidelines. | | | | |
| **4.1** | **NON DSR** | PVC pipe diameter of 1" (FS One Firestop Sealant) | **Nos** | 814.21 | 200 | 162,842 |
| **4.2** | **NON DSR** | PVC pipe diameter of 2" (FS One Firestop Sealant) | **Nos** | 1,219.58 | 200 | 243,915 |
| **4.3** | **NON DSR** | PVC pipe diameter of 2.5" (CP 648-E Firestop Wrap), Min. recommended hole dia. in wall/floor: 92 mm | **Nos** | 1,593.58 | 256 | 407,956 |
| **4.4** | **NON DSR** | PVC pipe diameter of 3" (CP 648-E Firestop Wrap), Min. recommended hole dia. in wall/floor: 112 mm | **Nos** | 1,816.59 | 256 | 465,046 |
| **4.5** | **NON DSR** | PVC pipe diameter of 4" (CP 648-E Firestop Wrap), Min. recommended hole dia. in wall/floor: 132 mm | **Nos** | 2,270.73 | 296 | 672,137 |
| **4.6** | **NON DSR** | PVC pipe diameter of 5" (CP 648-E Firestop Wrap), Min. recommended hole dia. in wall/floor: 152 mm | **Nos** | 2,861.94 | 40 | 114,477 |
| **4.7** | **NON DSR** | PVC pipe diameter of 6" (CP 648-E Firestop Wrap), Min. recommended hole dia. in wall/floor: 202 mm | **Nos** | 3,405.52 | 80 | 272,441 |
| | | | | | | |
| | | **Total of Reinforced Cement Concrete Carried Over to Summary** | | | | 10,972,572 |
| | | | | | | |
| **E** | | **SAND STONE** | | | | |
| | | | | | | |

| CIVIL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **NON DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| **1.0** | **NON DSR** | Providing and Applying water repellent treatment - reactive hydrophobic silane-siloxane solvented formulation. The product shall have deep penetrating effect and shall not stain the substrate. The product shall reduce the water absorption by the substrate andshall exhibit beading effect to water. The product shall be one component and ready to use and shall not require any dilution at site. The formulation shall be of specific gravity below 0.8 & low viscous. (<15 cps, at 25ºC). The product shall exhibit water reduction of not less then 85% when tested as per NCHRP 244 standard. Consumption Assumed: 350 ml Per Lit | **Sqm** | 308.00 | 29225 | 9,001,300 |
| | | | | | | |
| **2.0** | **NON DSR** | Providing and Fixing of 18mm thk Red/Dholpur Sandstone on walls with textured pattern all complete as per architectural drawings. | | | | |
| **2.1** | **NON DSR** | Geometric CNC 2D Pattern on Stone using state of the art technology and craftsmanship | **Sqm** | 13,938.00 | 493 | 6,871,434 |
| **2.2** | **NON DSR** | Handcrafted Mural with Innovative designs as per architectural design | **Sqm** | 24,159.00 | 947 | 22,878,573 |
| **3.0** | **NON DSR** | Providing and fixing in position solid Red Sand Stone bollards of following dimensions. The bollard shall be made from good quality sand stone free from any cracks , fissures etc. The top and bottom part (if applicable) shall be shot blasted stone to give desired rough texture. Motifs (patterns) of desired shape shall also be carved out by the shot blasting process by masking the motif portions. All fabrication work shall be done as per design drawing and as per instructions of the engineer in charge. | | | | |
| **3.1** | **NON DSR** | 150x150x600mm (additional 200mm buried in sub-base) | **Each** | 5,808.00 | 50 | 290,400 |
| **3.2** | **NON DSR** | 200x200x1200mm (additional 300mm buried in sub-base) | **Each** | 9,292.00 | 50 | 464,600 |
| **3.3** | **NON DSR** | 250x250x2100mm (additional 450mm buried in sub-base) | **Each** | 20,907.00 | 50 | 1,045,350 |
| **4.0** | **NON DSR** | Providing and fixing in position solid Red Sand Stone bollard for light fixtures of following dimensions. The bollard shall be made from good quality sand stone free from any cracks , fissures etc. The top part shall be shot blasted stone to give desired rough texture. Motifs (patterns) of desired shape shall also be carved out by the shot blasting process by masking the motif portions. All fabrication work shall be done as per design drawing and as per instructions of the engineer in charge. | | | | |
| **4.1** | **NON DSR** | 250x250x900mm (additional 250mm buried in sub-base) The bollard has portions of sand stone chisselled out by mechanically to provide for recessed light fixture and provision for electrical cable as indicated in the drawings. | **Each** | 17,423.00 | 379 | 6,603,317 |

| CIVIL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **NON DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| **4.2** | **NON DSR** | 250x250x900mm (additional 250mm buried in sub-base) The bollard has provision for electrical cable as indicated in the drawings. | **Each** | 12,196.00 | 341 | 4,158,836 |
| **5.0** | **NON DSR** | Providing and fixing in position solid Machine cut Red Sand Stone bench of overall top dimension 1600mmx600mm. Top slab shall be 100mm thick and verticals shall be 200 mmx600mmx400mm high with additional 200mm to be buried in ground. The bench shall be made from good quality sand stone free from any cracks , fissures etc. All fabrication work shall be done as per design drawing and as per instructions of the engineer in charge. | **Each** | 20,907.00 | 100 | 2,090,700 |
| **6.0** | **NON DSR** | Providing and fixing in position solid Machine cut Red Sand Stone spheres of following dimensions; The spheres shall be made from good quality sand stone free from any cracks , fissures etc. All fabrication work shall be done as per design drawing and as per instructions of the engineer in charge. | | | | |
| **6.1** | **NON DSR** | 300mm diameter | **Each** | 6,969.00 | 20 | 139,380 |
| **6.2** | **NON DSR** | 400mm diameter | **Each** | 8,711.00 | 20 | 174,220 |
| **6.3** | **NON DSR** | 500mm diameter | **Each** | 12,777.00 | 20 | 255,540 |
| **7.0** | **NON DSR** | Providing and placing in position large boulders of following sizes by mechanical mean. The contractor shall use excavated from SAU site for this work, credit shall be given by the contractor for the excavated rock under the relevant item. Item includes storage, carriage, cleaning by washing with water etc. and placing in position the boulders to be used as artefacts, landscape features for creating rock gardens etc. | | | | |
| **7.1** | **NON DSR** | 1 cum to 1.5 cum* | **Each** | 5,000.00 | 20 | 100,000 |
| **7.2** | **NON DSR** | 1.5 cum to 2.0 cum* | **Each** | 6,000.00 | 20 | 120,000 |
| **7.3** | **NON DSR** | 2 cum to 2.5 cum* | **Each** | 7,000.00 | 20 | 140,000 |
| **7.4** | **NON DSR** | 2.5 cum to 3.0 cum* | **Each** | 8,000.00 | 20 | 160,000 |
| **7.5** | **NON DSR** | 2.5 cum to 3.0 cum* | **Each** | 9,000.00 | 17 | 153,000 |
| | | | | | | |
| | | **Total of Sand Stone Carried Over to Summary** | | | | 54,646,650 |
| | | | | | | |
| **G** | | **WOOD & PVC WORK** | | | | |
| **1.0** | **NON DSR** | Double skin twin board GI stud partition minimum 120 mm thick which includes two layers of 12.5mm | **Sqm** | 2,211.00 | 7228 | 15,981,108 |

| CIVIL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **NON DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| | | Metal to Metal flat head screws. The boards are to be fixed vertically to the framework with joints staggered to avoid leakage through joints. 25x25x0.5mm angle bead should be used at all L-Junctions of partition. 50mm glasswool slab of density 20kg/m³ shall be placed in metal framework. Glasswool holding clip should be used to hold Glasswool slab in its position. Finally square and tapered edges of the boards are to be jointed and finished so as to have a flush look which includes filling and finishing with Jointing compound, Joint Paper tape or fiber tape (as per manufacturer's recommended practices). | | | | |
| **2.0** | **NON DSR** | The junction of the partition with masonry & all penetration through the partition has to treated with Hilti/Pyroplex fire and acoustic sealant. The proposed system is to provide 60 minutes of fire rating and accoustic performance of 50 db. All other detailing and specifications to be followed as per approved shop drawing and as per directions of Engineer-in-Charge Double skin twin board impact resistent GI stud partition minimum 120 mm thick which includes outer layers of tapered edge minimum 12.5mm thick impact resistant board on outer layers (conforming to EN 520:2004, Type D,F,I & R) & inner layer of tapered edge 12.5mm thick Gypboard Plain (conforming to IS:2095 – 2011-Part-I) is screw fixed with Drywall Screws of 25mm & 35mm at minimum spacing of 300mm at Centre and 150mm at periphery of wall to either side of 70mm C stud | **Sqm** | 2,625.00 | 803 | 2,107,875 |
| | | (0.5mm thick having one flange of 34mm and another flange of 36mm made of GI Steel) placed at 610mm Centre to Centre in 72mm floor and ceiling channel (0.5mm thick have equal flanges of 32mm made of GI steel), which is anchored to the floor & true ceiling using Rawl plug Ø8x45mm/Hilti X-GN20MX anchor fasteners at 600mm c/c in centre line. Stud and floor channel are crimped together with crimping tool. A noggin channel of 70mm width (0.5mm thick having two flanges of 40mm each) has to be provided at the horizontal joints of the outer layer boards screw fixed to the studs using Metal to Metal flat head screws. 50mm Glass wool slab of density 20kg/m³ shall be placed in metal framework. Glasswool holding clip should be used to hold Glasswool slab in its position. | | | | |

| CIVIL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **NON DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| | | The boards are to be fixed vertically to the framework with joints staggered to avoid leakage through joints. 25x25x0.5mm angle bead should be used at all L-Junctions of partition. Finally square and tapered edges of the boards are to be jointed and finished so as to have a flush look which includes filling and finishing with Pro-Fill Jointing compound, Joint Paper tape or fibre tape (as per manufacturer's recommended practices). The junction of the partition with masonry & all penetration through the partition has to be treated with Hilti/Pyroplex fire and acoustic sealant. All other detailing and specifications to be followed as per approved shop drawing and as per directions of Engineer-in-Charge | | | | |
| | | **Total of Wood & PVC Work Carried Over to Summary** | | | | 18,088,983 |
| | | | | | | |
| **H** | | **STEEL WORK** | | | | |
| | | | | | | |
| **1.0** | **NON DSR** | Stainless steel & Laminated Toughened Glass Railing | | | | |
| **1.1** | **NON DSR** | Providing and fixing Dorma/Sadev/Q Railing Modular (Weld Free) Component base Flat Balustrade in angular of 12mmx55mm wide, Handrail 50.8mm diax 1.6mm thick fixed in to the flat Balustrade with Offset rail Bracket or Top Adapter (Neck) Type with M4 X 10mm two nos. of screws. The upright c/c is 900mm. Ht of the Handrail 1000mm from FFL. The baluster fixed on the floor with baseplate by 3/2 nos. of M1X120mm Long Anchor fastener or fixed on the side wall with baseplate. Infill glass fixed to the Flat Balustrade with Glass Link (Two Sets per Balustrade). Complete with End Cap, Mid span Sleeve, Elbow Etc. All the material of Flat Balustrade Component and handrail should be of SS 304 grade Satin Finish. | **Sqm** | 39,669.00 | 719 | 28,522,011 |
| | | Including supplying and Fixing of 6mm + 6mm toughened Laminated Safety Glass with 1.5mm thk. PVB film over stainless steel railing above all complete including Railing Holes as per directions of Engineer in Charge. | | | | |

| CIVIL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **NON DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| **2.0** | **NON DSR** | Providing and Fixing of Single Skin Motorized Rolling Shutter WITH 1MM Thick Galvanized Steel Sheet, Guide Rail to be made up of 2mm thk. Galvanized Steel. Bottom Bar is 75mm fabricated from 2 Piece of 38mmx38mmx3mm thick Hot Dip Galvanized Steel Angle.<br>Shutter Box & Covers shall be standard welded steel pipe with double flange steel shafts supported by enclosed bearings 0.8mm thick Galvanized Steel Box casing Cover. Shutter shall be finished with standard RAL 7040 Powder Coating.<br><br>Shutter shall be motorized with 220 Volt 50Hz single phase, come with One unit Push Button Switch (Up, Stop, Down) along with motor capacity of 3 HP output Torque shall be 168M-m with current Rating of 3.3 A | **Sqm** | 7,283.00 | 308 | 2,243,164 |
| | | | | | | |
| **3.1** | **NON DSR** | Supplying, fabricating & eracting in position by mechanical means and testing bolted and / or<br>insert plates etc. , inluding storing cutting to required size, straightening/ bending if required, edge preparation, cleaning, preheating, bolting/ welding of joints by SAW/MIG/ MMAW welding process, including sealing the joints of box sections/ hollow sectionswith continious welding , finishing edges by grinding, fixing in line and level with temporary staging & bracing and removal of the same after erection , grouting with ordinary grout or premix free flow non shrink grout as specified, including scafolding required to work at all heights, including preparation and submission of detailed fabrication drawings, preparation of surface for painting ,The rate shall be inclusive of fabrication of all members at the fabrication yard to be established by contractor at a suitable separate location beyond the boundary limit of site,<br>transporting the fabricated material to the site of erection, deployment of power cranes and erection of members by mechanical means/ power cranes all as per the erection plan approved by Engineer-in-charge | **KG** | 121.00 | 478725 | 57,925,725 |
| | | **Total of Steel Work Carried Over to Summary** | | | | **88,690,900** |
| | | | | | | |
| **I** | | **FLOORING** | | | | |
| | | **High Performance Polyurethane traffic Coating for basement car parking.** | | | | |

| CIVIL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **NON DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| **1.1** | **NON DSR** | Providing and laying polyurethane protection coating for basement car parking. System shall include proper surface preparation to achieve sound base followed by two component solvent free epoxy surface sealer and primer, broadcasting sand @ .6kg.sqmt using oven dried silica sand followed by wearing cum crack bridging coat which is a two component solvent free polyurathene coat applied at 0.7kg per sqmt having tensile strength >6 N/mm2 as per ASTM C957 and elongation of 100% as per ASTM D957. Over partially dried wearing coat silica sand broadcasting shall be done @ 1.5kg per sqmt. Application of Final coat shall be done @ 0.3 Kg per Sq.mtr in all areas & @ 0.8 Kg per Sq.mtr in ramps and turning areas using solvent free two component polyurathene coat having tensile strength >6 N/mm2 as per ASTM C957 and elongation of 100% as per ASTM D957,<br><br>All Line arrows marking (white/yellow color) or contrast effect shall be done using separate two component polyurethane top coat @0.4 Kg per Sq.mtr that shall be UV stable having tensile strength of 18 MPa , Tear resistance of 45 MPa as per DIN 53504 in 14 days. Colors considered: White, Yellow, Light Grey RAL 7035, Pebble grey RAL 7032. Rate shall include arrows and line marking. | **Sqm** | 2,323.00 | 19865 | 46,146,395 |
| **2.1** | **NON DSR** | Providing and applying of a 2 component polyurethane sealant at construction joints of same colour as the floor matching the performance parameter mentioned in BOQ | **Rmt** | 348.00 | 990 | 344,520 |
| | | | | | | |
| | | **Total of Flooring Carried Over to Summary** | | | | 46,490,915 |
| | | | | | | |
| **J** | | **ROOFING** | | | | |
| **1.0** | **NON DSR** | **ACOUSTICAL TILE (AT) OF SIZE- 600mm X 600mm GI METAL SWING DOWN Clip In STANDARD PERFORATED (TOILETS)** | | | | |
| | | **Providing & Fixing true horizontal level suspended ceiling comprising of GI Clip-in with double pip self-leveling feature and special tabs to allow removal of tile to enable plenum access with standard perforated ( 2.5mm diameter – 16% open area) visual consisting of 600X600 mm clip in tiles of galvanized steel in 0.5 mm thickness with bevel edge in Global white color precoated with primer coat at the rear side with Light Reflectance > 60% and suitable for Green Building application, with Recycled content of 25%. Tiles would have Soundtex fleece hot pressed at the back of the perforated panel to achieve an NRC of upto 0.7 and fire performance of Class A2-s1.d0 as per EN13501.** | **Sqm** | 1,517.50 | 3594 | 5,453,895 |

| CIVIL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **NON DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| **2.0** | **NON DSR** | **ACOUSTICAL CEILING TILE OF SIZE 600x1200 - Providing and fixing of Techzone Suspended ceiling system or equivalent with sand textured mineral fibre tiles 16mm thick with 15mm exposed grid system. (General Office Areas)**<br>The Techzone ceiling system has a ceiling module of 1200x1350 and the on centre spacing between two adjacent technical zones is 1350 mm. The Techzone orientation is such that the main runners run parallel to the technical zone and hence making this layout compatible with continuous lighting fixtures or Air diffusers. Field panel is of size 600x1200x16mm. The 150mm wide technical zone formed is where the technical elements like lighting fixtures & air diffusers would be installed. Where there are no technical elements the technical zone would be covered by using mineral fibre tile Technical Panels of size 1200mm x150mm in conjunction with a special 150mm long cross tee.<br>The ceiling panels should have Humidity Resistance (RH) of 99, NRC 0.5, Light Reflectance ≥85%, Thermal Conductivity k = 0.052 - 0.057 w/m K, Colour White, Fire Performance UK Class 0 / Class 1 (BS 476 pt - 6 &7), suitable for Green Building application, with Recycled content of 32%.<br>The panels shall be laid on 15 mm wide T - section flanges with 38mm web height, colour white having rotary stitching on all T sections i.e. the Main Runner & 1200 mm Cross Tees with a web height of 38mm. The T Sections have a Galvanizing of 90 grams per M2 with pull out strength of minimum 100 Kgs and need to be installed with suspension system. | **Sqm** | 1,159.91 | 8327 | 9,658,571 |
| **3.0** | **NON DSR** | **ACOUSTICAL CEILING TILE OF SIZE 600x1200 - Providing and fixing of Techzone Suspended ceiling system or equivalent with sand textured mineral fibre tiles 20mm thick with 15mm exposed grid system. (Classroom)** | **Sqm** | 1,270.97 | 15213 | 19,335,267 |

| CIVIL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **NON DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| | | The Techzone ceiling system has a ceiling module of 1200x1350 and the on centre spacing between two adjacent technical zones is 1350 mm. The Techzone orientation is such that the main runners run parallel to the technical zone and hence making this layout compatible with continuous lighting fixtures or Air diffusers. Mineral Fibre field panel is of size 600x1200x20mm. The 150mm wide technical zone formed is where the technical elements like lighting fixtures & air diffusers would be installed. Where there are no technical elements the technical zone would be covered by using Mineral Fibre Tile Technical Panels of size 1200mm x150mm in conjunction with a special 150mm long cross tee. | | | | |
| | | The panels should have Humidity Resistance (RH) of 99, NRC 0.7, Light Reflectance ≥85%, Thermal Conductivity k = 0.052 - 0.057 w/m K, Colour White, Fire Performance UK Class 0 / Class 1 (BS 476 pt - 6 &7), suitable for Green Building application, with Recycled content of 63%.<br>The panels shall be laid on 15 mm wide T - section with 38mm web height flanges colour white having rotary stitching on all T sections i.e. the Main Runner & 1200 mm Cross Tees with a web height of 38mm. The T Sections have a Galvanizing of 90 grams per M2 with pull out strength of minimum 100 Kgs and need to be installed with suspension system of make. | | | | |
| **4.0** | **NON DSR** | **ACOUSTICAL CEILING TILE OF SIZE 600x1200 - Providing and fixing of Techzone Suspended ceiling system or equivalent with Soft Fibre Glasswool ceiling tiles 20mm thick with 15mm exposed grid system. (Video Confrence/ Confrence Room / Library)** | **Sqm** | 1,578.05 | 1727 | 2,725,292 |
| | | The Techzone ceiling system has a ceiling module of 1200x1350 and the on centre spacing between two adjacent technical zones is 1350 mm. The Techzone orientation is such that the main runners run parallel to the technical zone and hence making this layout compatible with continuous lighting fixtures or Air diffusers. Soft Fibre ceiling tile field panel is of size 600x1200x20mm. The 150mm wide technical zone formed is where the technical elements like lighting fixtures & air diffusers would be installed. Where there are no technical elements the technical zone would be covered by using Soft Fibre tile Technical Panels of size 1200mm x150mm in conjunction with a special 150mm long cross tee. | | | | |

| CIVIL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **NON DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| | | The panels should have Humidity Resistance (RH) of 95, NRC 0.9, Light Reflectance ≥85%, Thermal Conductivity k = 0.052 - 0.057 w/m K, Colour White, Fire Performance UK Class 0 / Class 1 (BS 476 pt - 6 &7), suitable for Green Building application, with Recycled content of 66%.<br>The panels shall be laid on 15 mm wide T - section with 38mm web height flanges colour white having rotary stitching on all T sections i.e. the Main Runner & 1200 mm Cross Tees with a web height of 38mm. The T Sections have a Galvanizing of 90 grams per M2 with pull out strength of minimum 100 Kgs and need to be installed with suspension system. | | | | |
| **5.0** | **NON DSR** | **ACOUSTICAL CEILING TILE OF SIZE-600mmx600mm with 15mm Exposed Grid (Security Room/Services etc)**<br>Providing & Fixing of Mineral Fibre Acoustical Suspended Ceiling System with Classic Lite (Bevelled Tegular) Edge Tiles With 15mm Exposed GRID. The tiles should have Humidity Resistance (RH) of 99%, NRC 0.55, Light Reflectance ≥87%, Thermal Conductivity k = 0.052 - 0.057 w/m K, Colour White, Fire Performance UK Class 0 / Class 1 (BS 476 pt - 6 &7) in module size of 600 x 600 x 16mm , suitable for Green Building application, with Recycled content of 30%. The tile shall be laid on 15 mm wide T - section with 38mm web height flanges colour white having rotary stitching on all T sections i.e. the Main Runner, 1200 mm & 600 mm Cross Tees with a web height of 38mm and a load carrying capacity of 14 Kgs/M2 & pull out strength of 100kgs.. The T Sections have a Galvanizing of 90 grams per M2 and need to be installed with suspension system. | **Sqm** | 931.81 | 387 | 360,610 |
| **6.0** | **NON DSR** | **METALWORKS BAFFLE CEILING SYSTEM with 100mm X 25mm on centre spacing of 200mm in WOOD GRAIN FINISH (Convention Center Lobby)**<br>Providing & fixing Vertical Linear Baffle Ceiling made out of Aluminum Extrusion in Aluminum alloy grade 6063. The baffle blade shall be in size of 100x 25 x 3000/3600mm on centre spacing of 200mm in Wood grain finish.The baffle blade shall be suspended using Slotted U-profile at on-center spacing in multiples of 25mm. Longer lengths of Baffle to be connected by Baffle Joiner and the ends to be fixed with End caps. | **Sqm** | 6,304.91 | 3225 | 20,333,335 |

| CIVIL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **NON DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| **7.0** | **NON DSR** | **Metal Roofing & Cladding Works Item includes Designing, Supplying, installation and fixing of profiled zinc sheeting including Clips, stainless steel fasteners, inner closure at ridge and eaves with rivets and also providing all machineries (Straight profile machine) required for the project. All gutter and accessories shall be of same make & factory fabricated .** | | | | |
| | | Supply and fixing of ZINC Titanium Roofing 25/430 STANDING SEAM ROOFING SYSTEM IN 0.7mm THICK Zinc Titanium Alloy comprising of the following layers: - | | | | |
| **7.1** | **NON DSR** | Top layer – Zinc titanium standing seam profiled panels 25 /30 (25 mm seam height & 430 mm panel width) manufactured from zinc titanium alloy finish in 0.7 mm miniumum thickness .The material properties shall be as follows: Ultimate tensile strength: minimum 150 N/mm 2, 0.2% Proof Stress: min 100 N/mm2, Modulus of elasticity: 90,000 N/mm2 Panels shall be fixed to the substructure using Stainless Steel clips fixing & sliding clips of suitable height with spacing as required for the wind loads. The roofing sheets shall be as per EN 988 standards . | **Sqm** | 11,207.35 | 1864 | 20,890,500 |
| | | The panels shall have natural preweathered light gray zinc patina finish or as approved by the Engineer-in-Charge. The zinc roof sheets shall have a protection on its underside consisting of a 60 micron thick composite acrylate-urethane protective coating. | | | | |
| | | Second Layer :Supply & Instalaltion of Anti Abrasive membrane to be laid underneath the roofing sheets . | | | | |
| | | Third Layer : 1.0 mm thick GI strips to placed at distance of 430 mm for fixing of clips | | | | |
| | | Fourth Layer : 0.47mm TCT Hi-Tensile steel sheets profile with nominal 3.5 mm deep ribs at pitch of nominal 48 mm centre to centre distance 550 MPa Yield Strength.The decking sheet shall be fixed over the glavised steel Hat Section using appropiate screws /rivets. | | | | |
| | | Fifth Layer : GI Top hat Section of 1.2 mm thickness | | | | |
| | | Sixth Layer : Insulation layer – Rockwool / stonewool ( Roxul Rockwool) Insulation of overall thickness 100mm and density 50 kg/m3.Insualtion shall be with one sid Aluminium foil to act as vapour barrier . | | | | |

| CIVIL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **NON DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| | | Seventh Layer : Trapezoidal profiled high tensile (550 mpa yield stress) colour coated, zinc aluminum alloy coated steel sheet having crest height of 28-30mm at a pitch distance of 195mm – 250 mm . The sheet thickness shall be 0.47-0.58mm TCT (total coated thickness) comprising of base metal thickness of 0.47mm over which zinc aluminium alloy coating mass of 150 gms / m2 on both sides .Colour coating to be done as per finish approved by Engineer-in-Charge. | | | | |
| | | The zinc sheeting manufacturer shall be ISO certified | | | | |
| **7.2** | **NON DSR** | Supply & fixing of 0.7 mm zinc flashing in the same finish as the roof finish for eaves, gables, ridges, fascia, gutters, etc as required for site detailing. | **RM** | 1,808.65 | 245 | 443,300 |
| **7.3** | **NON DSR** | Supply and Fixing of 0.70 mm thick Galvanized Sheet maximum girth of 500 mm. | **RM** | 1,017.30 | 100 | 101,730 |
| **7.4** | **NON DSR** | Supply and fixing of 0.7 mm ZInc Titanium factory fabricaited half round gutter of 333 mm girth in preweathered quartz finish .The gutter shall be fixed on the exsiting Eave structure using galvanised concealed bracket Gutters and shall be of same finsh as zinc roof. | **RM** | 7,636.65 | 232 | 1,771,703 |
| **7.5** | **NON DSR** | Providing and fixing of Outward / Inward corners for Gutters . | **Nos** | 4,433.40 | 8 | 35,467 |
| **7.6** | **NON DSR** | Providing and fixing of Down spouts for connecting of downtake pipes with gutter | **Nos** | 2,679.97 | 19 | 50,919 |
| **7.7** | **NON DSR** | Providing and Fixing of Downtake pipes of 100mm dia with clamps, brackets etc. of same finish as gutters. | **RM** | 3,433.45 | 74 | 254,075 |
| **7.8** | **NON DSR** | Providing and fixing of 90 Degree Bends | **Nos** | 1,875.92 | 40 | 75,037 |
| | | Note: Shop drawings of the roofing work shall be prepared by the contractor for approval of the Engineer-in-Charge. All fabrication work shall be done as per approved shop drawing and as per instructions of the Engineer-in-Charge. | | | | |
| | | **Total of Roofing Carried Over to Summary** | | | | **81,489,702** |
| | | | | | | |
| **K** | | **FINISHING** | | | | |
| | | **Interior Painting Work** | | | | |

| CIVIL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **NON DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| **1.0** | **NON DSR** | Madreperlato - Providing and Applying of RAFFAELLO MADREPERLATO vapour permeable lime based polished pearl finish for interior formulated with pearlescent material by OIKOS India after cleaning the surface and removing any loose or flaking materials, apply one coat of quartz primer by OIKOS India followed by two coates of RAFFAELLO base coat and final coat of RAFFAELLO MADREPERLATO polished pearl finish in approved shade by OIKOS India and finish with CERA wax coat to achieve desired finish, exlcuding the cost of surface preparation but including the cost of scaffolding, apply by trowel and scraper and appropriate tools, all complete as per the manufacturer's specifications and the directions of Engineer-in-Charge. | **Sqm** | 1,919.63 | 1745 | 3,349,754 |
| **2.0** | **NON DSR** | Raffeallo - Providing and Applying of RAFFAELLO vapour permeable lime based polished smooth marble finish for interior by OIKOS India or equivalent after cleaning the surface and removing any loose or flaking materials, apply three coats of of RAFFEALLO polished smooth marble finish in approved colour by OIKOS India.on one coat of quartz primer by OKIOS Indiaand finish with CERA protective coat to achieve desired finish excluding the cost of surface preparation but including the cost of scaffolding, apply by trowel and scraper and appropriate tools, all complete as per the manufacturer's specifications and the directions of Engineer-in-Charge. | **Sqm** | 1,129.19 | 3474 | 3,922,806 |
| **3.0** | **NON DSR** | Ottocento - Providing and applying of OTTOCENTO vapour permeable water based special two-tone velvet tapestry finish of interior grade, made up of special metallic pigment by OIKOS India, after cleaning the surface and removing any loose or flacking materials, apply two coats of OTTOCENTO special effect finish by OIKOS India on two coats of Supercolour Base coat by OIKOS India over one coat of Quartz Primer by OIKOS India in approved colour and shade to achieve desired finish, excluding the cost of surface preparation but including the cost of scaffolding, apply by trowel and scraper and appropriate tools, all complete as per the manufacturer's specifications and the directions of Engineer-in-Charge. | **Sqm** | 1,355.03 | 3487 | 4,724,990 |
| **4.0** | **NON DSR** | Providing approved galvanised chicken wire mess (24 gauge 12 mm size) to junctions of concrete and masonary work and other locations where called for including cutting to required sizes, side laps of minimum 75 mm and fixing in position with galvanised wire nails as approved, complete including scafolding at all height. | **Sqm** | 40.00 | 1820 | 72,800 |
| | | **Total of Finishing Carried Over to Summary** | | | | 12,070,350 |

| CIVIL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **NON DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| | | | | | | |
| **L** | | **ROAD WORK** | | | | |
| **1.0** | **NON DSR** | Extra for using Flamed Granite Stone instead of polished Granite | **Sqm** | 250.00 | 12683 | 3,170,750 |
| **2.0** | **NON DSR** | Providing and laying factory made Cement Concrete grass paver blocks of required strength, thickness & size/shape, made by table vibratory method using PU/FRP mould, laid in required colour & pattern over 50mm thick compacted bed of fine sand, compacting and proper embedding/laying of paver blocks into the sand bedding layer complete as per manufacturer's specifications & direction of Engineer in-Charge. Grass paver block of size (330*330*120)mm of M-30 grade with approved colour, design & pattern | **Sqm** | 1,742.00 | 7986 | 13,911,612 |
| **3.0** | **NON DSR** | Providing and laying at or near ground level factory made saucer drain of M25 grade cement concrete made by table vibratory method using PU/FRP mould, on a bed of mortar 20mm thick(1:4)(1 cement :4 coarse sand) in position to the required line, level and curvature, jointed with cement mortar 1:3 (1 cement: 3 coarse sand), including making joints with or without grooves (thickness of joints except at sharp curve shall not to more than 5mm), thereby, providing proper slopes as per direction of Engineer-in-charge. Saucer Drain size (450*300*100)mm | **Rmt.** | 465.00 | 5707 | 2,653,755 |
| **4.0** | **NON DSR** | Providing and laying factory made Cement Concrete paver tiles of required strength, thickness & size/shape, made by table vibratory method using PU mould, laid in required colour & pattern over 20mm thick bed of mortar(1:4)(1 cement :4 coarse sand), jointed with neat cement slurry mixed with pigment to match the shade of the tiles and cutting of paver tiles as per required size and pattern and finishing complete in footpath, parks, lawns etc. complete as per manufacturer's specifications & direction of Engineer in-Charge. 25mm thick 'Flexi Paver' cement concrete paver tiles of assorted sizes (300*300)mm, (300*200)mm, (300*150)mm, (150*150)mm, (200*200)mm, (200*100)mm & (100*100)mm of M-35 grade with approved colour, design & pattern | | | | |
| **4.1** | **NON DSR** | Ordinary cement top layer witout any pigment | **Sqm** | 871.00 | 826 | 719,446 |
| **4.2** | **NON DSR** | Dark shade pigment using ordinary cement | **Sqm** | 912.00 | 826 | 753,312 |
| **4.3** | **NON DSR** | Light shade pigment using white cement | **Sqm** | 1,057.00 | 826 | 873,082 |
| **5.0** | **NON DSR** | With premium textures in top layer using automatic shot blasting machine complete with use of mosaic etc. | **Sqm** | 1,278.00 | 826 | 1,055,628 |

| CIVIL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **NON DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| **6.0** | **NON DSR** | 30 mm Thick Washed stone grit flooring on exterior pavements at ground level, in two layers, under layer 15 mm cement plaster 1:4 (1 cement : 4 coarse sand ), furrowing the under layer with scratching tool, applying cement slurry on the under layer @ 2 Kg of cement per square metre, top layer 15 mm cement plaster 1:1/ 2:2 (1 cement: 1/2 coarse sand : 2 stone chipping 10 mm nominal size), in panels (average dimension 1.8x1.8m) with 25mmx 15mm grooves all around as per approved pattern, including scrubbing and washing the top layer with brushes and water to expose the stone chippings ,complete as per specification and direction of Engineer-in- charge (payment for provo-ding joint filler in grooves shall be made separately in relevant item). | **Sqm** | 800.00 | 3866 | 3,092,800 |
| | | **Total of Road Work Carried Over to Summary** | | | | 26,230,385 |
| | | | | | | |
| **M** | | **DOORS, WINDOWS & ALUMINIUM WORKS** | | | | |
| | | **For all Metal Doors / Fire Doors/ Rail & Stile Doors please note the following:-**<br>**i) Shop drawings of all items to be prepared and submitted to Engineer-in-Charge for approval.** | | | | |
| **1.0** | **NON DSR** | **Metal Doors (Non Fire Rated)** | | | | |
| | | Providing and fixing of Hollow metal door at all levels from ISO 9001-2008 certified Manufacturer. All hollow metal doors with or without vision panel or louvers. Pressed Galvanised steel Single /Double leaf to required sizes of approved make which consists of frame, shutter, infill and finish as detailed below and conforming to IS 277. | | | | |
| | | Door frame shall be Single rebate Grooved profile of size 125 x 60 mm groved made out of 1.20mm thick galvanised steel sheet (18 gauge) with Rubber Silencer on strike Jamb. Frames should be Mitered and field assembled with self tabs. All provision should be mortised, drilled and tapped for receiving appropriate hardware. Rubber door silencers should be provided on the striking jamb.Frames should be provided with back plate bracket and anchor fasteners for installation on a finished plastered masonry wall opening. Once frame installed should be grouted with cement slurry if recommended on the clear masonary opening. | | | | |

| CIVIL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **NON DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| | | Door leaf should be 46mm thick fully flush double skin door with or without vision lite/louvers . Door leaf shall be manufactured from 1.0mm (20 guage) minimum thick galvanised steel sheet. The internal construction of the door should be rigid with steel stiffeners/ pads and reinforcement. The infill material shall be resin bonded honeycomb core. All doors should be factory prepped for receiving appropriate hardware and provided with necessary reinforcement for hinges, locks, and door closers. The edges should be interlocked with a bending radius of 1.4mm. For pair of doors astragals has to be provided on the meeting stile for both active and inactive leaf. Vision lite wherever applicable should be asper joinery details with a screw on glass beeding on the inside. | | | | |
| | | The glass should be 5mm clear toughned glass. Louvers when recommended should be site proof and shall be flush fixed on the external surface. All doors and frames shall be finished with etched primer coating, stove zinc phosphate primer and thermosetting polyurethane aliphatic grade paint of approved colour. The door leaf and frame shall have passed minimum 250 hours of salt sprey test. | | | | |
| | | Rate should include supply and installation of door and hardware set as mentioned in the door and hardware schedule. | | | | |
| **1.1** | **NON DSR** | Steel Door Single/Double leaf doors as per the elevation drawins of doors with the hardwares provisions.all Hardware cost will be paid seperatelly as per items listed Below. | **Sqm** | 8,816.00 | 2457 | 21,660,912 |
| | | | | | | |
| **2.0** | **NON DSR** | **RAIL & STYLE METAL GLAZED DOORS (Non Fire Rated)** | | | | |
| | | Providing and fixing of Hollow metal lead lined door from ISO 9001-2008 certified Manufacturer. Pressed Galvanized steel Single /Double leaf to required sizes of approved make which consists of frame, shutter, infill and finish as detailed below. | | | | |
| | | Door frame shall be Single rebate Grooved profile of size 125 x 60 mm groved made out of 1.20mm thick galvanised steel sheet (18 gauge) with Rubber Silencer on strike Jamb. Frames should be Mitered and field assembled with self tabs. All provision should be mortised, drilled and tapped for receiving appropriate hardware. Rubber door silencers should be provided on the striking jamb.Frames should be provided with back plate bracket and anchor fasteners for installation on a finished plastered masonry wall opening. Once frame installed should be grouted with cement slurry if recommended on the clear masonary opening. | | | | |

| CIVIL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **NON DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| | | Door leaf should be 46mm thick fully glazed door with or without midrails. Door leaf rail and stile shall be manufactured from 1.0mm (20 guage) minimum thick galvanised steel sheet. The maximum size of the top rail should not exceed 150mm & bottom rail 175mm respectively. The stiles can be 120mm as approved by the engineer. The internal construction of the door should be rigid with steel stiffeners/ pads and reinforcement. The infill material shall be resin bonded honeycomb core. All doors should be factory prepped for receiving appropriate hardware and provided with necessary reinforcement for hinges, locks, and door closers. | | | | |
| | | The edges should be interlocked with lock seam. For pair of doors astragals will be provided as required. Vision lite of 6mm toughend glass shall be fixed with steel beeding and screwed on to the face of rails and stile. Necessary gaskets to be used for holding the glass in position. Assembly of rail and stile shall be spot welded in the factory. | | | | |
| | | All doors and frames shall be finished with polyurethane aliphatic grade paint of approved colour. The door leaf and frame shall have passed minimum 250 hours of salt sprey test. | | | | |
| | | Rate should include supply and installation of doors | | | | |
| **2.1** | **NON DSR** | Steel Rail & Stile Single/Double leaf doors as per the elevation drawins of doors with the hardwares provisions.all Hardware & Glass cost will be paid seperatelly. | **Sqm** | 8,816.00 | 103 | 908,048 |
| **3.0** | **NON DSR** | **Hardware for Metal Doors** | | | | |
| **3.1** | **NON DSR** | Extra for GI Louvers in PU finish of size 300 x 700mm as per elevation drwg. | **Nos** | 3,293.00 | 377 | 1,241,461 |
| **3.2** | **NON DSR** | Supply & Fixing of SS 304 CE4330 ball bearing butt Hinges in Satin Finish of size 100x75x3mm of Approved Make | **Each** | 244.00 | 4287 | 1,046,028 |
| **3.3** | **NON DSR** | Supply & Fixing heavy duty Mortise sash lock H1-ZK-in silver finish of approved make with 5 pin cylinder 70mm long with one side key other side TT with lever handle LT001,19Dia with roses & escutcheion,SS304,Satin finish | **Each** | 2,265.00 | 490 | 1,109,850 |
| **3.4** | **NON DSR** | Supply & Fixing of approved make Mortise Dead lock H6, BS55, 20sq,forend included strike with 5pin cylinder 70mm long with one side key other side Thumb Turn. | **Each** | 1,916.00 | 208 | 398,528 |
| **3.5** | **NON DSR** | Supply & Fixing D type Pull handle 600mm long back to back 25mm dia with extended spindle SS 304 of approved Make | **Each** | 3,717.00 | 416 | 1,546,272 |
| **3.6** | **NON DSR** | Supply & Fixing of Mortise shaft lock with allen key CL 3506,20 mmSq forsed strike SS Satin Finish of approved Make | **Each** | 639.00 | 96 | 61,344 |

| CIVIL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **NON DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| **3.7** | **NON DSR** | Supply and Fixing of Flush Pull Handle FH1308 rectangular 120mm x 40mm in SS Satin Finish of approved Make | **Each** | 639.00 | 90 | 57,510 |
| **3.8** | **NON DSR** | Supply & Fixing of Heavy duty CE Marked Door Closer of approved make HDC- 35 with slide arm with EN 3-5 in silver finish | **Each** | 2,730.00 | 1305 | 3,562,650 |
| **3.9** | **NON DSR** | Supply and Fixing of Door coordinator H008 in SS Satin Finish of Horman ofapproved Make | **Each** | 1,975.00 | 437 | 863,075 |
| **3.1** | **NON DSR** | Supply and Fixing of Mortise Sash lock H3-ZK in SS Satin Finish with WC lever handle & WC Indicator of approved Make | **Each** | 2,846.00 | 18 | 51,228 |
| **3.11** | **NON DSR** | Supply & Fixing of lever Concealed flush bolt 009 L=300mm in SS Satin Finish of approved Make | **Each** | 755.00 | 864 | 652,320 |
| **3.12** | **NON DSR** | Supply and Fixing of 6mm thick clear toughned glass for non fire doors sizes as per the door elevation with EPDM Tape | **Sqm** | 5,808.00 | 104 | 604,032 |
| **3.13** | **NON DSR** | Supply and Fixing of PVC grooved frame seal for the non fire doors | **RMT** | 139.00 | 5309 | 737,951 |
| | | | | | | |
| **4.0** | **NON DSR** | **2hr. FIRE RATED METAL DOORS** | | | | |
| | | Providing and fixing of Hollow metal fire rated doors as per IS 3614 part-1 & part-2 for stability and integrity. Pressed Galvanized steel confirming to IS 277 with the following specification. Recommended fire door shall have doors tested at CBRI or ARAI for maximum rating of 2hrs with vision panel. Test certificates should be available for vision lites /panels as part of the fire door assembly. Independent glass test certificates will not be accepted. Manufacturer test certificate shall cover doors both single and double leaf and all doors supplied should be within the tested specimen, deviation in specification and sheet thickness other than what is mentioned in the test certificates are not allowed. Proper label confirming the type of door and the hourly rating is mandatory. | | | | |
| | | Door frame shall be Single rebate Grooved profile of size 125 x 60 mm made out of 1.60mm (16gauge) minimum thick galvanized steel sheet with grooved seal. Frames shall be Mitered and field assembled with self tabs. All provision should be mortised, drilled and tapped for receiving appropriate hardware. Rubber door silencers should be provided on the striking jamb. Frames should be provided with back plate bracket and anchor fasteners for installation on a finished plastered masonry wall opening. Once frame installed should be grouted with cement & sand slurry necessary for fire doors on the clear masonry opening. | | | | |

| CIVIL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **NON DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| | | Door leaf shall be 46mm thick fully flush double skin door with or without vision lite. Door leaf shall be manufactured from 1.2mm (18guage) minimum thick galvanised steel sheet. The internal construction of the door should be rigid reinforcement pads for receiving appropriate hardware. The infill material shall be resin bonded honeycomb core. All doors shall be factory prepped for receiving appropriate hardware and provided with necessary reinforcement for hinges, locks, and door closers. The edges should be interlocked with a bending radius of 1.4mm. For pair of doors astragals has to be provided on the meeting stile for both active and inactive leaf. Vision lite wherever applicable should be provided as per manufacturers recommendation with a beeding and screws from inside. | | | | |
| | | The glass should be **11mm / 12 mm** clear 2 hour fire rated glass of relavant rating of the door. All doors and frames shall be finished with etched primer coating, stove zinc phosphate primer and thermosetting polyurethane aliphatic grade paint of approved colour. The door leaf and frame shall have passed minimum 250 hours of salt sprey test. | | | | |
| | | Rate should include supply and installation of Doors | | | | |
| **4.1** | **NON DSR** | 2Hrs Fire Rated Door Single/Double leaf doors as per the elevation with hardware set provisions.Hardware cost will be paid seperately as per items listed. | **Sqm** | 9,117.00 | 2128 | 19,400,976 |
| **5.0** | **NON DSR** | **Hardware for Metal Fire Doors** | | | | |
| **5.1** | **NON DSR** | Supply & Fixing 2 hour fire rated & CE Mark SS 304 ball bearing butt Hinges in Satin Finish of size 100x75x3mm of approved Make | **Each** | 267.00 | 3501 | 934,767 |
| **5.2** | **NON DSR** | Supply & Fixing of 2 hour Fire rated & CE Mark Mortise sash lock, in silver finish, (RH/LH) of approved make with 5pin cylinder 70mm long with one side key other side TT with lever handle,19mm Dia with roses & escutcheion, SS304, Satin finish. | **Each** | 2,730.00 | 241 | 657,930 |
| **5.3** | **NON DSR** | Supply & Fixing of Fire rated & CE Marked Door Closer of approved make with slide arm in silver finish. | **Each** | 5,662.00 | 1104 | 6,250,848 |
| **5.4** | **NON DSR** | Supply and Fixing of Door coordinator in SS Satin Finish of approved Make | **Each** | 1,975.00 | 502 | 991,450 |
| **5.5** | **NON DSR** | Supply & Fixing of lever Concealed flush bolt L=300mm in SS Satin Finish of approved Make | **Each** | 755.00 | 1084 | 818,420 |
| **5.6** | **NON DSR** | Supply & Fixing of 2 hour fire rated Single Point panic bar suitable for door width upto 1200mm in silver finish ofapproved Make | **Each** | 6,562.00 | 460 | 3,018,520 |
| **5.7** | **NON DSR** | Suply & Fixing of 2 hour fire rated Panic bar for the double leaf door with two point latching in silver finish of approved Make | **Each** | 15,843.00 | 352 | 5,576,736 |

| CIVIL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **NON DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| **5.8** | **NON DSR** | Supply & Fixing of External lever handle with locking arrange ment complete with cylinder in silver finish of approved Make | **Each** | 3,310.00 | 812 | 2,687,720 |
| **5.9** | **NON DSR** | Supply & Fixing of **11mm / 12 mm** thick clear toughned 2hr fire rated glass for fire doors sizes as per the door elevation with ceramic tape. | **Sqm** | 40,653.00 | 414 | 16,830,342 |
| **5.10** | **NON DSR** | Supply & Fixing of 2 hour Fire rated groved frame seal for the fire doors. | **RMT** | 366.00 | 3400 | 1,244,400 |
| | | | | | | |
| | | **ALUMINIUM DOORS, WINDOWS** | | | | |
| | | **For all aluminium works please note the following:-**<br>**i) Shop drawings of all items to be prepared and submitted to Engineer-in-Charge for approval.**<br>**Ii) All items include necessary hardware such as hinges, handles, cleats, EPDM Gaskets etc. all complete as per directions of the Engineer-in-Charge** | | | | |
| **6.0** | **NON** | **Aluminium Fixed Window** | | | | |
| | | Providing and fixing Casement systems 'Aluminium works for Fix window. The extruded aluminium sections should be made from AW 6060 and AW 6063, Post-treatment T6 in accordance with EN 755-2, Tolerance In accordance with EN 12020-2, and suited for anodizing and powder coating. All profiles should be Non insulated Profiles. Corner connection Crimped/screwed sealed with two-component glue (epoxy). All Glazing gaskets Silicone compatible EPDM in accordance with TV 110, possible to vulcanize. System should be wih 3 layer gasket solution. Accessories should be used which are designed to be simple and rational to use. All materials which are used in should be corrosion-resistant so that the good functioning in different environments is guaranteed for a period of min. 10 years. | **Sqm** | 6,314.00 | 15108 | 95,391,912 |
| | | This means that the article can be used in all environments and that there are no negative influences either on the aluminium or on the surface treatment. | | | | |

| CIVIL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **NON DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| | | The system should allow the application of glazing or panels with thickness from 4 to 33 mm.The external perimeter of aluminium sections should be coated with 50-60 Micron RAL colour powder coating, Qualicoat certified surface treatment only. Coating thickness according to norm ISO 2360:1995. System should qualify Air tightness, max. Test pressure EN 1026; EN 12207(600pa), Water tightness EN 1027; EN 12208(900Pa), Wind load resistance EN 12211; EN 12210(class C E2400) ˜ System should have 10 year guarantee on properties, functionality and design, within restrictions defined by technical specifications, powder coating / anodising & 10 year guarantee on wearing parts only applies to normal and realistically foreseable use. Note :- Glass rate quote Separately. | | | | |
| **7.0** | **NON DSR** | **Aluminium Casement Door/Window** | **Sqm** | 13,838.00 | 2223 | 30,761,874 |
| | | Providing and fixing of Casement window/door systems ' Extra for Top / Casement Openable Door/Window Shutter over Fixed Window item ( Only Shutter area to be measured). The extruded aluminium sections should be made from AW 6060 and AW 6063, Post-treatment T66 in accordance with EN 755-2, Tolerance In accordance with EN 12020-2, and suited for anodizing and powder coating. All profiles should be Non insulated Profiles. Corner connection Crimped/screwed sealed with two-component glue (epoxy). All Glazing gaskets Silicone compatible EPDM in accordance with TV 110, possible to vulcanize. System should be wih 3 layer gasket solution. Accessories should be used which are designed to be simple and rational to use. System with Euro Nut compatible hardware only. | | | | |
| | | Hardware should be as per approved makes with hinges of capacity of 90/110Kg. All materials which are used in should be corrosion-resistant so that the good functioning in different environments is guaranteed and this for a period of min. 10 years. This means that the article can be used in all environments and that there are no negative influences either on the aluminium or on the surface treatment. | | | | |

| CIVIL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **NON DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| | | The system should allow the application of glazing or panels with thickness from 4 to 33 mm.System should qualify Air tightness, max. Test pressure EN 1026; EN 12207(600pa), Water tightness EN 1027; EN 12208(900Pa), Wind load resistance EN 12211; EN 12210(class C E2400). System should have 10 year guarantee on properties, functionality and design, within restrictions defined by technical specifications, powder coating / anodising & 10 year guarantee on wearing parts only applies to normal and realistically foreseable use. Note :- Glass rate quote Separately. | | | | |
| **8.0** | **NON DSR** | **Aluminium Z Type Louvres**<br>Providing and fixing Casement systems 'Aluminium works for Extra for Fix Z type Louvers (Only louvered area to be measured) Louvre depth / height 40mm. The extruded aluminium sections should be made from AW 6060 and AW 6063, Post-treatment T66 in accordance with EN 755-2, Tolerance In accordance with EN 12020-2, and suited for anodizing and powder coating. All profiles should be Non insulated Profiles. Corner connection Crimped/screwed sealed with two-component glue (epoxy). All Glazing gaskets Silicone compatible EPDM in accordance with TV 110, possible to vulcanize. Accessories should be used which are designed to be simple and rational to use.<br>All materials which are used in should be corrosion-resistant so that the good functioning in different environments is guaranteed and this for a period of min. 5 years. This means that the article can be used in all environments and that there are no negative influences either on the aluminium or on the surface treatment.The system should allow the application of glazing or panels with thickness from 4 to 33 mm.The external perimeter of aluminium sections should be coated with 50-60 Micron RAL colour powder coating, Qualicoat certified surface treatment only. Coating thickness according to norm ISO 2360:1995. System should qualify Air tightness, max. Test pressure EN 1026; EN 12207(600pa), | **Sqm** | 9,866.00 | 434 | 4,281,844 |
| **9.0** | **NON** | **Aluminium Sliding Window** | | | | |

| CIVIL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **NON DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| | **DSR** | Providing and fixing of , 2 Track 2 Slider slim line slider system with 40 mm visible aluminium section width in the centre mullion, The extruded aluminium sections should be made from AW 6060 and AW 6063, Post-treatment T66 in accordance with EN 755-2, Tolerance In accordance with EN 12020-2, and suited for anodizing and painting. All profiles should be Non insulated Profiles. The corner connections between the profiles of the outer frame are formed by pneumatically crimping or screwing the mitre-cut aluminium profiles. The vents are assembled by screwing the profiles, which are sawn with a straight cut. Plastic pieces are used for an aesthetic finish. | **Sqm** | 15,369.00 | 1509 | 23,191,821 |
| | | All Glazing gaskets Silicone compatible EPDM in accordance with TV 110, possible to vulcanize. System should be wih 3 layer gasket solution. Accessories should be used which are designed to be simple and rational to use. All materials which are used in should be corrosion-resistant so that the good functioning in different environments is guaranteed and this for a period of min. 10 years. This means that the article can be used in all environments and that there are no negative influences either on the aluminium or on the surface treatment.The system should allow the application of glazing or panels with thickness from 6 to 24 mm. | | | | |
| | | The external perimeter of aluminium sections should be coated with 50-60 Micron RAL colour powder coating, Qualicoat certified surface treatment only. Coating thickness according to norm ISO 2360:1995. System should qualify Air tightness, max. Test pressure EN 1026; EN 12207, Water tightness EN 1027; EN 12208, Wind load resistance EN 12211; EN 12210,impact resistance EN 13049, durability according EN 12400 Class 2, operating forces according EN 13115 Class 1 Glazing with envelope principle ensures perfect water-tightness. Sliding System shound be with stainless steel rail. Wool pile brush made of high quality polypropylene multifilament yarn and has a central polypropylene fin to be provided for additional protection for tightness. | | | | |

| CIVIL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **NON DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| | | The wind and water tightness around the vents should be sealed by brush seals located around the vent profile. Brush units should be applied in the outer frame, above and below the central vents. All sliding elements must have a drainage system in the bottom profile of the outer frame and the vents and in the horizontal transom mullion profile, the drainage is invisible from the outside.The door and window operating hardware is built in and makes the specified opening direction possible. The visible parts of the hardware are available in a limited range of colours.All screws are made of stainless steel.The sliding vent moves by means of stainless steel wheels over a stainless steel rail. All the accesories should be Patented accessories with single or multipoint locking options . | | | | |
| | | Rollers should be single or double carriage in 60 kg and 120 kg capacity with both fixed and adjustable versions. System should have 10 year guarantee on properties, functionality and design, within restrictions defined by technical specifications, Painting / anodising & 10 year guarantee on wearing parts only applies to normal and realistically foreseable use. Note :- Glass rate quote Separately. | | | | |
| **10.0** | **Non DSR** | **CURTAIN WALL GLAZING (Semi Unitized)** | | | | |
| **10.1** | **NON DSR** | Providing and fixing of curtain wall system. This system should holds An ISO 9001 certificate from the system supplier.The extruded aluminium sections should be made from AW 6060 and AW 6063, Post-treatment T66 in accordance with EN 755-2, Tolerance In accordance with EN 12020-2, and suited for anodizing and powder coating. All profiles should be Non insulated Profiles. The corner connections between the profiles of the outer frame are formed by pneumatically crimping or screwing the mitre-cut aluminium profiles. The vents are assembled by screwing the profiles, which are sawn with a straight cut. Plastic pieces are used for an aesthetic finish. All Glazing gaskets Silicone compatible EPDM in accordance with TV 110, possible to vulcanize. | **Sqm** | 10,502.00 | 2173 | 22,820,846 |
| | | Accessories should be used which are designed to be simple and rational to use. All materials which are used in should be corrosion-resistant so that the good functioning in different environments is guaranteed and this for a period of min. 10 years. This means that the article can be used in all environments and that there are no negative influences either on the aluminium or on the surface treatment. | | | | |

| CIVIL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **NON DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| | | The system should allows the application of glazing or panels with thickness from 6 to 62 mm.The external perimeter of aluminium sections should be coated with 50-60 Micron RAL colour powder coating, Qualicoat certified surface treatment only. Coating thickness according to norm ISO 2360:1995. System should qualify Air tightness, max. Test pressure EN 1026; EN 12207, Water tightness EN 1027; EN 12208, Wind load resistance EN 12211; EN 12210, Anti Burglary WK 3, . The depth of the mullion profiles should be between 41.5 mm-230.5 mm, depending on the inertia moment in relation to the loads. The transom profiles depth should be between 23.7 mm-193.2 mm that allows their inner side to be positioned flush or recessed in relation to the inside of the supporting profiles, | | | | |
| | | depending on the loads and the desired aesthetics. Syatem should take Maximal glass weight 350Kg. The system designed to build quickly vertical curtain walls,inclined curtain walls ,design shall include pressure equalization for improved weather performance, drainage at all floor levels. During assembly, the supporting and transverse profiles overlap one another.Glazing and drainage rubbers and the connecting sleeves are made of EPDM in accordance with TV 110. The continuous EPDM compartmentalisation rubbers are mounted on a rigid PVC insulator that in turn is mounted continuously in the screw channel of the transverse profiles | | | | |
| | | . The insulator and compartmentalisation seal guide the water from the transverse profiles into the supporting profiles or directly out of the construction via small drainage channels milled in the clamping strip and covering profile.The transverse profiles are mounted on the supporting profiles in such a way that expansion is possible. System should have 10 year guarantee on properties, functionality and design, within restrictions defined by technical specifications, Painting / anodising & 10 year guarantee on wearing parts only applies to normal and realistically foreseable use. | | | | |
| **11.0** | **Non DSR** | Providing and fixing 6mm thk. toughened clear glass in door, window, ventilator shutters and partitions etc. complete as per the architectural drawings and the directions of engineer-in-charge. (Cost of gaskets, aluminium/steel beading shall be paid in main item): | **Sqm** | 1,593.00 | 6079 | 9,683,847 |

| CIVIL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **NON DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| **12.0** | **Non DSR** | Providing and fixing laminated toughened glass in aluminium skylight sections, ventilators and partition etc. with 2 layers of 10 mm thick toughened glass, having 1.52 mm sentry PVB layer, including providing EPDM gasket, (Both primary and secondary sealant) etc. as per specifications, drawings and direction of Engineer-in-charge complete. | **Sqm** | 9,208.00 | 100 | 920,800 |
| **13.0** | **Non DSR** | Providing and fixing Hermetically sealed Double Glass Unit 24mm (6mm thk. toughened + 12 mm Air Gap + 6mm thk. Clear Toughened Glass) in door, window, ventilator shutters and partitions etc. complete as per the architectural drawings and the directions of engineer-in-charge. (Cost of gaskets, aluminium/steel beading shall be paid in main item) | **Sqm** | 2,988.00 | 9019 | 26,948,772 |
| **14.0** | **Non DSR** | Providing and fixing Hermeticaly Sealed Shatter Proof Double Glass Unit 39mm (Outer Layer of 2 x 6mm thk. toughened laminated glass with 1.52mm PVB Film + 12 mm Air Gap + Inner Layer of 2 x 6mm thk. toughened laminated glass) in Structural/Curtain Glazing. complete as per the architectural drawings and the directions of engineer-in-charge. (Cost of gaskets, aluminium/steel beading shall be paid in main item) | **Sqm** | 9,818.00 | 1969 | 19,331,642 |
| **15.0** | **Non DSR** | **Revolving Door** | | | | |
| | | Providing and Installation of DORMA KTV or Equivalent from aprooved make Manual 3 Wing Revolving Door 2600 mm diameter with RAL Finish, Grade 316. Manual Revolving Door with three wings (Leaves), rigid turnstile with standard frame profile system, drum walls made of glass, Inner Ceiling and Roof made of Melamine white dust protected (Top and Botteom), with Manual Locking System and Halogen Lamps in Inner Ceiling and Tubular Stainless Steel D Handles fixed on the door leaves.<br>Door Dimensions<br>Inside Diameter - 2504 mm<br>Outside Diameter - 2600 mm<br>Clear Passage Height - 2100mm<br>Canopy Height - 100mm<br>Total Heigh 2200 mm (Clear Passage Height + Canopy Height) | **Each** | 1,814,788.00 | 6 | 10,888,728 |
| | | | | | | |
| | | **Total of Doors, Windows & Ventillator Carried Over to Summary** | | | | 337,135,404 |
| | | | | | | |
| **N** | | **WATER PROOFING** | | | | |
| **1.0** | | **Spray Applied PU Waterproofing** | | | | |

| CIVIL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **NON DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| **1.1** | **Non DSR** | Providing and applying solvent free two component Polyurethane (PU) spray applied waterproofing system free of bituminous, polyurea to be laid directly above PUF insulation or mother slab in horizontal and vertical face covering every possible area at 2mm total average thickness. The item includes applying moisture insensitive epoxy primer broadcasted with sand directly above PUF insulation followed by applying waterproofing membrane using specialized 2 component spray machine as per approved manufacturer's specifications. The mixed product should have 100% solid content as per DIN 53213, density of 1-1.1g/cm3, tensile strength of 8-10 Mpa as per DIN 53504, fast setting less than 1 min and green certified. | **Sqm** | 2,349.00 | 25940 | 60,933,060 |
| **1.2** | **Non DSR** | II) Providing and laying geotextile of 300 GSM | **Sqm** | 105.00 | 25940 | 2,723,700 |
| **1.3** | **Non DSR** | III) UV Top Coat: (Only in areas where waterproofing is to be exposed)<br>Over spray applied waterproofing UV Top Coat is applied where waterproofing is to be exposed to sunlight. Such areas are to be protected with UV Top coat. | **Sqm** | 668.00 | 2594 | 1,732,792 |
| | | | | | | |
| **2.0** | **NON DSR** | Providing & installing high density polyethylene (HDPE) dimpled sheet; of make Delta MS/BASF/STP as protection over the waterproofing treatment on the retaining walls. The dimpled sheet should have the following technical properties.<br>Dimpled sheet : Virgin HDPE, No plasticizer, fully recyclable<br>Dimpled Height: 8mm<br>Compressive Strength: 250 kN /m²<br>Elongation at break : 60%<br>Elasticity modulus : 1500 N/mm² (ISO 178)<br>Tensile Strength MD/CMD: 480/460 N/5mm (DIN EN 12311-2)<br>Resitance to tearing (Nail Shank) : 390 N (DIN EN 12310-1)<br>Resistance to impact : No permeability at 350 mm (DIN EN 12691)<br>Air Gap between dimples: 5.3 l/m²<br>The dimpled sheet shall be installed with the dimples facing towards the retaining wall with minimum overlaps of 100 mm between 2 adjacent sheets as per the manufacturer's instructions. Self adhesive or mechanical fixtures to be used depending on the way waterproofing and backfilling is to be done. Overlaps to be sealed with special rubber adhesive to achieve water tightness. | **Sqm** | 392.00 | 14564 | 5,709,088 |
| | | **Total of Water Proofing Carried Over to Summary** | | | | 71,098,640 |

| CIVIL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **NON DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| | | | | | | |
| **O** | | **MISCELLANEOUS ITEMS** | | | | |
| | | | | | | |
| **1.0** | **Non DSR** | Providing and fixing change room/ toilet cubicle (of following standard dimension which includes 600mm door size width) made of heat, bacteria, water, chemical,scratch, impact and anti bacterial resistant 12mm thick solid compact laminate panels. Finish of the compact laminate should be suede, which includes doors, pilasters and intermediate panels finished with approved texture/ shade as per the detail drawings as per IS 2046 (Indian Standard) and as per fire retardant BS-476/97 standard. Panel is anchored to the wall with SS 304 grade U & F Channel. This also includes providing and fixing in position necessary hardware made out of stainless steel (Grade 304) as per manufacturer's specification & instruction of Engineer-in-charge like (1) SS Door Knob, (2) SS Gravity Hinges, | **Sqm** | 10,185.00 | 1128 | 11,488,680 |
| | | (3) SS Thumb turn lockset with occupancy indicators, (4) SS coat hooks with door stopper (5) SS U-channels, (6) Adjustable foot/ pedestal, (7) SS Top Rectangular rail (8) Rubber noise deafening tape, (9) screws & wall plugs. The top fitting should consist of SS top rectangular rail. SS wall fixing is used only on the wall which will hold the SS top rail. All screws will of 304 Grade in stainless steel with satin finish. All pilasters are supported by stainless steel bottom cladding. The baseof the stainless steel bottom cladding will be anchored to the floor." | | | | |
| | | **NOTE: The mode of measurement for payment purpose shall be per sqm area of laminated panels . For combined cubicles the common partition shall be measured only once for payment. Nothing extra will be paid on account of lamination of both sides. Doors also will be measured as plain panels.** | | | | |
| **2.0** | **NON DSR** | Providing and fixing Glass Reinforced Concrete G.R.C. Screens ( Jaali) 50mm thk. in approved size, pattern, design, thickness and color of specified make. The screens should be made from '53 grade' approved White portland cement, quartz, fine silica sand, alkali resistant glass fiber manufactured by Saint Gobain or equivalent, polymers manufcatured by BASF or equivalent, super plastisizers manufactured by BASF or equivalen with UV resistant synthetic inorganic pigments made by BAYFERROX (Germany) or equivalent. | **Sqm** | 4,478.00 | 4908 | 21,978,024 |

| CIVIL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **NON DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| | | The material casting should be done in synthetic rubber / FRP mould manufactured by 'Reckli' or equivalent. The fixing of screens should be done with galvanised M.S. / S.S. "L" shaped clamps, dash fasteners and pins etc. complete as per requirement, approved shop drawing and instructions. | | | | |
| **3.0** | **NON DSR** | Supply of C/S Pedismart Entrance Flooring Mat recessed with 13 mm base frame assembly whose Tread rails and frame shall be extruded from 6063-T5 aluminum alloy pitched at a maximum of 50mm centers and connected by a continuous mono durometer PVC combination hinge and cushion extrusion (connector spline). The connector splines shall be slotted to provide a 25 mm (slot) 12.5 mm (solid) perforation pattern, between each tread rail, for drainage, unless otherwise specified. Solid or unperforated systems that do not allow for dirt and water retention within the mat area shall not be acceptable. | **Sqm** | 20,907.00 | 581 | 12,146,967 |
| | | Tread Rails, Frames, Connector Splines, Inserts and Edge Fillers to be to selected finish and color. To facilitate easy removal for cleaning, single mat widths shall not exceed 3600 mm. Larger sizes shall be supplied as multiple units. Carpet Tread inserts color shall strictly be Wrought Iron. | | | | |
| | | **Qualtity Assurance & Applicable certification :** | | | | |
| | | Flammability in accordance with ASTM E648, Class 1, Critical Radiant Flux, minimum 0.45 watts/cm. Slip resistance in accordance with ASTM D-2047-96, Coefficient of Friction, minimum 0.60 for accessible routes. Standard rolling load performance is 250 kg/wheel with larger loading requirements as specified. (Load applied on a single wheel). [Please note: For entranceways such as airports ,retail malls, rolling load performance is a critical factor not only for goods trolleys but also for interior cleaning equipment].. | | | | |
| **4.0** | **NON DSR** | **Accessories for Differently Abled Toilet** | | | | |
| | | Providing and Fixing of Accessories for Differently Abled toilets made in SS 304 Grade 32mm dia pipe, 1.5mm thk, Matt Finish fixed to wall with 3" Screw/Anchor Fastener all complete as per drawing and directions of Engineer in Charge | | | | |
| **4.1** | **NON DSR** | Grab Bar 1500mm Long | **Nos** | 5,328.00 | 46 | 245,088 |
| **4.2** | **NON DSR** | Grab Bar 600mm Long | **Nos** | 2,889.00 | 46 | 132,894 |
| **4.3** | **NON DSR** | Horizontal/Vertical Grab Bar 600mmx600mm | **Nos** | 7,303.00 | 46 | 335,938 |
| **4.4** | **NON DSR** | Lift Up - Arm Support 600mm | **Nos** | 9,974.00 | 46 | 458,804 |
| **5.0** | **NON** | **Toilet Accessories** | | | | |

| CIVIL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **NON DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| | **DSR** | Providing and Fixing of Accessories for toilets made in Stainless Steel 304 Grade fixed to wall with 3" Screw/Anchor Fastener all complete as per directions of Engineer in Charge | | | | |
| **5.1** | **NON DSR** | Paper Dispenser (Capacity: 450 - 500 Towels) Euronics-EP01 or equivalent | **Each** | 4,239.00 | 108 | 457,812 |
| **5.2** | **NON DSR** | Paper Dispenser (Capacity: 300 - 350 Towels) Euronics-EP02S or equivalent | **Each** | 4,137.00 | 63 | 260,631 |
| **5.3** | **NON DSR** | Wall Mounted Waste Receptacle, Euronics- KINOX (KWR) or equivalent | **Each** | 7,374.00 | 159 | 1,172,466 |
| **5.4** | **NON DSR** | Horizontal Soap Dispenser - 1250ML Euronics- ES14H or equivalent | **Each** | 2,634.00 | 170 | 447,780 |
| **5.5** | **NON DSR** | Soap Dispenser - 800 ML Euronics- ES04 or equivalent | **Each** | 2,345.00 | 63 | 147,735 |
| **5.6** | **NON DSR** | Hand Dryer (Heavy Traffic) Euronics-EH 21NW or equivalent | **Each** | 16,971.00 | 159 | 2,698,389 |
| **5.7** | **NON DSR** | Surface Mounted Washroom Panel (2IN1,Paper Dispenser / Waste Receptacle) Euronics - KINOX (KPD2E) or equivalent | **Each** | 42,872.00 | 12 | 514,464 |
| **5.8** | **NON DSR** | Jet Hand Dryer with Air Filter (with 2 Years Warranty on Motor Euronics- STAHL - SJD 2S or Equivalent | **Each** | 76,404.00 | 12 | 916,848 |
| **6.0** | **NON DSR** | Providing and Placing In Position Auto Shoe Shining Machine Stainless Steel with 1 Lt. Polish Free.(High Traffic) as per directions of Engineer-in-Charge. | **Each** | 17,333.00 | 12 | 207,996 |
| **7.0** | **NON DSR** | Providing and fixing 6mm thk. 600x450 mm mirror of superior glass(of approved quality) complete with 12 mm thick marine plywood backing, 25x12x2mm SS Edging fixed to wall with 2" Glass Stud Spaceswith C.P. brass screws and washers complete. | **Sqm** | 7,111.00 | 163 | 1,159,093 |
| **8.0** | **NON DSR** | **Façade Cleaning System (Building Maintenance Unit)** | | | | |
| | | Floor Mounted Traversing Trolley Motorized (BMU-Building Maintenance Unit) Consisting of: Floor Mounted Twin Track , and Two Men Cradle. Motorized Traverse. Body Slewing. Cross bar Traverse. Cradle needs to be parked at Terrace level. All electricals. EN-1808 standard to be followed. | **Each** | 5177967.00 | 1 | 5,177,967 |
| | | Twin Track with suitable foundation /fixture , grouted on RCC upstand. Track to be supported at average 2M distance. | | | | |
| | | 2 Men Power Winch Cradle/Gondola 200 Kgs Capacity.2 M Suspension Centre. With branded European Winches of 500 Kgs Capacity each & Overspeed Safety Brake (both from , TIRAK/FIXTOR/POWER CLIMBER).With rope reeler/winder (with anti slack rope device). | | | | |
| **9.0** | **NON DSR** | Providing and laying geotextile of 300 GSM | **Sqm** | 105.00 | 8432 | 885,360 |

| CIVIL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **NON DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| **10.0** | **NON DSR** | Designing, construction, supply, installation, testing and commissioning of Water Feature (Cascade Fountain) comprising of two pools of water; Pool - 1 approx. 24,600mm length x 900mm wide x 500 deep at level 99.0 m, Pool - 2 shall be approx. 34900 x 1200mm width and 750mm deep at 93.0 m level and Both pools shall be constructed in a curvilinear form as per the Architectural / Landscape Drawings under relevant civil works items. | **Nos** | 2113930.00 | 1 | 2,113,930 |
| | | The scope of Water Feature (Cascade Fountain) includes all components; diffusers, filters, etc. for making, piping, cabling, light fixtures, with all electrical and mechanical equipment for pools at two levels and , supply, installation, testing and commissioning of pipes, NRV, valves, valve flanges, nipples, filters, pumps and associated accessories complete in all respects upto the satisfaction of Engineer-in-charge . The work shall also include loading, unloading, safe storage, painting of all materials at site. The rates shall include one year of Operation and maintenance including all consumables and manpower. | | | | |
| | | Floor Diffusers – 36 Nos. | | | | |
| | | Submersible Pumps - 3Hp – 2 Nos. | | | | |
| | | Diffuser's – 5 Nos. | | | | |
| | | Submersible Pump Single Phase 1.5Hp for filter. – 1 No. | | | | |
| | | Sand / Bio Filter Top-mounted 500MM Dia. - 1 No. | | | | |
| | | Chlorine Dosing Unit - 3 Nos. | | | | |
| | | Submersible Super Bright 18 watts LED Lights (IP 68 Certified) - 30 Nos. | | | | |
| | | Step Down transformers (Power Supply units) for submesible Lights - 5 Nos. | | | | |
| | | Deck Box / Junction Boxes for the Lights - 10 Nos. | | | | |
| | | Control Panel (Made of 16 gauge CRC sheet powder coated with<br>Starter, Single phase prevention, MCB, volt-meter, Ampmeter,<br>TPMCB's, Protection circuits and space for keep the transformer for<br>the lights.) With Auto Timer. 2 Nos. | | | | |
| | | Capital fitting such as control valves NRV's etc. required for the<br>final installation. | | | | |
| | | Complete Internal Plumbing items such as (uPVC pipe) & (fittings -<br>heavy) including Elbow, Tee, Socket etc. | | | | |
| | | Complete Electrical Work such as conduits, bends, fittings etc. of<br>required sizes. PVC insulated Copper Wires of Various sizes including accessories for electrical connections of final equipment installation. | | | | |

| CIVIL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **NON DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Total Quantity** | **Total Amount** |
| | | Water Body Maintence Kit Including SS Trooly, Hose Pipe,<br>Chemicals for 12 Months, Testing Kit, Vaccume Head etc. | | | | |
| | | **Total of Miscellaneous Items Carried Over to Summary** | | | | **62,946,866** |
| | | **GRAND TOTAL FOR EACH BUILDING** | | | | **809,861,367** |

## SUMMARY OF PHE WORKS

| S.No | Description of Work | AMOUNT (RS.) | |
|---|---|---|---|
| | | DSR | NON DSR |
| | | | |
| A. | SANITARY INSTALLATIONS | 1550004 | 39846239 |
| B. | INTERNAL DRAINAGE | 18282675 | 8712425 |
| C. | WATER-SUPPLY (INTERNAL) | 8662877 | 25836769 |
| D. | WATER-SUPPLY (EXTERNAL) | 22266136 | 3823568 |
| E. | EXTERNAL SEWERAGE SYSTEM | 16627903 | 2786246 |
| F. | EXTERNAL STORM WATER DRAINAGE | 25052001 | 6624206 |
| G. | GARDEN IRRIGATION SYSTEM | 50832 | 2447291 |
| H. | SEWERAGE TREATEMENT PLANT | - | 36655000 |
| I. | WATER TREATMENT PLANT | - | 7320000 |
| J. | SOLAR HOT WATER SYSTEM FOR HOT WATER GENERATION | - | 1097250 |
| | **TOTAL** | **92492428** | **135148994** |
| | **TOTAL (DSR + NON DSR)** | **227641422** | |

| PHE WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| **A.** | | **SANITARY INSTALLATIONS** | | | | |
| | | | | | | |
| 1.0 | 17.7 | Providing and fixing wash basin with C.I. brackets, 15 mm C.P. brass pillar taps, 32 mm C.P. brass waste of standard pattern, including painting of fittings and brackets, cutting and making good the walls wherever require: | | | | |
| | 17.7.2 | White Vitreous China Wash basin size 630x450 mm with a single 15 mm C.P. brass pillar tap. | Each | 2,010.35 | 44 | 88,455 |
| | | | | | | |
| 2.0 | 17.8 | Providing and fixing white vitreous china pedestal for wash basin completely recessed at the back for the reception of pipes and fittings . | Each | 979.95 | 44 | 43,118 |
| | | | | | | |
| 3.0 | 17.69 | Providing and fixing PTMT Waste Coupling for wash basin and sink, of approved quality and colour. | | | | |
| a) | 17.69.1 | Waste coupling 31 mm dia of 79 mm length and 62mm breadth weighing not less than 45 gms. | Each | 113.95 | 30 | 3,419 |
| b) | 17.69.2 | Waste coupling 38 mm dia of 83 mm length and 77mm breadth, weighing not less than 60 gms. | Each | 144.15 | 167 | 24,073 |
| | | | | | | |
| 4.0 | 17.70 | Providing and fixing PTMT Bottle Trap for Wash basin and sink. | | | | |
| a) | 17.70.1 | Bottle trap 31mm single piece moulded with height of 270 mm, effective length of tail pipe 260 mm from the centre of the waste coupling, 77 mm breadth with 25 mm minimum water seal, weighing not less than 260 gms. | Each | 494.90 | 30 | 14,847 |
| b) | 17.70.2 | Bottle trap 38 mm single piece moulded with height of 270 mm, effective length of tail pipe 260 mm from the centre of the waste coupling, 77 mm breadth with 25 mm minimum water seal, weighing not less than 263 gms. | Each | 518.15 | 105 | 54,406 |
| | | | | | | |
| 5.0 | 17.78 | Providing and fixing white vitreous china extended wall mounting water closet of size 780x370x690 mm of approved shape including providing & fixing white vitreous china cistern with dual flush fitting, of flushing capacity 3 litre/6 litre (adjustable to 4 litre/8 litres), including seat cover, and cistern fittings, nuts, bolts and gasket etc complete. | Each | 10,100.90 | 12 | 121,211 |
| | | | | | | |
| 6.0 | 18.21 | Providing and fixing uplasticised PVC connection pipe with brass unions : | | | | |
| | 18.21.1 | 30 cm length | | | | |
| | 18.21.1.1 | 15 mm nominal bore | Each | 60.10 | 62 | 3,726 |
| | 18.21.2 | 45 cm length | | | | |
| | 18.21.2.1 | 15 mm nominal bore | Each | 68.60 | 320 | 21,952 |
| | | | | | | |

| PHE WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| 7.0 | 17.79 | Providing & fixing white vitreous china water less urinal of size 600 x 330 x 315 mm having antibacterial /germs free ceramic surface, fixed with cartridge having debris catcher and hygiene seal. | Each | 21,835.55 | 6 | 131,013 |
| | | | | | | |
| 8.0 | 17.80 | Providing and fixing white vitreous china battery based infrared sensor operated urinal of approx. size 610 x 390 x 370 mm having pre & post flushing with water (250 ml & 500 ml consumption), having water inlet from back side, including fixing to wall with suitable brackets all as per manufacturers specification and direction of Engineer-in-charge. | Each | 16,724.95 | 7 | 117,075 |
| | | | | | | |
| 9.0 | 17.10 | Providing and fixing Stainless Steel A ISI 304 (18/8) kitchen sink as per IS: 13983 with C.I. brackets and stainless steel plug 40 mm, including painting of fittings and brackets, cutting and making good the walls wherever required : | | | | |
| | 17.10.1 | Kitchen sink with drain board | | | | |
| | 17.10.1.1 | 510x1040 mm bowl depth 250 mm. | Each | 7,052.15 | 20 | 141,043 |
| | 17.10.2 | Kitchen sink without drain board | | | | |
| | 17.10.2.1 | 610x510 mm bowl depth 200 mm. | Each | 4,343.45 | 18 | 78,182 |
| | | | | | | |
| 10.0 | 17.11 | Providing and fixing white vitreous china laboratory sink with C.I. brackets, C.P. brass chain with rubber plug, 40 mm C.P brass waste and 40mm C.P. brass trap with necessary C.P. brass unions complete, including painting of fittings and brackets, cutting and making good the wall wherever required : | | | | |
| | 17.11.1 | Size 450x300x150 mm. | Each | 2,343.90 | 32 | 75,005 |
| | 17.11.2 | Size 600x450x200 mm. | Each | 3,162.75 | 30 | 94,883 |
| | | | | | | |
| 11.0 | 18.15 | Providing and fixing brass bib cock of approved quality : | | | | |
| | 18.15.1 | 15 mm nominal bore. | Each | 260.60 | 32 | 8,339 |
| | 18.15.2 | 20 mm nominal bore. | Each | 280.95 | 32 | 8,990 |
| | | | | | | |
| 12.0 | 18.16 | Providing and fixing brass stop cock of approved quality : | | | | |
| | 18.16.1 | 15 mm nominal bore. | Each | 260.60 | 32 | 8,339 |
| | 18.16.2 | 20 mm nominal bore. | Each | 344.85 | 32 | 11,035 |
| | | | | | | |
| 13.0 | 18.50 | Providing and fixing C.P. brass long nose bib cock of approved quality conforming to IS standards and weighing not less than 810 gms. | | | | |
| | 18.50.1 | 15 mm nominal bore. | Each | 796.70 | 131 | 104,368 |
| | | | | | | |
| 14.0 | 18.49 | Providing and fixing C.P. brass bib cock of approved quality conforming to IS:8931 : | | | | |
| | 18.49.1 | 15 mm nominal bore. | Each | 459.50 | 112 | 51,464 |
| | | | | | | |

| PHE WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| 15.0 | 18.51 | Providing and fixing C.P. brass long body bib cock of approved quality conforming to IS standards and weighing not less than 690 gms. | | | | |
| | 18.51.1 | 15 mm nominal bore. | Each | 610.65 | 70 | 42,746 |
| | | | | | | |
| 16.0 | 18.52 | Providing and fixing C.P. brass stop cock (concealed) of standard design and of approved make conforming to IS:8931. | | | | |
| | 18.52.1 | 15 mm nominal bore. | Each | 619.75 | 130 | 80,568 |
| | | | | | | |
| 17.0 | 18.53 | Providing and fixing C.P. brass angle valve for basin mixer and geyser points of approved quality conforming to IS:8931 | | | | |
| | 18.53.1 | 15 mm nominal bore. | Each | 507.70 | 260 | 132,002 |
| | | | | | | |
| 18.0 | 18.84 | Providing & fixing chrome plated brass battery based infrared sensor operated pillar cock, having foam flow technology. | | | | |
| | 18.84.1 | 15 mm nominal bore | Each | 6,778.90 | 12 | 81,347 |
| | | | | | | |
| 19.0 | 7363 | 15 mm C.P. brass tap with elbow operation lever. | Each | 700.00 | 12 | 8,400 |
| | | | | | | |
| | | | | | | |
| | | **TOTAL FOR SUBHEAD (A) CARRIED OVER TO SUMMARY** | | | | **1,550,004** |
| **B.** | | **INTERNAL DRAINAGE** | | | | |
| | | | | | | |
| 1.0 | 17.35 | Providing and fixing soil, waste and vent pipes : | | | | |
| | 17.35.1 | 100 mm dia. | | | | |
| | 17.35.1.2 | Centrifugally cast (spun) iron socket & spigot (S&S) pipe as per IS: 3989 | Metre | 917.75 | 8780 | 8,057,845 |
| | 17.35.2 | 75 mm dia. | | | | |
| | 17.35.2.2 | Centrifugally cast (spun) iron socketed pipe as per IS: 3989 | Metre | 791.30 | 1710 | 1,353,123 |
| | | | | | | |
| 2.0 | 17.65 | Painting sand cast iron/ centrifugally cast (spun) iron soil, waste vent pipes and fittings with paint of any colour such as chocolate grey, or buff etc. over a coat of primer (of approved quality) for new work : | | | | |
| | 17.65.1 | 100 mm diameter pipe | Metre | 38.65 | 8780 | 339,347 |
| | 17.65.2 | 75 mm diameter pipe. | Metre | 29.50 | 1710 | 50,445 |
| | | | | | | |
| 3.0 | 17.36 | Providing and filling the joints with spun yarn, cement slurry and cement mortar 1:2 ( 1 cement : 2 fine sand) in S.C.I./ C.I. Pipes : | | | | |
| | 17.36.1 | 75 mm dia pipe | Each | 65.70 | 684 | 44,939 |
| | 17.36.2 | 100 mm dia pipe | Each | 77.40 | 4390 | 339,786 |
| | | | | | | |
| 4.0 | 18.29 | Supplying pig lead at site of work. | Quintal | 10,464.50 | 15 | 156,968 |
| | | | | | | |
| 5.0 | 17.38 | Providing and fixing bend of required degree with access door, insertion rubber washer 3 mm thick, bolts and nuts complete . | | | | |

| PHE WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| | 17.38.1 | 100 mm dia | | | | |
| | 17.38.1.2 | Sand cast iron S&S as per IS - 3989 | Each | 385.70 | 255 | 98,354 |
| | 17.38.2 | 75 mm dia | | | | |
| | 17.38.2.2 | Sand cast iron S&S as per IS- 3989 | Each | 318.50 | 60 | 19,110 |
| | | | | | | |
| 6.0 | 17.39 | Providing and fixing plain bend of required degree. | | | | |
| | 17.39.1 | 100 mm | | | | |
| | 17.39.1.2 | Sand cast iron S&S as per IS - 3989 | Each | 335.75 | 538 | 180,634 |
| | 17.39.2 | 75 mm dia | | | | |
| | 17.39.2.2 | Sand cast iron S&S as per IS - 3989 | Each | 248.80 | 315 | 78,372 |
| | | | | | | |
| 7.0 | 17.40 | Providing and fixing heel rest sanitary bend | | | | |
| | 17.40.1 | 100 mm dia | | | | |
| | 17.40.1.2 | Sand cast iron S&S as per IS - 3989 | Each | 371.75 | 130 | 48,328 |
| | 17.40.2 | 75 mm dia | | | | |
| | 17.40.2.2 | Sand cast iron S&S as per IS - 3989 | Each | 312.70 | 35 | 10,945 |
| | | | | | | |
| 8.0 | 17.42 | Providing and fixing double equal plain junction of required degree | | | | |
| | 17.42.1 | 100x100x100x100 mm | | | | |
| | 17.42.1.2 | Sand cast iron S&S as per IS - 3989 | Each | 748.10 | 175 | 130,918 |
| | | | | | | |
| 9.0 | 17.43 | Providing and fixing single equal plain junction of required degree with access door, insertion rubber washer 3 mm thick, bolts and nuts complete. | | | | |
| | 17.43.1 | 100 x 100 x 100 mm | | | | |
| | 17.43.1.2 | Sand cast iron S&S as per IS - 3989 | Each | 623.80 | 540 | 336,852 |
| | | | | | | |
| 10.0 | 17.44 | Providing and fixing single equal plain junction of required degree : | | | | |
| | 17.44.1 | 100x100x100 mm | | | | |
| | 17.44.1.2 | Sand cast iron S&S as per IS - 3989 | Each | 576.20 | 920 | 530,104 |
| | 17.44.2 | 75x75x75 mm | | | | |
| | 17.44.2.2 | Sand cast iron S&S as per IS - 3989 | Each | 405.60 | 308 | 124,925 |
| | | | | | | |
| 11.0 | 17.46 | Providing and fixing double unequal plain junction of required degree : | | | | |
| | 17.46.1 | 100x100x75x75 mm | | | | |
| | 17.46.1.2 | Sand cast iron S&S as per IS - 3989 | Each | 957.15 | 130 | 124,430 |
| | | | | | | |
| 12.0 | 17.47 | Providing and fixing single unequal junction of required degree with access door, insertion rubber washer 3 mm thick, bolts and nuts complete : | | | | |
| | 17.47.1 | 100x100x75 mm | | | | |
| | 17.47.1.2 | Sand Cast Iron S & S as per IS - 3989 | Each | 792.20 | 130 | 102,986 |
| | | | | | | |
| 13.0 | 17.48 | Providing and fixing single unequal plain junction of required degree : | | | | |
| | 17.48.1 | 100x100x75 mm | | | | |
| | 17.48.1.2 | Sand cast iron S&S as per IS - 3989 | Each | 690.00 | 320 | 220,800 |
| | | | | | | |

| PHE WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| 14.0 | 17.49 | Providing and fixing double equal plain invert branch of required degree: | | | | |
| | 17.49.1 | 100x100x100x100 mm | | | | |
| | 17.49.1.2 | Sand cast iron S&S as per IS 3989 | Each | 643.55 | 130 | 83,662 |
| | | | | | | |
| 15.0 | 17.50 | Providing and fixing single equal plain invert branch of required degree : | | | | |
| | 17.50.1 | 100x100x100 mm | | | | |
| | 17.50.1.2 | Sand cast iron S&S as per IS - 3989 | Each | 521.60 | 130 | 67,808 |
| | 17.50.2 | 75x75x75 mm | | | | |
| | 17.50.2.2 | Sand cast iron S&S as per IS - 3989 | Each | 397.45 | 130 | 51,669 |
| | | | | | | |
| 16.0 | 17.51 | Providing and fixing double unequal invert branch of required degree : | | | | |
| | 17.51.1 | 100x100x75x75 mm | | | | |
| | 17.51.1.2 | Sand cast iron S&S as per IS - 3989 | Each | 870.05 | 130 | 113,107 |
| | | | | | | |
| 17.0 | 17.52 | Providing and fixing single unequal plain invert branch of required degree : | | | | |
| | 17.52.1 | 100x100x75 mm | | | | |
| | 17.52.1.2 | Sand cast iron S&S as per IS - 3989 | Each | 660.95 | 310 | 204,895 |
| | | | | | | |
| 18.0 | 17.54 | Providing and fixing sand cast iron S&S off sets as per IS: 3989 : | | | | |
| | 17.54.1 | 75 mm off sets | | | | |
| | 17.54.1.1 | With 75 mm dia pipe | Each | 283.65 | 130 | 36,875 |
| | 17.54.2 | 150 mm off sets | | | | |
| | 17.54.2.1 | With 75 mm dia pipe | Each | 364.35 | 130 | 47,366 |
| | 17.54.2.2 | With 100 mm dia pipe | Each | 486.30 | 130 | 63,219 |
| | | | | | | |
| 19.0 | 17.55 | Providing and fixing door piece, insertion rubber washer 3mm thick, bolts & nuts complete : | | | | |
| | 17.55.1 | 100 mm | | | | |
| | 17.55.1.2 | Sand cast iron S&S as per IS - 3989 | Each | 513.45 | 130 | 66,749 |
| | 17.55.2 | 75 mm | | | | |
| | 17.55.2.2 | Sand cast iron S&S as per IS - 3989 | Each | 382.40 | 130 | 49,712 |
| | | | | | | |
| 20.0 | 17.56 | Providing and fixing terminal guard : | | | | |
| | 17.56.1 | 100 mm | | | | |
| | 17.56.1.2 | Sand cast iron S&S as per IS - 3989 | Each | 434.50 | 171 | 74,300 |
| | 17.56.2 | 75 mm | | | | |
| | 17.56.2.2 | Sand cast iron S&S as per IS - 3989 | Each | 370.75 | 69 | 25,582 |
| | | | | | | |
| 21.0 | 17.57 | Providing and fixing collar: | | | | |
| | 17.57.1 | 100 mm | | | | |
| | 17.57.1.2 | Sand cast iron S&S as per IS - 3989 | Each | 318.35 | 4390 | 1,397,557 |
| | 17.57.2 | 75 mm | | | | |
| | 17.57.2.2 | Sand cast iron S&S as per IS - 3989 | Each | 219.75 | 684 | 150,309 |
| | | | | | | |
| 22.0 | 17.58 | Providing lead caulked joints to sand cast iron/centrifugally cast (spun) iron pipes and fittings of diameter : | | | | |
| | 17.58.1 | 100 mm | Each | 243.75 | 4340 | 1,057,875 |
| | 17.58.2 | 75 mm | Each | 205.30 | 668 | 137,140 |

| PHE WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| | | | | | | |
| 23.0 | 17.59 | Providing and fixing M.S. stays and clamps for sand cast iron/centrifugally cast (spun) iron pipes of diameter . | | | | |
| | 17.59.1 | 100 mm | Each | 68.60 | 2933 | 201,227 |
| | 17.59.2 | 75 mm | Each | 57.15 | 583 | 33,338 |
| | | | | | | |
| 24.0 | 17.60 | Providing and fixing trap of self cleansing design with screwed down or hinged grating with or without vent arm complete, including cost of cutting and making good the walls and floors : | | | | |
| | 17.60.1 | 100 mm inlet and 100 mm outlet | | | | |
| | 17.60.1.1 | Sand cast iron S&S as per IS - 3989 | Each | 982.55 | 548 | 538,437 |
| | 17.60.2 | 100 mm inlet and 75 mm outlet | | | | |
| | 17.60.2.1 | Sand cast iron S&S as per IS - 3989 | Each | 1,020.90 | 65 | 66,359 |
| | | | | | | |
| 25.0 | 17.77 | Providing and fixing M.S. holder bat clamp of approved design to sand cast iron/ cast iron (spun) pipes comprising of M.S. flat brackets made of 50x5 mm flat of specified shape, projecting 75 mm outside the wall surface and fixed on wall with 4nos, 6mm dia expansion hold fasteners, including drilling necessary holes in brick wall/ CC/ RCC surface and the cost of bolts etc. The pipes shall be fixed to the already fixed brackets with the help of 30 mm x1.6 mm galvanised M.S. flats of specified shape and of total length 420 mm and shall be fixed with M.S. nuts, bolts, & washers of size 25x6 mm, one bolts on each side of the pipe. | | | | |
| | 17.77.1 | Total bracket length 580 mm of approved shape and design (for single 100 mm dia pipe) | Each | 197.80 | 130 | 25,714 |
| | 17.77.2 | Total bracket length 810 mm of approved shape and design (for two 100 mm dia pipes) | Each | 240.30 | 68 | 16,340 |
| | 17.77.3 | Total bracket length 1040 mm of approved shape and design (for three 100 mm dia pipes) | Each | 282.75 | 68 | 19,227 |
| | | | | | | |
| 26.0 | 17.61 | Cutting chases in brick masonry walls for following diameter sand cast iron/ centrifugally cast (spun) iron pipes and making good the same with cement concrete 1:3:6 ( 1 cement : 3 coarse sand :6 graded stone aggregate 12.5 mm nominal size), including necessary plaster and pointing in cement mortar 1:4 (1 cement : 4 coarse sand) : | | | | |
| | 17.61.1 | 100 mm dia | Metre | 332.00 | 730 | 242,360 |
| | | | | | | |
| 27.0 | 12.41 | Providing and fixing on wall face unplasticised Rigid PVC rain water pipes conforming to IS : 13592 Type A including jointing with seal ring conforming to IS : 5382 leaving 10 mm gap for thermal expansion.(i) Single socketed pipes. | | | | |
| | 12.41.2 | 110 mm dia pipe | Metre | 231.65 | 3070 | 711,166 |
| | | | | | | |

| PHE WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| 28.0 | 12.42 | Providing and fixing on wall face unplasticised - PVC moulded fittings/ accessories for unplasticised Rigid PVC rain water pipes conforming to IS : 13592 Type A including jointing with seal ring conforming to IS : 5382 leaving 10 mm gap for thermal expansion. | | | | |
| | 12.42.2 | Single Push fit coupler | | | | |
| | 12.42.2.2 | 110 mm dia | Each | 173.15 | 220 | 38,093 |
| | 12.42.4 | Single tee without door | | | | |
| | 12.42.4.2 | 110x110x110 mm | Each | 248.55 | 220 | 54,681 |
| | 12.42.5 | Bend 87.5° | | | | |
| | 12.42.5.2 | 110 mm bend | Each | 161.55 | 220 | 35,541 |
| | 12.42.6 | Shoe (Plain) | | | | |
| | 12.42.6.2 | 110 mm dia | Each | 295.10 | 220 | 64,922 |
| | | | | | | |
| 29.0 | 12.44 | Providing and fixing to the inlet mouth of rain water pipe cast iron grating 15 cm diameter and weighing not less than 440 grams. | Each | 41.10 | 171 | 7,028 |
| | | | | | | |
| 30.0 | 12.43 | Providing and fixing unplasticised -PVC pipe clips of approved design to unplasticised - PVC rain water pipes by means of 50x50x50 mm hard wood plugs, screwed with M.S. screws of required length, including cutting brick work and fixing in cement mortar 1:4 (1 cement : 4 coarse sand) and making good the wall etc. complete. | | | | |
| | 12.43.2 | 110 mm | Each | 189.05 | 1160 | 219,298 |
| | | | | | | |
| 31.0 | 12.22 | Making khurras 45x45 cm with average minimum thickness of 5 cm cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate of 20 mm nominal size) over P.V.C. sheet 1 mx1 mx400 micron, finished with 12 mm cement plaster 1:3 (1 cement : 3 coarse sand) and a coat of neat cement, rounding the edges, making and finishing the outlet complete. | Each | 186.65 | 171 | 31,917 |
| | | | | | | |
| | | **TOTAL FOR SUBHEAD (B) CARRIED OVER TO SUMMARY** | | | | **18,282,675** |
| | | | | | | |
| **C.** | | **WATER-SUPPLY (INTERNAL)** | | | | |
| | | | | | | |
| 1.0 | 18.7 | Providing and fixing Chlorinated Polyvinyl Chloride (CPVC) pipes, having thermal stability for hot & cold water supply, including all CPVC plain & brass threaded fittings, including fixing the pipe with clamps at 1.00 m spacing. This includes jointing of pipes & fittings with one step CPVC solvent cement and testing of joints complete as per direction of Engineer in Charge. | | | | |
| | | Internal work - Exposed on wall | | | | |
| | 18.7.1 | 15 mm nominal outer dia .Pipes. | Metre | 163.50 | 2120 | 346,620 |
| | 18.7.2 | 20 mm nominal outer dia .Pipes. | Metre | 190.55 | 1790 | 341,085 |
| | 18.7.3 | 25 mm nominal outer dia.Pipes | Metre | 231.30 | 2170 | 501,921 |

| PHE WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| | 18.7.4 | 32 mm nominal outer dia .Pipes. | Metre | 296.70 | 1720 | 510,324 |
| | 18.7.5 | 40 mm nominal outer dia .Pipes. | Metre | 407.90 | 1410 | 575,139 |
| | 18.7.6 | 50 mm nominal outer dia .Pipes. | Metre | 581.55 | 1080 | 628,074 |
| | | Note: All CPVC pipes shall be of SDR 11 category. | | | | |
| | | | | | | |
| 2.0 | 18.8 | Providing and fixing Chlorinated Polyvinyl Chloride (CPVC) pipes, having thermal stability for hot & cold water supply, including all CPVC plain & brass threaded fittings, i/c fixing the pipe with clamps at 1.00 m spacing. This includes jointing of pipes & fittings with one step CPVC solvent cement and the cost of cutting chases and making good the same including testing of joints complete as per direction of Engineer in Charge. | | | | |
| | | Concealed work including cutting chases and making good the walls etc. | | | | |
| | 18.8.1 | 15 mm nominal outer dia .Pipes. | Metre | 270.00 | 3720 | 1,004,400 |
| | 18.8.2 | 20 mm nominal outer dia .Pipes. | Metre | 296.40 | 2252 | 667,493 |
| | 18.8.3 | 25 mm nominal outer dia.Pipes | Metre | 351.30 | 1107 | 388,889 |
| | 18.8.4 | 32 mm nominal outer dia .Pipes. | Metre | 422.40 | 229 | 96,730 |
| | | Note: All CPVC pipes shall be of SDR 11 category. | | | | |
| 3.0 | 18.10 | Providing and fixing G.I. pipes complete with G.I. fittings and clamps, including cutting and making good the walls etc. | | | | |
| | | Internal work - Exposed on wall | | | | |
| | 18.10.1 | 15 mm dia nominal bore | Metre | 215.10 | 130 | 27,963 |
| | 18.10.2 | 20 mm dia nominal bore | Metre | 249.30 | 190 | 47,367 |
| | 18.10.3 | 25 mm dia nominal bore | Metre | 304.15 | 260 | 79,079 |
| | 18.10.4 | 32 mm dia nominal bore | Metre | 343.20 | 210 | 72,072 |
| | 18.10.5 | 40 mm dia nominal bore | Metre | 425.65 | 195 | 83,002 |
| | 18.10.6 | 50 mm dia nominal bore | Metre | 527.20 | 180 | 94,896 |
| | | | | | | |
| 4.0 | 18.11 | Providing and fixing G.I. Pipes complete with G.I. fittings and clamps, i/c making good the walls etc. concealed pipe, including painting with anti corrosive bitumastic paint, cutting chases and making good the wall : | | | | |
| | 18.11.1 | 15 mm dia nominal bore | Metre | 306.05 | 280 | 85,694 |
| | 18.11.2 | 20 mm dia nominal bore | Metre | 333.85 | 140 | 46,739 |
| | | | | | | |
| 5.0 | 18.13 | Making connection of G.I./DI distribution branch with DI/G.I. main of following sizes by providing and fixing tee, including cutting and threading the pipe etc. complete : | | | | |
| | 18.13.1 | 25 to 40 mm nominal bore | Each | 367.75 | 14 | 5,149 |
| | 18.13.2 | 50 to 80 mm nominal bore | Each | 761.10 | 14 | 10,655 |
| | | | | | | |
| 6.0 | 18.38 | Painting G.I. pipes and fittings with synthetic enamel white paint with two coats over a ready mixed priming coat, both of approved quality for new work : | | | | |
| | 18.38.1 | 15 mm dia nominal bore | Metre | 9.60 | 130 | 1,248 |

| PHE WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| | 18.38.2 | 20 mm dia nominal bore | Metre | 11.35 | 190 | 2,157 |
| | 18.38.3 | 25 mm dia nominal bore | Metre | 14.95 | 260 | 3,887 |
| | 18.38.4 | 32 mm dia nominal bore | Metre | 17.70 | 210 | 3,717 |
| | 18.38.5 | 40 mm dia nominal bore | Metre | 21.00 | 195 | 4,095 |
| | 18.38.6 | 50 mm dia nominal bore | Metre | 24.75 | 180 | 4,455 |
| | | | | | | |
| 7.0 | 18.46 | Providing and fixing G.I. Union in G.I. pipe including cutting and threading the pipe and making long screws etc. complete (New work) : | | | | |
| | 18.46.1 | 15 mm nominal bore | Each | 165.25 | 35 | 5,784 |
| | 18.46.2 | 20 mm nominal bore | Each | 188.50 | 70 | 13,195 |
| | 18.46.3 | 25 mm nominal bore | Each | 200.10 | 70 | 14,007 |
| | 18.46.4 | 32 mm nominal bore | Each | 240.75 | 70 | 16,853 |
| | 18.46.5 | 40 mm nominal bore | Each | 316.25 | 35 | 11,069 |
| | 18.46.6 | 50 mm diameter pipe | Each | 392.40 | 35 | 13,734 |
| | 18.46.7 | 65 mm diameter pipe | Each | 636.30 | 35 | 22,271 |
| | 18.46.8 | 80 mm diameter pipe | Each | 729.25 | 35 | 25,524 |
| | | | | | | |
| 8.0 | DSR E&M 16.11 | Supplying, fixing, testing and commissioning of following size valves, gauges and strainers for condenser water circulation as per specifications. | | | | |
| 9.0 | 16.11.1 | BUTTERFLY VALVE (MANUAL) with C I body SS disc nitrile sheet & O-ring & PN 16 pressure rating as specified. | | | | |
| | 16.11.1.4 | 100 mm dia. | Each | 4,645.00 | 65 | 301,925 |
| | 16.11.1.5 | 80 mm dia. | Each | 3,256.00 | 65 | 211,640 |
| | 16.11.1.6 | 65 mm dia. | Each | 2,921.00 | 77 | 224,917 |
| | 16.11.1.7 | 50 mm dia. | Each | 2,634.00 | 87 | 229,158 |
| | 16.11.1.8 | 40 mm dia. | Each | 2,329.00 | 110 | 256,190 |
| | | | | | | |
| 10.0 | DSR E&M 16.8 | Providing and fixing in position the industrial type pressure gauges with gun metal/ brass valves complete as required. | Each | 958.00 | 370 | 354,460 |
| | | | | | | |
| 11.0 | 18.17 | Providing & fixing gun metal gate valve with C.I wheel of approved quality ( screwed end ) : | | | | |
| | 18.17.1 | 25 mm nominal bore | Each | 428.85 | 130 | 55,751 |
| | 18.17.2 | 32 mm nominal bore | Each | 501.50 | 190 | 95,285 |
| | 18.17.3 | 40 mm nominal bore | Each | 585.50 | 70 | 40,985 |
| | 18.17.4 | 50mm nominal bore | Each | 750.75 | 70 | 52,553 |
| | 18.17.5 | 65 mm nominal bore | Each | 1,287.75 | 70 | 90,143 |
| | 18.17.6 | 80 mm nominal bore | Each | 1,920.60 | 65 | 124,839 |
| | | | | | | |
| 12.0 | 18.19 | Providing and fixing gun metal Non-return valve of approved quality (screwed end) : | | | | |
| | 18.19.1.1 | Horizontal. 25 mm Nominal bore | Each | 411.25 | 65 | 26,731 |
| | 18.19.2.1 | Horizontal. 32 mm Nominal bore | Each | 553.30 | 65 | 35,965 |
| | 18.19.3.1 | Horizontal. 40 mm Nominal bore | Each | 683.75 | 65 | 44,444 |
| | 18.19.4.1 | Horizontal. 50 mm Nominal bore | Each | 988.70 | 65 | 64,266 |
| | 18.19.5.1 | Horizontal. 65 mm Nominal bore | Each | 1,769.60 | 35 | 61,936 |
| | 18.19.6.1 | Horizontal. 80 mm Nominal bore | Each | 3,398.65 | 35 | 118,953 |
| | | | | | | |

| PHE WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| 13.0 | 12.37 | Providing and fixing 100 mm diameter and 60 cm long rain water spout in cement mortar 1:4 (1 cement : 4 fine sand). | | | | |
| | 12.37.1 | Stone ware spout | Each | 87.00 | 65 | 5,655 |
| | | | | | | |
| 14.0 | 18.48 | Providing and placing on terrace (at all floor levels) polyethylene water storage tank, ISI : 12701 marked, with cover and suitable locking arrangement and making necessary holes for inlet, outlet and overflow pipes but without fittings and the base support for tank. | per litre | 7.25 | 28000 | 203,000 |
| | | | | | | |
| 15.0 | 18.77 | Cutting holes up to 15x15 cm in R.C.C. floors and roofs for passing drain pipe etc. and repairing the hole after insertion of drain pipe etc. with cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size), including finishing complete so as to make it leak proof. | Each | 193.00 | 1600 | 308,800 |
| | | | | | | |
| | | **TOTAL FOR SUBHEAD (C) CARRIED OVER TO SUMMARY** | | | | **8,662,877** |
| | | | | | | |
| | | **EXTERNAL WORKS** | | | | |
| **D.** | | **WATER-SUPPLY (EXTERNAL)** | | | | |
| | | | | | | |
| 1.0 | 2.10 | Excavating trenches of required width for pipes, cables, etc including excavation for sockets, and dressing of sides, ramming of bottoms, depth upto 1.5 m, including getting out the excavated soil, and then returning the soil as required, in layers not exceeding 20 cm in depth, including consolidating each deposited layer by ramming, watering, etc. and disposing of surplus excavated soil as directed, within a lead of 50 m : | | | | |
| (i) | 2.10.1 | **All kinds of soil** | | | | |
| (a) | 2.10.1.1 | Pipes, cables etc. not exceeding 80 mm dia | Metre | 127.55 | 440 | 56,122 |
| (b) | 2.10.1.2 | Pipes, cables etc. exceeding 80 mm dia. but not exceeding 300 mm dia | Metre | 208.30 | 3400 | 708,220 |
| | | | | | | |
| 2.0 | 2.13 | Excavating trenches of required width for pipes, cables, etc, including excavation for sockets, depth upto 1.5 m, including getting out the excavated materials, returning the soil as required in layers not exceeding 20 cm in depth, including consolidating each deposited layers by ramming, watering etc., stacking serviceable material for measurements and disposal of unserviceable material as directed, within a lead of 50 m : | | | | |
| (i) | 2.13.1 | **Ordinary rock :** | | | | |
| (a) | 2.13.1.1 | Pipes, cables etc. not exceeding 80 mm dia | Metre | 181.85 | 210 | 38,189 |
| (b) | 2.13.1.2 | Pipes, cables etc. exceeding 80 mm dia but not exceeding 300 mm dia | Metre | 450.30 | 2230 | 1,004,169 |

| PHE WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| (ii) | 2.13.3 | **Hard rock (blasting prohibited):** | | | | |
| (a) | 2.13.3.1 | Pipes, cables etc. not exceeding 80 mm dia | Metre | 351.65 | 160 | 56,264 |
| (b) | 2.13.3.2 | Pipes, cables etc. exceeding 80 mm dia but not exceeding 300 mm dia | Metre | 870.70 | 1200 | 1,044,840 |
| | | | | | | |
| 3.0 | 2.27 | Supplying and filling in plinth with Jamuna sand under floors, including watering, ramming, consolidating and dressing complete. | cum | 910.25 | 200 | 182,050 |
| | | | | | | |
| 4.0 | 18.41 | Providing and filling sand of grading zone V or coarser grade, allround the G.I./D.I./HDPE pipes in external work : | | | | |
| | 18.41.3 | 25 mm diameter pipe | Metre | 69.05 | 10 | 691 |
| | 18.41.4 | 32 mm diameter pipe | Metre | 70.85 | 10 | 709 |
| | 18.41.5 | 40 mm diameter pipe | Metre | 71.75 | 140 | 10,045 |
| | 18.41.6 | 50 mm diameter pipe | Metre | 74.45 | 110 | 8,190 |
| | 18.41.7 | 65 mm diameter pipe | Metre | 117.50 | 300 | 35,250 |
| | 18.41.8 | 80 mm diameter pipe | Metre | 121.10 | 240 | 29,064 |
| | 18.41.9 | 100 mm diameter pipe | Metre | 128.25 | 2950 | 378,338 |
| | 18.41.10 | 150 mm diameter pipe | Metre | 191.05 | 680 | 129,914 |
| | | | | | | |
| 5.0 | 18.72 | Providing and laying S&S Centrifugally Cast (Spun) / Ductile Iron Pipes conforming to IS : 8329 : | | | | |
| | 18.72.15 | 100 mm dia Ductile Iron Class K-9 pipes | Metre | 1,130.55 | 850 | 960,968 |
| | 18.72.16 | 150 mm dia Ductile Iron Class K-9 pipes | Metre | 1,434.40 | 900 | 1,290,960 |
| | 18.72.17 | 200 mm dia Ductile Iron Class K-9 pipes | Metre | 1,973.45 | 4500 | 8,880,525 |
| | | | | | | |
| 6.0 | 18.70 | Providing push-on-joints to Centrifugally (Spun) Cast Iron Pipes or Ductile Iron Pipes including testing of joints and the cost of rubber gasket : | | | | |
| | 18.70.1 | 100 mm dia pipes | joint | 61.85 | 380 | 23,503 |
| | 18.70.2 | 150 mm dia pipes | joint | 96.15 | 400 | 38,460 |
| | 18.70.3 | 200 mm dia pipes | joint | 146.00 | 1200 | 175,200 |
| | | | | | | |
| 7.0 | 18.73 | Providing and laying Double Flanged (Screwed / Welded) Centrifugally (Spun) Ductile Iron Pipes of Class K - 9 conforming to IS : 8329 : | | | | |
| | 18.73.1 | 100 mm dia Ductile Iron Double Flanged | metre | 2,564.75 | 100 | 256,475 |
| | 18.73.2 | 150 mm dia Ductile Iron Double Flanged | metre | 4,114.55 | 180 | 740,619 |
| | 18.73.3 | 200 mm dia Ductile Iron Double Flanged | metre | 4,841.85 | 400 | 1,936,740 |
| | | | | | | |
| 8.0 | 18.25 | Providing and laying S&S C.I./ D.I standard specials such as tees, bends, collars, tapers, caps etc. (Heavy class) : | | | | |
| | 18.25.1 | Up to 300 mm dia | Quintal | 4,447.80 | 10 | 44,478 |
| | | | | | | |
| 9.0 | 18.12 | Providing and fixing G.I. pipes complete with G.I. fittings including trenching and refilling etc. | | | | |
| | | **External work** | | | | |
| | 18.12.2 | 20 mm dia. nominal bore | Metre | 209.95 | 80 | 16,796 |
| | 18.12.3 | 25 mm dia. nominal bore | Metre | 257.30 | 120 | 30,876 |
| | 18.12.4 | 32 mm dia. nominal bore | Metre | 281.05 | 100 | 28,105 |

| PHE WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| | 18.12.5 | 40 mm dia. nominal bore | Metre | 334.15 | 150 | 50,123 |
| | 18.12.6 | 50 mm dia. nominal bore | Metre | 399.50 | 120 | 47,940 |
| | 18.12.7 | 65 mm dia. nominal bore | Metre | 524.25 | 400 | 209,700 |
| | 18.12.8 | 80 mm dia. nominal bore | Metre | 637.05 | 680 | 433,194 |
| | | | | | | |
| 10.0 | 18.40 | Painting G.I. pipes and fittings with two coats of anti-corrosive bitumastic paint of approved quality : | | | | |
| | 18.40.2 | 20 mm dia. nominal bore | Metre | 6.85 | 80 | 548 |
| | 18.40.3 | 25 mm dia. nominal bore | Metre | 8.75 | 120 | 1,050 |
| | 18.40.4 | 32 mm dia. nominal bore | Metre | 10.40 | 100 | 1,040 |
| | 18.40.5 | 40 mm dia. nominal bore | Metre | 11.85 | 150 | 1,778 |
| | 18.40.6 | 50 mm dia. nominal bore | Metre | 14.15 | 120 | 1,698 |
| | 18.40.7 | 65 mm dia. nominal bore | Metre | 17.45 | 400 | 6,980 |
| | 18.40.8 | 80 mm dia. nominal bore | Metre | 20.25 | 680 | 13,770 |
| | | | | | | |
| 11.0 | 18.46 | Providing and fixing G.I. Union in G.I. pipe including cutting and threading the pipe and making long screws etc. complete (New work) : | | | | |
| | 18.46.2 | 20 mm dia. nominal bore | Metre | 188.50 | 10 | 1,885 |
| | 18.46.3 | 25 mm dia. nominal bore | Metre | 200.10 | 12 | 2,401 |
| | 18.46.4 | 32 mm dia. nominal bore | Metre | 240.75 | 10 | 2,408 |
| | 18.46.5 | 40 mm dia. nominal bore | Metre | 316.25 | 10 | 3,163 |
| | 18.46.6 | 50 mm dia. nominal bore | Metre | 392.40 | 10 | 3,924 |
| | 18.46.7 | 65 mm dia. nominal bore | Metre | 636.30 | 20 | 12,726 |
| | 18.46.8 | 80 mm dia. nominal bore | Metre | 729.25 | 40 | 29,170 |
| | | | | | | |
| 12.0 | 18.14 | Fixing water meter and stop cock in G.I./DI/HDPE pipe line including cutting and threading the pipe and making long screws etc. complete (cost of water meter and stop cock to be paid separately). | Each | 315.50 | 26 | 8,203 |
| | | | | | | |
| 13.0 | 4.2 | Providing and laying cement concrete in retaining walls, return walls, walls (any thickness) including attached pilasters, columns, piers, abutments, pillars, posts, struts, buttresses, string or lacing courses, parapets, coping, bed blocks, anchor blocks, plain window sills, fillets, sunken floor,etc., up to floor five level, excluding the cost of centering, shuttering and finishing: | | | | |
| | 4.2.6 | 1:3:6 (1 cement : 3 coarse sand : 6 graded stone aggregate 40 mm nominal size) | Cum | 5,656.20 | 40 | 226,248 |
| | | | | | | |
| 14.0 | 19.35 | Providing laying and lowering Non Pressure NP-3 class (Medium duty) R.C.C. pipes including collars/spigot jointed with stiff mixture of cement mortar in the proportion of 1:2 (1 cement : 2 fine sand) including testing of joints etc. Complete | | | | |
| | 19.35.1 | 450 mm dia RCC pipes. | metre | 1,920.50 | 50 | 96,025 |
| | 19.35.2 | 600 mm dia RCC pipes. | metre | 2,504.60 | 50 | 125,230 |
| | | | | | | |
| 15.0 | 18.17 | Providing and fixing gun metal gate valve with C.I. wheel of approved quality (screwed end) : | | | | |
| | 18.17.1 | 25 mm nominal bore | Each | 428.85 | 20 | 8,577 |

| PHE WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| | 18.17.2 | 32 mm nominal bore | Each | 501.50 | 30 | 15,045 |
| | 18.17.3 | 40 mm nominal bore | Each | 585.50 | 25 | 14,638 |
| | 18.17.4 | 50 mm nominal bore | Each | 750.75 | 30 | 22,523 |
| | 18.17.5 | 65 mm nominal bore | Each | 1,287.75 | 30 | 38,633 |
| | 18.17.6 | 80 mm nominal bore | Each | 1,920.60 | 20 | 38,412 |
| | | | | | | |
| 16.0 | 18.18 | Providing and fixing ball valve (brass) of approved quality, High or low pressure, with plastic floats complete : | | | | |
| | 18.18.1 | 15 mm nominal bore | Each | 288.50 | 5 | 1,443 |
| | 18.18.2 | 20 mm nominal bore | Each | 409.90 | 5 | 2,050 |
| | 18.18.3 | 25 mm nominal bore | Each | 449.95 | 5 | 2,250 |
| | | | | | | |
| 17.0 | 18.31 | Providing and fixing C.I. sluice valves (with cap) complete with bolts,nuts, rubber insertions etc. (the tail pieces if required will be paid separately) : | | | | |
| | 18.31.1 | 100 mm dia | | | | |
| | 18.31.1.2 | Class II | Each | 3,921.30 | 24 | 94,111 |
| | 18.31.3 | 150 mm dia | | | | |
| | 18.31.3.2 | Class II | Each | 5,694.00 | 22 | 125,268 |
| | 18.31.4 | 200 mm dia | | | | |
| | 18.31.4.2 | Class II | Each | 11,579.00 | 22 | 254,738 |
| | | | | | | |
| 18.0 | 18.59 | Providing and fixing C.I. double acting air valve of approved quality with bolts, nuts, rubber insertions etc. complete (The tail pieces, tapers etc if required will be paid separately) : | | | | |
| | 18.59.1 | 50 mm dia | Each | 4,778.30 | 4 | 19,113 |
| | 18.59.2 | 80 mm dia | Each | 6,172.10 | 4 | 24,688 |
| | | | | | | |
| 19.0 | 18.60 | Providing and fixing enclosed type water meter (bulk type) conforming to IS : 2373 and tested by Municipal Board complete with bolts, nuts, rubber insertions etc. (The tail pieces if required will be paid separately) : | | | | |
| | 18.60.1 | 80 mm dia nominal bore | Each | 3,114.85 | 2 | 6,230 |
| | 18.60.2 | 100 mm dia nominal bore | Each | 4,654.40 | 2 | 9,309 |
| | 18.60.3 | 150 mm dia nominal bore | Each | 6,814.15 | 2 | 13,628 |
| | 18.60.4 | 200 mm dia nominal bore | Each | 7,397.85 | 2 | 14,796 |
| | | | | | | |
| 20.0 | 18.61 | Providing and fixing C.I. dirt box strainer for bulk type water meter with nuts, bolts, rubber insertions etc. complete conforming to IS : 2373 : | | | | |
| | 18.61.1 | 80 mm dia | Each | 3,635.90 | 2 | 7,272 |
| | 18.61.2 | 100 mm dia | Each | 5,872.35 | 2 | 11,745 |
| | 18.61.3 | 150 mm dia | Each | 7,432.45 | 2 | 14,865 |
| | 18.61.4 | 200 mm dia | Each | 10,385.60 | 2 | 20,771 |
| | | | | | | |
| 21.0 | DSR E&M 16.11 | Supplying, fixing, testing and commissioning of following size valves, gauges and strainers for condenser water circulation as per specifications. | | | | |
| | 16.11.1 | BUTTERFLY VALVE (MANUAL) with C I body SS disc nitrile sheet & O-ring & PN 16 pressure rating as specified. | | | | |

| PHE WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| | 16.11.1.1 | 200 mm dia. | Each | 10,199.00 | 6 | 61,194 |
| | 16.11.1.2 | 150 mm dia. | Each | 5,845.00 | 6 | 35,070 |
| | 16.11.1.4 | 100 mm dia. | Each | 4,615.00 | 6 | 27,690 |
| | 16.11.1.5 | 80 mm dia. | Each | 3,256.00 | 4 | 13,024 |
| | 16.11.1.6 | 65 mm dia. | Each | 2,921.00 | 4 | 11,684 |
| | 16.11.1.7 | 50 mm dia. | Each | 2,634.00 | 4 | 10,536 |
| | 16.11.1.8 | 40 mm dia. | Each | 2,329.00 | 12 | 27,948 |
| | | | | | | |
| 22.0 | DSR E&M 16.8 | Providing and fixing in position the industrial type pressure gauges with gun metal/ brass valves complete as required. | Each | 958.00 | 850 | 814,300 |
| | | | | | | |
| 23.0 | 18.80 | Disinfecting C.I. / G.I./ D.I./ HDPE water mains by flushing with water containing bleaching powder @ 0.5 gms per litre of water and cleaning the same with fresh water, operation to be repeated three times including getting the sample of water from the disinfected main tested in the municipal laboratory. | | | | |
| | | | | | | |
| | 18.80.1 | 80 mm diameter | 100 metre | 704.00 | 4 | 2,816 |
| | 18.80.2 | 100 mm diameter | 100 metre | 926.60 | 12 | 11,119 |
| | 18.80.4 | 150 mm diameter | 100 metre | 1,395.40 | 12 | 16,745 |
| | 18.80.5 | 200 mm diameter | 100 metre | 1,868.90 | 42 | 78,494 |
| | | | | | | |
| 24.0 | 18.33 | Constructing masonry Chamber 60x60x75 cm inside, in brick work in cement mortar 1:4 (1 cement : 4 coarse sand) for sluice valve, with C.I. surface box 100mm top diameter, 160 mm bottom diameter and 180 mm deep ( inside) with chained lid and RCC top slab 1:2:4 mix (1 cement : 2 coarse sand : 4 graded stone aggregate 20mm nominal size ) , i/c necessary excavation, foundation concrete 1:5:10 (1 cement : 5 fine sand : 10 graded stone aggregate 40 mm nominal size) and inside plastering with cement mortar 1:3 (1 cement : 3 coarse sand) 12 mm thick, finished with a floating coat of neat cement complete as per standard design : | | | | |
| | 18.33.1 | With common burnt clay F.P.S.(non modular) bricks of class designation 7.5 | Each | 6,754.30 | 6 | 40,526 |
| | | | | | | |

| PHE WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| 25.0 | 18.34 | Constructing masonry Chamber 90x90x100 cm inside, in brick work in cement mortar 1:4 (1 cement : 4 coarse sand) for sluice valve, with C.I. surface box 100 mm top diameter, 160 mm bottom diameter and 180 mm deep (inside) with chained lid and RCC top slab 1:2:4 mix (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size ), i/c necessary excavation, foundation concrete 1:5:10 (1 cement : 5 fine sand : 10 graded stone aggregate 40 mm nominal size ) and inside plastering with cement mortar 1:3 (1 cement : 3 coarse sand) 12 mm thick, finished with a floating coat of neat cement complete as per standard design : | | | | |
| | 18.34.1 | With common burnt clay F.P.S.(non modular) bricks of class designation 7.5 | Each | 11,672.35 | 24 | 280,136 |
| | | | | | | |
| 26.0 | 18.35 | Constructing masonry Chamber 120x120x100 cm inside, in brick work in cement mortar 1:4 (1 cement : 4 coarse sand) for sluice valve, with C.I. surface box 100 mm top diameter, 160 mm bottom diameter and 180 mm deep ( inside) with chained lid and RCC top slab 1:2:4 mix (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) , i/c necessary excavation, foundation concrete 1:5:10 (1 cement : 5 fine sand : 10 graded stone aggregate 40 mm nominal size) and inside plastering with cement mortar 1:3 (1 cement : 3 coarse sand) 12 mm thick, finished with a floating coat of neat cement complete as per standard design : | | | | |
| | 18.35.1 | With common burnt clay F.P.S.(non modular) bricks of class designation 7.5 | Each | 16,095.10 | 26 | 418,473 |
| | | | | | | |
| 27.0 | 13.9 | Cement plaster 1:3 (1 cement: 3 coarse sand) finished with a floating coat of neat cement | | | | |
| | 13.9.1 | 12 mm cement plaster | sqm | 226.10 | 1200 | 271,320 |
| | | | | | | |
| | | **TOTAL FOR HEAD (D) CARRIED OVER TO SUMMARY** | | | | **22,266,136** |
| | | | | | | |
| **E.** | | **EXTERNAL SEWERAGE SYSTEM** | | | | |
| | | | | | | |
| 1.0 | 2.10 | Excavating trenches of required width for pipes, cables, etc including excavation for sockets, and dressing of sides, ramming of bottoms, depth upto 1.5 m, including getting out the excavated soil, and then returning the soil as required, in layers not exceeding 20 cm in depth, including consolidating each deposited layer by ramming, watering, etc. and disposing of surplus excavated soil as directed, within a lead of 50 m : | | | | |
| | 2.10.1 | **All kinds of soil** | | | | |
| | 2.10.1.1 | Pipes, cables etc, not exceeding 80 mm dia. | Metre | 127.55 | 180 | 22,959 |

| PHE WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| | 2.10.1.2 | Pipes, cables etc. exceeding 80 mm dia. but not exceeding 300 mm dia | Metre | 208.30 | 1800 | 374,940 |
| | | | | | | |
| 2.0 | 2.11 | Extra for excavating trenches for pipes, cables etc. in all kinds of soil for depth exceeding 1.5 m, but not exceeding 3 m. (Rate is over corresponding basic item for depth upto 1.5 metre). | | | | |
| | 2.11.1 | **All kinds of soil** | | | | |
| | 2.11.1.2 | Pipes, cables etc. exceeding 80 mm dia. but not exceeding 300 mm dia | Metre | 283.28 | 940 | 266,283 |
| | | | | | | |
| 3.0 | 2.12 | Extra for excavating trenches for pipes, cables, etc. in all kinds of soil exceeding 3m in depth but not exceeding 4.5 m. (Rate is over corresponding basic item for depth upto 1.5 metre). | | | | |
| | 2.12.1 | **All kinds of soil** | | | | |
| | 2.12.1.2 | Pipes, cables etc. exceeding 80 mm dia. but not exceeding 300 mm dia | Metre | 726.96 | 400 | 290,784 |
| | | | | | | |
| 4.0 | 2.13 | Excavating trenches of required width for pipes, cables, etc, including excavation for sockets, depth upto 1.5 m, including getting out the excavated materials, returning the soil as required in layers not exceeding 20 cm in depth, including consolidating each deposited layers by ramming, watering etc., stacking serviceable material for measurements and disposal of unserviceable material as directed, within a lead of 50 m : | | | | |
| | 2.13.1 | **Ordinary rock :** | | | | |
| | 2.13.1.2 | Pipes, cables etc. exceeding 80 mm dia but not exceeding 300 mm dia | Metre | 450.30 | 900 | 405,270 |
| | 2.13.3 | **Hard rock (blasting prohibited):** | | | | |
| | 2.13.3.2 | Pipes, cables etc. exceeding 80 mm dia but not exceeding 300 mm dia | Metre | 870.70 | 500 | 435,350 |
| | | | | | | |
| 5.0 | 2.14 | Extra for excavating trenches for pipes, cables, etc. in ordinary/hard rock exceeding 1.5 m in depth but not exceeding 3 m. (Rate is over corresponding basic item for depth upto 1.5 metre). | | | | |
| | 2.14.1 | **Ordinary rock :** | | | | |
| | 2.14.1.2 | Pipes, cables etc. exceeding 80 mm dia. but not exceeding 300 mm dia | Metre | 477.31 | 600 | 286,386 |
| | 2.14.3 | **Hard rock (blasting prohibited):** | | | | |
| | 2.14.3.2 | Pipes, cables etc. exceeding 80 mm dia but not exceeding 300 mm dia | Metre | 922.94 | 400 | 369,176 |
| | | | | | | |
| 6.0 | 2.15 | Extra for excavating trenches for pipes, cables, etc. in ordinary/hard rock exceeding 3m in depth but not exceeding 4.5 m. (Rate is over corresponding basic item for depth upto 1.5 metre). | | | | |

| PHE WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| | 2.15.1 | **Ordinary rock :** | | | | |
| | 2.15.1.2 | Pipes, cables etc. exceeding 80 mm dia. but not exceeding 300 mm dia | Metre | 1,188.79 | 400 | 475,516 |
| | 2.15.1 | **Hard rock (blasting prohibited):** | | | | |
| | 2.15.1.2 | Pipes, cables etc. exceeding 80 mm dia. but not exceeding 300 mm dia | Metre | 2,298.64 | 280 | 643,619 |
| | | | | | | |
| 7.0 | 2.6 | Earth work in excavation by mechanical means (Hydraulic excavator) / manual means over areas (exceeding 30cm in depth. 1.5 m in width as well as 10 sqm on plan) including disposal of excavated earth, lead upto 50m and lift upto 1.5m, disposed earth to be levelled and neatly dressed. | | | | |
| | 2.6.1 | All kinds of soil | cum | 155.60 | 2400 | 373,440 |
| | | | | | | |
| 8.0 | 2.7 | Earth work in excavation by mechanical means (Hydraulic excavator) / manual means over areas (exceeding 30 cm in depth, 1.5 m in width as well as 10 sqm on plan) including disposal of excavated earth, lead upto 50 m and lift upto 1.5 m, disposed earth to be levelled and neatly dressed. | | | | |
| | 2.7.1 | Ordinary rock | cum | 244.60 | 800 | 195,680 |
| | 2.7.3 | Hard rock (blasting prohibited) | cum | 618.10 | 550 | 339,955 |
| | | | | | | |
| 9.0 | 2.25 | Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and lift upto 1.5 m. | cum | 112.40 | 1200 | 134,880 |
| | | | | | | |
| 10.0 | 2.26 | Extra for every additional lift of 1.5 m or part thereof in excavation / banking excavated or stacked materials. | | | | |
| | 2.26.1 | All kinds of soil | cum | 46.25 | 1800 | 83,250 |
| | 2.26.2 | Ordinary or hard rock | cum | 82.95 | 800 | 66,360 |
| | | | | | | |
| 11.0 | 13.9 | Cement plaster 1:3 (1 cement: 3 coarse sand) finished with a floating coat of neat cement | | | | |
| | 13.9.1 | 12 mm cement plaster | sqm | 226.10 | 4500 | 1,017,450 |
| | | | | | | |
| 12.0 | 19.1 | Providing, laying and jointing glazed stoneware pipes class SP-1 with stiff mixture of cement mortar in the proportion of 1:1 (1 cement : 1 fine sand) including testing of joints etc. complete : | | | | |
| | 19.1.1 | 100 mm diameter | Metre | 206.55 | 150 | 30,983 |
| | 19.1.2 | 150 mm diameter | Metre | 314.35 | 200 | 62,870 |
| | 19.1.3 | 200 mm diameter | Metre | 462.15 | 3800 | 1,756,170 |
| | 19.1.4 | 250 mm diameter | Metre | 696.50 | 580 | 403,970 |
| | 19.1.5 | 300 mm diameter | Metre | 770.40 | 100 | 77,040 |
| | | | | | | |

| PHE WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| 13.0 | 19.2 | Providing and laying cement concrete 1:5:10 (1 cement : 5 coarse sand : 10 graded stone aggregate 40 mm nominal size) all-round S.W. pipes including bed concrete as per standard design: | | | | |
| | 19.2.1 | 100 mm diameter | Metre | 592.60 | 100 | 59,260 |
| | 19.2.2 | 150 mm diameter | Metre | 724.70 | 150 | 108,705 |
| | 19.2.3 | 200 mm diameter | Metre | 844.85 | 3000 | 2,534,550 |
| | 19.2.4 | 250 mm diameter | Metre | 977.00 | 280 | 273,560 |
| | | | | | | |
| 14.0 | 19.3 | Providing and laying cement concrete 1:5:10 (1 cement : 5 coarse sand : 10 graded stone aggregate 40 mm nominal size) up to haunches of S.W. pipes including bed concrete as per standard design : | | | | |
| | 19.3.1 | 100 mm diameter S.W. pipe | Metre | 281.65 | 50 | 14,083 |
| | 19.3.2 | 150 mm diameter S.W. pipe | Metre | 456.45 | 50 | 22,823 |
| | 19.3.3 | 200 mm diameter S.W. pipe | Metre | 536.55 | 800 | 429,240 |
| | 19.3.4 | 250 mm diameter S.W. pipe | Metre | 624.60 | 300 | 187,380 |
| | 19.3.5 | 300 mm diameter S.W. pipe | Metre | 720.70 | 100 | 72,070 |
| | | | | | | |
| 15.0 | 4.2 | Providing and laying cement concrete in retaining walls, return walls, walls (any thickness) including attached pilasters, columns, piers, abutments, pillars, posts, struts, buttresses, string or lacing courses, parapets, coping, bed blocks, anchor blocks, plain window sills, fillets, sunken floor,etc., up to floor five level, excluding the cost of centering, shuttering and finishing: | | | | |
| | 4.2.6 | 1:3:6 (1 cement : 3 coarse sand : 6 graded stone aggregate 40 mm nominal size) | Cum | 5,656.20 | 80 | 452,496 |
| | | | | | | |
| 16.0 | 19.4 | Providing and fixing square-mouth S.W. gully trap grade 'A'' S.P.-1 complete with C.I. grating brick masonry chamber with water tight C.I. cover with frame of 300 x300 mm size (inside) the weight of cover to be not less than 4.50 kg and frame to be not less than 2.70 kg as per standard design : | | | | |
| | 19.4.1 | 100 x 100 mm size P type | | | | |
| | 19.4.1.1 | With common burnt clay FPS(non-modular) bricks of class designation 7.5. | Each | 1,571.25 | 50 | 78,563 |
| | 19.4.2 | 150 x 100 mm size P type | | | | |
| | 19.4.2.1 | With common burnt clay FPS(non-modular) bricks of class designation 7.5. | Each | 1,594.35 | 60 | 95,661 |
| | 19.4.3 | 180x150 mm size P type | | | | |
| | 19.4.3.1 | 19.4.3.1 With common burnt clay F.P.S. (non modular) bricks of class designation 7.5 | Each | 1,678.85 | 40 | 67,154 |
| | | | | | | |

| PHE WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| 17.0 | 19.30 | Constructing brick masonry chamber for underground C.I. inspection chamber and bends with bricks in cement mortar 1:4 (1 cement : 4 coarse sand) C.I. cover with frame (light duty) 455x610 mm internal dimensions, total weight of cover with frame to be not less than 38 kg (weight of cover 23 kg and weight of frame 15 kg), R.C.C. top slab with 1:2:4 mix (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size), foundation concrete 1:5:10 (1 cement : 5 fine sand : 10 graded stone aggregate 40 mm nominal size), inside plastering 12 mm thick with cement mortar 1:3 (1 cement : 3 coarse sand), finished smooth with a floating coat of neat cement on walls and bed concrete etc. complete as per standard design : | | | | |
| | 19.30.1 | Inside dimensions 455x610 mm and 45 cm deep for single pipe line : | | | | |
| | 19.30.1.1 | With common burnt clay F.P.S. (non modular) bricks of class designation 7.5 | Each | 4,692.05 | 2 | 9,384 |
| | 19.30.2 | Inside dimensions 500x700 mm and 45 cm deep for pipe line with one or two inlets : | | | | |
| | 19.30.2.1 | With common burnt clay F.P.S. (non modular) bricks of class designation 7.5 | Each | 5,375.20 | 5 | 26,876 |
| | | | | | | |
| 18.0 | 19.7 | Constructing brick masonry manhole in cement mortar 1:4 ( 1 cement : 4 coarse sand ) with R.C.C. top slab with 1:2:4 mix (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm Nominal size), foundation concrete 1:4:8 mix (1 cement : 4 coarse sand : 8 graded stone aggregate 40mm Nominal size), inside plastering 12mm thick with cement mortar 1:3 (1 cement : 3 coarse sand) finished with floating coat of neat cement and making channels in cement concrete 1:2:4 (1cement : 2 coarse sand : 4 graded stone aggregate 20mm Nominal size) finished with a floating coat of neat cement complete as per standard design : | | | | |
| | 19.7.1 | Inside size 90x80 cm and 45 cm deep including C.I. cover with frame (light duty) 455x610 mm internal dimensions, total weight of cover and frame to be not less than 38 kg (weight of cover 23 kg and weight of frame 15 kg) : | | | | |
| | 19.7.1.1 | With FPS bricks of class designation 7.5 | Each | 8,507.00 | 80 | 680,560 |
| | | | | | | |
| 19.0 | 19.7.2 | Inside size 120 x 90 cm and 90 cm deep including C.I. cover with frame (medium duty) 500 mm internal diametre, total weight of cover and frame to be not less than 116 kg (weight of cover 58 kg and weight of frame 58 kg) : | | | | |
| | 19.7.2.1 | With FPS bricks of class designation 7.5 | Each | 18,304.45 | 30 | 549,134 |
| | | | | | | |

| PHE WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| 20.0 | 19.7.3 | Inside size 120x90 cm and 90 cm deep including C.I. cover with frame (heavy duty) 560 mm internal diameter, total weight of cover and frame to be not less than 208 kg (weight of cover 108 kg and weight of frame 100 kg) : | | | | |
| | 19.7.3.1 | With common burnt clay F.P.S. (non modular) bricks of class designation 7.5 | Each | 22,876.75 | 20 | 457,535 |
| | | | | | | |
| 21.0 | 19.8 | Extra for depth for manholes | | | | |
| | 19.8.1 | Size 90x80 cm | | | | |
| | 19.8.1.1 | With FPS bricks of class designation 7.5 | Metre | 5,638.20 | 2 | 11,276 |
| | 19.8.2 | Size 120 x 90 cm | | | | |
| | 19.8.2.1 | With FPS bricks of class designation 7.5 | Metre | 6,753.65 | 2 | 13,507 |
| | | | | | | |
| 22.0 | 19.9 | Constructing brick masonry circular type manhole 0.91m internal dia at bottom and 0.56m dia at top in cement mortar 1:4 (1 cement :4 coarse sand), in side cement plaster 12 mm thick with cement mortar 1:3 (1 cement : 3 coarse sand) finished with a floating coat of neat cement, foundation concrete 1:3:6 mix (1 cement : 3 coarse sand : 6 graded stone aggregate 40mm Nominal size), and making necessary channel in cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20mm Nominal size) finished with a floating coat of neat cement, all complete as per standard design : | | | | |
| | 19.9.1 | 0.91 m deep with S.F.R.C. cover and frame (heavy duty, HD-20 grade designation) 560mm internal diametre conforming to I.S. 12592, total weight of cover and frame to be not less than 182kg., fixed in cement concrete 1:2:4 (1 cement:2 coarse sand:4 graded stone aggregate 20 mm Nominal size) including centering, shuttering all complete. (Excavation, foot rests and 12mm thick cement plaster at the external surface shall be paid for separately): | | | | |
| | 19.9.1.1 | With FPS bricks of class designation 7.5 | Each | 8,738.55 | 60 | 524,313 |
| | | | | | | |
| 23.0 | 19.10 | Extra depth for circular type manhole 0.91m internal dia (at bottom) beyond 0.91m to 1.67m | | | | |
| | 19.10.1 | With FPS bricks of class designation 7.5 | Metre | 4,842.40 | 2 | 9,685 |
| | | | | | | |

| PHE WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| 24.0 | 19.11 | Constructing brick masonry circular manhole 1.22 m internal dia at bottom and 0.56 m dia at top in cement mortar 1:4 (1 cement :4 coarse sand) inside cement plaster 12 mm thick with cement mortar 1:3 (1 cement : 3 coarse sand) finished with a floating coat of neat cement foundation concrete 1:3:6 (1 cement : 3 coarse sand : 6 graded stone aggregate 40 mm nominal size) and making necessary channel in cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) finished with a floating coat of neat cement, all complete as per standard design : | | | | |
| | 19.11.1 | 1.68 m deep with SFRC Cover and frame (heavy duty HD-20 grade designation) 560 mm internal diameter conforming to I.S. 12592, total weight of cover and frame to be not less than 182 kg. fixed in cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) including centering, shuttering all complete. (Excavation, foot rests and 12 mm thick cement plaster at the external surface shall be paid for separately): | | | | |
| | 19.11.1.1 | With FPS bricks of class designation 7.5 | Each | 16,467.90 | 20 | 329,358 |
| | | | | | | |
| 25.0 | 19.12 | Extra depth for Circular type Manhole 1.22 m internal dia (at Bottom) beyond 1.68 to 2.29 m: | | | | |
| | 19.12.1 | With FPS bricks of class designation 7.5 | Metre | 6,270.70 | 2 | 12,541 |
| | | | | | | |
| 26.0 | 19.13 | Constructing brick masonry circular manhole 1.52 m internal dia at bottom and 0.56 m dia at top in cement mortar 1:4 (1 cement : 4 coarse sand) inside cement plaster 12 mm thick with cement mortar 1:3 (1 cement : 3 coarse sand) finished with a floating coat of neat cement, foundation concrete 1:3:6 (1 cement : 3 coarse sand : 6 graded stone aggregate 40 mm nominal size) and making necessary channel in cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) finished with a floating coat of neat cement, all complete as per standard design : | | | | |
| | | 2.30 m deep with SFRC Cover and frame (heavy duty HD-20 grade designation) 560 mm internal diameter conforming to I.S. 12592, total weight of cover and frame to be not less than 182 kg. fixed in cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) including centering, shuttering all complete. (Excavation, foot rests and 12 mm thick cement plaster at the external surface shall be paid for separately): | | | | |
| | 19.13.1.1 | With FPS bricks of class designation 7.5 | Each | 34,976.25 | 20 | 699,525 |
| | | | | | | |

| PHE WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| 27.0 | 19.14 | Extra depth for circular type manhole 1.52m internal dia (at bottom) Beyond 2.30m | | | | |
| | 19.14.1 | With FPS bricks of class designation 7.5 | Metre | 14,842.95 | 4 | 59,372 |
| | | | | | | |
| 28.0 | 19.16 | Providing orange colour safety foot rest of minimum 6 mm thick plastic encapsulated as per IS : 10910 on 12mm dia steel bar conforming to IS : 1786 having minimum cross section as 23 mmx25mm and over all minimum length 263 mm and width as 165mm with minimum 112 mm space between protruded legs having 2 mm tread on top surface by ribbing or chequering besides necessary and adequate anchoring projections on tail length on 138 mm as per standard drawing and suitable to with stand the bend test and chemical resistance test as per specifications and having manufacture's permanent identification mark to be visible even after fixing, including fixing in manholes with 30x20x15 cm cement concrete block 1:3:6 (1 cement : 3 coarse sand : 6 graded stone aggregate 20 mm nominal size) complete as per design. | Each | 311.60 | 1500 | 467,400 |
| | | | | | | |
| 29.0 | 19.33 | Constructing soak pit 1.20x1.20x1.20m filled with brickbats including S.W. drain pipe 100 mm diameter and 1.20 m long complete as per standard design. | Each | 2,082.45 | 1 | 2,082 |
| | | | | | | |
| 30.0 | 19.18 | Supplying and fixing C.I. cover without frame for manholes : | | | | |
| | 19.18.2 | 500 mm diameter C.I. cover (medium duty) the weight of the cover to be not less than 58 kg | Each | 2,745.15 | 10 | 27,452 |
| | 19.18.3 | 560 mm diameter C.I. cover (heavy duty) the weight of the cover to be not less than 108 kg | Each | 5,886.70 | 10 | 58,867 |
| | | | | | | |
| 31.0 | 19.19 | Providing and fixing in position pre-cast R.C.C. manhole cover and frame of required shape and approved quality 19.19.1 L D- 2.5 | | | | |
| | 19.19.1.1 | Rectangular shape 600x450 mm internal dimensions | Each | 1,131.70 | 10 | 11,317 |
| | 19.19.1.2 | Square shape 450 mm internal dimensions | Each | 960.90 | 10 | 9,609 |
| | 19.19.1.3 | Circular shape 450 mm internal diameter | Each | 902.80 | 10 | 9,028 |
| | 19.19.2 | M D - 10 | | | | |
| | 19.19.2.1 | Square shape 450 mm internal dimension | Each | 1,080.10 | 10 | 10,801 |
| | 19.19.2.2 | Circular shape 500 mm internal diameter | Each | 909.25 | 10 | 9,093 |
| | 19.19.3 | H D - 20 | | | | |
| | 19.19.3.1 | Circular shape 560 mm internal diameter | Each | 1,511.55 | 10 | 15,116 |
| | 19.19.4 | EHD - 35 | | | | |
| | 19.19.4.1 | Circular shape 560 mm internal dia | Each | 1,656.70 | 10 | 16,567 |
| | | | | | | |
| 32.0 | 19.20 | Supplying and fixing C.I. cover 300x300 mm without frame for gully trap (standard pattern) the weight of cover to be not less than 4.5 kg | Each | 278.40 | 10 | 2,784 |
| | | | | | | |

| PHE WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| 33.0 | 19.21 | Making connection of drain or sewer/storm line with existing manhole including breaking into and making good the walls, floors with cement concrete 1:2:4 mix (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) cement plastered on both sides with cement mortar 1:3 (1 cement : 3 coarse sand), finished with a floating coat of neat cement and making necessary channels for the drain etc. complete : | | | | |
| | | | | | | |
| | 19.21.1 | For pipes 100 to 250 mm diameter | Each | 364.60 | 8 | 2,917 |
| | 19.21.2 | For pipes 250 to 300 mm diameter | Each | 436.20 | 10 | 4,362 |
| | 19.21.3 | For pipes 350 to 450 mm diameter | Each | 636.40 | 5 | 3,182 |
| | | | | | | |
| 34.0 | 19.22 | Providing sand cast iron drop connection externally for 60 cm drop from branch sewer line to main sewer manhole including inspection and cleaning eye with chain and lid, sand cast iron drop pipe and bend encased allround with cement concrete 1:5:10 (1 cement : 5 fine sand : 10 graded stone aggregate 40 mm nominal size) with all centering and shuttering required, cutting holes in walls and making good with brick work in cement mortar 1:4 (1 cement : 4 coarse sand) plastered with cement mortar 1:3 (1 cement : 3 coarse sand) on inside of the manhole wall, lead caulked joints between sand cast iron pipes and fittings, stiff cement mortar 1:1 (1 cement : 1 fine sand) joints between sand cast iron tee and S.W. pipe, making required channels complete as per standard design and specifications : | | | | |
| | 19.22.1 | 100 mm dia sand cast iron drop connection | Each | 6,203.05 | 4 | 24,812 |
| | 19.22.2 | 150 mm dia sand cast iron drop connection | Each | 8,544.30 | 4 | 34,177 |
| | | | | | | |
| 35.0 | 19.23 | Extra for depths beyond 60 cm of sand cast iron drop connection complete: | | | | |
| | 19.23.1 | For 100 mm dia sand cast iron drop connection | Each | 1,903.05 | 4 | 7,612 |
| | 19.23.2 | For 150 mm dia sand cast iron drop connection | Each | 2,508.70 | 4 | 10,035 |
| | | | | | | |
| 36.0 | 7380 | Precast R.C.C. grating with frame 500x450 mm horizontal grating | Each | 650.00 | 10 | 6,500 |
| | | | | | | |
| 37.0 | 7381 | Precast R.C.C. grating with frame 450x100 mm vertical grating | Each | 325.00 | 10 | 3,250 |
| | | | | | | |
| | | **TOTAL FOR HEAD (E) CARRIED OVER TO SUMMARY** | | | | **16,627,903** |
| | | | | | | |
| **F.** | | **EXTERNAL STORM WATER DRAINAGE** | | | | |
| | | | | | | |

| PHE WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| 1.0 | 2.10 | Excavating trenches of required width for pipes, cables, etc including excavation for sockets, and dressing of sides, ramming of bottoms, depth upto 1.5 m, including getting out the excavated soil, and then returning the soil as required, in layers not exceeding 20 cm in depth, including consolidating each deposited layer by ramming, watering, etc. and disposing of surplus excavated soil as directed, within a lead of 50 m : | | | | |
| | 2.10.1 | **All kinds of soil** | | | | |
| | 2.10.1.1 | Pipes, cables etc, not exceeding 80 mm dia. | Metre | 127.55 | 280 | 35,714 |
| | 2.10.1.2 | Pipes, cables etc. exceeding 80 mm dia. but not exceeding 300 mm dia | Metre | 208.30 | 1800 | 374,940 |
| | 2.10.1.3 | Pipes, cables etc. exceeding 300 mm dia but not exceeding 600 mm | Metre | 325.20 | 260 | 84,552 |
| | | | | | | |
| 2.0 | 2.11 | Extra for excavating trenches for pipes, cables etc. in all kinds of soil for depth exceeding 1.5 m, but not exceeding 3 m. (Rate is over corresponding basic item for depth upto 1.5 metre). | | | | |
| | 2.11.1 | **All kinds of soil** | | | | |
| | 2.11.1.2 | Pipes, cables etc. exceeding 80 mm dia. but not exceeding 300 mm dia | Metre | 283.29 | 1200 | 339,946 |
| | 2.11.1.3 | Pipes, cables etc. exceeding 300 mm dia but not exceeding 600 mm | Metre | 442.27 | 390 | 172,486 |
| | | | | | | |
| 3.0 | 2.12 | Extra for excavating trenches for pipes, cables, etc. in all kinds of soil exceeding 3m in depth but not exceeding 4.5 m. (Rate is over corresponding basic item for depth upto 1.5 metre). | | | | |
| | 2.12.1 | **All kinds of soil** | | | | |
| | 2.12.1.2 | Pipes, cables etc. exceeding 80 mm dia. but not exceeding 300 mm dia | Metre | 726.97 | 600 | 436,180 |
| | 2.12.1.3 | Pipes, cables etc. exceeding 300 mm dia but not exceeding 600 mm | Metre | 1,134.95 | 400 | 453,979 |
| | | | | | | |
| 4.0 | 2.13 | Excavating trenches of required width for pipes, cables, etc, including excavation for sockets, depth upto 1.5 m, including getting out the excavated materials, returning the soil as required in layers not exceeding 20 cm in depth, including consolidating each deposited layers by ramming, watering etc., stacking serviceable material for measurements and disposal of unserviceable material as directed, within a lead of 50 m : | | | | |
| | 2.13.1 | **Ordinary rock :** | | | | |
| | 2.13.1.2 | Pipes, cables etc. exceeding 80 mm dia but not exceeding 300 mm dia | Metre | 450.30 | 580 | 261,174 |
| | 2.13.1.3 | Pipes, cables etc. exceeding 300 mm dia but not exceeding 600 mm | Metre | 518.15 | 200 | 103,630 |
| | 2.13.3 | **Hard rock (blasting prohibited):** | | | | |
| | 2.13.3.2 | Pipes, cables etc. exceeding 80 mm dia but not exceeding 300 mm dia | Metre | 870.70 | 400 | 348,280 |

| PHE WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| | 2.13.3.3 | Pipes, cables etc. exceeding 300 mm dia but not exceeding 600 mm | Metre | 1,001.90 | 150 | 150,285 |
| | | | | | | |
| 5.0 | 2.14 | Extra for excavating trenches for pipes, cables, etc. in ordinary/hard rock exceeding 1.5 m in depth but not exceeding 3 m. (Rate is over corresponding basic item for depth upto 1.5 metre). | | | | |
| | 2.14.1 | **Ordinary rock :** | | | | |
| | 2.14.1.2 | Pipes, cables etc. exceeding 80 mm dia. but not exceeding 300 mm dia | Metre | 477.32 | 390 | 186,154 |
| | 2.14.1.3 | Pipes, cables etc. exceeding 300 mm dia but not exceeding 600 mm | Metre | 549.24 | 250 | 137,310 |
| | | | | | | |
| | 2.14.3 | **Hard rock (blasting prohibited):** | | | | |
| | 2.14.3.2 | Pipes, cables etc. exceeding 80 mm dia but not exceeding 300 mm dia | Metre | 922.94 | 450 | 415,324 |
| | 2.14.3.3 | Pipes, cables etc. exceeding 300 mm dia but not exceeding 600 mm | Metre | 1,062.01 | 180 | 191,163 |
| | | | | | | |
| 6.0 | 2.15 | Extra for excavating trenches for pipes, cables, etc. in ordinary/hard rock exceeding 3m in depth but not exceeding 4.5 m. (Rate is over corresponding basic item for depth upto 1.5 metre). | | | | |
| | 2.15.1 | **Ordinary rock :** | | | | |
| | 2.15.1.2 | Pipes, cables etc. exceeding 80 mm dia. but not exceeding 300 mm dia | Metre | 1,188.79 | 460 | 546,844 |
| | 2.15.1.3 | Pipes, cables etc. exceeding 300 mm dia but not exceeding 600 mm | Metre | 1,367.92 | 170 | 232,546 |
| | | | | | | |
| | 2.15.1 | **Hard rock (blasting prohibited):** | | | | |
| | 2.15.1.2 | Pipes, cables etc. exceeding 80 mm dia. but not exceeding 300 mm dia | Metre | 2,298.65 | 300 | 689,594 |
| | 2.15.1.3 | Pipes, cables etc. exceeding 300 mm dia but not exceeding 600 mm | Metre | 2,645.02 | 150 | 396,752 |
| | | | | | | |
| 7.0 | 2.6 | Earth work in excavation by mechanical means (Hydraulic excavator) / manual means over areas (exceeding 30cm in depth. 1.5 m in width as well as 10 sqm on plan) including disposal of excavated earth, lead upto 50m and lift upto 1.5m, disposed earth to be levelled and neatly dressed. | | | | |
| | 2.6.1 | All kinds of soil | cum | 155.60 | 2800 | 435,680 |
| | | | | | | |
| 8.0 | 2.7 | Earth work in excavation by mechanical means (Hydraulic excavator) / manual means over areas (exceeding 30 cm in depth, 1.5 m in width as well as 10 sqm on plan) including disposal of excavated earth, lead upto 50 m and lift upto 1.5 m, disposed earth to be levelled and neatly dressed. | | | | |
| | | | | | | |
| | 2.7.1 | Ordinary rock | cum | 244.60 | 1200 | 293,520 |

| PHE WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| | 2.7.3 | Hard rock (blasting prohibited) | cum | 618.10 | 600 | 370,860 |
| | | | | | | |
| 9.0 | 2.8 | Earth work in excavation by mechanical means (Hydraulic excavator) / manual means in foundation trenches or drains (not exceeding 1.5 m in width or 10 sqm on plan), including dressing of sides and ramming of bottoms, lift upto 1.5 m, including getting out the excavated soil and disposal of surplus excavated soil as directed, within a lead of 50 m. | cum | 157.50 | 50 | 7,875 |
| | 2.8.1 | All kinds of soil. | | | | |
| | | | | | | |
| 10.0 | 2.9 | Excavation work by mechanical means (Hydraulic excavator)/ manual means in foundation trenches or drains (not exceeding 1.5m in width or 10 sqm on plan), including dressing of sides and ramming of bottoms, lift upto 1.5 m, including getting out the excavated soil and disposal of surplus excavated soils as directed, within a lead of 50 m. | | | | |
| | 2.9.1 | Ordinary rock | cum | 263.50 | 50 | 13,175 |
| | 2.9.3 | Hard rock (blasting prohibited) | cum | 620.55 | 50 | 31,028 |
| | | | | | | |
| 11.0 | 2.25 | Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and lift upto 1.5 m. | cum | 112.40 | 850 | 95,540 |
| | | | | | | |
| 12.0 | 2.26 | Extra for every additional lift of 1.5 m or part thereof in excavation / banking excavated or stacked materials. | | | | |
| | 2.26.1 | All kinds of soil | cum | 46.25 | 1600 | 74,000 |
| | 2.26.2 | Ordinary or hard rock | cum | 82.95 | 950 | 78,803 |
| | | | | | | |
| 13.0 | 13.9 | Cement plaster 1:3 (1 cement: 3 coarse sand) finished with a floating coat of neat cement | | | | |
| | 13.9.1 | 12 mm cement plaster | sqm | 226.10 | 3500 | 791,350 |
| | | | | | | |
| 14.0 | 19.6 | Providing and laying non-pressure NP2 class (light duty) R.C.C. pipes with collars jointed with stiff mixture of cement mortar in the proportion of 1:2 (1 cement : 2 fine sand) including testing of joints etc. complete : | | | | |
| | | | | | | |
| | 19.6.1 | 100 mm dia. R.C.C. pipe | Metre | 318.50 | 280 | 89,180 |
| | 19.6.2 | 150 mm.dia. R.C.C. pipe | Metre | 348.30 | 1800 | 626,940 |
| | 19.6.3 | 250 mm dia. R.C.C. pipe | Metre | 468.60 | 950 | 445,170 |
| | 19.6.4 | 300 mm dia. R.C.C. pipe | Metre | 506.35 | 3800 | 1,924,130 |
| | 19.6.5 | 450 mm dia. R.C.C. pipe | Metre | 705.90 | 400 | 282,360 |
| | 19.6.6 | 500 mm dia. R.C.C. pipe | Metre | 934.10 | 700 | 653,870 |
| | 19.6.7 | 600 mm dia. R.C.C. pipe | Metre | 1,379.45 | 400 | 551,780 |
| | 19.6.8 | 700 mm dia. R.C.C. pipe | Metre | 1,562.70 | 80 | 125,016 |
| | 19.6.9 | 800 mm dia. R.C.C. pipe | Metre | 1,748.75 | 90 | 157,388 |
| | | | | | | |

| PHE WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| 15.0 | 19.35 | Providing laying and lowering Non Pressure NP-3 class (Medium duty) R.C.C. pipes including collars/spigot jointed with stiff mixture of cement mortar in the proportion of 1:2 (1 cement : 2 fine sand) including testing of joints etc. Complete | | | | |
| | | | | | | |
| | 19.35.1 | 450 mm dia. R.C.C. pipe | Metre | 1,920.50 | 800 | 1,536,400 |
| | 19.35.2 | 600 mm.dia. R.C.C. pipe | Metre | 2,504.60 | 400 | 1,001,840 |
| | | | | | | |
| 16.0 | 19.3 | Providing and laying cement concrete 1:5:10 (1 cement : 5 coarse sand : 10 graded stone aggregate 40 mm nominal size) up to haunches of RCC pipes including bed concrete as per standard design : | | | | |
| | 19.3.1 | 100 mm diameter | Metre | 281.65 | 280 | 78,862 |
| | 19.3.2 | 150 mm diameter | Metre | 456.45 | 1800 | 821,610 |
| | 19.3.4 | 250 mm diameter | Metre | 624.60 | 950 | 593,370 |
| | 19.3.5 | 300 mm diameter | Metre | 720.70 | 4500 | 3,243,150 |
| | | | | | | |
| 17.0 | 4.2 | Providing and laying cement concrete in retaining walls, return walls, walls (any thickness) including attached pilasters, columns, piers, abutments, pillars, posts, struts, buttresses, string or lacing courses, parapets, coping, bed blocks, anchor blocks, plain window sills, fillets, sunken floor,etc., up to floor five level, excluding the cost of centering, shuttering and finishing: | | | | |
| | 4.2.6 | 1:3:6 (1 cement : 3 coarse sand : 6 graded stone aggregate 40 mm nominal size) | Cum | 5,656.20 | 100 | 565,620 |
| | | | | | | |
| 18.0 | 19.27 | Constructing brick masonry road gully chamber 50x45x60 cm with bricks of class designation 75 in cement mortar 1:4 (1 cement : 4 coarse sand) including 500x450 mm pre-cast R.C.C. horizontal grating with frame complete as per standard design : | | | | |
| | 19.27.1 | With common burnt clay FPS(non-modular) bricks of class designation 7.5. | Each | 3,957.50 | 80 | 316,600 |
| | | | | | | |
| 19.0 | 19.28 | Constructing brick masonry road gully chamber 45x45x77.5 cm with bricks in cement mortar 1:4 (1 cement : 4 coarse sand ) with precast R.C.C. vertical grating complete as per standard design : | | | | |
| | 19.28.1 | With common burnt clay F.P.S. (non modular) bricks of class designation 7.5 | Each | 4,408.95 | 28 | 123,451 |
| | | | | | | |
| 20.0 | 19.29 | Constructing brick masonry road gully chamber 110x50x 77.5 cm with bricks in cement mortar 1:4 (1 cement : 4 coarse sand) including 500x450 mm pre-cast R.C.C. horizontal grating with frame and vertical grating complete as per standard design : | | | | |
| | 19.29.1 | With common burnt clay F.P.S. (non modular) bricks of class designation 7.5 | Each | 7,501.45 | 20 | 150,029 |
| | | | | | | |

| PHE WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| 21.0 | 19.30 | Constructing brick masonry chamber for underground C.I. inspection chamber and bends with bricks in cement mortar 1:4 (1 cement : 4 coarse sand) C.I. cover with frame (light duty) 455x610 mm internal dimensions, total weight of cover with frame to be not less than 38 kg (weight of cover 23 kg and weight of frame 15 kg), R.C.C. top slab with 1:2:4 mix (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size), foundation concrete 1:5:10 (1 cement : 5 fine sand : 10 graded stone aggregate 40 mm nominal size), inside plastering 12 mm thick with cement mortar 1:3 (1 cement : 3 coarse sand), finished smooth with a floating coat of neat cement on walls and bed concrete etc. complete as per standard design : | | | | |
| | 19.30.1 | Inside dimensions 455x610 mm and 45 cm deep for single pipe line : | | | | |
| | 19.30.1.1 | With common burnt clay F.P.S. (non modular) bricks of class designation 7.5 | Each | 4,692.05 | 35 | 164,222 |
| | 19.30.2 | Inside dimensions 500x700 mm and 45 cm deep for pipe line with one or two inlets : | | | | |
| | 19.30.2.1 | With common burnt clay F.P.S. (non modular) bricks of class designation 7.5 | Each | 5,375.20 | 15 | 80,628 |
| | | | | | | |
| 22.0 | 19.7 | Constructing brick masonry manhole in cement mortar 1:4 ( 1 cement : 4 coarse sand ) with R.C.C. top slab with 1:2:4 mix (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm Nominal size), foundation concrete 1:4:8 mix (1 cement : 4 coarse sand : 8 graded stone aggregate 40mm Nominal size), inside plastering 12mm thick with cement mortar 1:3 (1 cement : 3 coarse sand) finished with floating coat of neat cement and making channels in cement concrete 1:2:4 (1cement : 2 coarse sand : 4 graded stone aggregate 20mm Nominal size) finished with a floating coat of neat cement complete as per standard design : | | | | |
| | 19.7.1 | Inside size 90x80 cm and 45 cm deep including C.I. cover with frame (light duty) 455x610 mm internal dimensions, total weight of cover and frame to be not less than 38 kg (weight of cover 23 kg and weight of frame 15 kg) : | | | | |
| | 19.7.1.1 | With FPS bricks of class designation 7.5 | Each | 8,507.00 | 40 | 340,280 |
| | | | | | | |
| 23.0 | 19.7.2 | Inside size 120 x 90 cm and 90 cm deep including C.I. cover with frame (medium duty) 500 mm internal diametre, total weight of cover and frame to be not less than 116 kg (weight of cover 58 kg and weight of frame 58 kg) : | | | | |
| | 19.7.2.1 | With FPS bricks of class designation 7.5 | Each | 18,304.45 | 30 | 549,134 |
| | | | | | | |
| 24.0 | 19.8 | Extra for depth for manholes | | | | |

| PHE WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| | 19.8.1 | Size 90x80 cm | | | | |
| | 19.8.1.1 | With FPS bricks of class designation 7.5 | Metre | 5,638.20 | 2 | 11,276 |
| | 19.8.2 | Size 120 x 90 cm | | | | |
| | 19.8.2.1 | With FPS bricks of class designation 7.5 | Metre | 6,753.65 | 2 | 13,507 |
| | | | | | | |
| 25.0 | 19.9 | Constructing brick masonry circular type manhole 0.91m internal dia at bottom and 0.56m dia at top in cement mortar 1:4 (1 cement :4 coarse sand), in side cement plaster 12 mm thick with cement mortar 1:3 (1 cement : 3 coarse sand) finished with a floating coat of neat cement, foundation concrete 1:3:6 mix (1 cement : 3 coarse sand : 6 graded stone aggregate 40mm Nominal size), and making necessary channel in cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20mm Nominal size) finished with a floating coat of neat cement, all complete as per standard design : | | | | |
| | 19.9.1 | 0.91 m deep with S.F.R.C. cover and frame (heavy duty, HD-20 grade designation) 560mm internal diametre conforming to I.S. 12592, total weight of cover and frame to be not less than 182kg., fixed in cement concrete 1:2:4 (1 cement:2 coarse sand:4 graded stone aggregate 20 mm Nominal size) including centering, shuttering all complete. (Excavation, foot rests and 12mm thick cement plaster at the external surface shall be paid for separately): | | | | |
| | 19.9.1.1 | With FPS bricks of class designation 7.5 | Each | 8,738.55 | 70 | 611,699 |
| | | | | | | |
| 26.0 | 19.10 | Extra depth for circular type manhole 0.91m internal dia (at bottom) beyond 0.91m to 1.67m | | | | |
| | 19.10.1 | With FPS bricks of class designation 7.5 | Metre | 4,842.40 | 2 | 9,685 |
| | | | | | | |
| 27.0 | 19.11 | Constructing brick masonry circular manhole 1.22 m internal dia at bottom and 0.56 m dia at top in cement mortar 1:4 (1 cement :4 coarse sand) inside cement plaster 12 mm thick with cement mortar 1:3 (1 cement : 3 coarse sand) finished with a floating coat of neat cement foundation concrete 1:3:6 (1 cement : 3 coarse sand : 6 graded stone aggregate 40 mm nominal size) and making necessary channel in cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) finished with a floating coat of neat cement, all complete as per standard design : | | | | |

| PHE WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| | 19.11.1 | 1.68 m deep with SFRC Cover and frame (heavy duty HD-20 grade designation) 560 mm internal diameter conforming to I.S. 12592, total weight of cover and frame to be not less than 182 kg. fixed in cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) including centering, shuttering all complete. (Excavation, foot rests and 12 mm thick cement plaster at the external surface shall be paid for separately): | | | | |
| | 19.11.1.1 | With FPS bricks of class designation 7.5 | Each | 16,467.90 | 40 | 658,716 |
| | | | | | | |
| 28.0 | 19.12 | Extra depth for Circular type Manhole 1.22 m internal dia (at Bottom) beyond 1.68 to 2.29 m: | | | | |
| | 19.12.1 | With FPS bricks of class designation 7.5 | Metre | 6,270.70 | 2 | 12,541 |
| | | | | | | |
| 29.0 | 19.13 | Constructing brick masonry circular manhole 1.52 m internal dia at bottom and 0.56 m dia at top in cement mortar 1:4 (1 cement : 4 coarse sand) inside cement plaster 12 mm thick with cement mortar 1:3 (1 cement : 3 coarse sand) finished with a floating coat of neat cement, foundation concrete 1:3:6 (1 cement : 3 coarse sand : 6 graded stone aggregate 40 mm nominal size) and making necessary channel in cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) finished with a floating coat of neat cement, all complete as per standard design : | | | | |
| | | 2.30 m deep with SFRC Cover and frame (heavy duty HD-20 grade designation) 560 mm internal diameter conforming to I.S. 12592, total weight of cover and frame to be not less than 182 kg. fixed in cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) including centering, shuttering all complete. (Excavation, foot rests and 12 mm thick cement plaster at the external surface shall be paid for separately): | | | | |
| | 19.13.1.1 | With FPS bricks of class designation 7.5 | Each | 34,976.25 | 25 | 874,406 |
| | | | | | | |
| 30.0 | 19.14 | Extra depth for circular type manhole 1.52m internal dia (at bottom) Beyond 2.30m | | | | |
| | 19.14.1 | With FPS bricks of class designation 7.5 | Meter | 14,842.95 | 1 | 14,843 |
| | | | | | | |

| PHE WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| 31.0 | 19.16 | Providing orange colour safety foot rest of minimum 6 mm thick plastic encapsulated as per IS : 10910 on 12mm dia steel bar conforming to IS : 1786 having minimum cross section as 23 mmx25mm and over all minimum length 263 mm and width as 165mm with minimum 112 mm space between protruded legs having 2 mm tread on top surface by ribbing or chequering besides necessary and adequate anchoring projections on tail length on 138 mm as per standard drawing and suitable to with stand the bend test and chemical resistance test as per specifications and having manufacture's permanent identification mark to be visible even after fixing, including fixing in manholes with 30x20x15 cm cement concrete block 1:3:6 (1 cement : 3 coarse sand : 6 graded stone aggregate 20 mm nominal size) complete as per design. | Each | 311.60 | 1800 | 560,880 |
| | | | | | | |
| 32.0 | 19.19 | Providing and fixing in position pre-cast R.C.C. manhole cover and frame of required shape and approved quality 19.19.1 L D- 2.5 | | | | |
| | 19.19.1.1 | Rectangular shape 600x450 mm internal dimensions | Each | 1,131.70 | 10 | 11,317 |
| | 19.19.1.2 | Square shape 450 mm internal dimensions | Each | 960.90 | 10 | 9,609 |
| | 19.19.1.3 | Circular shape 450 mm internal diameter | Each | 902.80 | 10 | 9,028 |
| | 19.19.2 | M D - 10 | | | | |
| | 19.19.2.1 | Square shape 450 mm internal dimension | Each | 1,080.10 | 10 | 10,801 |
| | 19.19.2.2 | Circular shape 500 mm internal diameter | Each | 909.25 | 15 | 13,639 |
| | 19.19.3 | H D - 20 | | | | |
| | 19.19.3.1 | Circular shape 560 mm internal diameter | Each | 1,511.55 | 18 | 27,208 |
| | 19.19.4 | EHD - 35 | | | | |
| | 19.19.4.1 | Circular shape 560 mm internal dia | Each | 1,656.70 | 20 | 33,134 |
| | | | | | | |
| | | **TOTAL FOR HEAD (F) CARRIED OVER TO SUMMARY** | | | | **25,052,001** |
| **G.** | | **GARDEN IRRIGATION SYSTEM** | | | | |
| 1.0 | 18.32 | Constructing masonry Chamber 30x30x50 cm inside, in brick work in cement mortar 1:4 (1 cement :4 coarse sand) for stop cock, with C. I. surface box 100x100 x75 mm (inside) with hinged cover fixed in cement concrete slab 1:2:4 mix (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size), i/c necessary excavation, foundation concrete 1:5:10 ( 1 cement : 5 fine sand : 10 graded stone aggregate 40mm nominal size ) and inside plastering with cement mortar 1:3 (1 cement : 3 coarse sand) 12mm thick, finished with a floating coat of neat cement complete as per standard design : | | | | |
| | 18.32.1 | With common burnt clay F.P.S.(non modular) bricks of class designation 7.5 | Each | 1,157.75 | 40 | 46,310 |
| | | | | | | |

| PHE WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| 2.0 | 13.9 | Cement plaster 1:3 (1 cement: 3 coarse sand) finished with a floating coat of neat cement | | | | |
| | 13.9.1 | 12 mm cement plaster | sqm | 226.10 | 20 | 4,522 |
| | | | | | | |
| | | **TOTAL FOR HEAD (G) CARRIED OVER TO SUMMARY** | | | | **50,832** |
| **TOTAL DSR - PHE WORKS** | | | | | | 92,492,428 |

| PHE WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| A. | | **SANITARY INSTALLATIONS** | | | | |
| | | **Note:** | | | | |
| | | Note: All fixtures & CP fittings should meet Griha requirement to achieve maximum rating. | | | | |
| 1.0 | **NON DSR** | Providing and fixing white water closet squatting pan (Indian type W.C. pan) (JAQUAR CNS-WHT-451 / HINDWARE- ORRISA PAN GRACE 20090 or approved equivalent) in cement concrete 1:2:4 mix (1 cement: 2 coarse sand : 4 stone agrregate 20 mm nominal size) including providing & fixing 100 mm dia Ceramic deep seal trap including brickwork supports & associated civil work with cutting and making good the wall & floors complete including providing and fixing white flushing cistern (JAQUAR WHC-WHT-184A / HINDWARE - CONCEALO 80mm or approved equp.) Economy Dual flush (3/6 ltr.) including flush pipe with all fittings complete. as required. | Each | 9,190.00 | 93 | 854,670 |
| | | | | | | |
| 2.0 | **NON DSR** | Providing and fixing Vitreous china wall mounted European type water closet (KOHLER-18133T-S-O PREQUILE WALL-HUNG TOILET WITH QUIET SEAT & COVER or approved equivalent) with lid, Solid seat cover with CP bolts, nuts, CP brass hinges and rubber buffers, flush pipe with clamp and adapter rubber joint, cast iron chair brackets (painted with two coats of enamel paint over a coat of primer) & necessary fittings, CP brass screws and washers for complete installation including cutting and making good the walls and floors where required. (Premium range) | Each | 20,441.00 | 42 | 858,522 |
| | | | | | | |
| 3.0 | **NON DSR** | Providing and fixing Vitreous china wall mounted European type water closet (KOHLER-6098IN-S-O approved equivalent) with lid , Solid seat cover with CP bolts, nuts, CP brass hinges and rubber buffers, flush pipe with clamp and adapter rubber joint, cast iron chair brackets (painted with two coats of enamel paint over a coat of primer) & necessary fittings, CP brass screws and washers, complete including cutting and making good the walls and floors where required. (Mid range) | Each | 13,491.00 | 235 | 3,170,385 |
| | | | | | | |
| 4.0 | **NON DSR** | Providing and fixing Vitreous china wall mounted European type water closet (KOHLER-18131IN-S-0 or approved equivalent) with lid , Solid seat cover with CP bolts, nuts, CP brass hinges and rubber buffers, flush pipe with clamp and adapter rubber joint, cast iron chair brackets (painted with two coats of enamel paint over a coat of primer) & necessary fittings, CP brass screws and washers complete including cutting and making good the walls and floors where required. (Low range) | Each | 7,604.00 | 28 | 212,912 |

| PHE WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| | | | | | | |
| 5.0 | NON DSR | Providing and fixing straight /offset type single body push fit type WC pan connector with factory supplied spring loaded seal guard with integral single mould sealing fins made of flexible EVA body, including bush/adaptor for use with C.I. Pipe as supplied with the pan connector complete in all respect. | Each | 850.00 | 305 | 259,250 |
| | | | | | | |
| 6.0 | NON DSR | Providing and fixing HYDRO TOWER INWALL TANK 3/6 L (SIDE INLET) (KOHLER-4178IN-2S-NA or approved equivalent) including connectors, flush pipe with all fittings complete. (common for all) | Each | 4,567.00 | 305 | 1,392,935 |
| | | | | | | |
| 7.0 | NON DSR | Providing and fixing I Flush Valve concealed body with exposed part kit with dual flush push buttn acuation and control stop cock (JAQUAR-FLV-CHR-1075C & or approved equivalent) including flush pipe with all fittings complete. | Each | 4,094.00 | 30 | 122,820 |
| | | | | | | |
| 8.0 | NON DSR | Providing and fixing Wall Flush plate (KOHLER 8857IN-A-CP or approved equivalent) chrome finish complete as directed by Engineer-in-charge. (Premium range) | Each | 2,030.00 | 42 | 85,260 |
| | | | | | | |
| 9.0 | NON DSR | Providing and fixing Wall Flush plate (KOHLER8857IN-2-CP or approved equivalent) chrome finish complete as directed by Engineer-in-charge. (Mid range) | Each | 1,649.00 | 235 | 387,515 |
| | | | | | | |
| 10.0 | NON DSR | Providing and fixing Wall Flush plate (KOHLER 4177IN-2-CP or approved equivalent) chrome finish complete as directed by Engineer-in-charge. (Low range) | Each | 1,353.00 | 28 | 37,884 |
| | | | | | | |
| 11.0 | NON DSR | Providing and fixing Ablution health faucet with flow restrictor (KOHLER- 12929IN-CP or approved equivalent) assembly with 1 m long flexible hose with mounting bracket fixed on wall with low flow aerator (3.78 lpm) complete with PVC cleats and S.S. screws including cutting and making good the walls wherever required complete as directed by Engineer-in-Charge. (Premium range) | Each | 2,842.00 | 194 | 551,348 |
| | | | | | | |
| 12.0 | NON DSR | Providing and fixing Ablution health faucet with flow restrictor (KOHLER-12927IN-CP or approved equivalent) assembly with 1 m long flexible hose with mounting bracket fixed on wall with low flow aerator (3.78 lpm) complete with PVC cleats and S.S. screws including cutting and making good the walls wherever required complete as directed by Engineer-in-Charge. (Mid range) | Each | 2,461.00 | 235 | 578,335 |
| | | | | | | |

| PHE WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| 13.0 | NON DSR | Providing and fixing Ablution health faucet with flow restrictor (KOHLER-12925IN-CP or approved equivalent) assembly with 1 m long flexible hose with mounting bracket fixed on wall with low flow aerator (3.78 lpm) complete with PVC cleats and S.S. screws including cutting and making good the walls wherever required complete as directed by Engineer-in-Charge. (Low range) | Each | 1,543.00 | 28 | 43,204 |
| | | | | | | |
| 14.0 | NON DSR | Providing and fixing wash basin (KOHLER-5373T-0 or approved equivalent), 32 mm dia CP brass waste coupling (KOHLER-45432IN-CP approved equivalent), 32 mm dia CP cast brass bottle trap (KOHLER-7314IN-CP or approved equivalent) & union and CP wall flange complete including cutting & making good the walls where required. (Premium range) | Each | 13,097.00 | 47 | 615,559 |
| | | | | | | |
| 15.0 | NON DSR | Providing and fixing white vitreous wash basin (KOHLER-11355K-1-WK or approved equivalent), 32 mm dia CP brass waste coupling (KOHLER 45432IN-CP or approved equivalent) , 32 mm dia CP cast brass bottle trap (KOHLER-7314IN-CP or approved equivalent) & union and CP wall flange complete including cutting & making good the walls where required.(Mid range) | Each | 10,087.00 | 388 | 3,913,756 |
| | | | | | | |
| 16.0 | NON DSR | Providing and fixing wash basin (KOHLER-5373T-0 or approved equivalent), 32 mm dia CP brass waste coupling (KOHLER 45432IN-CP or approved equivalent) , 32 mm dia CP cast brass bottle trap (KOHLER-16407IN-CP or approved equivalent) & union and CP wall flange complete including cutting & making good the walls where required. (Low range) | Each | 8,258.00 | 28 | 231,224 |
| | | | | | | |
| 17.0 | NON DSR | Providing and fixing wash basin faucet (KOHLER-37329 IN-4ND-CP or approved equivalent) complete including cutting and making good the walls where required. (Premium range) | Each | 14,430.00 | 47 | 678,210 |
| | | | | | | |
| 18.0 | NON DSR | Providing and fixing wash basin faucet (KOHLER-11545IN-4-CP or approved equivalent ) complete including cutting and making good the walls where required. (Mid range) | Each | 3,722.00 | 388 | 1,444,136 |
| | | | | | | |
| 19.0 | NON DSR | Providing and fixing wash basin faucet (KOHLER-99452IN-4-CP or approved equivalent ) complete including cutting and making good the walls where required.(Low range) | Each | 1,945.00 | 28 | 54,460 |
| | | | | | | |

| PHE WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| 20.0 | NON DSR | Providing & fixing white vitreous china urinal PATIO URINAL WITH REAR INLET (KOHLER-18645T-Y-0 or approved equivalent) including CP brass waste with dome type grating, CP cast brass bottle trap with extension piece, wall flanges complete with all fittings & accessories complete including cutting and making good the walls where required. (Premium range) | Each | 28,504.00 | 12 | 342,048 |
| | | | | | | |
| 21.0 | NON DSR | Providing & fixing white vitreous china urinal BARDON S MID-SIZE URINAL WITH REAR INLET (KOHLER-4978IN-ER-0 or approved equivalent) including CP brass waste with dome type grating, CP cast brass bottle trap with extension piece, wall flanges complete with all fittings & accessories including cutting and making good the walls where required.(Mid range) | Each | 10,150.00 | 180 | 1,827,000 |
| | | | | | | |
| 22.0 | NON DSR | Providing & fixing white vitreous china urinal DEXTER WASHDOWN URINAL WITH REAL INLET (KOHLER-5017IN-ER-0 or approved equivalent)including CP brass waste with dome type grating, CP cast brass bottle trap with extension piece, wall flanges complete with all fittings & accessories including cutting and making good the walls where required. (Low range) | Each | 7,147.00 | 14 | 100,058 |
| | | | | | | |
| 23.0 | NON DSR | Providing and fixing Urinal sensor in polished chrome (KOHLER-8791T-C01-CP or approved equivalent) including all necessary accessories, fittings complete and fixing to wall with suitable brackets all as per manufacturers specification and direction of Engineer-in-charge. (common for all) | Each | 16,324.00 | 206 | 3,362,744 |
| | | | | | | |
| 24.0 | NON DSR | Providing and Fixing Stainless Steel Toilet paper Holder (KOHLER-5633IN-CP or approved equivalent) including all necessary fittings and fixed on Wooden / PVC Cleats with CP Screws etc.complete as per directions of the Engineer-in-charge. (Premium & Mid range) | Each | 1,255.00 | 429 | 538,395 |
| | | | | | | |
| 25.0 | NON DSR | Providing and Fixing Stainless Steel Toilet paper Holder (KOHLER-5632IN-CP or approved equivalent) including all necessary fittings and fixed on Wooden / PVC Cleats with CP Screws etc. ll complete as per directions of the Engineer-in-charge. (Low range) | Each | 1,017.00 | 28 | 28,476 |
| | | | | | | |
| 26.0 | NON DSR | Providing and fixing CP Overhead Showerhead (KOHLER-73198IN-CP or approved equivalent) including all necessary fittings and Including the flanges & extention nipples etc complete as per direction of the Engineer-in-Charge. | Each | 7,727.00 | 5 | 38,635 |

| PHE WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| | | | | | | |
| 27.0 | NON DSR | Providing and fixing of Shower arm (KOHLER-16346IN-CP or approved equivalent), including all necessary fittings and Including accessories etc complete as per direction of the Engineer-in-Charge. | Each | 2,371.00 | 5 | 11,855 |
| | | | | | | |
| 28.0 | NON DSR | Providing and fixing of Concealed bath & shower valve with diverter (KOHLER 882IN-CP or approved equivalent) including all necessary fittings and complete as per direction of the Engineer-in-Charge. | Each | 3,835.00 | 5 | 19,175 |
| | | | | | | |
| 29.0 | NON DSR | Providing and fixing of Bath Spout (KOHLER 37344IN-CP or approved equivalent) including all necessary fittings and Including the flanges etc complete as per direction of the Engineer-in-Charge. | Each | 3,753.00 | 5 | 18,765 |
| | | | | | | |
| 30.0 | NON DSR | Providing and fixing of CP Plate for valve & diverter (KOHLER 72291IN-4FP-CP or approved equivalent) for shower including all necessary fittings and complete as per direction of the Engineer-in-Charge. | Each | 6,165.00 | 5 | 30,825 |
| | | | | | | |
| 31.0 | NON DSR | Providing and fixing of Bath tub FRP/Acrylic of approved make (Kohler DUO ACRYLIC BATH 1525 x 762 x 430 mm cat.no.18776T-0 with bath drain 17295T-CP / Jaquar POP 180/80 PLAIN TUB or approved equivalent) completely leveled, including waste overflow set, chain plug, cast brass P/S trap with overflow arrangement, mixer fittings & spout (Kohler CUFF 3 HOLE BATH TUB FILLER WITH HANDSHOWER/or approved equivalent) (with all accessories), hand shower & grouting of legs etc with cement concrete all complete as required. | Each | 44,455.00 | 1 | 44,455 |
| | | | | | | |
| 32.0 | NON DSR | Providing and fixing 15mm dia angular stop cock (Kohler ANGLE STOP VALVE, G3/8" X G1/2" Cat # 11568IN-7-CP or Jaquar Cat # FLR 5053N or approved equivalen) with wall flange and CP riser connection pipe of required length complete in all respect. | Each | 1,017.00 | 1910 | 1,942,470 |
| | | | | | | |
| 33.0 | NON DSR | Providing & fixing C.P. brass Concealed Stop cock (Jaquar CON-083KN or approved equivalent ) with wall flange complete in all respect. | | | | |
| | | 15mm nominal bore | Each | 1,115.00 | 76 | 84,740 |
| | | | | | | |
| 34.0 | NON DSR | Providing and fixing Wall mounted Double Robe Hook (Jaquar Cat. # ACN-1161 N or approved equivalent ) on door complete | Each | 336.00 | 398 | 133,728 |
| | | | | | | |

| PHE WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| 35.0 | NON DSR | Providing and fixing Towel ring ((HINDWARE-Contessa F880007 or approved equivalent) with screw and rawl plug etc. | Each | 634.00 | 44 | 27,896 |
| | | | | | | |
| 36.0 | NON DSR | Providing and fixing wall mounted Air Freshner dispenser (Make: EURONICS EA03 or approved equivalent) complete in all respect, including cutting and making good the wall wherever required complete as directed by Engineer-in-charge/ Architects. | Each | 2,647.00 | 512 | 1,355,264 |
| | | | | | | |
| 37.0 | NON DSR | Providing and fixing wall mounted single lever basin mixer ((Jaquar Cat. No. FLR 5177B or approved equivalent) low flow fixture as per Griha requirement for kitchen sink | Each | 5,098.00 | 37 | 188,626 |
| | | | | | | |
| 38.0 | NON DSR | SITC of wall hanging drinking fountain with AquaPointe Bottle Filler by OASIS(Model - PG8SBF) to deliver the normal & cold water through separate taps along with recipient , 100 Micron strainer , flexible bubbler guard , and operation between 20-120 PSI / 3KG Water Pressure, stainless steel finish , i/c providing & fixing of necessary hardware like stop valve, TRAP, pipe connector to waste line and supply line (Excluding Civil work). | Each | 107,729.00 | 68 | 7,325,572 |
| | | | | | | |
| 39.0 | NON DSR | SITC of RO System having 25 LPH Capacity with 24 ltr HPN Tank in 01 No. Powder coated MS Box(6 ft*2.5 ft*2.5 ft) having 02 No. DOW Membrane, 01 No. Kemflo Pump with 0.5 HP pump of approved make, 02 no. Power adopter (48 volts), 03 no. carbon and sediment filter and 01 no. of UVfilter. | Each | 73,871.00 | 68 | 5,023,228 |
| | | | | | | |
| 40.0 | NON DSR | Providing & fixing of Stainless Steel Janitor sink (Make Jayna or approved equivalent) including providing & fixing CI/MS brackets (duly painted with 2 coats of paint over a coat of primer) C.P. cast brass bottle trap, waste coupling with extension piece, rubber adopter, wall flange, union, C.P. brass chain rubber plug complete as required. | Each | 3,578.70 | 59 | 211,143 |
| | | | | | | |
| 41.0 | NON DSR | Providing and fixing of Emergency Shower comprising of 150mm dia brass CP overhead shower with pull chain complete with all accessories. (Make: Vijay Cat.no. 1023 or approved equivalent) | Each | 5,989.50 | 10 | 59,895 |
| | | | | | | |

| PHE WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| 42.0 | NON DSR | Providing and fixing in position 129x129 mm square stainless steel cockroach trap consisting of 0.45 mm thick inner and outer cup and 1 mm thick top grating (Jali) with ring to be fixed inside C.I./HDPE 'P' traps with cement concrete. | Each | 810.60 | 575 | 466,095 |
| | | | | | | |
| 43.0 | NON DSR | Providing and fixing of CP Eye Wash fountain self closing foot operated with SS Bowl having inlet of 15mm dia, bottle trap and waste coupling with all accessories complete. (Make: Vijay cat.no. 1036 or approved equivalent) | Each | 10,067.50 | 10 | 100,675 |
| | | | | | | |
| 44.0 | NON DSR | Providing, fixting, testing & commissioning of Electric Storage type water heater/ Geyser (pressurised type) vertical / horizontal wall mounted type conforming to IS 2082 latest provided with removable tubular type heating element of suitable capacity suitable for operating in single phase, 230 V, ac, 50 Hz supply complete with thermostat for temp. control adjustable between 30 degree to 85 degree. suitable length of electrical cable with required accessories like 15 mm CP angle valve on inlet & outlet line , heavy duty reinforced flexible PVC connector for cold water line and flexible CP brass connector with CP checkout for hot water line, water line connection, MS bracket with two coats of enamel paint, anchor fastners etc to hang the units, providing and fixing of 16 A 3 Pin plug of Anchor make, etc complete as required. | | | | |
| | | It should be provided with built in safety valve, neon indication lamp complete for automatic working of the unit. | | | | |
| | | STANDARD not less than 5 STAR Labled. Standing loss should not be less than 0.692 kWhr/24 hrs | | | | |
| | | Note: Tank with 5-7 years warranty with 3-4 years heating element warranty | | | | |
| a) | | 25 litres capacity | Each | 9,672.00 | 30 | 290,160 |
| b) | | 15 litres capacity | Each | 8,312.00 | 37 | 307,544 |
| | | | | | | |
| 45.0 | NON DSR | Providing and fixing wall mounted 2 Way bib cock with wall flange (Kohler 16094IN-4-CP or approved equivalent) complete in all respect. | | | | |
| | | 15 mm nominal bore | Each | 3,009.00 | 34 | 102,306 |
| | | | | | | |
| 46.0 | NON DSR | Providing and fixing wall mounted bib cock with wall flange (Jaquar 037 or approved equivalent) complete in all respect. | Each | 945.00 | 93 | 87,885 |
| | | | | | | |
| 47.0 | NON DSR | Providing and fixing Pillar cock with extended lever handle (Kohler 18161IN-ND-CP or approved equivalent) complete in all respect. | Each | 6,459.00 | 44 | 284,196 |
| | | **TOTAL FOR SUBHEAD (A) CARRIED OVER TO SUMMARY** | | | | 39,846,239 |

| PHE WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| B. | | INTERNAL DRAINAGE | | | | |
| | | | | | | |
| 1.0 | NON DSR | Providing and filling the joints with Drip Seal to spun iron or C.I. pipes and specials, including testing of joints and depth of joint and joining procedure shall be as per manufacturer recommendation. | | | | |
| a) | | 150 mm dia pipe | Each | 400.00 | 70 | 28,000 |
| b) | | 100 mm dia pipe | Each | 300.00 | 1198 | 359,400 |
| c) | | 75 mm dia pipe | Each | 200.00 | 181 | 36,200 |
| | | | | | | |
| 2.0 | NON DSR | Providing and Fixing Floor drain by fixing G.I. Reducing elbow of 100 x 50 mm in cement concrete 1:2:4 at all levels (exlcuding cost of grating) in sunken portions, complete as per drawings and as per approval of the Engineer-in-charge. | Each | 1,432.70 | 32 | 45,846 |
| | | | | | | |
| 3.0 | NON DSR | Providing and fixing GI hopper with two or more inlets fittings to receive 50 mm dia uPVC waste pipes confirming to IS 4985 from fixtures waste. Threaded waste pipes to be connected to hopper through GI / MS threaded Coupling (for connecting waste pipe). The hopper shall be fabricated from 100 mm dia GI "C Class" / Heavy Class pipe of required length and fixing to C.I. trap with spun yarn / drip seal joint and support through galvanized steel support from slab as required. The hopper shall be hot dip galvanized after fabrication and fixed to CI trap / pipe with spun yarn / drip seal joint. | Each | 2,500.00 | 548 | 1,370,000 |
| | | | | | | |
| 4.0 | NON DSR | Providing and fixing heavy duty long radius uPVC reducing elbow of 110x63 mm OD as floor drain in cement concrete 1:2:4 float with floor complete in all respects. | Nos. | 160.70 | 345 | 55,442 |
| | | | | | | |
| 5.0 | NON DSR | Providing, supplying, lowering, laying, Jointing by electro fusion welding, Field testing, commissioning complete at site in standard length ISI marked high density polyethylene HDPE (6kg/sq.cm) suitable for Effluent as per IS specifications 14333/1996 including all specials, including all cost of material, labour required, transportation, loading, unloading & stacking etc. complete. | | | | |
| a) | | 32 mm | metre | 148.70 | 160 | 23,792 |
| b) | | 50 mm | metre | 259.50 | 50 | 12,975 |
| c) | | 110 mm | metre | 1,137.50 | 450 | 511,875 |
| | | | | | | |
| 6.0 | NON DSR | Providing & fixing Polypropylene Silent Bottle trap 40 mm Ø with 75 mm clear water seal fitted with built-in Air Admittance valve of adequate capacity with factory supplied extension piece. | Each | 1,700.00 | 70 | 119,000 |

| PHE WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| | | | | | | |
| 7.0 | NON DSR | Providing, fixing, testing and commissioning of pipe inlet fittings fabricated with P.P. Pipe with maximum 3 inlets 40, 50 & 75 mm OD size pipe, fixed to 'P' traps including Dripseal/Pipe seal/solvent weld joint/rubber ring joint complete . | Each | 1,500.00 | 40 | 60,000 |
| | | | | | | |
| 8.0 | NON DSR | Providing and fixing trap of self cleansing in HDPE (110x110) complete, including cost of cutting and making good the walls and floors : | Each | 2,352.60 | 70 | 164,682 |
| | | | | | | |
| 9.0 | NON DSR | Providing and Fixing HDPE low height floor drains in cement concrete 1:2:4 at all levels (exlcuding cost of grating) for connection to floor traps in sunken portions, complete as per required slope as per drawings and as per approval of the Engineer-in-charge. | Each | 331.00 | 10 | 3,310 |
| | | | | | | |
| 10.0 | NON DSR | Providing and fixing HDPE inlet hopper with two or three inlets fittings to receive waste pipes from fixtures waste. The hopper shall be fabricated from 110 mm dia upto 300 mm long HDPE pipe and fixed to HDPE trap and support through galvanized steel support from slab or set in cement concrete mix 1:2:4 complete as required. The hopper shall be fixed to HDPE trap / pipe as directed by Engineer-in-charge. | Each | 3,000.00 | 70 | 210,000 |
| | | | | | | |
| 11.0 | NON DSR | Providing and fixing HDPE Clean out Plug (COP/FCO) of approved brand and manufacture with suitable insert keys for opening, male threaded joint with HDPE socket complete as per approval of the Engineer-in-charge. | | | | |
| | | For 110 mm dia pipe | Each | 1,752.80 | 50 | 87,640 |
| | | | | | | |
| 12.0 | NON DSR | Providing, fixing, jointing, testing and commissioning UPVC (Class III - 6 Kg.) pipe conforming to IS:4985 cut to required lengths including all necessary fittings and specials. UPVC fittings IS : 7834 (Part I to Part-7) 1987 (moulded as well as fabricated) like bends, tees, Y-tees, crosses, boss connections, access pieces, saddle pieces, cleanouts, adaptors for connections to other materials, plugs, reducers, cowls, offsets and other specials. with clamps/supports as required/directed at site Jointing with solvent cement joints / threaded joints/ as per manufacturer recommendation including cutting chase or holes in walls and floors and making good as required by Engineer-in-Charge. | | | | |
| a) | | 32 mm dia | Metre | 111.00 | 550 | 61,050 |
| b) | | 40 mm dia | Metre | 122.00 | 4350 | 530,700 |
| c) | | 50 mm dia | Metre | 181.00 | 640 | 115,840 |
| d) | | 63 mm dia | Metre | 263.00 | 2210 | 581,230 |
| | | | | | | |

| PHE WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| 13.0 | NON DSR | Providing, Fixing, testing and commissioning of Heavy class SS grating of approved quality, weighing not less than 150 gms. including setting in floor with cement motor to match with floor finish as per architect requirement. Complete as per direction of the Engineer-in-Charge. | | | | |
| | | 125 x 125 square outer Frame & 100mm Round inside dia for floor trap/ floor drain (close on top for urinal traps) | Each | 203.90 | 984 | 200,638 |
| | | | | | | |
| 14.0 | NON DSR | Providing, fixing, jointing, testing and commissioning UPVC (Class III - 6 Kg.) Rain water downtake pipe conforming to IS:4985 cut to required lengths including all necessary fittings and specials. UPVC fittings IS : 7834 (Part I to Part-7) 1987 (moulded as well as fabricated) like bends, tees, Y-tees, crosses, boss connections, access pieces, cleanout plug, adaptors for connections to other materials, plugs, reducers, cowls, offsets and other specials. Fixing at wall/ceiling level supported by galvanized steel clamps & hangers etc. Making proper connection with cement solvent joint as per BIS / manufacturer. Cutting, chases / holes in floors / walls / slab. | | | | |
| a) | | 200 mm dia | Metre | 1,197.20 | 700 | 838,040 |
| b) | | 160 mm dia | Metre | 792.90 | 2730 | 2,164,617 |
| | | | | | | |
| 15.0 | NON DSR | Providing and fixing uPVC clean out plug with opening arrangements for rain water pipe and other necessary fittings inlcuding jointing, all complete as per standard detail. | | | | |
| | | For 110 mm dia pipe | Each | 350.00 | 84 | 29,400 |
| | | | | | | |
| 16.0 | NON DSR | Providing and fixing Scupper Drain (Side wall) parapet CI body with aluminium grate with four SS SCREW with CI body outlet 50mm, floor size inlet 150mm, height 70mm and base of grate 60mm. | Each | 2,682.00 | 1 | 2,682 |
| | | | | | | |
| 17.0 | NON DSR | Providing and fixing Scupper Drain (Side wall) parapet CI body with aluminium grate with four SS SCREW with CI body outlet 75mm, floor size inlet 210mm, height 120mm and base of grate 90mm. | Each | 2,398.00 | 1 | 2,398 |
| | | | | | | |
| 18.0 | NON DSR | Providing and fixing Scupper Drain (Side wall) parapet CI body with aluminium grate with four SS SCREW with CI body outlet 100mm, floor size inlet 280mm, height 163mm and base of grate 115mm. | Each | 2,555.30 | 108 | 275,972 |
| | | | | | | |
| 19.0 | NON DSR | Providing and fixing Scupper Drain (Side wall) parapet CI body with aluminium grate with four SS SCREW with CI body outlet 150mm, floor size inlet 322mm, height 207mm and base of grate 166mm. | Each | 3,200.00 | 71 | 227,200 |
| | | | | | | |

| PHE WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| 20.0 | NON DSR | Providing and fixing Cast Iron floor drain (FD) with 50mm outlet and 100 mm inlet with SS grating having 19mm seal for indirect floor drain (FD). | Each | 1,176.10 | 5 | 5,881 |
| | | | | | | |
| 21.0 | NON DSR | Providing and fixing cleaning eye on horizontal CI waste pipes, made of 300 mm long heavy class GI pipe with one plain end lead / drip seal caulked in to the collar of CI pipe and the other end with flange which in covered by neoprene rubber gasket and blank flange, complete with nuts, bolts etc and hot dip galvanization after fabrication to the satisfaction of the Engineer-in-Charge. | | | | |
| a) | | For 150 mm dia pipe | Each | 1,364.00 | 14 | 19,096 |
| b) | | For 100 mm dia pipe | Each | 922.00 | 420 | 387,240 |
| c) | | For 75 mm dia pipe | Each | 760.00 | 28 | 21,280 |
| | | | | | | |
| 22.0 | NON DSR | Providing and fixing in position GI vent 100 mm dia with brass mosquito proof coupling and air filter including return bend, complete as required. The entire fitting shall be hot dip galvanised. | Each | 3,500.00 | 46 | 161,000 |
| | | | | | | |
| | | **TOTAL FOR SUBHEAD (B) CARRIED OVER TO SUMMARY** | | | | 8,712,425 |
| **C.** | | **WATER-SUPPLY (INTERNAL)** | | | | |
| | | | | | | |
| 1.0 | NON DSR | Providing, fixing, jointing and testing in position the following heavy class (Class C) G.I. pipes conforming to IS:1239 cut to required lengths including all necessary fittings (All fittings shall confirm to IS:1879 - part 1 to 10) and specials such as bends, tees, unions, reducers, flanges & plugs etc. Threading, jointing, and making proper connections. Cutting hole in wall / floor / slab and making good the same complete as required. | | | | |
| | | Fixing/supporting the pipes (& fittings) at wall/ceiling level supported by galvanized clamps, hangers etc, as per specification. Exposed pipes to be provided with two coats of synthetic enamel paint over a coat of primer, including painting of legends with direction arrow. GI pipe sleeves suitable higher size shall be provided wherever the pipes are crossing the fire rated walls / floors slab and sealing the sleeves with glass wool in between and fire sealant compound at either end all as per Engineer-in-Charge. | | | | |
| a) | | 15 mm dia | Metre | 215.00 | 1140 | 245,100 |
| b) | | 20 mm dia | Metre | 225.00 | 1230 | 276,750 |
| c) | | 25 mm dia | Metre | 296.00 | 1230 | 364,080 |
| d) | | 32 mm dia | Metre | 358.00 | 1170 | 418,860 |
| e) | | 40 mm dia | Metre | 417.00 | 860 | 358,620 |
| f) | | 50 mm dia | Metre | 535.00 | 850 | 454,750 |
| g) | | 65 mm dia | Metre | 678.00 | 1640 | 1,111,920 |

| PHE WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| h) | | 80 mm dia | Metre | 812.00 | 930 | 755,160 |
| i) | | 100 mm dia | Metre | 1,113.00 | 310 | 345,030 |
| j) | | 150 mm dia | Metre | 1,383.00 | 85 | 117,555 |
| | | | | | | |
| 2.0 | **NON DSR** | Providing & fixing full way lever operated forged brass ball valve of brass body with forged brass hard chromeplated steel ball tested to a pressure not less than 15 Kg / sqcm with threaded / flanged joints complete with nuts, bolts, gaskets, washers etc. and fixing to pipework with metal adaptor. | | | | |
| a) | | 15 mm dia | Nos. | 324.00 | 460 | 149,040 |
| b) | | 20 mm dia | Nos. | 462.00 | 775 | 358,050 |
| c) | | 25 mm dia | Nos. | 714.48 | 805 | 575,160 |
| d) | | 32 mm dia | Nos. | 1,233.95 | 762 | 940,268 |
| e) | | 40 mm dia | Nos. | 1,755.18 | 48 | 84,249 |
| f) | | 50 mm dia | Nos. | 2,563.63 | 34 | 87,164 |
| | | | | | | |
| 3.0 | **NON DSR** | Providing and fixing nsulation on hot water supply pipes, closed Cell Polyolefin Foam which should not have thermal conductivity exceeding 0.034 W/m.K at an average temp of 0 ºC. The density of material shall be 30 ±5 kg/m3, capable to operate in the range of –80degC to+95degC. The material should be (H)CFC- Free. Insulation shall be certified as BS 476 part 7 class 1 complete. The insulation material should not release ammonia and ammonium to prevent SCC (stress crack corrosion. The Joints of Insulation and Fittings should be covered with ThermaTape. The Tape should be Self Adhesive and made of Polyolefin Material. and complete in all respect. | | | | |
| a) | | 15 mm dia (6 mm thickness) | Metre | 76.10 | 310 | 23,591 |
| b) | | 20 mm dia (6 mm thickness) | Metre | 81.00 | 360 | 29,160 |
| c) | | 25 mm dia (13 mm thickness) | Metre | 140.00 | 225 | 31,500 |
| d) | | 32 mm dia (19 mm thickness) | Metre | 180.00 | 150 | 27,000 |
| e) | | 40 mm dia (19 mm thickness) | Metre | 220.00 | 10 | 2,200 |
| | | | | | | |
| 4.0 | **NON DSR** | Providing, fixing, testing & commissioning of following size electromagnetic flow meter - equipped and connected with data logger sensor, ABB type or equivalent, including but not limited to the following: bolts, Gaskets, reducers, coupling, flanges, jacking and concrete supports, complete and as directed by the Engineer-in-Charge. | | | | |
| a) | | On 40 dia pipe line | Each | 37,503.00 | 2 | 75,006 |
| b) | | On 50 dia pipe line | Each | 38,980.00 | 2 | 77,960 |
| c) | | On 65 dia pipe line | Each | 43,114.00 | 9 | 388,026 |
| d) | | On 80 dia pipe line | Each | 44,886.00 | 3 | 134,658 |
| e) | | On 100 dia pipe line | Each | 50,201.00 | 0 | |
| f) | | On 150 dia pipe line | Each | 62,013.00 | 0 | |
| g) | | On 200 dia pipe line | Each | 79,731.00 | 2 | 159,462 |
| | | | | | | |

| PHE WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| 5.0 | NON DSR | Providing supplying and fixing of approved make 20mm dia Auto Air vent of approved brand and manufacture for cold water supply risers. Body in brass UNI EN-12165:98, Plug in brass UNI EN-12165:98, Float in polypropylene(PP). suitable for pressure not less than 10 Kg/Sq.cm, with unions etc. Complete as per direction of the Engineer-in-Charge. | Each | 1,075.40 | 116 | 124,746 |
| | | | | | | |
| 6.0 | NON DSR | Providing and fixing local level controllers near / on each overhead tank, comprising of control module and level sensor SS guide and float type, to close the Motorised valve ( installed at the inlet line of the tank ) when the level in the tank is high and open the valve when the level in the tank is low. ( The power to this controller shall be provided to the vendor at the installation point ) It shall include one no. byepass assembly including fittings, specials and flanges etc. as required. ( The complete set up shall be required to be installed just before the inlet of overhead tank which can be 10 - 15 feet above the roof top terrace level. The contractor should take this into account while quoting. (For Domestic Water Supply). It should be compatible with BMS System. | Each | 16,000.00 | 42 | 672,000 |
| | | | | | | |
| 7.0 | NON DSR | Providing, fixing, testing and commissioning C.I. body, Motorised Butterfly valve (PN10 rating) with quarter turn, on/off electric actuator, SG Iron disc with EPDM/Nitrile seat, wafer type,with panel, IP-67 water tight alluminium enclosure with postion indicator working on operated by float type level controller and manually, VOLTAGE 220V AC | | | | |
| a) | | 25 mm dia. Nominal bore | Each | 16,206.00 | 14 | 226,884 |
| b) | | 32 mm dia. Nominal bore | Each | 16,656.00 | 14 | 233,184 |
| | | | | | | |
| 8.0 | NON DSR | Providing and fixing of screwed end Gun Metal Pressure Reducing valves as per IS 9739 : 1981 with inbuilt filter/strainer, complete with all bypass connections including valves, pressure gauge at inlet and outlet and necessary flanges as required. The system should be tested to a pressure not less than 15 Kg/Sq.cm and suitable to reduce the pressure upto 3 Kg/Sq.cm) Including flanges/ unions, nuts, bolts and washers complete as required. (Pressure gauge and isolation valves shall be paid as per seperate item.) | | | | |
| a) | | 15mm dia | Each | 1,280.00 | 144 | 184,320 |
| b) | | 20mm dia | Each | 1,614.00 | 175 | 282,450 |
| c) | | 25mm dia | Each | 2,940.00 | 385 | 1,131,900 |
| d) | | 32mm dia | Each | 3,617.00 | 340 | 1,229,780 |
| e) | | 40mm dia | Each | 4,094.00 | 126 | 515,844 |

| PHE WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| f) | | 50mm dia | Each | 5,867.00 | 126 | 739,242 |
| | | | | | | |
| 9.0 | **NON DSR** | Providing and fixing M.S. structural work fabricated from structural steel sections M.S. rounds, angles, channels, tees, square bars, plates including U Clamps, cutting to size, drilling, welding fixing and welding to insert plates in RCC structural works, as directed by Architects. M.S. ladders and tank covers & frame etc. cutting and making good the wall and floor where ever required including two coats of synthetic enamel paint/epoxy paint over a coat of primer zinc chrome. | Kg | 90.00 | 11500 | 1,035,000 |
| | | | | | | |
| 10.0 | **NON DSR** | Providing and fixing Galvanised pipes sleeves upto 600mm length of the following diameter fabricated / cut from G.I ( Heavy Class) pipe of Jindal Hissar or eq. make embedded in concrete/masonary work with alignment as per standard Detail to the satisfaction of Development Manager. | | | | |
| a) | | 50 mm dia | Each | 680.00 | 140 | 95,200 |
| b) | | 65 mm dia | Each | 890.00 | 280 | 249,200 |
| c) | | 80 mm dia | Each | 1,260.00 | 420 | 529,200 |
| d) | | 100 mm dia | Each | 1,400.00 | 560 | 784,000 |
| e) | | 125 mm dia | Each | 1,620.00 | 700 | 1,134,000 |
| f) | | 150 mm dia | Each | 1,800.00 | 1600 | 2,880,000 |
| g) | | 180 mm dia | Each | 2,000.00 | 1050 | 2,100,000 |
| h) | | 200 mm dia | Each | 2,200.00 | 700 | 1,540,000 |
| i) | | 250 mm dia | Each | 2,600.00 | 140 | 364,000 |
| | | | | | | |
| 11.0 | **NON DSR** | Providing & fixing Galvanised Puddle Flange threaded/ flanged ends as per ASME/ANSI 16.5 B Class 150 the case may be, upto 750 mm long of the following diameter with Square size equal to 3 times the dia of pipes fabricated from G.I. (Heavy class) pipe of Jindal Hissar or from mild steel pipes with Hot Dip Galvanisation [For water tanks, retaining walls or as specified in the drawings] | | | | |
| a) | | 25 mm dia | Each | 850.00 | 70 | 59,500 |
| b) | | 50 mm dia | Each | 980.00 | 132 | 129,360 |
| c) | | 65 mm dia | Each | 1,240.00 | 76 | 94,240 |
| d) | | 80 mm dia | Each | 1,800.00 | 106 | 190,800 |
| e) | | 100 mm dia | Each | 3,200.00 | 104 | 332,800 |
| f) | | 150 mm dia | Each | 4,200.00 | 134 | 562,800 |
| g) | | 200 mm dia | Each | 5,000.00 | 70 | 350,000 |
| h) | | 250 mm dia | Each | 6,800.00 | 70 | 476,000 |
| i) | | | | | | |
| | | **TOTAL FOR SUBHEAD C** | | | | 25,836,769 |
| | | **EXTERNAL WORKS** | | | | |
| **D.** | | **WATER-SUPPLY (EXTERNAL)** | | | | |
| | | | | | | |

| PHE WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| 1.0 | **NON DSR** | Providing, fixing, jointing and testing in position the following heavy class (Class C) G.I. pipes conforming to IS:1239 cut to required lengths including all necessary fittings and specials such as bends, tees, unions, reducers, flanges & plugs etc. Fittings shall be hot dip galvanized butt weld seamless fittings of schedule 80. The work shall be be complete with all nessary fittings, accessories and pipe identification tape required for complete installations as directed & specified. | | | | |
| a) | | 25 mm dia nominal bore | Metre | 296.00 | 60 | 17,760 |
| b) | | 32 mm dia nominal bore | Metre | 358.00 | 45 | 16,110 |
| c) | | 40 mm dia nominal bore | Metre | 417.00 | 38 | 15,846 |
| d) | | 50 mm dia nominal bore | Metre | 535.00 | 72 | 38,520 |
| e) | | 65 mm dia nominal bore | Metre | 678.00 | 64 | 43,392 |
| f) | | 80 mm dia nominal bore | Metre | 812.00 | 90 | 73,080 |
| g) | | 100 mm dia nominal bore | Metre | 1,113.00 | 600 | 667,800 |
| h) | | 150 mm dia nominal bore | Metre | 1,383.00 | 500 | 691,500 |
| | | | | | | |
| 2.0 | **NON DSR** | Providing and filling sand of grading zone V or coarser grade, allround the G.I./D.I./HDPE pipes in external work : | | | | |
| a) | | 200 mm diameter pipe | Metre | 256.00 | 4500 | 1,152,000 |
| | | | | | | |
| 3.0 | **NON DSR** | Providing and fixing weather Proof treatment by applying Pypkote Primer @ 100 gm/sqm. There after wrapping 150 mm wide 6mm thick Pypkote (AW - 6mm) Protection coating by thermo fusion process over lap shall be maintained at 50mm (for burried pipe) (Pipe shall be provided with anti crossive protective treatment Pypkote / Coatek confirming to AWWA C 203 / IS 10221 standard complete as per specification). The installation of tape shall be done as per approved manufacturer's recommendations. | | | | |
| a) | | 25 mm dia. nominal bore | Metre | 180.00 | 60 | 10,800 |
| b) | | 32 mm dia. nominal bore | Metre | 200.00 | 45 | 9,000 |
| c) | | 40 mm dia. nominal bore | Metre | 220.00 | 38 | 8,360 |
| d) | | 50 mm dia. nominal bore | Metre | 250.00 | 72 | 18,000 |
| e) | | 65 mm dia. nominal bore | Metre | 350.00 | 64 | 22,400 |
| f) | | 80 mm dia. nominal bore | Metre | 500.00 | 90 | 45,000 |
| g) | | 100 mm dia nominal bore | Metre | 650.00 | 600 | 390,000 |
| h) | | 150 mm dia nominal bore | Metre | 860.00 | 500 | 430,000 |
| | | | | | | |
| 4.0 | **NON DSR** | Providing and fixing truck fill point consisting of 150 mm dia water filling point having 150 mm dia brass plug (Truck fill point shall be housed in suitable lockable chamber) | Each | 12,000.00 | 2 | 24,000 |
| | | | | | | |

| PHE WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| 5.0 | NON DSR | Effecting connection from Existing Water Supply line for ductile iron 200 dia pipe including necessary excavation & making good the same including cutting, boring and tapping the Existing line by providing and installing ferrule / Tee connections with necessary fittings as required and making good the same. The rate for this item also includes complete services from the contractor for liasoning works such as filing necessary applications, submission of forms for approval to the municipal authorities, depositing the fees / other amounts as required for getting the premises / installations, inspected and approved and all other formalities required till the water connection is obtained.<br><br>All the expenses incurred in this regard shall be borne by the Contractor except for the official payments to be made for any security deposit etc. which will be reimbursed on production of original voucher. | LS | 150,000.00 | 1 | 150,000 |
| | | | | | | |
| | | **TOTAL FOR HEAD D** | | | | 3,823,568 |
| **E.** | | **EXTERNAL SEWERAGE SYSTEM** | | | | |
| | | | | | | |
| 1.0 | NON DSR | Extra for excavating trenches for pipes, cables, etc. in all kinds of soil exceeding 4m in depth but not exceeding 6 m. (Rate is over and above corresponding basic DSR item no. 2.10 for depth upto 1.5 metre). | | | | |
| | | **All kinds of soil** | | | | |
| | | Pipes, cables etc. exceeding 80 mm dia. but not exceeding 300 mm dia | Metre | 1,145.65 | 80 | 91,652 |
| | | | | | | |
| 2.0 | NON DSR | Extra for excavating trenches for pipes, cables, etc. in ordinary/hard rock exceeding 4m in depth but not exceeding 6m. (Rate is over and above corresponding basic DSR item no. 2.13 for depth upto 1.5 metre). | | | | |
| | | **Ordinary rock :** | | | | |
| a) | | Pipes, cables etc. exceeding 80 mm dia. but not exceeding 300 mm dia | Metre | 2,026.35 | 50 | 101,318 |
| | | **Hard rock (blasting prohibited):** | | | | |
| b) | | Pipes, cables etc. exceeding 80 mm dia. but not exceeding 300 mm dia | Metre | 3,918.00 | 50 | 195,900 |
| | | | | | | |
| 3.0 | NON DSR | Providing laying and lowering Non Pressure NP-3 class (Medium duty) R.C.C. pipes including collars/spigot jointed with stiff mixture of cement mortar in the proportion of 1:2 (1 cement : 2 fine sand) including testing of joints etc. complete. including pipe bedding as per standard design: | | | | |
| a) | | 200 mm diameter | Metre | 610.52 | 490 | 299,155 |
| b) | | 250 mm diameter | Metre | 661.45 | 250 | 165,363 |
| c) | | 300 mm diameter | Metre | 953.87 | 200 | 190,774 |

| PHE WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| | | | | | | |
| 4.0 | NON DSR | Supply, Laying, Lowering, Jointing, Field Testing, Commissioning complete at site of HDPE (PE63 Grade Compound) Pipes PN-6 (6.0 kg/sqcm) as per IS: 14333 and specifications for drainage application, including all cost of material, fittings, labour required, transportation, loading, unloading & stacking etc. complete. | | | | |
| a) | | 200 OD pipe | Metre | 3,871.30 | 450 | 1,742,085 |
| | | | | | | |
| | | **TOTAL FOR HEAD E** | | | | 2,786,246 |
| **F.** | | **EXTERNAL STORM WATER DRAINAGE** | | | | |
| | | | | | | |
| 1.0 | NON DSR | Excavating trenches of required width for pipes, cables, etc including excavation for sockets, and dressing of sides, ramming of bottoms, depth upto 1.5 m, including getting out the excavated soil, and then returning the soil as required, in layers not exceeding 20 cm in depth, including consolidating each deposited layer by ramming, watering, etc. and disposing of surplus excavated soil as directed, within a lead of 50 m : | | | | |
| a) | | **All kinds of soil** | | | | |
| | | Pipes, cables etc. exceeding 600 mm dia but not exceeding 800 mm | Metre | 650.00 | 80 | 52,000 |
| | | | | | | |
| 2.0 | NON DSR | Extra for excavating trenches for pipes, cables etc. in all kinds of soil for depth exceeding 1.5 m, but not exceeding 3 m. (Rate is over corresponding basic item for depth upto 1.5 metre). | | | | |
| a) | | **All kinds of soil** | | | | |
| | | Pipes, cables etc. exceeding 600 mm dia but not exceeding 800 mm | Metre | 885.00 | 80 | 70,800 |
| | | | | | | |
| 3.0 | NON DSR | Extra for excavating trenches for pipes, cables, etc. in all kinds of soil exceeding 3m in depth but not exceeding 4.5 m. (Rate is over corresponding basic item for depth upto 1.5 metre). | | | | |
| a) | | **All kinds of soil** | | | | |
| | | Pipes, cables etc. exceeding 600 mm dia but not exceeding 800 mm | Metre | 2,270.00 | 50 | 113,500 |
| | | | | | | |
| 4.0 | NON DSR | Excavating trenches of required width for pipes, cables, etc, including excavation for sockets, depth upto 1.5 m, including getting out the excavated materials, returning the soil as required in layers not exceeding 20 cm in depth, including consolidating each deposited layers by ramming, watering etc., stacking serviceable material for measurements and disposal of unserviceable material as directed, within a lead of 50 m : | | | | |
| a) | | **Ordinary rock :** | | | | |

| PHE WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| | | Pipes, cables etc. exceeding 600 mm dia but not exceeding 800 mm | Metre | 622.00 | 50 | 31,100 |
| b) | | **Hard rock (blasting prohibited):** | | | | |
| | | Pipes, cables etc. exceeding 600 mm dia but not exceeding 800 mm | Metre | 1,202.00 | 50 | 60,100 |
| | | | | | | |
| 5.0 | **NON DSR** | Extra for excavating trenches for pipes, cables, etc. in ordinary/hard rock exceeding 1.5 m in depth but not exceeding 3 m. (Rate is over corresponding basic item for depth upto 1.5 metre). | | | | |
| a) | | **Ordinary rock :** | | | | |
| | | Pipes, cables etc. exceeding 600 mm dia but not exceeding 800 mm | Metre | 659.00 | 50 | 32,950 |
| b) | | **Hard rock (blasting prohibited):** | | | | |
| | | Pipes, cables etc. exceeding 600 mm dia but not exceeding 800 mm | Metre | 1,062.00 | 50 | 53,100 |
| | | | | | | |
| 6.0 | **NON DSR** | Extra for excavating trenches for pipes, cables, etc. in ordinary/hard rock exceeding 3m in depth but not exceeding 4.5 m. (Rate is over corresponding basic item for depth upto 1.5 metre). | | | | |
| a) | | **Ordinary rock :** | | | | |
| | | Pipes, cables etc. exceeding 600 mm dia but not exceeding 800 mm | Metre | 1,641.00 | 50 | 82,050 |
| b) | | **Hard rock (blasting prohibited):** | | | | |
| | | Pipes, cables etc. exceeding 600 mm dia but not exceeding 800 mm | Metre | 3,174.00 | 50 | 158,700 |
| | | | | | | |
| 7.0 | **NON DSR** | Providing and laying non-pressure NP2 class (light duty) R.C.C. pipes with collars jointed with stiff mixture of cement mortar in the proportion of 1:2 (1 cement : 2 fine sand) including testing of joints etc. complete : | | | | |
| a) | | 200 mm.dia. R.C.C. pipe | Metre | 549.00 | 670 | 367,830 |
| b) | | 400 mm dia. R.C.C. pipe | Metre | 1,051.00 | 600 | 630,600 |
| | | | | | | |
| 8.0 | **NON DSR** | Providing and fixing over straight or curved drain DI grating with fixed frame inclusive of all fittings complete. | | | | |
| a) | | 300x600 (HD-C250) | Each | 3,948.00 | 50 | 197,400 |
| b) | | 450x600 (HD-C250) | Each | 4,507.00 | 50 | 225,350 |
| | | | | | | |
| 9.0 | **NON DSR** | Providing and fixing F.R.P. Grating. (Load Bearing cap. 2.5 T, suitable for car parking, basement, Pump room, Parking Area) (Required angle size 35x35x5mm) | | | | |
| a) | | 266mm x 1006 mm x 30mm | Each | 2,303.00 | 50 | 115,150 |
| b) | | 303mm x 1006 mm x 30mm | Each | 2,572.00 | 50 | 128,600 |
| c) | | 377mm x 1006 mm x 30mm | Each | 3,111.00 | 500 | 1,555,500 |
| | | | | | | |

| PHE WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| 10.0 | NON DSR | Constructing brick masonry grease trap chamber with FPS bricks of class designation 3.5 in cement mortar 1:4 (1cement:4 coarse sand) R.C.C top slab of 150mm thickness with 1:2:4 mix (1 cement:2 coarse sand:4 graded stone aggregate 20mm nominal size) external plastering to a height of 30 cm on all sides & inside plastering with 12mm thick with cement mortar 1:3 (1 cement : 3 coarse sand) finished with floating coat of neat cement and making channels in cement concrete 1:2:4(1 cement:2 coarse sand:4 graded stone aggregate 40mm nominal size) finished with a floating coat of neat cement, two RCC baffle walls of 150 mm thick, medium duty SFRC covers and frame of 60 x 60 cm etc. complete and as per the directions of the Engineer-in-charge/ Architects. | | | | |
| a) | | 1800 x1200x1200mm effective depth | Each | 65,000.00 | 8 | 520,000 |
| | | | | | | |
| 11.0 | NON DSR | Supplying and fixing of Stainless Slot gratings of size 500x180x105mm confirming to Load Class C250 as per EN DIN 1433. The gratings to be laid on polymer concrete channels as per specifications of the manufacturer and instructions of Engineer-in-charge. (Make: ACO, catalogue no :49962 or approved equivalent) | Each | 12,115.00 | 20 | 242,300 |
| | | | | | | |
| 12.0 | NON DSR | Supplying and fixing of Stainless Slot gratings of size 500x174x128mm for maintenace opening and confirming to Load Class C250 as per EN DIN 1433. The gratings to be laid on polymer concrete channels as per specifications of the manufacturer and instructions of Engineer-in-charge. (Make:ACO, catalogue no:49963 or approved equivalent) | Each | 32,177.00 | 40 | 1,287,080 |
| | | | | | | |
| 13.0 | NON DSR | Providing & fixing Ductile Iron Manhole cover with frame: | | | | |
| a) | | 600 x 600 mm, Light Duty (A-15), Wt - 40 kg | Each | 3,631.00 | 10 | 36,310 |
| b) | | 600 x 600 mm, Medium Duty (B-125), Wt - 65 kg | Each | 5,870.00 | 12 | 70,440 |
| c) | | 600 x 600 mm, Heavy Duty (C-250), Wt - 90 kg | Each | 8,134.00 | 15 | 122,010 |
| d) | | 600 mm dia, Medium Duty (B-125), Wt - 60 kg | Each | 6,714.00 | 10 | 67,140 |
| e) | | 600 mm dia, Heavy Duty (C-250), Wt - 85 kg | Each | 7,658.00 | 16 | 122,528 |
| f) | | 450 x 450 mm, Grating with frame (LD) | Each | 2,914.00 | 18 | 52,452 |
| g) | | 450 x 600 mm, Grating with frame (LD) | Each | 3,453.00 | 12 | 41,436 |
| h) | | 600 x 600 mm, Grating with frame (MD) | Each | 6,315.00 | 12 | 75,780 |
| | | | | | | |
| 14.0 | | Providing and fixing SFRC perforated heavy duty manhole cover of 610 mm dia with lifting lugs and frame for storm water manhole. | Each | 2,800.00 | 40 | 112,000 |
| | | | | | | |
| | | **TOTAL FOR HEAD F** | | | | 6,624,206 |
| **G.** | | **GARDEN IRRIGATION SYSTEM** | | | | |
| | | | | | | |

| PHE WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| 1.0 | NON DSR | Providing, fixing, testing and commissioning of HDPE pipe conforming IS 4984 suitable for the respective working pressures with all fittings and accessories e.g. couplings, tees, bends, reducers, screwed adapters, flanged tail pieces etc. jointing as per manufacturers' recommendation. | | | | |
| a) | | HDPE pipe 110mm-10 kg/cm2, PE-100 | RM | 1,020.50 | 2150 | 2,194,075 |
| b) | | HDPE pipe 75mm-6 kg/cm2, PE-100 | RM | 399.00 | 100 | 39,900 |
| c) | | HDPE pipe 63mm-6 kg/cm2, PE-100 | RM | 293.00 | 100 | 29,300 |
| d) | | HDPE pipe 50mm-6 kg/cm2, PE-100 | RM | 202.30 | 120 | 24,276 |
| e) | | HDPE pipe 40mm-6 kg/cm2, PE-80 | RM | 145.00 | 180 | 26,100 |
| f) | | HDPE pipe 32mm-8 kg/cm2, PE-80 | RM | 126.00 | 140 | 17,640 |
| g) | | HDPE pipe 25mm-10 kg/cm2, PE-80 | RM | 104.00 | 100 | 10,400 |
| | | | | | | |
| 2.0 | | Providing, fixing, testing and commissioning of self closing spring loaded quick coupling 25mm hydrant made of brass & having self closing thermoplastic hinged lid. | Each | 1,420.00 | 40 | 56,800 |
| | | | | | | |
| 3.0 | | Providing, fixing, testing and commissioning of 25mm key for quick coupling hydrant made up of brass. | Each | 600.00 | 40 | 24,000 |
| | | | | | | |
| 4.0 | | Providing, fixing, testing and commissioning Brass Swivel Hose Elbow 25mm X 25mm. | Each | 620.00 | 40 | 24,800 |
| | | | | | | |
| | | **TOTAL FOR HEAD G** | | | | 2,447,291 |
| **H.** | **NON DSR** | **SEWERAGE TREATEMENT PLANT** | | | | |
| | | **Design, Erection, Supply, installation, testing and commissioning of following items:** | | | | |
| 1.0 | | Supply Installation, testing and commissioning of Sewerage Treatment Plant of capacities of 360 KLD - 1 No. & 280 KLD- 1 No. and ETP of capacity of 3 KLD -1 No. based on Pytorid technology of NEERI, Nagpur. The scope includes designing, construction, supply, installation, testing and commissioning of Phytorid based Effluent /Sewage Treatment Plant by a licensee of Phytorid technology having minimum of three years of experience of similar work. The rates shall include design approval by CSIR-NEERI and the RCC structural design approval by IIT Delhi.The work shall be carried out through specialized agency approved by the engineer-in-charge. | | | | |

| PHE WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| | | The scope includes design and construction of Collection sump tank, Pre-settling tank and Phytorid bed including plantation with all plumbing, electrical and mechanical equipments, pumps for ETP and STP including supply, installation, testing and commissioning of pipe, suction & delivery header, NRV, ball valve & butterfly valve flange, nipples, bypass line and associated accessories complete in all respects from collection tank to phytorid bed (both inclusive) upto the satisfaction of Engineer–in-charge . The work shall also include loading, unloading, safe storage of material and equipments and painting at site. The rates shall include two years DLP and obtaining consent from the state pollution control board. | | | | |
| | | Note: The guaranteed performance/outlet parameters should meet the state pollution control board standards. The contractor shall be responsible for obtaining consent for the ETP & STP from the state pollution control board. However, the statutory fees shall be reimbursed by SAU on production of valid receipts. | | | | |
| | **a.** | STP 360 KLD Capacity | Job | 15,075,000.00 | 1 | 15,075,000 |
| | **b.** | STP 280 KLD capacity | Job | 11,525,000.00 | 1 | 11,525,000 |
| | **c.** | ETP 3 KLD capacity | Job | 800,000.00 | 1 | 800,000 |
| | | | | | | |
| | | **STP Works (Electro-mechanical works after phytorid bed)** | | | | |
| 2.0 | | **Pumps:** | | | | |
| 2.1 | | SITC of Fully submersible, centrifugal non-clog type sewage handling pumps as per technical specifications & other associated works & accessories etc.complete as reqd. | | | | |
| | | Flow rate (each) = 30 m3 / hr @ 20-25 mtr hd | | | | |
| | | Solid Handling = 10-12mm | | | | |
| | | Set of Pump (3 Nos. – 2 W + 1 S) | Set | 450,000.00 | 1 | 450,000 |
| | | | | | | |
| 2.2 | | SITC of Centrifuge non-submersible type pumps as per technical specifications & other associated works & accessories etc.complete. | | | | |
| | | | | | | |
| 2.2.1 | | Filter Feed Pumps -Flow rate (each) = 50 m3 / hr @ 30-35 mtr hd | | | | |
| | | Set of Pump (3 Nos. – 2 W + 1 S) | Set | 360,000.00 | 1 | 360,000 |
| | | | | | | |
| 2.2.2 | | Softner Feed Pumps -Flow rate (each) = 25 m3 / hr @ 25-30 mtr hd | | | | |
| | | Set of Pump (3 Nos. – 2 W + 1 S) | Set | 280,000.00 | 1 | 280,000 |
| | | | | | | |
| 2.2.3 | | Soft Water Transfer Pumps -Flow rate (each) = 25 m3 / hr @ 25-30 mtr hd | | | | |
| | | Set of Pump (3 Nos. – 2 W + 1 S) | Set | 280,000.00 | 1 | 280,000 |
| | | | | | | |

| PHE WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| 2.2.4 | | Irrigation Water Transfer Pump -Flow rate (each) = 20 m3 / hr @ 50-55 mtr hd | | | | |
| | | Set of Pump (3 Nos. – 2 W + 1 S) | Set | 280,000.00 | 1 | 280,000 |
| | | | | | | |
| 2.3 | | SITC of Flushing water transfer pumps (Hydro-pneumatic pumps with VFD on each pump): Control panel with cables, sensors & accessories and Factory assembled as per technical specifications with pressure vessel of 450 ltr of 2 Nos polypropylene vessel & other associated works & accessories etc.complete as reqd. The complete pump set should be factory assembled only. | | | | |
| | | Flow Rate ( each) - 65 m3 / hr @ 75-80 m hd | | | | |
| | | (4 Nos. - 3 W +1 S) | Set | 1,200,000.00 | 1 | 1,200,000 |
| | | | | | | |
| | | Plant room drainage pumps: | | | | |
| 2.4 | | SITC of Single stage single entry drainage pumps (1W+1SB) as per techical specifications & other associated works & accessories etc.complete as reqd. | | | | |
| | | Flow rate (each) = 10.8 m3 / hr @ 10-12 mtr | Set | 85,000.00 | 1 | 85,000 |
| | | | | | | |
| 2.5 | | **Filters:** | | | | |
| | | Supply, installation, testing and commissioning of vertical Filter of MS construction & other associated works & accessories etc.complete as reqd. Flow rate - 50 m3/hr, Filteration Velocity = 12m3/m2/hr | | | | |
| 2.5.1 | | Multigrade Pressure Sand Filter with back wash pump: | Set | 450,000.00 | 2 | 900,000 |
| 2.5.2 | | Activated Carbon Filter: | Set | 400,000.00 | 2 | 800,000 |
| 2.5.3 | | Softener with salt saturation arrangement: Inlet hardness 400 ppm, outlet less than 5 ppm, Flow rate - 25 m3/hr | Set | 450,000.00 | 2 | 900,000 |
| | | | | | | |
| 2.6 | | Chlorine dosing: | | | | |
| | | Supply, installation, testing and commissioning of electronic metering type of Chlorine dosing pump of 12 lph (1W+1SB) with 2 nos. PP tank of 500 ltrs each & other associated works like piping, valves, clamps & accessories etc. complete as reqd. | Set | 85,000.00 | 1 | 85,000 |
| | | | | | | |
| 2.7 | | Ozonator | | | | |
| | | Supplying, installing, testing and commissioning of Ozone generation capacity as required, Built-in Oxygen Feed Gas System With Compressor. | Nos. | 900,000.00 | 2 | 1,800,000 |
| | | | | | | |

| PHE WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| 2.8 | | Supply, fixing, testing & commissioning of Plant room Piping with GI heavy class pipe with fittings and diaphragm type valves, gauges, controller, indicator, instrumentation etc., for all plumbing works for pump room (after phytorid bed to soft water tank) and complete system should be compatible with BMS. | Lot | 550,000.00 | 1 | 550,000 |
| | | | | | | |
| 2.9 | | Providing, installing, testing and commissioning of Water Flow meter Electro magnetic type ( Inlet To STP & Treated water Lines for Flushing, Soft water and Irrigation system) | | | | |
| | | On 200 dia line | Nos. | 155,000.00 | 2 | 310,000 |
| | | On 150 dia line | Nos. | 140,000.00 | 2 | 280,000 |
| | | On 100 dia line | Nos. | 115,000.00 | 2 | 230,000 |
| | | | | | | |
| 2.10 | | Providing, installing, testing and commissioning of Online digital type pH meter. | Nos. | 15,000.00 | 1 | 15,000 |
| | | | | | | |
| 2.11 | | Supply, installation, testing and commissioning of front operated, front access, totally enclosed, free standing, dust and vermin proof Panel (Indoor type) with IP 54 ingress protection, fabricated from 2 mm thick CRCA sheets, with hinged, gasketted and lockable doors including the cost of interconnections, copper crimping lugs, brass glands, bonding to earth and painting, suitable for use at 415 volts, 3 phase 4 wire 50 Hz system with 16 KA rupturing capacity at 415 volts complete. | | | | |
| | | Electrical Motor Control Centre shall be suitable for all equipments connected to the STP with 3 Nos of spare feeders | | | | |
| | | Inter unit cabling for all equipments with necessary armoured/unarmoured cables with necessary termination lugs, glands etc<br>complete - lot | | | | |
| | | (The Shop drawing to be prepared and approved before fabrication) | Set | 450,000.00 | 1 | 450,000 |
| | | | | | | |
| | | **TOTAL FOR HEAD H** | | | | 36,655,000 |
| **I.** | **NON DSR** | **WATER TREATMENT PLANT** | | | | |
| | | **Supply, installation, testing, commissioning of :** | | | | |
| 1.0 | | Centrifuge non-submersible type pumps as per techical specifications & other associated works & accessories etc.complete | | | | |
| | | Filter feed pump, Softener feed pump, Soft water transfer pumps | | | | |
| 1.1 | | Flow rate (each) = 25 m3 / hr @ 30 mtr hd | | | | |
| | | Set of Pump (3 Nos. – 2 W + 1 S) | Set | 280,000.00 | 3 | 840,000 |
| | | | | | | |

| PHE WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| 1.2 | | Fully submersible, centrifugal non-clog type with 10-12 solid handling capacity Lake water transfer pumps -Flow rate (each) = 54 m3 / hr @ 12-15 mtr hd including Control panel with cables, sensors & accessories complete. | | | | |
| | | Set of Pump (2 Nos. – 1 W + 1 S) | Set | 600,000.00 | 1 | 600,000 |
| | | | | | | |
| 1.3 | | Single stage single entry fully submersible pumps for basement drainage 10-12mm solid handling capacity including Control panel with cables, sensors & accessories complete. | | | | |
| | | Flow rate (each) = 12 m3 / hr @ 10-12 mtr | | | | |
| | | Set of Pump (2 Nos. – 1 W + 1 S) | Set | 90,000.00 | 15 | 1,350,000 |
| | | | | | | |
| 1.4 | | Domestic water transfer pumps (Hydro-pneumatic pumps with VFD on each pump): Control panel with cables, sensors & accessories and Factory assembled set as per technical specifications with pressure vessel of 450 ltr of 2 Nos polypropylene vessel & other associated works & accessories etc.complete as reqd. | | | | |
| | | Flow Rate ( each) - 65 m3 / hr @ 80 m hd | | | | |
| | | (4 Nos. - 3 W +1 S) | Set | 1,200,000.00 | 1 | 1,200,000 |
| | | | | | | |
| 2.0 | | **Filters:** | | | | |
| | | Supply, installation, testing and commissioning of vertical Filter of MS construction & other associated works & accessories etc.complete as reqd. Flow rate - 25 m3/hr, Filteration Velocity = 15m3/m2/hr | | | | |
| 2.1 | | Multigrade Pressure Sand Filter with back wash pump: | Set | 350,000.00 | 2 | 700,000 |
| 2.2 | | Activated Carbon Filter | Set | 300,000.00 | 2 | 600,000 |
| 2.3 | | Softener with salt saturation arrangement: Inlet hardness 400 ppm, outlet less than 5 ppm | Set | 450,000.00 | 2 | 900,000 |
| | | Contractor has responsibility to check the water hardness from actual water analysis report before procuring the equipment. | | | | |
| | | | | | | |
| | | Chlorine dosing: | | | | |
| 3.0 | | Supply, installation, testing and commissioning of electronic metering type of Chlorine dosing pump of 12 lph (1W+1SB) with PP tank 2 nos. of 500 ltrs & other associated works & accessories etc.complete as reqd. | Set | 70,000.00 | 1 | 70,000 |
| | | | | | | |
| 4.0 | | Supply, fixing, testing & commission of Plant room Piping with GI heavy class pipes with fittings and diaphragm type valves, gauges, indicator, controller, instrumentation etc., for all plumbing works in pump room. The complete system should be BMS compatible. | Job | 450,000.00 | 1 | 450,000 |
| | | | | | | |

| PHE WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| 5.0 | | Supply, installation, testing and commissioning of tanker inlet connection complete with 200 mm dia GI (heavy) inlet piping (approx.20 mtr.), hose inlet connection, MS cabinet enclosure (epoxy painted after fabriction), pad locking arrangement, inlet flexible hose complete with all necessary arrangement. | Nos. | 80,000.00 | 2 | 160,000 |
| | | | | | | |
| 6.0 | | Supply, installation, testing and commissioning of front operated, front access, totally enclosed, free standing, dust and vermin proof Panel (Indoor type) with IP 54 ingress protection, fabricated from 2 mm thick CRCA sheets, with hinged, gasketted and lockable doors including the cost of interconnections, copper crimping lugs, brass glands, bonding to earth and painting, suitable for use at 415 volts, 3 phase 4 wire 50 Hz system with 16 KA rupturing capacity at 415 volts complete. | | | | |
| | | Electrical Motor Control Centre shall be suitable for all equipments connected to the WTP with 3 Nos of spare feeders | | | | |
| | | Inter unit cabling for all equipments with necessary armoured/ unarmoured cables with necessary termination lugs, glands etc. complete - lot | | | | |
| | | (The Shop drawing to be prepared and approved before fabrication) | Set | 450,000.00 | 1 | 450,000 |
| | | | | | | |
| | | **TOTAL FOR HEAD I** | | | | 7,320,000 |
| **J.** | **NON DSR** | **SOLAR HOT WATER SYSTEM FOR HOT WATER GENERATION** | | | | |
| | | | | | | |
| | | Providing, fixing, installation, testing and commissioning of Solar Hot Water direct/indirect Heating system using heating liquid medium comprising of flat plate solar panels, including all interconnecting piping, pressure type glass enameled coated insulated hot water storage tank, including valves on inlet, outlet, air release valve all mounted on powder coated galvanized MS sections complete. | | | | |
| | | Solar water heating system based on Flat plat collector system technology with output capacity of as mentioned below with hot water at 60 degree centigrade having reqired Nos. solar collectors and reqired nos. of electric heating element each controlled by thermostat as per complete item as per technical specification. The system has to be installed by Manufacturers authorised distributors/approved specialised firms of Solar water heating system. | | | | |

| PHE WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item No. | Description of Work | Unit | Rate | TOTAL | |
| | | | | | Total Quantity | Total Amount |
| | | COLLECTOR: Solar System of Capacity 500 Litre/day (With 4 no of Solar Collector) of 2Sqm area each. For 300 LPD ( with 3 collectors) of 2 sqm area each. For 200 LPD ( 2 collectors) of 2 sq m area each. For 100 LPD ( 1 collector) of 2 sqm. Absorptivity : 0.95 +/- 0.02 and Emmisivity: 0.047 +/- 0.02. The collector should withsatnd 10 bar pressure. | | | | |
| | | COLLECTOR GLASS: Collector glass should be textured toughned of minimum 3.2 mm with minimum iron percentage. | | | | |
| | | | | | | |
| | | TANK: The storage tank to be well insulated with CFC free Polyurethane foam 50 mm thick. Outer case should be minimum 0.4mm pre coated metal sheet (Cold Roll Cold Ani) which can withstand hard weather without loosing its color and look. The tank to be 2.50 mm thick made of low carbon steel (MS) with glass enamel coating of minimum 250 micron. The tank should withstand 6 bar pressure and 7.5 bar under test conditions. The tank should have a sacrificial Anode of 20 mm Magnesium and an electrical heating element of 3 KW for no sunshine days. | | | | |
| | | Heat Transfer Closed Circuit Fluid:<br>Only Anti scaling, Anti-corrosion and Anti-freeze Propylene Glycol food grade liquid shall be used on the primary closed circuit mixed with distilled water. | | | | |
| | | **Installation**<br>Solar hot water collectors must be installed on roof with tilt and exposed to direct sun (without shadowing). They should be tilted towards equator (south direction) with angles as per latitude of the location. Single unit or multiple units can be connected together in series to cover the desired daily hot water load. | | | | |
| a) | | Quantity of 500 Ltrs. Capacity | Set | 165,900.00 | 5 | 829,500 |
| b) | | Quantity of 300 Ltrs. Capacity | Set | 133,875.00 | 2 | 267,750 |
| | | **TOTAL FOR HEAD J** | | | | 1,097,250 |
| **TOTAL NON DSR - PHE WORKS** | | | | | | **135,148,994** |

## SUMMARY OF FF WORKS

| S.No | Description of Work | AMOUNT (RS.) | |
|---|---|---|---|
| | | DSR | NON DSR |
| | | | |
| A. | FIRE PUMPS, EQUIPMENT, PIPING, VALVES & ACCESSORIES : | 2089956 | 5741649 |
| B. | FIRE HYDRANT SYSTEM (INTERNAL) | 21914031 | 20296948 |
| C. | FIRE HYDRANT SYSTEM (EXTERNAL) | 15199012 | 7572955 |
| D. | SPRINKLER SYSTEM | 25224428 | 31881108 |
| E. | FIRE EXTINGUISHERS | - | 10637249 |
| F. | GAS SUPPRESSION SYSTEM FOR ADMIN BLOCK SERVER FLOOR (3RD FL) | - | 34628427 |
| G. | FIRE SUPPRESSION SYSTEM FOR ELECTRICAL PANELS | - | 8982560 |
| | | | |
| | **TOTAL** | **64427426** | **119740896** |
| | **TOTAL (DSR + NON DSR)** | **184168322** | |

## FIRE FIGHTING WORKS - DSR

| S.No | DSR Item No. | Description of Work | Unit | Rate | Total Quantity | Total Amount |
|---|---|---|---|---|---|---|
| | | | | | | |
| A | | **FIRE PUMPS, EQUIPMENT, PIPING, VALVES & ACCESSORIES :** | | | | |
| | | | | | | |
| 1.0 | DSR E&M 16.7.4 | Y-Strainer of ductile CI body flanged ends with stainless steel strainer for chilled/ hot water circulation including insulation as specified | | | | |
| | | | | | | |
| a) | 16.7.4.1 | 200mm dia | Each | 20,741.00 | 10 | 207,410 |
| b) | 16.7.4.2 | 150mm dia | Each | 10,418.00 | 10 | 104,180 |
| c) | 16.7.4.4 | 100mm dia | Each | 6,806.00 | 8 | 54,448 |
| d) | 16.7.4.5 | 80mm dia | Each | 4,948.00 | 6 | 29,688 |
| e) | 16.7.4.6 | 65mm dia | Each | 4,746.00 | 6 | 28,476 |
| | | | | | | |
| 2.0 | DSR E&M 16.8 | Providing and fixing in position the industrial type pressure gauges with gun metal/ brass valves complete as required. | Each | 958.00 | 24 | 22,992 |
| | | | | | | |
| 3.0 | DSR E&M 16.10.1 | Supplying, fixing, testing and commissioning of condenser water pipes of following sizes of MS 'C' class along with necessary clamps, vibration isolators and fittings such as bends,tees etc.but excluding valves, strainers, gauges etc.adequately supported on rigid supports duly painted/buried in ground excavation and refilling etc. as per specification and as required complete in all respect. | | | | |
| | | Note:-The Pipes size 150mm & below shall be M.S. 'C' class as per IS : 1239 and pipes size above 150mm shall be welded black steel pipe heavy class as per IS: 3589, from minimum 6.35mm thick M.S. Sheet for pipes upto 350 mm dia. And from minimum 7mm thick MS sheet for pipes of 400 mm dia and above. | | | | |
| | 16.10.1.6 | 100 mm dia | RM | 1,399.00 | 60 | 83,940 |
| | 16.10.1.4 | 150 mm dia | RM | 1,942.00 | 150 | 291,300 |
| | 16.10.1.3 | 200 mm dia | RM | 2,875.00 | 100 | 287,500 |
| | 16.10.1.2 | 250 mm dia | RM | 3,485.00 | 50 | 174,250 |
| | 16.10.1.1 | 300 mm dia | RM | 4,140.00 | 50 | 207,000 |
| | | | | | | |
| 4.0 | DSR E&M 16.11.1 | Supplying, fixing, testing and commissioning of following size BUTTERFLY VALVE (MANUAL) with C I body SS disc nitrile sheet & O-ring & PN 16 pressure rating as specified. | | | | |
| a) | 16.11.1.1 | 200 mm dia | Each | 10,199.00 | 16 | 163,184 |
| b) | 16.11.1.2 | 150 mm dia | Each | 5,845.00 | 14 | 81,830 |
| c) | 16.11.1.4 | 100 mm dia | Each | 4,615.00 | 10 | 46,150 |
| d) | 16.11.1.5 | 80 mm dia | Each | 3,256.00 | 12 | 39,072 |
| e) | 16.11.1.6 | 65 mm dia | Each | 2,921.00 | 10 | 29,210 |
| f) | 16.11.1.7 | 50 mm dia | Each | 2,634.00 | 6 | 15,804 |
| g) | 16.11.1.8 | 40 mm dia | Each | 2,329.00 | 6 | 13,974 |
| | | | | | | |

## FIRE FIGHTING WORKS - DSR

| S.No | DSR Item No. | Description of Work | Unit | Rate | Total Quantity | Total Amount |
|---|---|---|---|---|---|---|
| 5.0 | DSR E&M 16.11.2 | NON - RETURN VALVE with dual plate of C I body SS plates vulcanized NBR seal flanged end & PN 16 pressure rating as specified. | | | | |
| a) | 16.11.2.1 | 200 mm dia | Each | 8,740.00 | 4 | 34,960 |
| b) | 16.11.2.2 | 150 mm dia | Each | 5,705.00 | 8 | 45,640 |
| c) | 16.11.2.4 | 100 mm dia | Each | 3,257.00 | 6 | 19,542 |
| d) | 16.11.2.5 | 80 mm dia | Each | 2,345.00 | 6 | 14,070 |
| e) | 16.11.2.6 | 65 mm dia | Each | 2,011.00 | 4 | 8,044 |
| g) | 16.11.2.7 | 50 mm dia | Each | 2,634.00 | 4 | 10,536 |
| | | | | | | |
| 6.0 | 18.31 | Providing and fixing C.I. sluice valves (with cap) complete with bolts,nuts, rubber insertions etc. (the tail pieces if required will be paid separately) : | | | | |
| a) | 18.31.1 | 100 mm dia | | | | |
| | 18.31.1.2 | Class II | Each | 3,921.30 | 1 | 3,921 |
| b) | 18.31.3 | 150 mm dia | | | | |
| | 18.31.3.2 | Class II | Each | 5,694.00 | 1 | 5,694 |
| c) | 18.31.4 | 200 mm diameter | | | | |
| | 18.31.4.2 | Class II | Each | 11,579.00 | 1 | 11,579 |
| d) | 18.31.5 | 250 mm diameter | | | | |
| | 18.31.5.2 | Class II | Each | 18,520.65 | 3 | 55,562 |
| | | | | | | |
| | | **TOTAL FOR SUB HEAD (A) CARRIED OVER TO SUMMARY** | | | | 2,089,956 |
| | | | | | | |
| **B.** | | **FIRE HYDRANT SYSTEM (INTERNAL)** | | | | |
| 1.0 | 2.10 | Excavating trenches of required width for pipes, cables, etc including excavation for sockets, and dressing of sides, ramming of bottoms, depth upto 1.5 m, including getting out the excavated soil, and then returning the soil as required, in layers not exceeding 20 cm in depth, including consolidating each deposited layer by ramming, watering, etc. and disposing of surplus excavated soil as directed, within a lead of 50 m : | | | | |
| | 2.10.1 | **All Kinds of Soil** | | | | |
| | 2.10.1.2 | Pipes, cables etc. exceeding 80 mm dia. but not exceeding 300 mm dia | RM | 208.30 | 2400 | 499,920 |
| 2.0 | 2.13 | Excavating trenches of required width for pipes, cables, etc, including excavation for sockets, depth upto 1.5 m, including getting out the excavated materials, returning the soil as required in layers not exceeding 20 cm in depth, including consolidating each deposited layers by ramming, watering etc., stacking serviceable material for measurements and disposal of unserviceable material as directed, within a lead of 50 m : | | | | |
| | 2.13.1 | **Ordinary rock :** | | | | |
| | 2.13.1.2 | Pipes, cables etc. exceeding 80 mm dia but not exceeding 300 mm dia | Metre | 450.30 | 900 | 405,270 |
| | 2.13.3 | **Hard rock (blasting prohibited):** | | | | |
| | 2.13.3.2 | Pipes, cables etc. exceeding 80 mm dia but not exceeding 300 mm dia | Metre | 870.70 | 500 | 435,350 |
| | | | | | | |

## FIRE FIGHTING WORKS - DSR

| S.No | DSR Item No. | Description of Work | Unit | Rate | Total Quantity | Total Amount |
|---|---|---|---|---|---|---|
| 3.0 | DSR E&M 16.10.1 | Supplying, fixing, testing and commissioning of condenser water pipes of following sizes of MS 'C' class along with necessary clamps, vibration isolators and fittings such as bends,tees etc.but excluding valves, strainers, gauges etc.adequately supported on rigid supports duly painted/buried in ground excavation and refilling etc. as per specification and as required complete in all respect. | | | | |
| | | Note:-The Pipes size 150mm & below shall be M.S. 'C' class as per IS : 1239 and pipes size above 150mm shall be welded black steel pipe heavy class as per IS: 3589, from minimum 6.35mm thick M.S. Sheet for pipes upto 350 mm dia. And from minimum 7mm thick MS sheet for pipes of 400 mm dia and above. | | | | |
| a) | 16.10.1.3 | 200 mm dia | RM | 2,875.00 | 3200 | 9,200,000 |
| | 16.10.1.4 | 150 mm dia | RM | 1,942.00 | 4155 | 8,069,010 |
| | 16.10.1.6 | 100 mm dia | RM | 1,399.00 | 1415 | 1,979,585 |
| | | | | | | |
| 4.0 | DSR E&M 16.11.1 | Supplying, fixing, testing and commissioning of following size BUTTERFLY VALVE (MANUAL) with C I body SS disc nitrile sheet & O-ring & PN 16 pressure rating as specified. | | | | |
| a) | 16.11.1.1 | 200mm nominal dia | Each | 10,199.00 | 10 | 101,990 |
| b) | 16.11.1.2 | 150mm nominal dia | Each | 5,845.00 | 62 | 362,390 |
| c) | 16.11.1.4 | 100mm nominal dia | Each | 4,615.00 | 20 | 92,300 |
| | | | | | | |
| 5.0 | DSR E&M 16.11.2 | NON - RETURN VALVE with dual plate of C I body SS plates vulcanized NBR seal flanged end & PN 16 pressure rating as specified. | | | | |
| a) | 16.11.2.2 | 150mm nominal dia | Each | 5,705.00 | 47 | 268,135 |
| b) | 16.11.2.4 | 100mm nominal dia | Each | 3,257.00 | 10 | 32,570 |
| | | | | | | |
| 6.0 | DSR E&M 16.8 | Providing and fixing in position the industrial type pressure gauges with gun metal/ brass valves complete as required. | Each | 958.00 | 320 | 306,560 |
| | | | | | | |
| 7.0 | 18.35 | Constructing masonry Chamber 120x120x100 cm inside, in brick work in cement mortar 1:4 (1 cement : 4 coarse sand) for sluice valve, with C.I. surface box 100 mm top diameter, 160 mm bottom diameter and 180 mm deep ( inside) with chained lid and RCC top slab 1:2:4 mix (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) , i/c necessary excavation, foundation concrete 1:5:10 (1 cement : 5 fine sand : 10 graded stone aggregate 40 mm nominal size) and inside plastering with cement mortar 1:3 (1 cement : 3 coarse sand) 12 mm thick, finished with a floating coat of neat cement complete as per standard design : | | | | |
| | 18.35.1 | With common burnt clay F.P.S.(non modular) bricks of class designation 7.5 | Each | 16,095.10 | 10 | 160,951 |

## FIRE FIGHTING WORKS - DSR

| S.No | DSR Item No. | Description of Work | Unit | Rate | Total Quantity | Total Amount |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | **TOTAL FOR SUB HEAD (B) CARRIED OVER TO SUMMARY** | | | | 21,914,031 |
| **C.** | | **FIRE HYDRANT SYSTEM (EXTERNAL)** | | | | |
| | | | | | | |
| 1.0 | 2.10 | Excavating trenches of required width for pipes, cables, etc including excavation for sockets, and dressing of sides, ramming of bottoms, depth upto 1.5 m, including getting out the excavated soil, and then returning the soil as required, in layers not exceeding 20 cm in depth, including consolidating each deposited layer by ramming, watering, etc. and disposing of surplus excavated soil as directed, within a lead of 50 m : | | | | |
| | 2.10.1 | **All Kinds of Soil** | | | | |
| | 2.10.1.1 | Pipes, cables etc, not exceeding 80 mm dia. | RM | 127.55 | 1250 | 159,438 |
| | 2.10.1.2 | Pipes, cables etc. exceeding 80 mm dia. but not exceeding 300 mm dia | RM | 208.30 | 2400 | 499,920 |
| 2.0 | 2.13 | Excavating trenches of required width for pipes, cables, etc, including excavation for sockets, depth upto 1.5 m, including getting out the excavated materials, returning the soil as required in layers not exceeding 20 cm in depth, including consolidating each deposited layers by ramming, watering etc., stacking serviceable material for measurements and disposal of unserviceable material as directed, within a lead of 50 m : | | | | |
| | 2.13.1 | **Ordinary rock :** | | | | |
| | 2.13.1.1 | Pipes, cables etc. not exceeding 80 mm dia | Metre | 181.85 | 410 | 74,559 |
| | 2.13.1.2 | Pipes, cables etc. exceeding 80 mm dia but not exceeding 300 mm dia | Metre | 450.30 | 1180 | 531,354 |
| | 2.13.3 | **Hard rock (blasting prohibited):** | | | | |
| | 2.13.3.1 | Pipes, cables etc. not exceeding 80 mm dia | Metre | 351.65 | 400 | 140,660 |
| | 2.13.3.2 | Pipes, cables etc. exceeding 80 mm dia but not exceeding 300 mm dia | Metre | 870.70 | 330 | 287,331 |
| | | | | | | |
| 3.0 | DSR E&M 16.10.1 | Supplying, fixing, testing and commissioning of condenser water pipes of following sizes of MS 'C' class along with necessary clamps, vibration isolators and fittings such as bends,tees etc.but excluding valves, strainers, gauges etc.adequately supported on rigid supports duly painted/buried in ground excavation and refilling etc. as per specification and as required complete in all respect. | | | | |
| | | Note:-The Pipes size 150mm & below shall be M.S. 'C' class as per IS : 1239 and pipes size above 150mm shall be welded black steel pipe heavy class as per IS: 3589, from minimum 6.35mm thick M.S. Sheet for pipes upto 350 mm dia. And from minimum 7mm thick MS sheet for pipes of 400 mm dia and above. | | | | |
| a) | 16.10.1.3 | 200 mm dia | RM | 2,875.00 | 3200 | 9,200,000 |
| b) | 16.10.1.4 | 150 mm dia | RM | 1,942.00 | 625 | 1,213,750 |

## FIRE FIGHTING WORKS - DSR

| S.No | DSR Item No. | Description of Work | Unit | Rate | Total Quantity | Total Amount |
|---|---|---|---|---|---|---|
| c) | 16.10.1.6 | 100 mm dia | RM | 1,399.00 | 650 | 909,350 |
| | | | | | | |
| 4.0 | 19.35 | Providing and laying Non Pressure NP-3 class (Medium duty) R.C.C. pipes including collars/spigot jointed with stiff mixture of cement mortar in the proportion of 1:2 (1 cement : 2 fine sand) including testing of joints etc. Complete | | | | |
| | 19.35.1 | 450 mm dia RCC pipes. | RM | 1,920.50 | 800 | 1,536,400 |
| | | | | | | |
| 5.0 | DSR E&M 16.11.1 | Supplying, fixing, testing and commissioning of following size BUTTERFLY VALVE (MANUAL) with C I body SS disc nitrile sheet & O-ring & PN 16 pressure rating as specified. | | | | |
| a) | 16.11.1.1 | 200mm nominal dia | Each | 10,199.00 | 12 | 122,388 |
| b) | 16.11.1.2 | 150mm nominal dia | Each | 5,845.00 | 2 | 11,690 |
| c) | 16.11.1.4 | 100mm nominal dia | Each | 4,615.00 | 2 | 9,230 |
| | | | | | | |
| 6.0 | 18.36 | Constructing masonry Chamber 60x60x75 cm, inside in brick work in cement mortar 1:4 (1 cement : 4 coarse sand) for fire hydrants, with C.I. surface box 350x350 mm top and 165 mm deep ( inside) with chained lid and RCC top slab 1:2:4 mix (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) , i/c necessary excavation, foundation concrete 1:5:10 (1 cement : 5 fine sand:10 graded stone aggregate 40 mm nominal size) and inside plastering with cement mortar 1:3 (1 cement : 3 coarse sand) 12 mm thick, finished with a floating coat of neat cement complete as per standard design: | | | | |
| | 18.36.1 | With common burnt clay F.P.S.(non modular) bricks of class designation 7.5 | Each | 6,431.70 | 10 | 64,317 |
| | | | | | | |
| 7.0 | 18.34 | Constructing masonary chamber 90x90x100 cm, inside with 75 class designation brick work in cement mortar 1:5 (1 cement: 5 fine sand) for butterfly valve, with C.I. Surface box 100mm top diameter, 160mm bottom diameter and 180mm deep (inside) with chained lid and RCC top slab 1:2:4 mix. ( 1 cement : 2 coarse sand : 4 graded stone aggregate 20mm nominal size) necessary excavation foundation concrete 1:5:10 ( 1 cement : 5 fine sand : 10 graded stone aggregate 40mm nominal size) and inside plastering with cement mortar 1:3 (1 cement : 3 coarse sand) 12mm thick finished with a floating coat of neat cement complete as per standard design : | | | | |
| | 18.34.1 | With FPS bricks of class designation 7.5. | Each | 11,672.35 | 10 | 116,724 |
| | | | | | | |

## FIRE FIGHTING WORKS - DSR

| S.No | DSR Item No. | Description of Work | Unit | Rate | Total Quantity | Total Amount |
|---|---|---|---|---|---|---|
| 8.0 | 18.35 | Constructing masonry Chamber 120x120x100 cm inside, in brick work in cement mortar 1:4 (1 cement : 4 coarse sand) for sluice valve, with C.I. surface box 100 mm top diameter, 160 mm bottom diameter and 180 mm deep ( inside) with chained lid and RCC top slab 1:2:4 mix (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) , i/c necessary excavation, foundation concrete 1:5:10 (1 cement : 5 fine sand : 10 graded stone aggregate 40 mm nominal size) and inside plastering with cement mortar 1:3 (1 cement : 3 coarse sand) 12 mm thick, finished with a floating coat of neat cement complete as per standard design : | | | | |
| | 18.35.1 | With common burnt clay F.P.S.(non modular) bricks of class designation 7.5 | Each | 16,095.10 | 20 | 321,902 |
| | | | | | | |
| | | **TOTAL FOR SUB HEAD (C) CARRIED OVER TO SUMMARY** | | | | 15,199,012 |
| **D.** | | **SPRINKLER SYSTEM** | | | | |
| | | | | | | |
| 1.0 | 2.10 | Excavating trenches of required width for pipes, cables, etc including excavation for sockets, and dressing of sides, ramming of bottoms, depth upto 1.5 m, including getting out the excavated soil, and then returning the soil as required, in layers not exceeding 20 cm in depth, including consolidating each deposited layer by ramming, watering, etc. and disposing of surplus excavated soil as directed, within a lead of 50 m : | | | | |
| | 2.10.1 | All Kinds of Soil | | | | |
| | 2.10.1.2 | Pipes, cables etc. exceeding 80 mm dia. but not exceeding 300 mm dia | RM | 208.30 | 2800 | 583,240 |
| 2.0 | 2.13 | Excavating trenches of required width for pipes, cables, etc, including excavation for sockets, depth upto 1.5 m, including getting out the excavated materials, returning the soil as required in layers not exceeding 20 cm in depth, including consolidating each deposited layers by ramming, watering etc., stacking serviceable material for measurements and disposal of unserviceable material as directed, within a lead of 50 m : | | | | |
| | 2.13.1 | **Ordinary rock :** | | | | |
| | 2.13.1.2 | Pipes, cables etc. exceeding 80 mm dia but not exceeding 300 mm dia | Metre | 450.30 | 1300 | 585,390 |
| | 2.13.3 | **Hard rock (blasting prohibited):** | | | | |
| | 2.13.3.2 | Pipes, cables etc. exceeding 80 mm dia but not exceeding 300 mm dia | Metre | 870.70 | 380 | 330,866 |
| | | | | | | |

## FIRE FIGHTING WORKS - DSR

| S.No | DSR Item No. | Description of Work | Unit | Rate | Total Quantity | Total Amount |
|---|---|---|---|---|---|---|
| 3.0 | DSR E&M 16.10.1 | Supplying, fixing, testing and commissioning of condenser water pipes of following sizes of MS 'C' class along with necessary clamps, vibration isolators and fittings such as bends,tees etc.but excluding valves, strainers, gauges etc.adequately supported on rigid supports duly painted/buried in ground excavation and refilling etc. as per specification and as required complete in all respect. | | | | |
| | | Note:-The Pipes size 150mm & below shall be M.S. 'C' class as per IS : 1239 and pipes size above 150mm shall be welded black steel pipe heavy class as per IS: 3589, from minimum 6.35mm thick M.S. Sheet for pipes upto 350 mm dia. And from minimum 7mm thick MS sheet for pipes of 400 mm dia and above. | | | | |
| a) | 16.10.1.3 | 200 mm dia | RM | 2,875.00 | 3200 | 9,200,000 |
| b) | 16.10.1.4 | 150 mm dia | RM | 1,942.00 | 5490 | 10,661,580 |
| c) | 16.10.1.6 | 100 mm dia | RM | 1,399.00 | 1350 | 1,888,650 |
| | | | | | | |
| 4.0 | DSR E&M 16.8 | Providing and fixing in position the industrial type pressure gauges with gun metal/ brass valves complete as required. | Each | 958.00 | 306 | 293,148 |
| | | | | | | |
| 5.0 | DSR E&M 16.11.1 | Supplying, fixing, testing and commissioning of following size BUTTERFLY VALVE (MANUAL) with C I body SS disc nitrile sheet & O-ring & PN 16 pressure rating as specified. | | | | |
| a) | 16.11.1.1 | 200mm nominal dia | Each | 10,199.00 | 15 | 152,985 |
| b) | 16.11.1.2 | 150mm nominal dia | Each | 5,845.00 | 109 | 637,105 |
| c) | 16.11.1.4 | 100mm nominal dia | Each | 4,615.00 | 66 | 304,590 |
| d) | 16.11.1.5 | 80 mm nominal dia | Each | 3,256.00 | 24 | 78,144 |
| e) | 16.11.1.6 | 65 mm nominal dia | Each | 2,921.00 | 24 | 70,104 |
| | | | | | | |
| 6.0 | 18.34 | Constructing masonary chamber 90x90x100 cm, inside with 75 class designation brick work in cement mortar 1:5 (1 cement: 5 fine sand) for butterfly valve, with C.I. Surface box 100mm top diameter, 160mm bottom diameter and 180mm deep (inside) with chained lid and RCC top slab 1:2:4 mix. ( 1 cement : 2 coarse sand : 4 graded stone aggregate 20mm nominal size) necessary excavation foundation concrete 1:5:10 ( 1 cement : 5 fine sand : 10 graded stone aggregate 40mm nominal size) and inside plastering with cement mortar 1:3 (1 cement : 3 coarse sand) 12mm thick finished with a floating coat of neat cement complete as per standard design : | | | | |
| | 18.34.1 | With FPS bricks of class designation 7.5. | Each | 11,672.35 | 10 | 116,724 |
| | | | | | | |

## FIRE FIGHTING WORKS - DSR

| S.No | DSR Item No. | Description of Work | Unit | Rate | Total Quantity | Total Amount |
|---|---|---|---|---|---|---|
| 7.0 | 18.35 | Constructing masonry Chamber 120x120x100 cm inside, in brick work in cement mortar 1:4 (1 cement : 4 coarse sand) for sluice valve, with C.I. surface box 100 mm top diameter, 160 mm bottom diameter and 180 mm deep ( inside) with chained lid and RCC top slab 1:2:4 mix (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) , i/c necessary excavation, foundation concrete 1:5:10 (1 cement : 5 fine sand : 10 graded stone aggregate 40 mm nominal size) and inside plastering with cement mortar 1:3 (1 cement : 3 coarse sand) 12 mm thick, finished with a floating coat of neat cement complete as per standard design : | | | | |
| | 18.35.1 | With common burnt clay F.P.S.(non modular) bricks of class designation 7.5 | Each | 16,095.10 | 20 | 321,902 |
| | | | | | | |
| | | **TOTAL FOR SUB HEAD D CARRIED OVER TO SUMMARY** | | | | **25,224,428** |
| **TOTAL DSR - FF WORKS** | | | | | | **64,427,426** |

**FIRE FIGHTING WORKS - NON DSR**

| S.No | DSR Item No. | Description of Work | Unit | Rate | Total Quantity | Total Amount |
|---|---|---|---|---|---|---|
| **A.** | | **FIRE PUMPS, EQUIPMENT, PIPING, VALVES & ACCESSORIES :** | | | | |
| | | | | | | |
| 1 | **NON DSR** | **FIRE FIGHTING PUMPS & ACCESSORIES:** | | | | |
| | | | | | | |
| | | **Electric Motor Driven Hydrant / Sprinkler Pump:** | | | | |
| | | Supply, installation, testing and commissioning of electrically driven high pressure centrifugal fire hydrant / sprinkler pump, suitable for automatic/manual operation consisting of the following: | | | | |
| i) | | End Suction, high pressure single/ multistage centrifugal type fire pump capable of delivering 2850 LPM against a total head of 88 M while running at 2900 RPM complete with gland / mechanical seal, proper connection to suction and delivery line, and including 80 mm bypass arrangement for testing of pumps, having a name plate indicating suction, delivery, head, discharge, stages, RPM and direction of rotation. | | | | |
| | | Pump shall be capable of furnishing not less than 150% of rated capacity at a head not less than 65 % of rated head. The shut off head shall not exceed 120% of rated head. | | | | |
| | | | | | | |
| ii) | | Squirrel cage, induction motor, TEFC type, efficiency class. eff-1, suitable for 415 + 10%V, 3 phase, 50 Hz, AC supply, of suitable HP rating for the above pump with asynchronous speed of 2900 RPM conforming to IP 55 protection & class 'F' insulation. The motor shall conform to IS 12615 : 2011, IS: 12066 - 1987 and IS 325 : 1978 (up to date) with expansion bellow, flexible coupling and coupling guard. | | | | |
| iii) | | Common base plate for mounting pump and motor fabricated of mild steel channel / Cast iron frame as per manufacturer's recommendation with heavy duty Anti Vibration pads (6 Nos., heavy duty). | | | | |
| iv) | | Suitable reinforced cement concrete pump foundation as per manufacturer's design including foundation bolts, washers as required. | | | | |
| v) | | Flexible Coupling and coupling guard for direct coupling of pump and motor. | | | | |
| vi) | | Drain Pipe with Valve (50 mm dia) | | | | |
| | | Main Fire Pump/Sprinkler Pump | | | | |
| | | Flow : 2850 LPM | | | | |
| | | Head (approx.) : 88 Metres | | | | |
| vii) | | Rate should include interconnection cables and foundation bolts, grouting of Foundation bolts and other accessories required. | Each | 303,796.13 | 4 | **1,215,185** |
| | | | | | | |
| 2 | **NON DSR** | **Diesel Engine Driven Fire Pump [Stand by pump] (Location - Basement Plant Room) :** | | | | |

**FIRE FIGHTING WORKS - NON DSR**

| S.No | DSR Item No. | Description of Work | Unit | Rate | Total Quantity | Total Amount |
|---|---|---|---|---|---|---|
| | | Supply, installation, testing and commissioning of Diesel Engine driven fire pump suitable for automatic operation comprising of the following and conforming to BS 649/IS 10002 all amended upto date. | | | | |
| i) | | Horizontal, end suction, high pressure centrifugal pump, suitable for operation on 415 volts ± 6%, 3 phase, 50 HZ A.C supply. The installation shall be complete with flexible coupling and coupling guard as required. Fire pump shall have C.I. casing, CS diffusers, bronze impeller (hard finished and dynamically balanced) and SS (304) shaft with gland / mechanical seal, capable for delivering 2850 LPM at outlet head of 88 mts to ensure a minimum pressure of 3.5 Kg/Sqcm at the farthest or topmost hydrant / sprinkler. The installation shall be complete with necessary pressure gauge with gun metal shut off cock on delivery side, expansion bellow complete (The pump should be tested for bench mark at factory and shall be gotten approved by the Local fire Authority). | | | | |
| | | Pump shall be capable of furnishing not less than 150% of rated capacity at a head of not less than 65% of the rated head. The shut off head shall not exceed 120% of rated head. | | | | |
| ii) | | Radiator / heat exchanger Water cooled diesel engine of 105 BHP or as per manufacturer recommendation at 1500 RPM for the above pump complete with standard accessories & suitable cooling system as described in specifications.(Diesel engine shall be 4 cylinder 2 stroke engine with turbo charger.) | | | | |
| iii) | | Common base plate for mounting pump & engine of required strength manufactured out of M.S. channels as per manufacture's recommendation with heavy duty Anti Vibration pads. (Cushy foot) (8 nos., heavy duty). | | | | |
| iv) | | Flexible Coupling & coupling guard for direct coupling of engine & pump. | | | | |
| v) | | Suitable reinforced cement concrete pump foundations as per manufacturer design including foundation bolts, washer as required. | | | | |
| vi) | | 1 No. 8 hours capacity day oil storage tank fabricated from 3 mm thick M.S. plates. Tank shall be provided with inlet, outlet, overflow, air vent, drain connections, filling connection & magnetic level indicator. Tank shall be mounted on a suitable steel structure (Painted with 2 coats of red oxide paint). Tank shall be provided with epoxy coat from inside & two or more coats of synthetic enamel paint outside over two coats of red oxide primer. Diesel storage tank shall be double skin. The rate should include first time fill of HSD in day oil tank. | | | | |

**FIRE FIGHTING WORKS - NON DSR**

| S.No | DSR Item No. | Description of Work | Unit | Rate | Total Quantity | Total Amount |
|---|---|---|---|---|---|---|
| vii) | | 24 volts 180 AH lead acid battery (12 volts - 2 Nos) with boost/Trickle charger for starting the engine automatically complete as required. | | | | |
| viii) | | Provision for starting of Engine automatically in case of power failure at the time of fire | | | | |
| | | Diesel Engine driven pump of: | | | | |
| | | Flow : 2850 LPM | | | | |
| | | Head (approx.) : 88 M | | | | |
| ix) | | Rate should include inter connecting cables & foundation bolts, grouting of Foundation bolts and other accessories required. | Each | 491,244.81 | 2 | **982,490** |
| | | | | | | |
| 3 | **NON DSR** | **Electrical Motor Driven Jockey Pump (Location - Basement Plant Room) :** | | | | |
| | | Supplying, installing, testing & commissioning of fire authority approved electrically driven Jockey pump suitable for automatic/manual operation consisting of the following: | | | | |
| i) | | Horizontal mounted end suction jockey pump having cast iron body, volute bronze impeller, Diffusers, stainless steel (304) shaft capable of delivering 180 LPM against total head of 88 M while running at 2900 RPM complete with mechanical seal pressure gauge with gland / mechanical seal GM cock on the delivery side of pump including bypass arrangement (with 25 mm GM stop valve and up to 5 meter G.I. class 'C' pipe) for testing of working of the pumping set as required. The pump should meet the recommended requirement and must be approved by the local fire authority. | | | | |
| ii) | | Squirrel cage induction motor suitable for 415 + 10%V, 3 phase, 50 Hz, AC supply of suitable HP rating for the above pump with asynchronous speed of 2900 RPM T.E.F.C type having effliciency class eff-1 as per IS 12615 : 2011 & IS: 12066 - 1987 connected to pump with expansion bellow, flexible coupling and coupling guard . | | | | |
| iii) | | Common base plate for mounting pump and motor fabricated of mild steel channel as per manufacturer's recommendation with heavy duty 4 Nos. Anti Vibration pads.(Cushy foot) | | | | |
| iv) | | Suitable reinforced cement concrete pump foundations as per manufacturer's design including foundation bolts, washers as required. | | | | |
| | | Drain pipe with valve (25 mm dia) | | | | |
| v) | | Jockey Pump :- | | | | |
| a) | | Flow : 180 LPM | | | | |
| | | Head (approx.) : 88 M | | | | |
| vi) | | Rate shall include inter connecting cables, grouting of Foundation bolts and other accessories required. | Each | 90,492.47 | 4 | **361,970** |
| | | | | | | |
| 4 | **NON DSR** | **Electrical Motor Driven water curtain Pump:** | | | | |
| | | | | | | |

**FIRE FIGHTING WORKS - NON DSR**

| S.No | DSR Item No. | Description of Work | Unit | Rate | Total Quantity | Total Amount |
|---|---|---|---|---|---|---|
| | | Supplying, installing, testing & commissioning of electrically driven Water Curtain Pump (as per specifications) suitable for automatic /manual operation consisting of the following: | | | | |
| | | End suction horizontally mounted centrifugal pump having cast iron body, stainless steel shaft, bronze impeller running at 2900 r.p.m. capable of delivering 2280 LPM against a total head of 80 meters to ensure a minimum pressure of 3.5 Kg per Sq.cm at the farthest outlet complete with tail pieces for proper connection to suction and delivery line. | | | | |
| | | Squirel cage induction motor totally enclosed fan cooled type suitable for 415 Volt (± 10%) 3 Phase 50 Hz AC supply of suitable capacity for the above pump with Synchronous speed of 2900 rpm confirming to IS 12615 : 2011, IS: 12066 - 1987 & IS:325-1978. | | | | |
| | | Common bed plate of requisite strength manufactured out of M.S. channels of suitable size of ISMC including with suitable nos. of cushy foot mounting below ISMC channel and with suitable C.C. foundation, expansion bellow for pumps etc. complete as required. | | | | |
| | | 1 No. pressure gauge on the pump delivery line with isolation cock. | | | | |
| | | Suitable mechanical seal with mounting arrangement. | | | | |
| | | Tyre type coupling and coupling guard for direct coupling of pump and motor. | | | | |
| | | Drain pipe with valve (25 mm dia. ) | | | | |
| | | Rate should include inter connecting cables & foundation bolts, grouting of Foundation bolts and other accessories required to complete the system. | | | | |
| | | For pump defined above & of duty as follows : | | | | |
| | | For Water Curtain System | | | | |
| | | Flow : 2280 LPM | | | | |
| | | Head : 80 mtrs | Each | 232,694.91 | 2 | **465,390** |
| | | | | | | |
| 5 | **NON DSR** | **CONTROL PANEL FOR FIRE PUMPS** | | | | |

**FIRE FIGHTING WORKS - NON DSR**

| S.No | DSR Item No. | Description of Work | Unit | Rate | Total Quantity | Total Amount |
|---|---|---|---|---|---|---|
| | | Supply, installation, testing and commissioning of following fire fighting panel suitable for 415 V, +/- 10% Volts, 3 phase, 4 wires, 50 Hz power distribution system. The panel shall be free standing floor mounting sheet metal enclosed dust and vermin proof conforming to IP-52, compartmentalized design, fabricated out of 14 SWG sheet steel, painting, earthing numbering, danger plate as per specifications and drawings , flush front with Aluminum bus bars, separate earth bus bars of 40 x 5 mm (Aluminum) to be provided throughout the length of the panel. The incoming and outgoing feeder breakers, fuses, indicating lamps etc shall be accommodated in a modular multitier arrangement. The painting shall be done as per relevant IS codes/as specified in the specifications. | | | | |
| | | Adequate size cable alley shall be provided all round the panel and in the back for each cable bending and termination. The panel shall be fabricated by TAC/Fire authority approved vendor. The outgoing feeders inside the panel shall be connected through solid bus bars. Flexible cable links are not acceptable. All pumps stator feeder must have potential free contact to give status of pump (ON and trip status to fire control panel) Bus bars shall be provided with heat shrinkable sleeves and shall be colour coded. The panels shall be suitable for cable entry from top. The panels shall be fabricated after the approval of fabrication drawings. | | | | |
| | | All wires shall be PVC insulated and cables used will be XLPE insulated. 2 Nos. earthing terminals shall be provided for 3 phase, 415 V, 50 HZ supply system. M Lifting hooks shall also be provided in case of large panels. Cadmium plated hardware shall be used in fabrication of Panels. | | | | |
| | | A. COMMON PANEL IN FIRE PUMP HOUSE | | | | |
| | | (I) INCOMER | | | | |
| | | One (1) No. 630A TPN MCCB (50 KA). | | | | |
| | | One (1) No. Multifunction Meter for measurement of voltages, current and frequency (ELF-3254 of conzerv or approved Equivalent) with suitable ratio CTs and back up SP MCB/Fuses. | | | | |
| | | 1 Set (3 Nos.) of phase indication lamps LED Type with backup SP MCB. | | | | |
| | | Three (3) Nos. of indication lamps for ON/OFF & Trip with backup SP MCB. | | | | |
| | | Incoming feeder must have provision of potential free contact for fire panel. This contact will provide the status of power in Fire fighting pump panel. | | | | |
| | | (II) BUSBAR | | | | |
| | | 800A, 25KA,TPN Aluminium busbar insulated with PVC Colour coded heat shrinkable sleeve. | | | | |

**FIRE FIGHTING WORKS - NON DSR**

| S.No | DSR Item No. | Description of Work | Unit | Rate | Total Quantity | Total Amount |
|---|---|---|---|---|---|---|
| | | Separate earth busbar of 50X6mm Aluminium shall be provided. | | | | |
| | | (III) OUTGOING. | | | | |
| | | a) MAIN FIRE PUMP - 02 Nos | | | | |
| | | 250 Amps TPN MCCB of reqd HP star delta starter with thermal range of 300A with Ammeter (0-300A) with selector switch and CTs of ratio 300/5A , 5VA, Class 1.0. complete with over load relay with separate single phasing protection feature, ON/OFF & TRIP, indication lamp, AC3 duty contactors, Auto/Manual selector switch and sufficient nos. of potential free spare contacts, etc. (For Hydrant & Sprinkler pump) | | | | |
| | | b) JOCKEY PUMP - 02 No | | | | |
| | | 63A TPN MCCB suitable of reqd HP star delta starter with thermal range of 100A with Ammeter (0-100A), selecter switch CTs of ratio 100/5A , 5VA, Class 1.0. complete with over load relay with separate single phasing protection feature, ON/OFF & TRIP, indication lamp, AC3 duty contactors, Auto/Manual selector switch and sufficient nos. of potential free spare contacts, etc. (Jockey Pumps) | | | | |
| | | c) WATER CURTAIN PUMP - 01 No | | | | |
| | | 200A TPN MCCB suitable for reqd HP star delta starter with thermal range of 200A with Ammeter (0-200A), selecter switch CTs of ratio 200/5A , 5VA, Class 1.0. complete with over load relay with separate single phasing protection feature, ON/OFF & TRIP, indication lamp, AC3 duty contactors, Auto/Manual selector switch and sufficient nos. of potential free spare contacts, etc. | | | | |
| | | d) DIESEL ENGINE MAIN PUMP - 01 No | | | | |
| | | Control for Diesel engine comprising:- | | | | |
| | | Auto/Manual selector switch & 3 attempt starting device, timers and relays as required, push buttons, start/stop in manual mode. | | | | |
| | | Indication lamp for High/Low Lub.oil pressure, High Water Temperature. And Engine ON indication. | | | | |
| | | Battery charger suitable for 12 V/24V DC with boost and tickle selector switch, 0-15 V/0-30 V DC volt metre, 0-20A DC Ammetre. | | | | |
| | | d)1 No. 63 A TPN MCB of 10 KA for (L + PDB) | | | | |
| | | e) 1 No. 40A DP MCB (with 5000 VA, 415/24V Transformer for diesel engine) | | | | |
| | | f) One (1) No. 250A TPN MCCB SPARE | | | | |
| | | g) One (1) No. 63 A TPN MCCB SPARE | | | | |
| | | h) One (1) No. 40 A TPN MCB SPARE | | | | |
| | | i) One (1) No. 32 A TPN MCB SPARE | | | | |
| | | All standard relays and accessories for automatic operation of diesel engine. | | | | |
| | | 12V/24V battery of suitable AH rating (minimum 180 AH) | | | | |
| | | SYSTEM CONTROLLER | | | | |

**FIRE FIGHTING WORKS - NON DSR**

| S.No | DSR Item No. | Description of Work | Unit | Rate | Total Quantity | Total Amount |
|---|---|---|---|---|---|---|
| | | Designing, Supply, installation, testing and commissioning of system controller to control operation of Main Electric Fire Pump, Diesel Pump, Pressurization Pump in sequence as per specification consisting of relays, timers, sensors, annunciation window for fault indication, complete as per specification. | | | | |
| | | Panel shall have sufficient NO/NC contacts for extending the status( annunciation) of fire pumps to the Fire alarm panel. | | | | |
| | | | | | | |
| | | All interconnecting power & control wires/cables suitable size within the panel and from panel to motors diesel engine, pressure switches, level switches, cable Tray, pipes etc. including brass glands termination within fire pump house and earthing as per specifications including necessary RCC foundation for mounting of panel. | Each | 1,026,227.64 | 2 | **2,052,455** |
| | | Note:- Contractor should submit necessary shop drawing for approval of electrical consultants before fabricating the panel. | | | | |
| | | | | | | |
| 6 | **NON DSR** | Providing, fixing, testing and commissioning adjustable type pressures switches with isolation valve suitable for operating with hydrant and sprinkler systems for working pressure pressure including electrical wiring complete as required. The cost of electrical wiring will be included in this item. Vendor also need to submit the calibration certificate of Pressure switch. | Each | 1,423.87 | 12 | **17,086** |
| | | | | | | |
| 7 | **NON DSR** | Providing, fixing, testing and commissioning of MS air vessel fabricated from 10mm thick MS plate with dished ends (size 450 mm dia & 1500 mm height) to operate jockey, main & diesel engine driven pumps at drop of pressures complete with adequate pressure switches (design to be submitted by vendor as per requirement) with valves to operate as per operating sequences including 25 mm dia drain valve, air release valve with stop cock on the top, 25 mm dia inlet with isolating valve duly painted from inside and outside with two coats of synthetic enamel paint over a coat of primer complete as required. (Vessel should be suitable for rated working pressure).For pumps. | Each | 42,000.00 | 4 | **168,000** |
| | | | | | | |

**FIRE FIGHTING WORKS - NON DSR**

| S.No | DSR Item No. | Description of Work | Unit | Rate | Total Quantity | Total Amount |
|---|---|---|---|---|---|---|
| 8 | **NON DSR** | Supply, installation, testing and commissioning of Black Mild Steel Pipe class 'C' (heavy duty) conforming to IS:1239 including all accessories such as screwed/welded joints, flanges, tees, reducers etc. including lift to all heights, welding, jointing, and inserted rubber gaskets, nuts, bolts etc. as required shall be fixed in ceiling, Brick work /RCC for all heights with Clamps/structural steel supports (as per TAC norms) and fasteners including cutting, chasing of walls/columns /ceiling etc. including painting of one primary coat of Zinc chromate with two coat of compatible epoxy paint give an even look (fire red, shade No. 536 as per IS:5) including all civil breakages and making good the same as required and wherever the pipes are crossing the walls / floors / ceiling, the sleeves/ cutouts with fire sealent (equivalent to fire wall rating) compound at either end shall be provided. | | | | |
| | | **Notes :** | | | | |
| i) | | Pipe upto 50 mm dia shall be threaded joints, above 50 mm shall be welded joints. | | | | |
| ii) | | For pipe upto 50mm dia threaded forged steel fittings and for pipe above 50mm dia standard Malleable MS fittings with welded joints shall be used. | | | | |
| iii) | | Supports are included in this items. | | | | |
| iv) | | G.I Pipe sleeve of suitable higher size shall be provided wherever the pipes are crossing the wall/ floors and sealing the sleeves with glass wool in between and sealant compound at either end as per Engineer-in-Charge requirement. | | | | |
| | | | | | | |
| a) | | 32 mm dia | RM | 340.51 | 50 | **17,025** |
| b) | | 40 mm dia | RM | 396.12 | 50 | **19,806** |
| c) | | 50 mm dia | RM | 566.68 | 60 | **34,001** |
| d) | | 65 mm dia | RM | 742.69 | 80 | **59,415** |
| e) | | 80 mm dia | RM | 890.30 | 80 | **71,224** |
| | | | | | | |
| 9 | **NON DSR** | Providing, fixing 100 mm dia test line complete with all accessories, valves for testing of fire pumps with bypass arrangment including piping & bypass valves. | Each | 18,000.00 | 2 | **36,000** |
| | | | | | | |
| 10 | **NON DSR** | Supplying, fixing, testing and commissioning of following size BUTTERFLY VALVE (MANUAL) with C I body SS disc nitrile sheet & O-ring & PN 16 pressure rating as specified. | | | | |
| a) | | 250 mm dia (with gear box operation) | Each | 14,796.00 | 4 | **59,184** |
| | | | | | | |
| 11 | **NON DSR** | Providing and fixing NON - RETURN VALVE with dual plate of C I body SS plates vulcanized NBR seal flanged end & PN 16 pressure rating as specified. | | | | |
| a) | | 250 mm dia | Each | 15,723.00 | 4 | **62,892** |

**FIRE FIGHTING WORKS - NON DSR**

| S.No | DSR Item No. | Description of Work | Unit | Rate | Total Quantity | Total Amount |
|---|---|---|---|---|---|---|
| | | | | | | |
| 12 | **NON DSR** | Providing and fixing CI flanged end foot valve as per IS 4038/1979 with brass strainer with erection testing and commissioning and necessary rubber insertion/bolts and nuts etc complete. | | | | |
| a) | | 200 mm dia | Each | 15,513.00 | 2 | **31,026** |
| | | | | | | |
| 13 | **NON DSR** | Providing & fixing rock wool sectional pipe insulation of density 144kg/cub.m. for fire pump exhaust pipes & fittings over a coat of primer held in position with GI bands of 20mm x 24 SWG at 300 centre to centre complete as required. | | | | |
| | | For 200 mm dia pipe - SP insulation 40mm thick | RM | 750.00 | 50 | **37,500** |
| | | | | | | |
| 14 | **NON DSR** | Providing and fixing 25mm dia. Gunmetal fitting for water level indicator gauge complete with isolation cock at top and bottom, heavy gauge transparent polythene tube of upto 3.0m length, 100 mm wide 20mm thick teak wood board duly painted in white and having incriptions of cm and liters in red fitted at the back of the tube on wall with rawl plugs and screws etc. as required. | Each | 4,500.00 | 3 | **13,500** |
| 15 | **NON DSR** | Supply, assembly, erection, testing and commissioning of liquid level controllers with low voltage relays, required number of stainless steel probes and PVC shrouds, wiring from tank top to probes of required length, interconnection between level controller and the concerned contactor, as required for the following functions: | | | | |
| | | To switch on the tubewell pump when the raw water U.G. Tank level is low and switch off when the level is high. | Each | 12,500.00 | 3 | **37,500** |
| | | | | | | |
| | | **TOTAL FOR SUBHEAD (A) CARRIED OVER TO SUMMARY** | | | | **5,741,649** |
| | | | | | | |
| **B.** | | **FIRE HYDRANT SYSTEM (INTERNAL)** | | | | |
| | | | | | | |

**FIRE FIGHTING WORKS - NON DSR**

| S.No | DSR Item No. | Description of Work | Unit | Rate | Total Quantity | Total Amount |
|---|---|---|---|---|---|---|
| 1 | **NON DSR** | Providing, laying, jointing, testing and commissioning of following sizes of M.S. pipes (Class-C) conforming to IS-1239 with all accessories like all fittings (MS fitting with threaded joints below 50mm dia) including tees, elbows, reducers, union, flanges, rubber gaskets, nuts bolts, washer including supporting/fixing the pipe on floor / wall /ceiling with clamps, hangers (using anchor fastners) as per specification. G.I. pipe sleeve of suitable higher size shall be provided wherever the pipes are crossing the walls/floors and sealing the sleeves with glass wool in between & fire sealent material like Navair or equivalent to match the fire rating of the wall / structure including cutting holes and chases in brick, R.C.C work and making good the same to original conditions complete in all respects. | | | | |
| | | All hangers, clamps, brackets etc. shall be of galvanized iron unless specified otherwire and then supply of the same shall also be included for rates under this head. Painting of two coats of synthetic enamel paint over one coat of red oxide zinc chromate primer. Welding of any kind on the galvanized support / hanger shall not be permitted. | | | | |
| | | **Notes :** | | | | |
| (i) | | Pipe upto 50 mm dia shall be threaded joints, above 50 mm shall be welded joints. | | | | |
| (ii) | | For pipe upto 50mm dia threaded forged steel fittings and for pipe above 50mm dia standard Malleable MS fittings with welded joints shall be used. | | | | |
| (iii) | | Supports are included in this items. | | | | |
| (iv) | | G.I Pipe sleeve of suitable higher size shall be provided wherever the pipes are crossing the wall/ floors and sealing the sleeves with glass wool in between and sealant compound at either end as per engineer-in-charge requirement. | | | | |
| a) | | 50 mm dia | RM | 566.68 | 350 | **198,337** |
| b) | | 80 mm dia | RM | 890.30 | 2480 | **2,207,936** |
| | | | | | | |
| 2 | **NON DSR** | Providing protection to embedded heavy class MS pipes and fittings (running below trenches) by applying pyp kote primer (@ 100 gm/sqm) thereafter wrapping 4 mm thick protection coating by thermo fusion process and overlaping of joints shall be done as per manufacturer's specification. Wrapping shall be confirm to ISI 10221 including conducting Holiday Test. | | | | |
| a) | | 200 mm dia | RM | 580.00 | 3200 | **1,856,000** |
| b) | | 150 mm dia | RM | 450.00 | 500 | **225,000** |
| | | | | | | |

**FIRE FIGHTING WORKS - NON DSR**

| S.No | DSR Item No. | Description of Work | Unit | Rate | Total Quantity | Total Amount |
|---|---|---|---|---|---|---|
| 3 | **NON DSR** | Supplying and fixing single headed Internal hydrant valve with instantaneous Gun metal couplings of 63mm dia with Cast iron wheel ISI marked conforming to IS 5290 (Type -A) with blank Gun Metal cap and chain as required Including fixing with anchor fastner and flanged tapping from wet riser and providing pressure gauge with gun metal ball valve complete as required. | Each | 6,896.77 | 269 | **1,855,231** |
| | | | | | | |
| 4 | **NON DSR** | Providing & fixing gun metal fire hydrant double headed oblique pattern hydrant landing valves with 100 N.B. flanged inlet, brass spindle controlled 63 mm dia female instantaneous outlet type. G.M. coupling, blank cap, chain, twist release type lug & all accessories Conforming to IS:5290. Including fixing with anchor fastner and flanged tapping from wet riser and providing pressure gauge with gun metal ball valve complete as required. | Each | 14,625.91 | 36 | **526,533** |
| | | | | | | |
| 5 | **NON DSR** | Supplying and fixing 63mm dia, 15 mtr long RRL hose pipe with 63mm dia Male and Female Gun metal couplings duly binded with GI wire, rivets etc conforming to IS 636 (Type -A) as required. | Each | 9,733.20 | 682 | **6,638,042** |
| | | | | | | |
| 6 | **NON DSR** | Providing and fixing of standard short size gunmetal branch pipe IS: 903 with gunmetal nozzle 20 mm nominal bore outlet with standard instantaneous type 63mm dia coupling complete in all respects. | Each | 2,770.18 | 341 | **944,631** |
| | | | | | | |
| 7 | **NON DSR** | Providing and fixing standard fireman axe with heavy duty insulated rubber handle as per IS: 926 with clamps. | Each | 612.21 | 305 | **186,724** |
| | | | | | | |
| 8 | **NON DSR** | Providing and fixing of Wall mounting swinging type first aid fire hose reel with drum (conforming to IS:884) ISI marked, hanging bracket, 30.0 Mtr. length x 20 mm dia high pressure hose reel tubing as per IS: 444 with gun metal (GM) shut off nozzle having 6.5 mm dia orifice. The hose reel shall be conforming to IS : 884-1985. Rate shall include 25 mm dia M.S.pipe (heavy class) connection from Riser to hose reel, sockets, nipples, elbows and ball valve. Drum shall be fixed on adjoining wall by means of 120 mm x 100 mm long fasteners, bolts and nuts including painting. (25mm brass ball with wheel tested to 20 Kg/cm2 (I.S:778-1971, Class - II) of approved quality for hose reel) | Each | 6,593.00 | 275 | **1,813,075** |
| | | | | | | |

**FIRE FIGHTING WORKS - NON DSR**

| S.No | DSR Item No. | Description of Work | Unit | Rate | Total Quantity | Total Amount |
|---|---|---|---|---|---|---|
| 9 | **NON DSR** | Providing and fixing M.S. fire hose shaft door with frame fabricated from angle iron frame 40 x 40 x 6 mm thick, angle iron shutter 25 x 25 x 4 mm thick, 16 g M.S. sheet of fully welded construction with hinged double front door with locking arrangement and butt hinges, 15 x 3 mm lugs 10 cm long (6 Nos) embedded in cement conc. blocks ( 1: 3: 6 mix) or with rawl plug and screws/bolts and nuts as required, partly glass door 4 mm thick approved by local fire aurthority, painted with one coat of primer, stove enamelled fire red finished, "Fire Hose" written on front, suitable to accommodate 1 No single/ double headed Hydrant landing valve, 1 fire hose reel, 2/4 nos.15m long 63mmdia hose, 1-branch pipe, 1 fire-man's axe, including suitably mounted on a raised masonry platform as required. (Approx.size 0.9m x 2.1m) | Each | 9,500.00 | 275 | **2,612,500** |
| | | | | | | |
| 10 | **NON DSR** | Providing, fixing, testing & commissioning of Weather proof standard fire hose cabinet (750 mm x 600 mm x 250 mm deep) for yard hydrants made of 16 SWG powder coated M.S. sheet having single or double opening glazed (4.0 mm thick glass) shutter including necessary locking arrangement by allan key, stove enamelled Fire red finish (as per IS : 5, shade no. 536) with " Fire Hose" marked on front, suitable for housing 2 nos. Hose pipe, 1 No. branch pipe & nozzle spanner. | Each | 3,147.00 | 62 | **195,114** |
| | | | | | | |
| 11 | **NON DSR** | Providing, fixing, testing & commissioning of MS air cushion tank on top of each riser fabricated from 6mm thick MS plate, 200 mm in diameter and 1.2 m in height with dished ends fabricated from 8mm thick MS plate with Air release valve with stop cock, flanged inlet connection and drain arrangement with 25mm dia valve, pressure gauge with gun metal stop cock complete with all accessories as required and conforming to IS 4736-1968. (The cushion tank should be suitable for rated working pressure. ) | Each | 16,557.89 | 60 | **993,474** |
| | | | | | | |
| 12 | **NON DSR** | Supply, installation, testing and commissioning of 25 mm dia Air Release Valve. | Each | 1,007.96 | 44 | **44,350** |
| | | | | | | |
| | | **TOTAL FOR SUBHEAD (B) CARRIED OVER TO SUMMARY** | | | | **20,296,948** |
| **C.** | | **FIRE HYDRANT SYSTEM (EXTERNAL)** | | | | |
| | | | | | | |
| | | **SUPPLY, INSTALLATION, TESTING AND COMMISSIONING OF:** | | | | |
| | | | | | | |

**FIRE FIGHTING WORKS - NON DSR**

| S.No | DSR Item No. | Description of Work | Unit | Rate | Total Quantity | Total Amount |
|---|---|---|---|---|---|---|
| 1 | **NON DSR** | Providing at site, lowering & laying in trenches, aligning & jointing, testing and commissioning of following sizes of M.S. pipes (Class-C) conforming to IS : 1239 (Part I) pipes up to 150 mm dia/ IS 3589 for pipes above 150 mm dia with all accessories like all fittings (welded joints 65mm dia size and above, forged fittings with threaded joints below 65 mm dia including tees, elbows, reducers, union, flanges, rubber gaskets, GI nuts bolts, washer including supporting/fixing the pipe on floor / wall /ceiling with clamps, hangers (using anchor fastners) as per specification. | | | | |
| | | G.I. pipe sleeve of suitable higher size shall be provided wherever the pipes are crossing the walls/floors and sealing the sleeves with glass wool in between & fire sealent compound at either end all as per Engineer-in-charge requirements including cutting holes and chases in brick, R.C.C work and making good the same to original conditions complete in all respects. All hangers, clamps, brackets etc. shall be of galvanized iron unless specified otherwire and then supply of the same shall also be included for rates under this head. Painting of two coats of synthetic enamel paint over two coats of red oxide zince chromate primer . | | | | |
| a) | | 80 mm dia | RM | 980.00 | 1400 | **1,372,000** |
| | | | | | | |
| 2 | **NON DSR** | Providing protection to embedded heavy class MS pipes and fittings (running below trenches) by applying pyp kote primer (@ 100 gm/sqm) thereafter wrapping 4 mm thick protection coating by thermo fusion process and overlaping of joints shall be done as per manufacturer's specification. Wrapping shall be confirm to ISI 10221 including conducting Holiday Test. | | | | |
| a) | | 200 mm dia | RM | 580.00 | 3200 | **1,856,000** |
| b) | | 150 mm dia | RM | 450.00 | 625 | **281,250** |
| c) | | 100 mm dia | RM | 320.00 | 650 | **208,000** |
| d) | | 80 mm dia | RM | 200.00 | 600 | **120,000** |
| | | | | | | |
| 3 | **NON DSR** | Providing and fixing gunmetal external (yard) hydrant stand post type comprising of the stand post, plain duck foot flanged bends, butterfly valve 80mm (PN 16) and single headed gunmetal male coupling valve conforming to IS: 5290-1985. The stand post column shall be galvanized iron size 80mm, conforming to IS:1239 (heavy class). The oulet shall be angled to the ground with an instantaneous spring lock type gunmetal female coupling of 63mm dia for connecting to the hose pipe. | Each | 14,658.47 | 80 | **1,172,678** |
| | | | | | | |

**FIRE FIGHTING WORKS - NON DSR**

| S.No | DSR Item No. | Description of Work | Unit | Rate | Total Quantity | Total Amount |
|---|---|---|---|---|---|---|
| 4 | **NON DSR** | Supply,Installation, Testing & Commissioning of Controlled Percolating (CP) Hose ISI marked (IS:8423) 63 mm dia complete with instanteneous type gunmetal 63 mm dia, ISI marked Male & Female couplings (IS:903) bound and rivetted to hose pipe with copper rivets and 1.5 mm copper wire. suitable for hot ambient condition for external hydrant. | | | | |
| a) | | 22.5 mtr length | Each | 9,026.81 | 160 | **1,444,289** |
| | | | | | | |
| 5 | **NON DSR** | Providing and fixing of standard short size gunmetal branch pipe IS: 903 with gunmetal nozzle 20 mm nominal bore outlet with standard instantaneous type 63mm dia coupling complete in all respects. | Each | 2,770.18 | 80 | **221,614** |
| | | | | | | |
| 6 | **NON DSR** | Providing and fixing standard fireman axe with heavy duty insulated rubber handle as per IS: 926 with clamps. | Each | 612.21 | 80 | **48,977** |
| | | | | | | |
| 7 | **NON DSR** | Providing & fixing Weather proof standard fire hose cabinet (750 mm x 600 mm x 250 mm deep) for yard hydrants made of 16 SWG powder coated M.S. sheet having single or double opening glazed (4.0 mm thick glass) shutter including necessary locking arrangement by allan key, stove enamelled Fire red finish (as per IS : 5, shade no. 536) with " Fire Hose" marked on front, suitable for housing 2 nos. Hose pipe, 1 No. branch pipe & nozzle spanner. | Each | 3,147.04 | 80 | **251,763** |
| | | | | | | |
| 8 | **NON DSR** | Providing & fixing gun metal fire service inlet connection to directly pressurised the system consist of 4 nos. Gun metal 63mm dia with instantaneous male coupling with built in check valve, 1 no. 150mm dia butterfly / sluice valve and 150 dia flanged outlet, complete with Gun Metal drain valves, 4 rubber blank caps and chain complete with bolts, nut and rubber inserts as required as per IS 904-1963. (Butterfly valve/ sluice valve shall be paid seperately as per DSR item) | Each | 10,542.00 | 4 | **42,168** |
| | | | | | | |
| 9 | **NON DSR** | Providing and fixing Gun metal Fire Brigade suction hose coupling with 2 nos. 63mm dia instantaneous type male coupling as per IS: 904-1983, 1 no. 150mm dia Sluice / butterfly valve and foot valve with strainer complete in all respect as required by Engineer-in-Charge. (Foot valve & strainer shall be paid seperately as per DSR item) | Each | 4,432.00 | 14 | **62,048** |
| | | | | | | |

**FIRE FIGHTING WORKS - NON DSR**

| S.No | DSR Item No. | Description of Work | Unit | Rate | Total Quantity | Total Amount |
|---|---|---|---|---|---|---|
| 10 | **NON DSR** | Providing and fixing Gun metal Siamese breeching connection with 4 nos. 63mm dia instantaneous type female coupling as tank fill connection with blank cap with 1 no. 150mm dia butterfly / sluice valve and 150 dia flanged outlet complete with bolts, nut and rubber inserts as required as per IS 904-1963. (Butterfly valve/ sluice valve shall be paid seperately as per DSR item) | Each | 10,542.00 | 4 | **42,168** |
| | | | | | | |
| 11 | **NON DSR** | Providing and fixing M.S. structural work fabricated from standard sections, (MS rounds, angles, channels etc.) including cutting to size, drilling, welding, including cost of fasteners, U clamps in RCC structural members as directed, including two or more coats of synthetic paint over one coat of primer after surface preparation including cutting and making good walls (For structural work other than pipe supports). | Kg | 90.00 | 5000 | **450,000** |
| | | | | | | |
| | | **TOTAL FOR SUB HEAD (C) CARRIED OVER TO SUMMARY** | | | | **7,572,955** |
| **D.** | | **SPRINKLER SYSTEM** | | | | |
| | | | | | | |
| 1 | **NON DSR** | Providing, laying, jointing, testing and commissioning of following sizes of M.S. pipes (Class-C) conforming to IS-1239 with all accessories like all fittings (MS fitting with threaded joints below 50mm dia) including tees, elbows, reducers, union, flanges, rubber gaskets, nuts bolts, washer including supporting/fixing the pipe on floor / wall /ceiling with clamps, hangers (using anchor fastners) as per specification. G.I. pipe sleeve of suitable higher size shall be provided wherever the pipes are crossing the walls/floors and sealing the sleeves with glass wool in between & fire sealent material like Navair or equivalent to match the fire rating of the wall / structure including cutting holes and chases in brick, R.C.C work and making good the same to original conditions complete in all respects. | | | | |
| | | All hangers, clamps, brackets etc. shall be of galvanized iron unless specified otherwire and then supply of the same shall also be included for rates under this head. Painting of two coats of synthetic enamel paint over one coat of red oxide zinc chromate primer. Welding of any kind on the galvanized support / hanger shall not be permitted. | | | | |
| | | **Notes :** | | | | |
| i) | | Pipe upto 50 mm dia shall be threaded joints, above 50 mm shall be welded joints. | | | | |
| ii) | | For pipe upto 50mm dia threaded forged steel fittings and for pipe above 50mm dia standard Malleable MS fittings with welded joints shall be used. | | | | |

**FIRE FIGHTING WORKS - NON DSR**

| S.No | DSR Item No. | Description of Work | Unit | Rate | Total Quantity | Total Amount |
|---|---|---|---|---|---|---|
| iii) | | Supports are included in this items. | | | | |
| iv) | | G.I Pipe sleeve of suitable higher size shall be provided wherever the pipes are crossing the wall/ floors and sealing the sleeves with glass wool in between and sealant compound at either end as per Engineer-in-Charge's requirement. | | | | |
| a) | | 80 mm dia | RM | 890.30 | 2810 | **2,501,734** |
| b) | | 65 mm dia | RM | 742.69 | 4790 | **3,557,502** |
| c) | | 50 mm dia | RM | 566.68 | 3585 | **2,031,543** |
| d) | | 40 mm dia | RM | 396.12 | 3940 | **1,560,715** |
| e) | | 32 mm dia | RM | 340.51 | 5160 | **1,757,029** |
| f) | | 25 mm dia | RM | 264.46 | 28700 | **7,589,880** |
| | | | | | | |
| 2 | **NON DSR** | Providing protection to embedded heavy class MS pipes and fittings (running below trenches) by applying pyp kote primer (@ 100 gm/sqm) thereafter wrapping 4 mm thick protection coating by thermo fusion process and overlaping of joints shall be done as per manufacturer's specification. Wrapping shall be confirm to ISI 10221 including conducting Holiday Test. | | | | |
| a) | | 200 mm dia | RM | 580.00 | 3200 | **1,856,000** |
| b) | | 150 mm dia | RM | 450.00 | 1280 | **576,000** |
| | | | | | | |
| 3 | **NON DSR** | Providing, fixing, testing and commissioning of 15 mm dia quartzoid bulb sprinkler head (UL/FM/LOC listed /approved) suitable for sustaining the pressure on the seat & water hammer effect. The type & temperature rating shall be as follows : | | | | |
| a) | | Concealed Sprinkler 680C Quick response | Each | 1,317.00 | 60 | **79,020** |
| b) | | Pendent Sprinkler 680C Quick response | Each | 498.00 | 240 | **119,520** |
| c) | | Pendent/ Upright Sprinkler 790C | Each | 600.00 | 2385 | **1,431,000** |
| d) | | Side wall Sprinkler 680C (Quick Response) | Each | 805.00 | 110 | **88,550** |
| e) | | Pendent Sprinkler 680C | Each | 320.00 | 10120 | **3,238,400** |
| | | **Notes :** | | | | |
| a) | | All sprinklers shall be chrome finish / powder coated except for concealed. | | | | |
| b) | | The concealed sprinkler shall be brass finish. The cover plate of concealed sprinkler shall be factory painted at manufacturers work and the shade be conformed prior to application on the cover plate. | | | | |
| c) | | The sprinkler shall be either pendent or upright type/side wall and shall not be universal style. | | | | |
| d) | | Contractor shall ensure provision of sprinkler guard at no additional cost | | | | |
| e) | | All pendent sprinkler will be provided with rossette plate | | | | |
| | | | | | | |

**FIRE FIGHTING WORKS - NON DSR**

| S.No | DSR Item No. | Description of Work | Unit | Rate | Total Quantity | Total Amount |
|---|---|---|---|---|---|---|
| 4 | **NON DSR** | Providing and fixing of UL listed flow indicating switch (retarded type with adjustable spring attached to the vane type) of following diameter with U clamp connection with pipe and flexible full bore paddle & NO/NC contact terminals as specified complete with all accessories and necessary wiring. Flow indicators shall be retarded type with adjustable spring attached to the paddle. switch can be addjustable to 0 to 70 sceonds on delay. | | | | |
| a) | | For 150 dia pipe | Each | 4,960.16 | 65 | **322,410** |
| b) | | For 100 dia pipe | Each | 4,960.16 | 41 | **203,367** |
| c) | | For 80 dia pipe | Each | 4,960.16 | 7 | **34,721** |
| d) | | For 65 dia pipe | Each | 4,960.16 | 7 | **34,721** |
| | | | | | | |
| 5 | **NON DSR** | Providing and fixing 25 mm dia inspection & testing assembly with gun metal ball valve,union, gun metal sight glass, drain valve & connection to drain inclusive of all accessories complete | Each | 6,624.00 | 120 | **794,880** |
| | | | | | | |
| 6 | **NON DSR** | Providing and fixing Orifice plates, S.S. 304, 12 mm thick, bore and construction as per TAC's Sprinklers manual / IS:15105, for all horizontal tapping from the sprinkler riser inclusive of all accessories complete as per design. | Each | 1,775.75 | 300 | **532,725** |
| | | | | | | |
| 7 | **NON DSR** | Supply, installation, testing & commissioning of Sprinkler Flexible Joint of 25mm diameter, consisting of - Flexible Tube (SS 304) (UL listed), S.S. Slip nut, Isolated Ring & O Ring - for Sprinklers Drop, which shall include necessary supports with a maximum working pressure of 14kgf/cm2 and temperature rating of 225oF. The length of Flexible Sprinklers Pipe shall be :- | | | | |
| | | 1500mm length | Each | 1,022.22 | 300 | **306,666** |
| | | | | | | |
| 8 | **NON DSR** | Providing and fixing MS cabinet (size 600 x 450 x 150 mm) fabricated from 16 gauge MS sheet with full front glass door & locking arrangement with suitable shelves for keeping 24 Nos. spare sprinklers of each type & one no. spanner properly fixed in shelves. Cabinet shall be painted with enamel paint of approved shade. (Cost shall include 24 Nos. Pendent sprinkler (68 deg.standard response), , Side wall 24 Nos (68 deg. extended coverage) spare sprinklers & one No. spanner). | Each | 20,787.63 | 7 | **145,513** |
| | | | | | | |

**FIRE FIGHTING WORKS - NON DSR**

| S.No | DSR Item No. | Description of Work | Unit | Rate | Total Quantity | Total Amount |
|---|---|---|---|---|---|---|
| 9 | **NON DSR** | Providing, fixing, testing, commissioning of installation control valve of Cast iron body and brass / Bronze working parts comprising of water, motor alarm, bronze seat clapper, and clapper arm, hydraulically driven mechanical gong bell to sound continuous alarm when the Wet riser / Sprinkler system activates, pressure gauges, emergency releases, strainer, pressure switch, cock valve complete with drain valve and bypass , test control box, ball valves, Ms pipe of required size, flanges, orifice plate, gasket etc of size 150mm dia as required. | Each | 58,109.73 | 18 | **1,045,975** |
| | | | | | | |
| 10 | **NON DSR** | Providing, fixing, testing & commissioning of deluge valve of required dia suitable for 12 bars rated pressure with cast iron housing and cover, cast bronze clapper, clamp ring and seat, neoprene/EPDM diaphragm and seat rubber, stainless steel bolts operated through a smoke sensor for initializing flow in the water curtain system with wet pilot trim (Hydraulic Release), electric release trim test and alarm trim complete with all accessories viz fittings, pressure gauge, valves, actuator, manifold etc. alarm gong including up stream & down stream main header where required complete as directed by Engineer-in-charge. | | | | |
| | | The system shall be provided with isolation valves on inlet and out let, by-pass arrangement with isolation valve, 'Y' strainer on inlet, 1/2" dia solenoid valve on detection line to be actuated by low voltage signal from addressable type fire detectors (to be provided by vendor for fire dection works). | | | | |
| a) | | 50 mm dia | Each | 63,298.10 | 4 | **253,192** |
| b) | | 80 mm dia | Each | 137,306.25 | 6 | **823,838** |
| c) | | 100 mm dia | Each | 158,118.75 | 2 | **316,238** |
| | | | | | | |
| 11 | **NON DSR** | Providing & fixing water curtain nozzle in Brass K-23 (ASTM B'16) suitable for 20 to 50 psi effective working pressure, with 3/4" BSPT inlet and coverage of 2.5 meter either side at 1.4 Bar where required as directed by Engineer-in-charge. (Installation shall be as per NFPA recommendation) [for Compartmentation] [Contractor shall submit the shop drawing for comment/approval]. | Each | 936.00 | 438 | **409,968** |
| | | | | | | |
| 12 | **NON DSR** | Supplying, receiving, storing, laying, effecting proper connections, testing and commissioning of the following sizes of 1.1 KV grade PVC insulated FRLS copper conductor armoured stranded control cable complete as required including termination. | | | | |
| | | 2 C x 2.5 Sq.mm | RM | 216.00 | 1250 | **270,000** |
| | | [For linking deluge valve operation to Fire detection System.] | | | | |

**FIRE FIGHTING WORKS - NON DSR**

| S.No | DSR Item No. | Description of Work | Unit | Rate | Total Quantity | Total Amount |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | **TOTAL FOR SUBHEAD (D) CARRIED OVER TO SUMMARY** | | | | **31,881,108** |
| **E.** | | **FIRE EXTINGUISHERS** | | | | |
| | | | | | | |
| | | Supply, installation, testing and commissioning of following types of extinguisher with provision of wall bracket (fixed with anchor fastner). | | | | |
| | | | | | | |
| 1 | **NON DSR** | Providing and fixing water Co2(ISI marked) extinguishers including all accessories as per IS specification. (IS:15683:2006) with wall bracket with rawl plug. | | | | |
| a) | | Capacity 9 litres. | Each | 5,901.52 | 415 | **2,449,131** |
| | | | | | | |
| 2 | **NON DSR** | Providing and fixing Carbon-di-oxide fire extinguishers consisting of welded M.S cylinderical body, squeeze lever discharge valve fitted with internal discharge tube, 30cms long ISI marked high pressure discharge hose, discharge nozzle, suspension bracket, confirming to IS : 934 finished externally with red enamel paint and fixed to wall with brackets with rawl plug/dash fasteners complete with internal charge. | | | | |
| a) | | Capacity 4.5kg. I.S.I. Marked. (IS : 15683:2006) | Each | 11,102.87 | 415 | **4,607,691** |
| | | | | | | |
| 3 | **NON DSR** | Providing and fixing ABC stored pressure dry chemical powder (monoammonium phosphate) Fire Extinguisher IS : 15683 latest revision manufacturer and of CRCA sheet in welded construction, finish with epoxy polyster powder coated complete with brass forged ball valve, gun metal cap and nozzel, including initial filled and wall suspension bracket (suitable for fighting in class 'A', B & 'C' that is wood, textile, flammable liquid, electric and gases. | | | | |
| a) | | Capacity 2 Kg | Each | 3,330.45 | 70 | **233,132** |
| b) | | Capacity 4 Kg | Each | 4,966.58 | 135 | **670,488** |
| c) | | Capacity 6 Kg | Each | 5,667.78 | 70 | **396,745** |
| | | | | | | |
| 4 | **NON DSR** | Providing and fixing carbon-di-oxide fire extingushers trolley mounted with all accessories internal discharge tube, high pressure discharge hose, discharge nozzle, suspension bracket, ISI marked as per IS:2878 finished externally with red enamel paint and complete with internal charge. | | | | |
| a) | | Capacity 22.5 kg. | Each | 28,573.69 | 2 | **57,147** |
| | | | | | | |

**FIRE FIGHTING WORKS - NON DSR**

| S.No | DSR Item No. | Description of Work | Unit | Rate | Total Quantity | Total Amount |
|---|---|---|---|---|---|---|
| 5 | **NON DSR** | Providing and fixing mechanical foam type (IS:15683:2006) fire extinguishers consisting of welded M.S. cylindrical body squeeze lever discharge valve 30 cm long high pressure discharge hose, discharge nozzle suspension bracket ISI marked as per IS 933 finished externally with red enamel paint and fixed to wall with brackets complete with internal charger. | | | | |
| a) | | 9 litres capacity. | Each | 6,135.25 | 60 | **368,115** |
| | | | | | | |
| 6 | **NON DSR** | Providing and fixing wet chemical Class K type fire extinguishers with SS body cylindrical body squeeze lever discharge valve, testing pressure 35 bar, service pressure 12 bar fixed to wall with brackets complete with internal charger. | | | | |
| | | 6 ltr capacity | Each | 17,800.00 | 28 | **498,400** |
| | | 9 ltr capacity | Each | 22,550.00 | 28 | **631,400** |
| | | | | | | |
| 7 | **NON DSR** | Providing and fixing of Ceiling / Wall mounted Illuminated exit signage with CFL Lamp encased in 16 gauge MS boxing and 4 mm thick acrylic sheet front cover connected to external power supply with 7 Ah SMF Battery Back up. | Each | 5,000.00 | 140 | **700,000** |
| | | | | | | |
| 8 | **NON DSR** | Supplying and installing at approved location approved make fire buckets of 24 gauge galvanized steel sheet, standard 9 liters capacity and of round bottom shape, painted white inside and red outside and black on the bottom, inscribed with letter "FIRE" in black and gold. Cost shall be inclusive of providing MS stand duly painted over a coat of primer (one stand shall be suitable for hanging 5 buckets). | Set | 5,000.00 | 5 | **25,000** |
| | | | | | | |
| | | **TOTAL FOR SUBHEAD (E) CARRIED OVER TO SUMMARY** | | | | **10,637,249** |
| | | | | | | |
| **F.** | **NON DSR** | **GAS SUPPRESSION SYSTEM FOR ADMIN BLOCK SERVER FLOOR (3RD FL)** | | | | |
| | | | | | | |
| | | Designing , providing, fixing, testing & commissioning of | | | | |
| | | | | | | |
| 1 | | Novec 1230, CCOE Approved 150.0 Ltrs. Cylinder working at 34.5 bar pressure with Valve Assembly and arrangement for Supervisory Switch connection for monitoring cylinder pressure, a pressure gauge with a safety burst disc and safety cap | Nos. | 197,186.00 | 30 | **5,915,580** |
| 2 | | Novec 1230 manufactured by 3M, with Zero Ozone Depeltion Potential and Very Low Global Warming Potential of 1 with 20 Years Blue Sky Warantee against any regulatory Bans and Restrictions. | Kgs. | 5,680.00 | 4300 | **24,424,000** |

**FIRE FIGHTING WORKS - NON DSR**

| S.No | DSR Item No. | Description of Work | Unit | Rate | Total Quantity | Total Amount |
|---|---|---|---|---|---|---|
| 3 | | Master Cylinder Kit complete comprises of Electric Control Head operated electrically from the detection and control system or locally with a manual actuator, complete with cylinder supervisory switch. | Nos. | 57,649.00 | 3 | **172,947** |
| 4 | | Manual Actuator Assembly complete with liver to activate the system manually. | Nos. | 17,490.00 | 3 | **52,470** |
| 5 | | Wire Braided Flexible Rubber Hose with Elbow and connectors complete assembly to Connect Novec 1230 Cylinder Assembly Discharge outlet with Discharge Pipe or Discharge Manifold. | Nos. | 5,500.00 | 30 | **165,000** |
| 6 | | Warning Signs and Plates for Inside Room and Outside Room application. | Nos. | 4,070.00 | 6 | **24,420** |
| 7 | | Primary pressure operated slave control head complete kit with pneumatic actuating valve operated pneumatically from the master cylinder discharge pressure, Flexible interconnincting hose. Complete with cylinder supervisory switch. | Nos. | 46,860.00 | 27 | **1,265,220** |
| 8 | | Manifold check valve for non return arrangement of Novel 1230 gas after discharge back into cylinder. | Nos. | 27,500.00 | 27 | **742,500** |
| 9 | | Discharge Nozzles to Discharge Novec 1230 Gas in the Hazard Area as hydraulic calculation and flow rate required in 180 Deg/360 Deg Discharge Pattern. | | | | |
| a | | Φ 40 | Nos. | 19,800.00 | 22 | **435,600** |
| 10 | | Cylinder Bracket | Nos. | 4,400.00 | 30 | **132,000** |
| 11 | | Discharge Pressure switch | Nos. | 21,399.00 | 1 | **21,399** |
| | | | | | | |
| **B** | | **Piping** | | | | |
| 1 | | Manifold Schedule 40 Seamless pipe with flange | Lot | 138,307.00 | 1 | **138,307** |
| 2 | | Discharge Pipe with Support and Fittings, CS Seamless to ASTM A-106 Schedule 40. | Lot | 369,684.00 | 1 | **369,684** |
| | | | | | | |
| | | **Fire Alarm System** | | | | |
| 1 | | supply, installation, testing and commissioning of Networkable Microprocessor based analogue addressable type 1 Loop Fire Alarm Control Panel with 80 character LCD display, The panel should be equipped with sufficient numbers of loops with 20 % Spare capacity in each loop. The panel shall be capable of taking atleast 300 analog addressable devices (150 Detectors & 150 Devices) in loop. .<br><br>The panel shall have Four access levels, capable of taking Flash Scan devices, flash EPROM sufficient numbers of programmable relay controls for controlling AHUs, pressurization fans, ventilation fans at fire pump room, monitoring of fire sprinkler and fire hydrant pump, 240 volts AC power supply, automatic battery charger, 24 volts sealed lead acid batteries sufficient for 24 hours normal working and then be capable of operating the system for 30 min during an emergency conditions as required.The Panel should have inbuilt gas release module. (UL listed & FM approved). | Nos. | 230,769.00 | 1 | **230,769** |

**FIRE FIGHTING WORKS - NON DSR**

| S.No | DSR Item No. | Description of Work | Unit | Rate | Total Quantity | Total Amount |
|---|---|---|---|---|---|---|
| 2 | | supply, installation, testing and commissioning of Addressable Relay modulewith Address Switch to programme the modules from 01- 99, complete as required as per specification sUL &FM approved | Nos. | 5,056.00 | 4 | **20,224** |
| 3 | | supply, installation, testing and commissioning of Automatic Floating Sensitivity type Analog addressable inteligent Multi Sensor - Heat Cum Smoke detector with mounting Base. Dual LED, Address Switch to programme the detectors from 01-159, complete as required. Above False Ceiling. | Nos. | 4,481.00 | 60 | **268,860** |
| 4 | | Supply, installation, testing and commissioning of Dual action Releasing station with Abort switch | Nos. | 16,408.00 | 3 | **49,224** |
| 5 | | supply, installation, testing and commissioning of Addressable monitor modules for Abort Station& Release stationAddress Switch to programme the modules from 01- 99, complete as required as per specifications | Nos. | 4,184.00 | 6 | **25,104** |
| 6 | | supply, installation, testing and commissioning of Hooter cum Flasher, | Nos. | 7,537.00 | 3 | **22,611** |
| 7 | | supply, installation, testing and commissioning of Addressable control module for Hooter, Address Switch to programme the modules from 01- 99, complete as required as per specifications | Nos. | 5,056.00 | 3 | **15,168** |
| 8 | | supply, installation, testing and commissioning of Novec 1230 Gas caution sign boards inside & outside Room for approved location. | Nos. | 2,090.00 | 6 | **12,540** |
| 9 | | supply, installation, testing and commissioning of 2x 1.5 sq mm armoured cable complete with all accessories as required. | RM | 130.00 | 960 | **124,800** |
| | | NOTE: Quantities considered above is for estimation purpose only. Contractor will varify the quantities while quoting the same as this will be vendor based design. | | | | |
| | | **TOTAL FOR SUBHEAD (F) CARRIED OVER TO SUMMARY** | | | | **34,628,427** |
| | | | | | | |
| **G.** | **NON DSR** | **FIRE SUPPRESSION SYSTEM FOR ELECTRICAL PANELS** | | | | |
| I | | **MAIN LT PANEL (SIZE CONSIDERED 20 MTR X 1.4 MTR X 2.4 M)** | | | | |
| | | **Designing, Providing, fixing, testing & commissioning of** | | | | |
| 1 | | 10LB capacity Novec 1230 , DLP Assembly with automatic valve, push in connector for tube, 5 LB Novec 1230 gas , mounting bracket, End of Line adopter and low pressure switch for monitoring system activation. | Nos. | 190,637.00 | 5 | **953,185** |
| 2 | | Linear pneumatic heat Detection Tube with all necessary fittings & supports. | mtrs. | 1,942.00 | 250 | **485,500** |
| 3 | | Master Control Unit with Audio Visual Alarm with wiring to make complete system operational . The control Panel should have provision for integration with fire Alarm /SCAD/BMS System. | Nos | 5,591.00 | 5 | **27,955** |
| | | | | | | |

**FIRE FIGHTING WORKS - NON DSR**

| S.No | DSR Item No. | Description of Work | Unit | Rate | Total Quantity | Total Amount |
|---|---|---|---|---|---|---|
| II | | **MAIN HT PANEL (SIZE CONSIDERED 11 MTR X 1.6 MTR X 2.4 M)** | | | | |
| | | | | | | |
| 1 | | 10LB capacity Novec 1230 , DLP Assembly with automatic valve, push in connector for tube, 5 LB Novec 1230 gas , mounting bracket, End of Line adopter and low pressure switch for monitoring system activation. | Nos. | 190,637.00 | 3 | **571,911** |
| 2 | | Linear pneumatic heat Detection Tube with all necessary fittings & supports. | mtrs. | 1,942.00 | 138 | **267,996** |
| 3 | | Master Control Unit with Audio Visual Alarm with wiring to make complete system operational . The control Panel should have provision for integration with fire Alarm /SCAD/BMS System. | Nos | 5,591.00 | 3 | **16,773** |
| | | | | | | |
| III | | **CAPACITOR PANEL (SIZE CONSIDERED 5 MTR X 1.2 MTR X 2.4 M) - PANEL-1** | | | | |
| | | | | | | |
| 1 | | 10LB capacity Novec 1230 , DLP Assembly with automatic valve, push in connector for tube, 5 LB Novec 1230 gas , mounting bracket, End of Line adopter and low pressure switch for monitoring system activation. | Nos. | 190,637.00 | 2 | **381,274** |
| 2 | | Linear pneumatic heat Detection Tube with all necessary fittings & supports. | mtrs. | 1,942.00 | 63 | **122,346** |
| 3 | | Master Control Unit with Audio Visual Alarm with wiring to make complete system operational . The control Panel should have provision for integration with fire Alarm /SCAD/BMS System. | Nos | 5,591.00 | 2 | **11,182** |
| | | | | | | |
| **IV** | | **CAPACITOR PANEL (SIZE CONSIDERED 5 MTR X 1.2 MTR X 2.4 M) - PANEL-2** | | | | |
| | | | | | | |
| 1 | | 10LB capacity Novec 1230 , DLP Assembly with automatic valve, push in connector for tube, 5 LB Novec 1230 gas , mounting bracket, End of Line adopter and low pressure switch for monitoring system activation. | Nos. | 190,637.00 | 2 | **381,274** |
| 2 | | Linear pneumatic heat Detection Tube with all necessary fittings & supports. | mtrs. | 1,942.00 | 63 | **122,346** |
| 3 | | Master Control Unit with Audio Visual Alarm with wiring to make complete system operational . The control Panel should have provision for integration with fire Alarm /SCAD/BMS System. | Nos | 5,591.00 | 2 | **11,182** |
| | | | | | | |
| **V** | | **CAPACITOR PANEL (SIZE CONSIDERED 5 MTR X 1.2 MTR X 2.4 M) - PANEL-3** | | | | |
| | | | | | | |
| 1 | | 10LB capacity Novec 1230 , DLP Assembly with automatic valve, push in connector for tube, 5 LB Novec 1230 gas , mounting bracket, End of Line adopter and low pressure switch for monitoring system activation. | Nos. | 190,637.00 | 2 | **381,274** |

**FIRE FIGHTING WORKS - NON DSR**

| S.No | DSR Item No. | Description of Work | Unit | Rate | Total Quantity | Total Amount |
|---|---|---|---|---|---|---|
| 2 | | Linear pneumatic heat Detection Tube with all necessary fittings & supports. | mtrs. | 1,942.00 | 63 | **122,346** |
| 3 | | Master Control Unit with Audio Visual Alarm with wiring to make complete system operational . The control Panel should have provision for integration with fire Alarm /SCAD/BMS System. | Nos | 5,591.00 | 2 | **11,182** |
| | | | | | | |
| **VI** | | **CAPACITOR PANEL (SIZE CONSIDERED 5 MTR X 1.2 MTR X 2.4 M) - PANEL-4** | | | | |
| | | | | | | |
| 1 | | 10LB capacity Novec 1230 , DLP Assembly with automatic valve, push in connector for tube, 5 LB Novec 1230 gas , mounting bracket, End of Line adopter and low pressure switch for monitoring system activation. | Nos. | 190,637.00 | 2 | **381,274** |
| 2 | | Linear pneumatic heat Detection Tube with all necessary fittings & supports. | mtrs. | 1,942.00 | 63 | **122,346** |
| 3 | | Master Control Unit with Audio Visual Alarm with wiring to make complete system operational . The control Panel should have provision for integration with fire Alarm /SCAD/BMS System. | Nos | 5,591.00 | 2 | **11,182** |
| | | | | | | |
| **VII** | | **NORMAL PANEL** | | | | |
| 1 | | 10 Lb capacity Novec 1230 , DLP Assembly with automatic valve, push in connector for tube, 10 Lb Novec 1230 Gas, mounting bracket, End of Line adopter and low pressure switch for monitoring system activation. | No. | 190,637.00 | 8 | **1,525,096** |
| 2 | | Linear pneumatic heat Detection Tube with all necessary fittings & supports. | mtrs. | 1,942.00 | 400 | **776,800** |
| 3 | | Master Control unit with Audio Visual Alarm with wiring to make complete system operational. The Control panel should have provision for integration with Fire Alarm/ SCADA/BMS system. | Nos | 5,591.00 | 8 | **44,728** |
| | | | | | | |
| **VIII** | | **EMERGENCY PANEL** | | | | |
| 1 | | 10 Lb capacity Novec 1230 , DLP Assembly with automatic valve, push in connector for tube, 10 Lb Novec 1230 Gas, mounting bracket, End of Line adopter and low pressure switch for monitoring system activation. | No. | 190,637.00 | 8 | **1,525,096** |
| 2 | | Linear pneumatic heat Detection Tube with all necessary fittings & supports. | mtrs. | 1,942.00 | 352 | **683,584** |
| 3 | | Master Control unit with Audio Visual Alarm with wiring to make complete system operational. The Control panel should have provision for integration with Fire Alarm/ SCADA/BMS system. | Nos | 5,591.00 | 8 | **44,728** |
| | | NOTE: Quantities considered above is for estimation purpose only. Contractor will varify the quantities while quoting the same as this will be vendor based design. | | | | |
| | | **TOTAL FOR SUBHEAD (G) CARRIED OVER TO SUMMARY** | | | | **8,982,560** |
| **TOTAL NON DSR - FF WORKS** | | | | | | **119,740,896** |

| SUMMARY OF ELECTRICAL WORKS | | | |
|---|---|---|---|
| | | | |
| S.No. | Description of Work | Amount (Rs.) DSR | Amount (Rs.) Non DSR |
| A. | POINT WIRING AND SUBMAINS | 79736456 | - |
| B. | CABLES & CABLE TRAYS | 11068885 | - |
| C. | DISTRIBUTION BOARDS | 5787588 | - |
| D. | LIGHTING FIXTURES AND FANS | 696032 | - |
| E. | CONDUITING & CABLEING FOR TELEPHONE, DATA & MATV SYSTEM | 30030732 | - |
| F. | FIRE DETECTION, ALARM AND PA SYSTEM | 22776650 | - |
| G. | CONDUITING FOR CCTV SYSTEM | 2869750 | - |
| H. | ACCESS CONTROL SYSTEM | 494190 | - |
| I. | CIVIL WORKS | 2253338 | - |
| J. | EARTHING SYSTEM | 1917038 | - |
| K. | HT CABLES AND TERMINATIONS | 1934760 | - |
| L | MISCELLANEOUS ITEMS | 11855010 | - |
| | | | |
| A | POINT WIRING AND SUBMAINS | - | 10161133 |
| B | CABLES & CABLE TRAYS | - | 69191277 |
| C | DISTRIBUTION BOARDS | - | 985044 |
| D | LIGHTING FIXTURES AND FANS | - | 159270281 |
| E | UPS SYSTEM | - | 49806667 |
| F | EARTHING SYSTEM | - | 4766944 |
| G | LIGHTNING PROTECTION SYSTEM | - | 3973770 |
| H | ELEVATORS | - | 84810000 |
| I | CONDUITING & CABLING FOR TELEPHONE, DATA & MATV SYSTEM | - | 54207777 |
| J | FIRE DETECTION, ALARM AND PA SYSTEM | - | 79439615 |
| K | CONDUITING FOR CCTV SYSTEM | - | 3434678 |
| L | ACCESS CONTROL SYSTEM | - | 6829352 |
| M | BUS DUCT (IN SANDWICH CONSTRUCTION) | - | 1924650 |
| N | DISTRIBUTION BOARDS & PANELS | - | 47745399 |
| O | POWER AND DISTRIBUTION TRANSFORMERS & COMPACT SUB STATION | - | 65621177 |
| P | 66 KV GIS SWITCHGEARS , 11 KV MAIN HT PANEL & DG SYNCH. PANEL | - | 53917445 |
| Q | ISOLATOR PANEL BOARDS (INDOOR & OUTDOOR TYPE) | - | 71297831 |
| R | DG SETS AND EXHAUST PIPING SYSTEM | - | 45020531 |
| S | HSD STORAGE AND SUPPLY SYSTEM | - | 2548975 |
| T | EXTERNAL LIGHTING FIXTURES: | - | 23036200 |
| U | SAFETY AND FIRE PROTECTION EQUIPMENTS | - | 1874430 |
| V | HT CABLES AND TERMINATIONS | - | 15051117 |
| W | SCADA SYSTEM | - | 8400000 |
| X | NITROGEN INJECTION FIRE PREVENTION AND EXTINGUISHING SYSTEM | - | 2200000 |
| Y | ENERGY MANAGEMENT SYSTEM | - | 3771787 |
| Z | MISCELLANEOUS ITEMS | - | 1017718 |
| | TOTAL | 171420429 | 870303798 |
| | GRAND TOTAL | | 1041724227 |

| ELECTRICAL WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| Sl. No | ITEMS | Description of Items | Unit | Rate | Total QTY | AMOUNT (INR) DSR |
| | | | | | | |
| A | | **POINT WIRING AND SUBMAINS** | | | | |
| 1 | 1.3 | Wiring for light/fan point/ exhaust fan point/ call bell point with 1.5sqmm FRLS PVC insulated copper conductor single core cable in surface/ recessed steel conduit, with modular switch, modular plate, suitable GI box and earthing the point with 1.5sqmm FRLS PVC insulated copper conductor single core cable etc as required. | | | | |
| 1.1 | 1.3.3 | Group C | Pts. | 1,003.00 | 17729 | 17,782,187 |
| 2 | 1.4 | Wiring for twin control light point with 1.5 sq.mm FRLS PVC insulated copper conductor single core cable in surface/ recessed steel conduit, 2 way modular switch, modular plate, suitable GI box and earthing the pont with 1.5sq.mm FRLS PVC insulated copper conductor single core cable etc. as required | Pts. | 1,069.00 | 25 | 26,725 |
| 3 | 1.5 | Wiring for light /power plug with 2X4 sq. mm FRLS PVC insulated copper conductor single core cable in surface/ recessed steel conduit along with 1 No 4 sq. mm FRLS PVC insulated copper conductor single core cable for loop earthing as required. | Meter | 233.00 | 21800 | 5,079,400 |
| 4 | 1.6 | Wiring for light/power plug with 4X4 sq. mm FRLS PVC insulated copper conductor single core cable in surface/ recessed steel conduit alongwith 2 Nos 4 sq. mm FRLS PVC insulated copper conductor single core cable for loop earthing as required. | Meter | 359.00 | 22630 | 8,124,170 |
| 5 | 1.7 | Wiring for circuit/ submain wiring along with earth wire with the following sizes of FRLS PVC insulated copper conductor, single core cable in surface/ recessed steel conduit as required | | | | |
| a | 1.7.2 | 2 X 2.5 sq. mm + 1 X 2.5 sq. mm earth wire | Meter | 200.00 | 178230 | 35,646,000 |
| b | 1.7.3 | 2 X 4.0 sq. mm + 1 X 4.0 sq. mm earth wire | Meter | 231.00 | 6200 | 1,432,200 |
| c | 1.7.4 | 2 X 6 sq. mm + 1 X 6 sq. mm earth wire | Metre | 315.00 | 5750 | 1,811,250 |
| d | 1.7.8 | 4 X 4 sq. mm + 2 X 4 sq. mm earth wire | Metre | 365.00 | 4150 | 1,514,750 |
| e | 1.7.9 | 4 X 6 sq. mm + 2 X 6 sq. mm earth wire | Metre | 509.00 | 2050 | 1,043,450 |
| f | 1.7.10 | 4 X 10 sq. mm + 2 X 10 sq. mm earth wire | Metre | 803.00 | 925 | 742,775 |
| 6 | 1.20 | Supplying and fixing of following sizes of steel conduit along with accessories in surface/recess including painting in case of surface conduit, or cutting the wall and making good the same in case of recessed conduit as required. | | | | |
| a | 1.20.1 | 20 mm | Metre | 121.00 | 1450 | 175,450 |
| b | 1.20.2 | 25 mm | Metre | 142.00 | 8600 | 1,221,200 |
| c | 1.20.3 | 32 mm | Metre | 193.00 | 700 | 135,100 |
| 7 | 1.24 | Supplying and fixing following modular switch/ socket on the existing modular plate & switch box including connections but excluding modular plate etc. as required. | | | | |
| a | 1.24.1 | 5/6 amps switch | Each | 81.00 | 6905 | 559,305 |
| b | 1.24.3 | 15/16 amps switch | Each | 111.00 | 1389 | 154,179 |
| c | 1.24.4 | 3 Pin 5/6 amps socket outlet | Each | 79.00 | 6667 | 526,693 |
| d | 1.24.5 | 6 pin 15/16 amp socket outlet | Each | 150.00 | 1208 | 181,200 |
| e | 1.24.8 | Bell Push | Each | 111.00 | 12 | 1,332 |

| ELECTRICAL WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| Sl. No | ITEMS | Description of Items | Unit | Rate | Total QTY | AMOUNT (INR) DSR |
| 8 | 1.25 | **S/F Modular Type Electronic Fan Regulator : Supplying and fixing stepped type electronic fan regulator on the existing modular plate & switch box including connections but excluding modular plate etc. as required.** | Nos | 284.00 | 496 | 140,864 |
| 9 | 1.27 | Supplying and fixing following size/ modules, GI box alongwith modular base & cover plate for modular switches in recess etc as required. | | | | |
| a | 1.27.1 | 1 or 2 Module (75mmX75mm) | Each | 166.00 | 6345 | 1,053,270 |
| b | 1.27.3 | 4 Module (125mmX75mm) | Each | 195.00 | 4526 | 882,570 |
| c | 1.27.4 | 6 module ( 200mmX75mm) | Each | 248.00 | 396 | 98,208 |
| d | 1.27.5 | 8 Module (125mmX125mm) | Each | 287.00 | 3594 | 1,031,478 |
| 10 | 1.26 | Supplying and fixing modular blanking plate on the existing modular plate & switch box excluding modular plate as required. | Each | 23.00 | 905 | 20,815 |
| 11 | 1.33 | Supply and fixing 3pin, 5 amp ceiling rose on the existing junction box/ wooden block including connection etc. as required. | Each | 43.00 | 970 | 41,710 |
| 12 | 1.38 | Supply and fixing call bell / buzzer suitable for single phase, 230volts, complete as required. | Each | 61.00 | 16 | 976 |
| 13 | 2.18 | Supply & fixing 20 amps, SPN, industrial type, socket outlet, with 2 pole and earth, metal enclosed plug top alongwith 20amps "C" curve, SP, MCB, in sheet steel enclosure, on surface or in recess, with chained metal cover for the socket outlet and complete with connections, testing and commissioning etc. as required. | Each | 954.00 | 98 | 93,492 |
| 14 | 2.19 | Supplying and fixing 20amps, 415 volts, TPN industrial type, socket outlet, with 4 pole and earth, metal enclosed plug top alongwith 20amps "C" curve, TPMCB, in sheet steel enclosure , on surface or in recess, with chained metal cover for the socket outlet and complete with connections, testing and commissioning etc. as required. | Each | 1,967.00 | 38 | 74,746 |
| 15 | 2.2 | Supplying and fixing 30amps, 415 volts, TPN industrial type, socket outlet, with 4 pole and earth, metal enclosed plug top alongwith 32amps "C" curve, TPMCB, in sheet steel enclosure , on surface or in recess, with chained metal cover for the socket outlet and complete with connections, testing and commissioning etc. as required. | Each | 2,473.00 | 57 | 140,961 |
| | | **TOTAL CARRIED OVER TO SUMMARY** | | | | **79,736,456** |
| | | | | | | |
| B | | **CABLES & CABLE TRAYS** | | | | |
| B1 | | **MV CABLE LAYING** | | | | |
| 1 | 7.8 | Laying and fixing of one number PVC insulated and PVC sheathed / XLPE power cable of 1.1 KV grade of following size on cable tray as required. | | | | |
| 1.1 | 7.8.1 | Upto 35 sq. mm (clamped with 1mm thick saddle) | Mtrs. | 20.00 | 51300 | 1,026,000 |
| 1.2 | 7.8.2 | Above 35 sq. mm and upto 95 sq. mm (clamped with 25x3mm MS flat clamp) | Mtrs. | 48.00 | 6800 | 326,400 |
| 1.3 | 7.8.3 | Above 95 sq. mm and upto 185 sq. mm (clamped with 25/40x3mm MS flat clamp) | Mtrs. | 59.00 | 50 | 2,950 |
| 1.3 | 7.8.4 | Above 185 sq. mm and upto 400 sq. mm (clamped with 25/40x3mm MS flat clamp) | Mtrs. | 91.00 | 35 | 3,185 |

| ELECTRICAL WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| Sl. No | ITEMS | Description of Items | Unit | Rate | Total QTY | AMOUNT (INR) DSR |
| | | | | | | |
| 2 | 7.10 | Laying of one number PVC insulated and PVC sheathed / XLPE power cable of 1.1 KV grade of following size direct in ground including excavation, sand cushioning, protective covering and refilling the trench etc as required. | | | | |
| 1.1 | 7.1.1 | Upto 35 sq. mm | Mtrs. | 195.00 | 20 | 3,900 |
| 1.2 | 7.1.2 | Above 35 sq. mm and upto 95 sq. mm | Mtrs. | 202.00 | 50 | 10,100 |
| 1.3 | 7.1.3 | Above 95 sq. mm and upto 185 sq. mm | Mtrs. | 210.00 | 2375 | 498,750 |
| 1.3 | 7.1.4 | Above 185 sq. mm and upto 400 sq. mm | Mtrs. | 233.00 | 16680 | 3,886,440 |
| | | | | | | |
| 3 | 7.20 | Laying of one number additional PVC insulated and PVC sheathed / XLPE power cable of 1.1 KV grade of following size direct in ground in the same trench in one tier horizontal formation including excavation, sand cushioning, protective covering and refilling the trench etc as required. | | | | |
| 3.1 | 7.2.1 | Upto 35 sq. mm | Mtrs. | 133.00 | 20 | 2,660 |
| 3.2 | 7.2.2 | Above 35 sq. mm and upto 95 sq. mm | Mtrs. | 141.00 | 20 | 2,820 |
| 3.3 | 7.2.3 | Above 95 sq. mm and upto 185 sq. mm | Mtrs. | 149.00 | 20 | 2,980 |
| 3.4 | 7.2.4 | Above 185 sq. mm and upto 400 sq. mm | Mtrs. | 171.00 | 20 | 3,420 |
| | | | | | | |
| 4 | | MV cable laying in existing Hume Pipe :Laying of one number PVC insulated XLPE insulated and PVC sheathed/XLPE power cable of 1.1 KV grade of following size in the existing RCC/HUME/METAL pipe as required. | | | | |
| 4.1 | 7.5.1 | Up to 35 sq.mm | Metre | 16.00 | 50 | 800 |
| 4.2 | 7.5.2 | Above 35 sq.mm and up to 95 sq. mm | Metre | 25.00 | 100 | 2,500 |
| 4.3 | 7.5.3 | Above 95 sq.mm and up to 185 sq. mm | Metre | 33.00 | 100 | 3,300 |
| 4.4 | 7.5.4 | Above 185 sq.mm and up to 400 sq. mm | Metre | 58.00 | 100 | 5,800 |
| | | | | | | |
| B2 | | **CABLE TRAYS AND OVERHEAD RACEWAYS** | | | | |
| 1 | 4.1.2 | Supply and installing following size of perforated pre-painted MS Cable Trays with perforation not more than 17.5%, in convenient sections, joined with connectors, suspended from ceiling with MS suspenders including bolts & nuts, painting suspenders etc as required. | | | | |
| | | (All cable tray accessories shall be factory fabricated only.) | | | | |
| 1.1 | 4.1.2 | 150 mm width X 50 mm depth X 1.6 mm thickness | Metre | 520.00 | 343 | 178,360 |
| 1.2 | 4.1.4 | 300 mm width X 50 mm depth X 1.6 mm thickness | Metre | 789.00 | 2486 | 1,961,454 |
| 1.3 | 4.1.6 | 450 mm width X 50 mm depth X 2.0 mm thickness | Metre | 1,117.00 | 1325 | 1,480,025 |
| 1.4 | 4.1.11 | 600 mm width X 62.5 mm depth X 2.0 mm thickness | Metre | 1,445.00 | 345 | 498,525 |
| 1.5 | 4.1.12 | 750 mm width X 62.5 mm depth X 2.0 mm thickness | Metre | 1,875.00 | 130 | 243,750 |
| 1.6 | 4.1.13 | 900 mm width X 62.5 mm depth X 2.0 mm thickness | Metre | 2,006.00 | 461 | 924,766 |
| | | | | | | |
| | | **TOTAL (1 +2) CARRIED OVER TO SUMMARY** | | | | **11,068,885** |
| | | | | | | |
| C | | **DISTRIBUTION BOARDS** | | | | |

| ELECTRICAL WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| Sl. No | ITEMS | Description of Items | Unit | Rate | Total QTY | AMOUNT (INR) DSR |
| 1 | 2.3 | Supply and fixing following way, single pole and neutral, sheet steel, MCB distribution board,240volts,on surface/recess, complete with tinned copper bus bar , neutral bus bar , earth bar , din bar , interconnections , power painted including earthing , numbering etc. as required. (But without MCB/RCCB/Isolator ) | | | | |
| 1.1 | 2.3.5 | 2+4 Way/ 6 Way ,Double Door | Each | 923.00 | 20 | 18,460 |
| 1.2 | 2.3.6 | 2+6 Way/ 8 Way ,Double Door | Each | 1,041.00 | 2 | 2,082 |
| 1.3 | 2.3.7 | 2+8 Way/ 10 Way ,Double Door | Each | 1,132.00 | 18 | 20,376 |
| 2 | 2.4 | Supplying and fixing following way,horizontal type three pole and neutral,sheet steel,MCB distribution board, 415 Volts, on surface/recess,complete with tinned copper busbar,neutral busbar,earth bar,din bar,interconnections, powder painted including earthing , numbering etc. as required. (But without MCB/RCCB/Isolator) | | | | |
| 2.1 | 2.4.4 | 4 way (4+12), Double door | Each | 2,175.00 | 152 | 330,600 |
| 2.2 | 2.4.5 | 6 way (4+18), Double door | Each | 2,636.00 | 235 | 619,460 |
| 2.3 | 2.4.6 | 8 way (4+24), Double door | Each | 3,148.00 | 76 | 239,248 |
| 2.4 | Derived from DSR-2.4.6 | 12way (4+36), Double door | Each | 4,497.00 | 21 | 94,437 |
| | | | | | | |
| 3 | 2.5 | Supply and fixing of following ways surface/ recess mounting, vertical type, 415volts, TPN MCB distribution board of sheet steel, dust protected, duly powder panited, inclusinve of 200 amps tinned copper bus bar, common neutral link, earth basr, din bar for molunting MCBs (but without MCBs and incomer) as required. | | | | |
| 3.1 | Derived from DSR-2.5.6 | 10 way (4 + 30) Double door | | 6,090.00 | 16 | 97,440 |
| 3.2 | 2.5.6 | 12 way (4 + 36) Double door | | 7,165.00 | 4 | 28,660 |
| 4 | 2.10 | Supplying and fixing 5 amps to 32 amps, rating, 240/415 volts, 'C' Curve , miniature circuit breaker suitable for inductive load of following poles in the existing MCB DB complete with connections, testing and commissioning etc. as required. | | | | |
| 4.1 | 2.10.1 | Single Pole | Each | 169.00 | 8890 | 1,502,410 |
| 4.2 | 2.10.3 | Double Pole | Each | 459.00 | 98 | 44,982 |
| 5 | 2.14 | Supply and fixing following rating, double pole, (single phase and neutral), 240volts, residual current circuit breaker (RCCB), having a sensitivity current up to 300miliamperes in the existing MCB DB complete with connections, testing and commissioning etc. as required. | | | | |
| a | 2.14.2 | 40 amps | Each | 1,714.00 | 1185 | 2,031,090 |
| b | 2.14.3 | 63 amps | Each | 2,237.00 | 339 | 758,343 |
| | | The RCCBs shall be of 30mA ratings. | | | | |
| | | **TOTAL CARRIED OVER TO SUMMARY** | | | | **5,787,588** |
| | | | | | | |
| D | | **LIGHTING FIXTURES AND FANS** | | | | |

| ELECTRICAL WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| Sl. No | ITEMS | Description of Items | Unit | Rate | Total QTY | AMOUNT (INR) DSR |
| 2 | | **INSTALLATION OF LIGHTING FIXTURES** | | | | |
| 2.1 | 1.45 | Installation, testing & commissioning of ceiling fan , including wiring the down rod of standard lengths (30cm) with 1.5sqmm FRLS PVC insulated, copper conductor, single core cable, including providing and fixing phenolic laminated sheet cover on the fan box etc. as required. | Each | 122.00 | 496 | 60,512 |
| | | | | | | |
| | | **CABLING AND INSTALLATION OF LIGHTING FIXTURES FOR EXTERNAL / LANDSCAPE & FAÇADE LIGHTING** | | | | |
| 2.2 | 14.13 | Providing, laying and fixing following dia GI pipe (medium class) in ground complete with G.I. fitting including trenching (75mm deep) and re-filling etc. as required. | | | | |
| 2.2.1 | 14.13.2 | 80 mm GI pipe | Mtrs | 697.00 | 660 | 460,020 |
| 2.2.2 | 14.13.1 | 50 mm GI pipe | Mtrs | 450.00 | 390 | 175,500 |
| | | **TOTAL CARRIED OVER TO SUMMARY** | | | | **696,032** |
| | | | | | | |
| E | | **CONDUITING & CABLEING FOR TELEPHONE, DATA & MATV SYSTEM** | | | | |
| | | Providing and installing of all conduiting, structured cabling for telephone, data and MATV system including providing and fixing of the following: | | | | |
| 1 | | All necessary specials and fittings. | | | | |
| 2 | | Approved cover plates for inspection, junction and outlet boxes. | | | | |
| 3 | | 2 mm thick outlet boxes and junction boxes. | | | | |
| 4 | | All fixing accessories such as clips, brass bushes, nails, screws etc. | | | | |
| 5 | | Providing and fixing approved saddles, hooks and grouting the same as required, in the case of all exposed conduit work. | | | | |
| 6 | | Embedding conduits and accessories in wall, floors etc. during construction and / or cutting chases and making good as necessary in the case of all concealed conduit work. | | | | |
| 7 | | Providing 14 SWG GI pull wire in all conduit work. | | | | |
| 8 | | Repainting of MS conduits, outlet boxes and junction boxes where ever damaged. | | | | |
| (i) | | **TELEPHONE SYSTEM** | | | | |
| 1 | 1.20 | **S/F Steel conduit : Supplying and fixing of following sizes of Steel conduits along with accessories in surface/ recess including painting in case of surface conduit,or cutting the wall and making good the same in case of recessed conduit as required.** | | | | |
| a | 1.20.1 | 20mm | Metre | 121.00 | 3900 | 471,900 |
| b | 1.20.2 | 25mm | Metre | 142.00 | 63600 | 9,031,200 |
| c | 1.20.3 | 32 mm | Metre | 193.00 | 550 | 106,150 |
| | | **TOTAL CARRIED TO SUMMARY (i)** | | | | **9,609,250** |
| (ii) | | **DATA SYSTEM** | | | | |

| ELECTRICAL WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| Sl. No | ITEMS | Description of Items | Unit | Rate | Total QTY | AMOUNT (INR) DSR |
| 1 | 1.20 | **S/F Steel conduit : Supplying and fixing of following sizes of Steel conduits along with accessories in surface/ recess including painting in case of surface conduit,or cutting the wall and making good the same in case of recessed conduit as required.** | | | | |
| a | 1.20.1 | 20mm | Metre | 121.00 | 36520 | 4,418,920 |
| b | 1.20.2 | 25mm | Metre | 142.00 | 107650 | 15,286,300 |
| c | 1.20.3 | 32 mm | Metre | 193.00 | 950 | 183,350 |
| | | **TOTAL CARRIED TO SUMMARY (ii)** | | | | **19,888,570** |
| (iii) | | **MATV SYSTEM** | | | | |
| 1 | 1.24 | Supply & fixing following modular switch / socket on the existing modular plate & switch box including connections but excluding modular plate etc as required. | | | | |
| a | 1.24.7 | TV antenna socket outlet | Each | 94.00 | 28 | 2,632 |
| 2 | 1.20 | **S/F Steel conduit : Supplying and fixing of following sizes of Steel conduits along with accessories in surface/ recess including painting in case of surface conduit,or cutting the wall and making good the same in case of recessed conduit as required.** | | | | |
| a | 1.20.1 | 20mm | Metre | 121.00 | 470 | 56,870 |
| b | 1.20.2 | 25mm | Metre | 142.00 | 2475 | 351,450 |
| c | 1.20.3 | 32 mm | Metre | 193.00 | 320 | 61,760 |
| 3 | 1.19 | Supplying and drawing co-axial TV cable RG-6 grade, 0.7mm solid copper conductor PE insulated, shielded with fine tinned copper braid and protected with PVC sheath in existing surface / recessed steel/ PVC conduit as required | Mtrs. | 28.00 | 2150 | 60,200 |
| | | **TOTAL CARRIED TO SUMMARY (iii)** | | | | **532,912** |
| | | **TOTAL (I + ii + iii) CARRIED OVER TO SUMMARY** | | | | **30,030,732** |
| | | | | | | |
| F | | **FIRE DETECTION, ALARM AND PA SYSTEM** | | | | |
| 1 | 1.20 | **S/F Steel conduit : Supplying and fixing of following sizes of Steel conduits along with accessories in surface/ recess including painting in case of surface conduit,or cutting the wall and making good the same in case of recessed conduit as required.** | | | | |
| a | 1.20.1 | 20mm | Metre | 121.00 | 12600 | 1,524,600 |
| b | 1.20.2 | 25mm | Metre | 142.00 | 146000 | 20,732,000 |
| c | 1.20.3 | 32 mm | Metre | 193.00 | 1650 | 318,450 |
| 2 | 1.17 | Supplying and drawing Following size of FRLS PVC insulated copper conductor, single core cable in the existing surface/ recessed steel conduit as required. | | | | |
| a | 1.17.2 | 2 x 1.5 Sq. mm | RM | 36.00 | 5600 | 201,600 |
| | | **TOTAL CARRIED OVER TO SUMMARY** | | | | **22,776,650** |
| | | | | | | |
| G | | **CONDUITING FOR CCTV SYSTEM** | | | | |
| | | **ITEM DESCRIPTION** | | | | |
| | | Supply, Installation, Testing & commissioning of the below mentioned Items: | | | | |

| ELECTRICAL WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| Sl. No | ITEMS | Description of Items | Unit | Rate | Total QTY | AMOUNT (INR) DSR |
| 1 | 1.20 | **S/F Steel conduit : Supplying and fixing of following sizes of Steel conduits along with accessories in surface/ recess including painting in case of surface conduit,or cutting the wall and making good the same in case of recessed conduit as required.** | | | | |
| a | 1.20.1 | 20mm | Mtrs. | 121.00 | 19650 | 2,377,650 |
| b | 1.20.2 | 25mm | Mtrs. | 142.00 | 2650 | 376,300 |
| c | 1.20.3 | 32 mm | Mtrs. | 193.00 | 600 | 115,800 |
| | | **TOTAL CARRIED OVER TO SUMMARY** | | | | **2,869,750** |
| | | | | | | |
| H | | **ACCESS CONTROL SYSTEM** | | | | |
| 1 | 1.20 | S/F Steel conduit : Supplying and fixing of following sizes of Steel conduits along with accessories in surface/ recess including painting in case of surface conduit,or cutting the wall and making good the same in case of recessed conduit as required. | | | | |
| a | 1.20.1 | 20mm | Metre | 121.00 | 1450 | 175,450 |
| b | 1.20.2 | 25mm | Metre | 142.00 | 2000 | 284,000 |
| c | 1.20.3 | 32 mm | Metre | 193.00 | 180 | 34,740 |
| | | **TOTAL CARRIED OVER TO SUMMARY** | | | | **494,190** |
| | | | | | | |
| I | | **CIVIL WORKS** | | | | |
| 1 | 4.1 | Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level : | | | | |
| 1.1 | 4.1.5 | 1:3:6 (1 Cement : 3 coarse sand : 6 graded stone aggregate 20 mm nominal size) | Cum | 4,834.30 | 81 | 391,578 |
| 2 | 4.2 | Providing and laying cement concrete in retaining walls, return walls, walls (any thickness) including attached pilasters, columns, piers, abutments, pillars, posts, struts, buttresses, string or lacing courses, parapets, coping, bed blocks, anchor blocks, plain window sills, fillets, sunken floor,etc., up to floor five level, excluding the cost of centering, shuttering and finishing: | | | | |
| 2.1 | 4.2.5 | 1:3:6 (1 cement : 3 coarse sand : 6 graded stone aggregate 20 mm nominal size) | Cum | 5,818.00 | 320 | 1,861,760 |
| | | **TOTAL CARRIED OVER TO SUMMARY** | | | | **2,253,338** |
| | | | | | | |
| J | | **EARTHING SYSTEM** | | | | |
| 1.0 | 5.1 | Earthing with GI earth pipe 4.5 Mtr long , 40 mm dia including accessories and providing masonary enclosure with cover plate having locking arrangement and watering pipe etc with charcoal/coke & salt as required. | Set | 3,007.00 | 150 | 451,050 |
| | | | | | | |

| ELECTRICAL WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| Sl. No | ITEMS | Description of Items | Unit | Rate | Total QTY | AMOUNT (INR) DSR |
| 2.0 | 5.3 | **Earthing with GI earth plate 600mm X 600mm X 6 mm thick including accessories and providing masonary enclosure with cover plate having locking arrangement and watering pipe of 2.7 metre long etc. with charcoal/coke and salt as required.** | Set | 3,557.00 | 72 | 256,104 |
| | | | | | | |
| 3.0 | 5.5 | **Earthing with Copper earth plate 600mm X 600mm X 3 mm thick including accessories and providing masonary enclosure with cover plate having locking arrangement and watering pipe of 2.7 metre long etc. with charcoal/coke and salt as required.** | Set | 8,359.00 | 46 | 384,514 |
| 5.0 | 5.7 | Supplying and laying 6 SWG G.I. wire at 0.50 metre below ground level for conductor earth electrode, including connection/ termination with GI thimble etc. as required. | Metre | 27.00 | 400 | 10,800 |
| | | | | | | |
| 6.0 | 5.8 | Supplying and laying 25 mm X 5 mm copper strip at 0.50 metre below ground as strip earth electrode, including connection/ terminating with G.I. nut, bolt, spring, washer etc. as required. (Jointing shall be done by overlapping and with 2 sets of G.I. nut bolt & spring washer spaced at 50mm). | Metre | 753.00 | 50 | 37,650 |
| | | | | | | |
| 7.0 | 5.9 | Supplying and laying 25mm x 5 mm GI strip at 0.50 m below ground as strip earth electrocde, including connection/terminating with G.I. nut, bolt, spring, washer etc. as required. (Jointing shall be done by overlapping and with 2 sets of G.I nut bolt & spring washer sapced at 50mm). | Metre | 109.00 | 50 | 5,450 |
| | | | | | | |
| 8.0 | 5.1 | Providing & Fixing 25mm x 5 mm Copper strip in 40 mm dia G.I. Pipe from earth electrode including connection with brass nut, bolt, spring, washer excavation and re-filling etc. as required. | Metre | 1,082.00 | 50 | 54,100 |
| | | | | | | |
| 9.0 | 5.11 | Providing & Fixing 25mm x 5 mm G.I. Strip in 40 mm dia G.I. pipe from earth electrode including connection with G.I. nut, bolt, spring, washer excavation and re-filling etc. as required. | Metre | 421.00 | 60 | 25,260 |
| | | | | | | |
| 10.0 | 5.12 | Providing and laying earth connection from earth electrode with 6 SWG dia G.I. Wire in 15 mm dia G.I. pipe from earth electrode including connection with G.I. thimble excavation and re-filling as required. | Metre | 151.00 | 150 | 22,650 |
| | | | | | | |
| 11.0 | 5.13 | Providing and laying earth connection from earth electrode with 4.00 mm dia copper wire in 15 mm dia G.I. pipe from earth electrode including connection with copper thimble excavation and re-filling as required. | Metre | 213.00 | 100 | 21,300 |
| | | | | | | |

| ELECTRICAL WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| Sl. No | ITEMS | Description of Items | Unit | Rate | Total QTY | AMOUNT (INR) DSR |
| 12.0 | 5.14 | Providing and fixing 25mm X 5mm Copper strip on surface or in recess for connections etc. as required. | Metre | 856.00 | 10 | 8,560 |
| | | | | | | |
| 13.0 | 5.2 | Providing and fixing 50 mm x 6 mm thick copper tape. | RM | 1,599.00 | 400 | 639,600 |
| | | | | | | |
| | | | | | | **1,917,038** |

| | | | | | | |
|---|---|---|---|---|---|---|
| K | | **HT CABLES AND TERMINATIONS** | | | | |
| 1.0 | 8.1 | Laying of one number PVC insulated and PVC sheathed / XLPE power cable of 11 KV grade of following size direct in ground including excavation, sand cushioning, protection covering and refilling the trench etc as required. | | | | |
| a | 8.1.2 | Above 120 Sq.mm and upto 400 Sq.mm | Mtr | 278.00 | 3300 | 917,400 |
| | | | | | | |
| 2.0 | 8.2 | Laying of one number additional PVC insulated and PVC sheathed / XLPE power cable of 11 KV grade of following size direct in existing RCC trench in one tier horizontal formation including dressing , saddling on angle iron supports. | | | | |
| a | 8.2.2 | Above 120 Sq.mm and upto 400 Sq.mm | Mtr | 197.00 | 100 | 19,700 |
| | | | | | | |
| 3.0 | 8.3 | Laying of one number PVC insulated and PVC sheathed / XLPE power cable of 11 KV grade of following size in the existing RCC/ HUME/ METAL pipe as required. | | | | |
| a | 8.3.2 | Above 120 Sq.mm and upto 400 Sq.mm | Mtr | 59.00 | 100 | 5,900 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 3.0 | 8.4 | Laying of one number PVC insulated and PVC sheathed / XLPE power cable of 11 KV grade of following size in the existing masonary open duct as required. | | | | |
| a | 8.4.2 | Above 120 Sq.mm and upto 400 Sq.mm | Mtr | 50.00 | 100 | 5,000 |
| | | | | | | |
| 4.0 | 10.6 | Supply and making straight through cable jointing with heat shrinkable jointing kit complete with all accessories including ferrules suitable for follwing size of 3 core, XLPE aluminium conductor cable of 11 KV grade as required. | | | | |
| a | 10.6.4 | 300 Sq.mm | Each | 10,540.00 | 12 | 126,480 |
| | | | | | | |
| 5.0 | 14.4 | Excavation for cable trenches in soft soil, depth upto 1.2 m including dressing of sides lift upto 1.5m, including getting out the excavated soil , refilling with sand and or good soil after laying of cable / pipe etc in layers of 20 cm, ramming, watering and disposal of surplus excavated soil as directed. | Cum | 285.00 | 3000 | 855,000 |
| | | | | | | |

| ELECTRICAL WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| Sl. No | ITEMS | Description of Items | Unit | Rate | Total QTY | AMOUNT (INR) DSR |
| 6.0 | 14.6 | Excavation of cable trenches in hard rock not exceeding 1.5 meters in width, and lift upto 1.5 metres, including getting out the excavated soil and disposal of excavated soil as directed within a lead of 50 metres. | Cum | 528.00 | 10 | 5,280 |
| | | | | | | **1,934,760** |
| L | | **MISCELLANEOUS ITEMS** | | | | |
| 1.0 | 14.1 | Providing, laying and fixing following dia G.I. pipe (medium class) in ground complete with G.I. fittings including trenching (75 cm deep) and re-filling etc as required | | | | |
| a | 14.13.1 | 50 mm dia | metre | 450.00 | 750 | 337,500 |
| b | 14.13.2 | 80 mm dia | metre | 697.00 | 1100 | 766,700 |
| c | 14.13.3 | 100 mm dia | metre | 983.00 | 650 | 638,950 |
| | | | | | | |
| 2.0 | 14.1 | Providing, laying and fixing following dia RCC pipe NP2 class (light duty) in ground complete with RCC collars, jointing with cement mortar 1:2 (1 cement : 2 fine sand) including trenching (75 cm deep) and refilling etc as required. | | | | |
| a | 14.14.1 | 100 mm dia | metre | 337.00 | 1220 | 411,140 |
| b | 14.14.2 | 150 mm dia | metre | 384.00 | 6920 | 2,657,280 |
| c | 14.14.3 | 250 mm dia | metre | 455.00 | 2120 | 964,600 |
| d | 14.14.4 | 300 mm dia | metre | 566.00 | 10740 | 6,078,840 |
| | | **TOTAL** | | | | **11,855,010** |
| **TOTAL ELECRTICAL DSR** | | | | | | **171420429** |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| A | | **POINT WIRING AND SUBMAINS** | | | | |
| 1 | NDSR | Wiring for the following light points with 2.5 sq.mm (including circuit wiring) PVC insulated FRLS copper conductor 1100 volts grade stranded flexible wires of approved make in surface/ concealed 25 mm dia stove enamled black MS conduit controlled by SP MCB provided in the DB and earthing the point with 2.5 sq.mm. FRLS PVC insulated copper conductor single core cable etc as required. (Cost of MCB not to be included) | | | | |
| a | | Primary points for length upto 10 mtr. | Pts. | 988.00 | 667 | 658,996 |
| b | | Primary points for length above 10 mtr.& upto 18 mtr | Pts. | 1,168.00 | 412 | 481,216 |
| c | | Loop Point | Pts. | 480.00 | 4864 | 2,334,720 |
| | | | | | | |
| 2 | NDSR | Wiring for following 250 volts single phase and neutral 6/16 amps switched socket outlet and one light point (bulkhead) for lift shafts with 4 sq.mm PVC insulated FRLS copper conductor 1100 volts grade stranded flexible wires in concealed 25 mm dia stove enamled black MS conduit including providing and fixing of 16 amps 3 pin switched socket of approved make and design in 1.2 mm thick GI boxes with grid plates and earthing of third pin of socket outlet and GI box with 4 sq.mm PVC insulated FRLS copper conductor stranded flexible wire for following sets(point for lift shaft): (Cost of MCB/ bulk head light fixture not to be included) | | | | |
| a | | One sets of above controlled by one 20 A SP MCB in DB | Pts. | 1,700.00 | 11 | 18,700 |
| b | | Two sets of above controlled by one 20 A SP MCB in DB | Pts. | 2,200.00 | 19 | 41,800 |
| c | | Four sets of above controlled by one 20 A SP MCB in DB | Pts. | 3,500.00 | 26 | 91,000 |
| | | | | | | |
| 3 | NDSR | Supply and fixing of metal fan hook box of 10 mm M.S. round bar , bounded to to RCC bar up to 50 mm length each side & pierced through a 16 SWG thick MS bowl 100 mm dia , depth up to 75 mm , complete erected in position . With one coat of red oxide paint and 2 coats of synthetic paint . | Nos | 250.00 | 36 | 9,000 |
| | | | | | | |
| 4 | NDSR | Supply, installation, testing & commissioning of following isolators fabricated out of 16 guage CRCA sheet steel enclosure, dust and vermin proof including MCBs/ MCCBs. Enclosure shall be fabricated as per specifications. 2 nos. Earthing terminal shall be provided. (For UPS) | | | | |
| a | | 315 amps TPN MCCB of 25kA (Ics) | Nos. | 25,000.00 | 7 | 175,000 |
| b | | 250 amps TPN MCCB of 25kA (Ics) | No. | 8,053.00 | 8 | 64,424 |
| b | | 160 amps TPN MCCB of 25kA (Ics) | No. | 8,053.00 | 9 | 72,477 |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| 5 | NDSR | Wiring for 250 volts single phase and neutral 20 A switch & socket outlet with 4 sq.mm PVC insulated FRLS copper conductor 1100 volts grade stranded flexible wires in concealed or surface mounted 25 mm dia 16 gauge M.S. conduit, including providing and fixing of 20 A 3 pin switched socket of approved make and design in 1.6 mm thick GI boxes with grid plates and earthing the third pin of socket outlet with 2.5 Sq. mm PVC insulated FRLS copper conductor stranded flexible wire. (For Air conditioner).Switch and Socket to be installed separately in different locations as requred. | Pts | 2,500.00 | 1207 | 3,017,500 |
| | | | | | | |
| 6 | NDSR | Wiring for 250 volts single phase and neutral 20 A switched socket outlet with 4 sq.mm PVC insulated FRLS copper conductor 1100 volts grade stranded flexible wires in concealed or surface mounted 25 mm dia 16 gauge M.S. conduit, including providing and fixing of 20 A 3 pin switched socket of approved make and design in 1.6 mm thick GI boxes with grid plates and earthing the third pin of socket outlet with 2.5 Sq. mm PVC insulated FRLS copper conductor stranded flexible wire. (For Gyser). | Pts | 2,500.00 | 1243 | 3,107,500 |
| | | | | | | |
| 7 | NDSR | Supply & fixing of 3mm thick bakelite sheet cover in circular shape (minimum 80mm dia) with all types of juction boxes complete with brass machine screw & washers etc | Each | 30.00 | 2960 | 88,800 |
| | | **TOTAL FOR POINT WIRING AND SUBMAIN** | | | | 10,161,133 |
| | | | | | | |
| B | | **CABLES & CABLE TRAYS** | | | | |
| B1 | | **CABLES** | | | | |
| 1 | NDSR | Supply, loading, transportation unloading at site, storages at site ,shifting from storage place to site of following sizes of XLPE insulated PVC sheathed, outersheath FRLS, Aluminium conductor flat strip armoured power cable of 1.1 KV grade conforming to IS amended upto date and as per specifications. | | | | |
| a | | 3.5 C x 400 Sqmm | Metre | 2,365.00 | 6000 | 14,190,000 |
| b | | 3.5 C x 300 Sqmm | Metre | 1,860.00 | 6560 | 12,201,600 |
| c | | 3.5 C x 240 Sqmm | Metre | 1,517.00 | 4120 | 6,250,040 |
| d | | 3.5 C x 185 Sqmm | Metre | 1,203.00 | 2250 | 2,706,750 |
| e | | 3.5 C x 150 Sqmm | Metre | 967.00 | 45 | 43,515 |
| f | | 3.5 C x 120 Sqmm | Metre | 815.00 | 80 | 65,200 |
| g | | 3.5 C x 95 Sqmm | Metre | 653.00 | 90 | 58,770 |
| h | | 3.5 C x 70 Sqmm | Metre | 525.00 | 3141 | 1,649,025 |
| i | | 3.5 C x 50 Sqmm | Metre | 396.00 | 3485 | 1,380,060 |
| j | | 3.5 C x 35 Sqmm | Metre | 307.00 | 618 | 189,726 |
| k | | 4 C x 25 Sqmm | Metre | 268.00 | 135 | 36,180 |
| l | | 4 C x 16 Sqmm | Metre | 211.00 | 22559 | 4,759,949 |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| 2 | NDSR | Supply, loading, transportation unloading at site, storages at site ,shifting from storage place to site of following sizes of XLPE insulated PVC tape innersheathed, outersheath FRLS, Copper conductor flat strip armoured power cable of 1.1 KV grade conforming to IS:7098 (part-1) 1988 or amended upto date and as per specifications. | | | | |
| a | | 3 C x 6 Sqmm | Metre | 342.00 | 700 | 239,400 |
| b | | 4 C x 6 Sqmm | Metre | 441.00 | 15822 | 6,977,502 |
| c | | 3 C x 10 Sqmm | Metre | 533.00 | 800 | 426,400 |
| d | | 4C x 10 Sqmm | Metre | 688.00 | 9300 | 6,398,400 |
| | | | | | | |
| 3 | NDSR | Supply, loading, transportation unloading at site, storages at site ,shifting from storage place to site of following sizes of PVC insulated unsheathed single core, Copper conductor flexible power cable of 1.1 KV grade conforming to IS:694 : 1990 or amended upto date and as per specifications. | | | | |
| a | | 1C x 95 Sqmm | Metre | 744.00 | 600 | 446,400 |
| b | | 1C x 16 Sqmm | Metre | 82.00 | 550 | 45,100 |
| | | | | | | |
| 4 | NDSR | Supplying and making indoor end termination with brass double compression gland and aluminium lugs for following size of XLPE insulated and PVC sheathed / XLPE aluminium conductor cable of 1.1 KV grade as required. | | | | |
| a | | 3.5 C x 400 Sqmm(82mm) | Each | 2,500.00 | 102 | 255,000 |
| b | | 3.5 C x 300 Sqmm(70mm) | Each | 2,150.00 | 60 | 129,000 |
| c | | 3.5 C x 240 Sqmm(62mm) | Each | 2,100.00 | 48 | 100,800 |
| d | | 3.5 C x 185 Sqmm(57mm) | Each | 1,950.00 | 30 | 58,500 |
| e | | 3.5 C x 150 Sqmm(50mm) | Each | 1,900.00 | 8 | 15,200 |
| f | | 3.5 C x 120 Sqmm(45mm) | Each | 1,850.00 | 4 | 7,400 |
| g | | 3.5 C x 95 Sqmm(45mm) | Each | 1,650.00 | 56 | 92,400 |
| h | | 3.5 C x 70 Sqmm(38mm) | Each | 1,550.00 | 136 | 210,800 |
| i | | 3.5 C x 50 Sqmm(35mm) | Each | 1,390.00 | 88 | 122,320 |
| j | | 3.5 C x 35 Sqmm (32mm) | Each | 1,375.00 | 8 | 11,000 |
| k | | 4 C x 25 Sqmm (28mm) | Each | 1,275.00 | 2 | 2,550 |
| l | | 4 C x 16 Sqmm (28mm) | Each | 1,270.00 | 544 | 690,880 |
| | | | | | | |
| 5 | NDSR | Supplying and making indoor end termination with double brass compression gland and Copper lugs for following size of XLPE insulated and PVC sheathed / XLPE insulated copper conductor cable of 1.1 KV grade as required. | | | | |
| a | | 3 C x 6 Sqmm | Nos. | 120.00 | 56 | 6,720 |
| b | | 4 C x 6 Sqmm | Nos. | 200.00 | 388 | 77,600 |
| c | | 4 C x 10 Sqmm | Nos. | 260.00 | 208 | 54,080 |
| d | | 3 C x 10 Sqmm | Nos. | 230.00 | 36 | 8,280 |
| | | | | | | |
| 6 | NDSR | Supplying and making indoor end termination with PVC gland and Copper lugs for following size of PVC insulated and PVC unsheathed copper conductor cable of 1.1 KV grade as required. | | | | |
| a | | 1 C x 95 Sqmm | Nos. | 550.00 | 50 | 27,500 |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| b | | 1 C x 16 Sqmm | Nos. | 150.00 | 40 | 6,000 |
| c | | 1 C x 50 Sqmm | Nos. | 150.00 | 50 | 7,500 |
| | | | | | | |
| B2 | | **CABLE TRAYS AND OVERHEAD RACEWAYS** | | | | |
| 1 | NDSR | Design, manufacturing, supply and installation of overhead raceways made from 1.6mm thick G.I. sheet in following size for CCTV, tele, data, fire alarm system etc complete with suitable knockouts, suspended rods / angle iron, reducer, 1.2mm thick removable top cover and cable holding arrangement commplete for installationas required: | | | | |
| a | | 450mm x 80mm x 1.6 thick with one compartments. | Meter | 1,100.00 | 25 | 27,500 |
| b | | 300mm x 80mm x 1.6 thick with one compartments. | Meter | 830.00 | 45 | 37,350 |
| c | | 200mm x 80mm x 1.6 thick with one compartments. | Meter | 450.00 | 180 | 81,000 |
| d | | 150mm x 80mm x 1.6 thick with one compartments. | Meter | 350.00 | 230 | 80,500 |
| e | | 100mm x 80mm x 1.6 thick with one compartments. | Meter | 350.00 | 30 | 10,500 |
| | | | | | | |
| 2 | NDSR | Design, manufacturing, supply and installation of pre-galvalized floor raceways made from 2.0mm thick G.I. sheet in following size for industrial power outlet wiring, tele, data, etc complete with suitable knockouts, junction box, tap off points, reducer, 3mm thick removable top cover and cable holding arrangement : | | | | |
| a | NDSR | 300mm x 40mm x 2.0 thick with two compartments. | RM | 1,636.00 | 342 | 559,512 |
| b | NDSR | 200mm x 40mm x 2.0 thick with one compartments. | RM | 1,636.00 | 2452 | 4,011,472 |
| c | NDSR | 150mm x 40mm x 1.6/2 thick with one compartments. | RM | 1,134.00 | 554 | 628,236 |
| d | NDSR | 100mm x 40mm x 1.6/2 thick with one compartments. | RM | 850.00 | 2955 | 2,511,750 |
| | | | | | | |
| 3.0 | | Supplying and making cable route marker with cement concrete 1:2:4 ( 1 cement : 2 coarse sand :4 graded stone aggregate 20 mm nominal size) of size 60 cm X 60 cm at the bottom and 50 cm X 50 cm at the top with thickness of 10cm including incription duly engraved as required. | Each | 372.00 | 50 | 18,600 |
| | | | | | | |
| 4.0 | | Supplying and laying of following 1100 volts grade PVC insulated sheathed copper conductor armoured control cables in existing trenches cables trays, clamped on wall with suitable saddles, fixing bolts, including testing and commissioning. | | | | |
| a | | 2 core 2.5 sq mm PVC insulated copper conductor armoured control cables | RM | 100.00 | 200 | 20,000 |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| b | | 4 core 2.5 sq mm PVC insulated copper conductor armoured control cables | RM | 160.00 | 400 | 64,000 |
| c | | 7 core 2.5 sq mm PVC insulated copper conductor armoured control cables | RM | 250.00 | 400 | 100,000 |
| d | | 10 core 2.5 sq mm PVC insulated copper conductor armoured control cables | RM | 330.00 | 400 | 132,000 |
| e | | 12 core 2.5 sq mm PVC insulated copper conductor armoured control cables | RM | 380.00 | 150 | 57,000 |
| f | | 2 core 1.5 sq mm PVC insulated copper conductor armoured control cables | RM | 80.00 | 150 | 12,000 |
| | | | | | | |
| 5.0 | | Cable end termination with brass double compression gland and copper lugs for following size of XLPE insulated and PVC sheathed copper condutor cable of 1.1kV grade as required with earthing. | | | | |
| a | | 3C x 6 Sqmm | Each | 150.00 | 520 | 78,000 |
| | | | | | | |
| 6.0 | | Cable end termination of the following PVC insulated sheathed copper conductor control cables of 1100 volt grade including supplying and fixing of COPPER lugs. Double compression glands with earthing | | | | |
| a | | 7 core 2.5 sq.mm Control cable | No. | 275.00 | 10 | 2,750 |
| b | | 10 core 2.5 sq.mm Control cable | No. | 220.00 | 20 | 4,400 |
| c | | 12 core 2.5 sq mm control cables | No. | 160.00 | 10 | 1,600 |
| d | | 4 core 2.5 sq mm control cables | No. | 160.00 | 20 | 3,200 |
| e | | 2 core 2.5 sq mm PVC insulated copper conductor armoured control cables | No. | 140.00 | 10 | 1,400 |
| f | | 2 core 1.5 sq mm PVC insulated copper conductor armoured control cables | No. | 120.00 | 8 | 960 |
| | | | | | | |
| 7.0 | | Providing and fixing of fire retardant sealant on wall / floor crossings/Manholes. | Sqmtr | 2,000.00 | 400 | 800,000 |
| | | | | | | |
| | | **TOTAL** | | | | **69,191,277** |
| | | | | | | |
| C | | **DISTRIBUTION BOARDS** | | | | |
| 1 | NDSR | Supply and fixing following rating, double pole, 240 volts, MCB, C curve in the existing MCB DB complete with connections, testing and commissioning etc. as required | | | | |
| a | | 40 amps | Each | 595.00 | 420 | 249,900 |
| b | | 63 amps | Each | 601.00 | 186 | 111,786 |
| | | | | | | |
| 2 | NDSR | **Supplying and fixing of following rating, four pole , 415 volts, MCB, C curve in the existing MCB DB complete with connections, testing and commissioning etc. as required.** | | | | |
| a | | 40 amps | Each | 1,264.00 | 394 | 498,016 |
| b | | 63 amps | Each | 1,279.00 | 98 | 125,342 |
| | | **TOTAL FOR DISTRIBUTION BOARDS** | | | | **985,044** |
| | | | | | | |
| D | | **LIGHTING FIXTURES AND FANS** | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| 1 | NDSR | Supply, loading, unloading at site, complete in all respects such as all clamps, internal wiring between accessories and earthing terminal etc. All Compact lighting fixtures such as T5/ LED shall be provided with Electronic ballast/ drivers and shall be a part of the lighting fixtures. | | | | |
| 1.1 | NDSR | 10W RECESS MOUNTED LED CIRCULAR DOWN LIGHTER SIMILAR TO AMBIELLA IND G3 LED1000-840 ET OF TRILUX OR EQUIVALENT | Nos. | 2,156.00 | 2107 | 4,542,692 |
| 1.2 | NDSR | 12W RECESS MOUNTED LED CIRCULAR DOWN LIGHTER SIMILAR TO AMBIELLA IND G3 LED1200-840 ET OF TRILUX OR EQUIVALENT | Nos. | 2,242.00 | 326 | 730,892 |
| 1.3 | NDSR | 36W RECESS MOUNTED 600mmX600mm LED LUMINAIRE SIMILAR TO ENTERIO IND M73 OA LED 3600 840 ET OF TRILUX OR EQUIVALENT | Nos. | 5,692.00 | 32 | 182,144 |
| 1.4 | NDSR | 2X28 W SURFACE MOUNTED T5 LAMP SIMILAR TO WIF20128 SAVIOUR SLIM ENERGY SAVING CHANNEL OF WIPRO OR EQUIVALENT | Nos. | 1,267.00 | 42 | 53,214 |
| 1.5 | NDSR | 1X28 WSURFACE MOUNTED T5 LAMP SIMILAR TO WIF 20128 SAVIOUR SLIM ENERGY SAVING CHANNEL OF WIPRO OR EQUIVALENT | Nos. | 966.00 | 267 | 257,922 |
| 1.6 | NDSR | 20W SURFACE MOUNTED IP 65 RATED LED DOWN LIGHTER SIMILAR TO 74R-WD 2 LED 2000-840 ET OF TRILUX OR EQUIVALENT | Nos. | 14,572.00 | 686 | 9,996,392 |
| 1.7 | NDSR | 36W RECESS MOUNTED 600mmX600mm LED LUMINAIRE SIMILAR TO ENTERIO IND M73 OA LED 3600 840 ET OF TRILUX OR EQUIVALENT | Nos. | 5,692.00 | 174 | 990,408 |
| 1.8 | NDSR | 1X28 W WALL MOUNTED T5 LAMP SIMILAR TO WIF 20128 SAVIOUR SLIM ENERGY SAVING CHANNEL OF WIPRO OR EQUIVALENT | Nos. | 966.00 | 428 | 413,448 |
| 1.9 | NDSR | 9W BULK HEAD CFL LIGHT FIXTURE SIMILAR TO WKP 14109 OF WIPRO OR EQUIVALENT | Nos. | 615.00 | 355 | 218,325 |
| 1.10 | NDSR | 25W LED DECORATIVE HANGING LIGHT FITTING MADE OF POWDER COATED ALUMINUM BODY SIMILAR TO HX 5513 OF HALOMAX OF EQUIVALENT. | Nos. | 6,520.00 | 22 | 143,440 |
| 1.11 | NDSR | 20W SURFACE MOUNTED IP 65 RATED LED DOWN LIGHTER SIMILAR TO 7483 G2 LED1900-840 ET OF TRILUX OR EQUIVALENT | Nos | 29,530.00 | 42 | 1,240,260 |
| 1.12 | NDSR | 28W RECESSED DECORATIVE TWO RING INDIRECT CIRCULAR LUMINAIRE SIMILAR TO PolaronIQ WD1-2 LED3000-840 + WD2 C2 ET OF TRILUX OR EQUIVALENT | Nos | 91,662.00 | 66 | 6,049,692 |
| 1.13 | NDSR | 100W, IP65 LED CIRCULAR HIGH BAY LUMINAIRE SIMILAR TO Mirona RL TB LED12000-840 ET OF TRILUX OR EQUIVALENT | Nos | 81,916.00 | 96 | 7,863,936 |
| 1.14 | NDSR | 2 X 5W WALL MOUNTED UP AND DOWN LIGHTER WITH GU10 BASE MADE OF DIE CAST ALUMINUM SIMILAR TO HX 3003 OF HALOMAX OR EQUIVALENT | Nos | 2,958.00 | 21 | 62,118 |
| 1.15 | NDSR | 29W CHANNEL LIGHT (Recessed) IN EXTRUDED ALUMINIUM HOUSING WITH PMMA DIFFUSER SIMILAR TO ALINDI C OTA LED2900 NW ET 01 OF TRILUX OR EQUIVALENT | Nos | 9,487.00 | 977 | 9,268,799 |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| Sl. No | DSR Item No. | Description of Items | Unit | Rate | Total QTY | AMOUNT (INR) |
| 1.16 | NDSR | 6W WALL RECESSED LIGHT FOR FLOOR ILLUMINATION SIMILAR TO Pareda R Plan LEDww ET 26 OF TRILUX OR EQUIVALENT | Nos | 34,245.00 | 134 | 4,588,830 |
| 1.17 | NDSR | 8.3W MIRROR LIGHT FIXTURE SIMILAR TO Acuro LED1000nw ET 01 OF TRILUX OR EQUIVALENT | Nos | 31,183.00 | 110 | 3,430,130 |
| 1.18 | NDSR | 17W, INDIRECT LED SUSPENDED CIRCULAR LUMINAIRE SIMILAR TO POLARONIQ H2 LED2000-840 OF TRILUX OR EQUIVALENT | Nos | 66,719.00 | 9 | 600,471 |
| 1.19 | NDSR | 58W SUSPENDED DIRECT/INDIRECT RECTANGULAR LED LUMINAIRE WITH BINARY LIGHT GUIDE SYSTEM SIMILAR TO LATERALOP H1 LED6000-840 01 ETDD OF TRILUX OR EQUIVALENT | Nos | 101,584.00 | 10 | 1,015,840 |
| 1.20 | NDSR | 18W RECESS MOUNTED LED CIRCULAR DOWN LIGHTER WITH CDP DIFFUSER SIMILAR TO INPLANA C09 CDP19 2000-840 01 ET OF TRILUX OR EQUIVALENT | Nos | 30,705.00 | 8 | 245,640 |
| 1.21 | NDSR | 2X28 W SURFACE MOUNTED COMPACT ENERGY SAVING CHANNEL WITH REFLECTOR SIMLAR TO WIF91228SGOF WIPRO OR EQUIVALENT | Nos | 1,630.00 | 372 | 606,360 |
| 1.22 | NDSR | 1X28 W SURFACE MOUNTED COMPACT ENERGY SAVING CHANNEL WITH REFLECTOR SIMLAR TO WIF91128SGOF WIPRO OR EQUIVALENT | Nos | 1,340.00 | 141 | 188,940 |
| 1.23 | NDSR | 21W RECESS MOUNTED LED CIRCULAR DOWN LIGHTER SIMILAR TO AVIELLA C07 OA 2000-840 01 ET OF TRILUX OR EQUIVALENT | Nos | 4,138.00 | 354 | 1,464,852 |
| 1.24 | NDSR | 30W LED LUMINAIRE (RECESSED) IN EXTRUDED ALUMINIUM HOUSING WITH PMMA DIFFUSER SUITABLE FOR TECZONE CEILING SIMILAR TO ALINDI C TZ OTA LED 2400 NW ET OF TRILUX OR EQUIVALENT | Nos | 12,937.00 | 1738 | 22,484,506 |
| 1.25 | NDSR | 2 X 20 W LED LUMINAIRE TUBE MADE OF IMPACT DUST AND JET PROOF SIMILAR TO HX 6005 OF HALOMAX OR EQUIVALENT | Nos | 3,501.00 | 108 | 378,108 |
| 1.26 | NDSR | 54W SUSPENDED DIRECT/INDIRECT CIRCULAR LED LUMINAIRE WITH BINARY LIGHT GUIDE SYSTEM SIMILAR TO LATERALOR H1 LED6000-840 01 ETDD OF TRILUX OR EQUIVALENT | Nos | 137,106.00 | 8 | 1,096,848 |
| 1.27 | NDSR | 25 W LED LAMP DECORATIVE HANGING LIGHT FITTING MADE OF POWDER COATED ALUMINNIUM SIMILAR TO HALOMAX HX 5513 OR EQUIVALENT | Nos | 6,520.00 | 79 | 515,080 |
| 1.28 | NDSR | 30 W COB TRACK MOUNTED SPOT LIGHT FIXTURE MADE OF DIE CAST ALUMINNIUM AND REFLACTOR ALONG WITH 1 METRE RECESSED TYPE 3 PHASE TRACK SIMILAR TO HX 6302 OF HALOMAX OR EQUIVALENT | Nos | 9,297.00 | 20 | 185,940 |
| 1.29 | NDSR | 32.4W SURFACE MOUNTED CHANNEL LIGHT IN EXTRUDED ALUMINIUM HOUSING SIMILAR TO ALINDI H OTA LED2900 NW ET 01 OF TRILUX OR EQUIVALENT | Nos | 9,487.00 | 14 | 132,818 |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| Sl. No | DSR Item No. | Description of Items | Unit | Rate | Total QTY | AMOUNT (INR) |
| 1.30 | NDSR | 27W RECESS MOUNTED CIRCULAR LED DOWNLIGHTER SIMLAR TO CRDL11R033HP57 OF WIPRO OR EQUIVALENT | Nos | 4,105.00 | 68 | 279,140 |
| 1.31 | NDSR | 11W RECESSED MOUNTED LED DOWNLIGHTER SIMLAR TO LD71-111-SMS-57-XX MINIIRIS OF WIPRO OR EQUIVALENT | Nos | 1,690.00 | 807 | 1,363,830 |
| 1.32 | NDSR | 11W RECESSED MOUNTED LED DOWNLIGHTER SIMLAR TO LD71-111-SMS-65-XX MINIIRIS OF WIPRO OR EQUIVALENT | Nos | 1,690.00 | 5195 | 8,779,550 |
| 1.33 | NDSR | 16W RECESSED MOUNTED LED DOWNLIGHTER SIMLAR TO LD71-161-SML-57-XX MINIIRIS OF WIPRO OR EQUIVALENT | Nos | 1,992.00 | 1656 | 3,298,752 |
| 1.34 | NDSR | 33W RECESS MOUNTED 600mmX600mm LED LUMINAIRE SIMILAR TO CRCO10R036HP57G1 OF WIPRO OR EQUIVALENT | Nos | 4,347.00 | 23 | 99,981 |
| 1.35 | NDSR | 34W SUSPENDED CIRCULAR LED DOWNLIGHTER SIMLAR TO LM71-441-XXX-40-XX OF WIPRO OR EQUIVALENT | Nos | 9,297.00 | 140 | 1,301,580 |
| 1.36 | NDSR | 80W SURFACE MOUNTED LED DOWN LIGHTER SIMILAR TO LH06-931-120-57-PM LED OF WIPRO OR EQUIVALENT | Nos | 17,086.00 | 26 | 444,236 |
| 1.37 | NDSR | 6W LED 2FET BATTEN SIMILAR TO LL20-550-XXX-60-XX TRIMLED OF WIPRO OR EQUIVALENT | Nos | 1,086.00 | 191 | 207,426 |
| 1.38 | NDSR | 2 X 5W WALL MOUNTED UP AND DOWN LIGHTER WITH GU10 BASE MADE OF DIE CAST ALUMINUM SIMILAR TO HX 3003 OF HALOMAX OR EQUIVALENT | Nos | 2,958.00 | 27 | 79,866 |
| 1.39 | NDSR | 29W CONTAINS LED TUBE LIGHT (RECESSED) IN EXTENDED ALUMINIUM HOUSING WITH PPMA DIFFUSER SIMILAR TO LM35-361-XXX-57-XX OF WIPRO OR EQUIVALENT | Nos | 6,158.00 | 24 | 147,792 |
| 1.40 | NDSR | 32W CONTAINS LED TUBE LIGHT (RECESSED) IN EXTENDED ALUMINIUM HOUSING WITH PPMA DIFFUSER SIMILAR TO LM30-401-XXX-57-XX OF WIPRO OR EQUIVALENT | Nos | 6,158.00 | 2991 | 18,418,578 |
| 1.41 | NDSR | 32W CONTAINS LED TUBE LIGHT (RECESSED) IN EXTENDED ALUMINIUM HOUSING WITH PPMA DIFFUSER SIMILAR TO LM30-401-XXX-57-XX OF WIPRO OR EQUIVALENT | Nos | 6,158.00 | 1163 | 7,161,754 |
| 1.42 | NDSR | 58W CONTAINS LED TUBE LIGHT (RECESSED) IN EXTENDED ALUMINIUM HOUSING WITH PPMA DIFFUSER SIMILAR TO LM35-761DALI-57-CT OF WIPRO OR EQUIVALENT | Nos | 8,452.00 | 207 | 1,749,564 |
| 1.43 | NDSR | 58W CONTAINS LED TUBE LIGHT (RECESSED) IN EXTENDED ALUMINIUM HOUSING WITH PPMA DIFFUSER SIMILAR TO LM35-761DALI-57-G1 OF WIPRO OR EQUIVALENT | Nos | 8,452.00 | 28 | 236,656 |
| 1.44 | NDSR | 15W RECESS MOUNTED LED CIRCULAR DOWN LIGHTER SIMILAR TO AMBIELLA IND G3 LED1500-840 ET OF TRILUX OR EQUIVALENT | Nos | 2,673.00 | 194 | 518,562 |
| 1.45 | NDSR | 15W SURFACE MOUNTED LED DOWN LIGHTER SIMILAR TO LD81-131-XXX-60SM IRIS OF WIPRO OR EQUIVALENT | Nos | 1,932.00 | 485 | 937,020 |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| Sl. No | DSR Item No. | Description of Items | Unit | Rate | Total QTY | AMOUNT (INR) |
| 1.46 | NDSR | 39W 4FTX1FT RECESS MOUNTED LIGHT FIXTURE SIMILAR TO LE20-491-XXX-57-XX CAPSULE OF WIPRO OR EQUIVALENT | Nos | 5,071.00 | 27 | 136,917 |
| 1.47 | NDSR | 13W SURFACE MOUNTED IP 65 RATED LED DOWN LIGHTER SIMILAR TO LW01-101-XXX-60-XX OF WIPRO OR EQUIVALENT | Nos | 1,932.00 | 35 | 67,620 |
| 1.48 | NDSR | 1X28 W WALL MOUNTED T5 LAMP SIMILAR TO WIF 20128 SAVIOUR SLIM ENERGY SAVING CHANNEL OF WIPRO OR EQUIVALENT | Nos | 966.00 | 158 | 152,628 |
| 1.49 | NDSR | 31W RECESS MOUNTED 2X2 LED LUMINAIRE WITH DIFFUSER SIMLAR TO CLEANRAY CRCO10R038HP57G1 IMMACULATE OF WIPRO OR EQUIVALENT | Nos | 3,984.00 | 5 | 19,920 |
| 1.50 | NDSR | 18W SURFACE MOUNTED CIRCULAR LED DOWNLIGHTER SIMLAR TO CRDL11S023HP57 OF WIPRO OR EQUIVALENT | Nos | 1,750.00 | 16 | 28,000 |
| 1.51 | NDSR | 29W LED CHANNEL LIGHT FITTING SIMLAR TO LM35-361-XXX-57-XX RECESS MOUNTED LED LINEAR LUMINAIRE SUITABLE FOR TECHZONE WIPRO | Nos | 6,158.00 | 147 | 905,226 |
| 1.52 | NDSR | 32W LED CHANNEL LIGHT FITTING SIMLAR TO LM30-401-XXX-57-XX RECESS MOUNTED LED LINEAR LUMINAIRE SUITABLE FOR TECHZONE WIPRO | Nos | 6,158.00 | 28 | 172,424 |
| 1.53 | NDSR | 80W SURFACE MOUNTED LED DOWN LIGHTER SIMILAR TO LH06-931-120-57-PM LED OF WIPRO OR EQUIVALENT | Nos | 17,086.00 | 60 | 1,025,160 |
| 1.54 | NDSR | 36W SURFACE MOUNTED 1FT X 4FT LED SIMILAR TO CLEANRAY CRCO13S036HP57 AURA PLUS OF WIPRO OR EQUIVALENT | Nos | 5,796.00 | 50 | 289,800 |
| 1.55 | NDSR | 13W WALL LIGHT SUITABLE FOR TRUE CEILING SIMLAR TO LW02-101-XXX-60-XX MoonLED SQ IP65 Circular OF WIPRO OR EQUIVALENT | Nos | 1,932.00 | 29 | 56,028 |
| 1.56 | NDSR | 18W SURFACE MOUNTED CIRCULAR LED DOWNLIGHTER SIMLAR TO CRDL11S023HP57 OF WIPRO OR EQUIVALENT | Nos | 3,501.00 | 2 | 7,002 |
| 1.57 | NDSR | 30 W COB TRACK MOUNTED SPOT LIGHT FIXTURE MADE OF DIE CAST ALUMINNIUM AND REFLACTOR ALONG WITH 1 METRE RECESSED TYPE 3 PHASE TRACK SIMILAR TO HX 6302 OF HALOMAX OR EQUIVALENT | Nos | 9,297.00 | 149 | 1,385,253 |
| 1.58 | NDSR | 30 W COB TRACK MOUNTED SPOT LIGHT FIXTURE MADE OF DIE CAST ALUMINNIUM AND REFLACTOR ALONG WITH 1 METRE RECESSED TYPE 3 PHASE TRACK SIMILAR TO HX 6302 OF HALOMAX OR EQUIVALENT | Nos | 9,297.00 | 89 | 827,433 |
| 1.59 | NDSR | 36W RECESS MOUNTED 600mmX600mm LED LUMINAIRE SIMILAR TO ENTERIO IND M73 OA LED 3600 840 ET OF TRILUX OR EQUIVALENT | Nos | 5,692.00 | 7 | 39,844 |
| 1.60 | NDSR | 28W RECESSED DECORATIVE TWO RING INDIRECT CIRCULAR LUMINAIRE SIMILAR TO PolaronIQ WD1-2 LED3000-840 + WD2 C2 ET OF TRILUX OR EQUIVALENT | Nos | 91,662.00 | 40 | 3,666,480 |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| 1.61 | NDSR | 54W, IP65 LED CIRCULAR HIGH BAY LUMINAIRE SIMILAR TO Mirona RL B LED6000-840 ET OF TRILUX OR EQUIVALENT | Nos | 65,340.00 | 6 | 392,040 |
| 1.62 | NDSR | 8.3W MIRROR LIGHT FIXTURE SIMILAR TO Acuro LED1000nw ET 01 OF TRILUX OR EQUIVALENT | Nos | 31,183.00 | 33 | 1,029,039 |
| | | | | | | |
| 1.63 | NDSR | Ceiling Fan : Supplying of capacitor type 1200 mm sweep ceiling fan complete with blades, shakle etc. with high breeze, high speed for operation on 230V, 50 Cy. Single phase A.C. supply confirming to IS 374-1979 and with double ball bearing system The fan shall be green rated with 5 star as per BEE norms. | Nos. | 2,128.00 | 496 | 1,055,488 |
| | | | | | | |
| 2 | | **INSTALLATION OF LIGHTING FIXTURES** | | | | |
| | | Receiving & Installation of following light fixtures. The rate shall include components required for installation like | | | | |
| a | | Suitable length of GI down rod, hanger, connecting wires where called for. | | | | |
| b | | Bonding with earth wire. | | | | |
| c | | Drilling holes for support where ever required. | | | | |
| d | | Fixing clamps, GI bolt, nuts, brass screws, saddles, rowlbolts and other fixing accessories as required. | | | | |
| e | | Testing of all fixtures before and after installation. | | | | |
| | | | | | | |
| 2.1 | NDSR | 10W RECESS MOUNTED LED CIRCULAR DOWN LIGHTER SIMILAR TO AMBIELLA IND G3 LED1000-840 ET OF TRILUX OR EQUIVALENT | Nos. | 100.00 | 2107 | 210,700 |
| 2.2 | NDSR | 12W RECESS MOUNTED LED CIRCULAR DOWN LIGHTER SIMILAR TO AMBIELLA IND G3 LED1200-840 ET OF TRILUX OR EQUIVALENT | Nos. | 100.00 | 326 | 32,600 |
| 2.3 | NDSR | 36W RECESS MOUNTED 600mmX600mm LED LUMINAIRE SIMILAR TO ENTERIO IND M73 OA LED 3600 840 ET OF TRILUX OR EQUIVALENT | Nos. | 250.00 | 32 | 8,000 |
| 2.4 | NDSR | 2X28 W SURFACE MOUNTED T5 LAMP SIMILAR TO WIF20128 SAVIOUR SLIM ENERGY SAVING CHANNEL OF WIPRO OR EQUIVALENT | Nos. | 160.00 | 42 | 6,720 |
| 2.5 | NDSR | 1X28 WSURFACE MOUNTED T5 LAMP SIMILAR TO WIF 20128 SAVIOUR SLIM ENERGY SAVING CHANNEL OF WIPRO OR EQUIVALENT | Nos. | 140.00 | 267 | 37,380 |
| 2.6 | NDSR | 20W SURFACE MOUNTED IP 65 RATED LED DOWN LIGHTER SIMILAR TO 74R-WD 2 LED 2000-840 ET OF TRILUX OR EQUIVALENT | Nos. | 100.00 | 686 | 68,600 |
| 2.7 | NDSR | 36W RECESS MOUNTED 600mmX600mm LED LUMINAIRE SIMILAR TO ENTERIO IND M73 OA LED 3600 840 ET OF TRILUX OR EQUIVALENT | Nos. | 250.00 | 174 | 43,500 |
| 2.8 | NDSR | 1X28 W WALL MOUNTED T5 LAMP SIMILAR TO WIF 20128 SAVIOUR SLIM ENERGY SAVING CHANNEL OF WIPRO OR EQUIVALENT | Nos. | 140.00 | 428 | 59,920 |
| 2.9 | NDSR | 9W BULK HEAD CFL LIGHT FIXTURE SIMILAR TO WKP 14109 OF WIPRO OR EQUIVALENT | Nos. | 150.00 | 355 | 53,250 |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| Sl. No | DSR Item No. | Description of Items | Unit | Rate | Total QTY | AMOUNT (INR) |
| 2.10 | NDSR | 25W LED DECORATIVE HANGING LIGHT FITTING MADE OF POWDER COATED ALUMINUM BODY SIMILAR TO HX 5513 OF HALOMAX OF EQUIVALENT. | Nos. | 350.00 | 22 | 7,700 |
| 2.11 | NDSR | 20W SURFACE MOUNTED IP 65 RATED LED DOWN LIGHTER SIMILAR TO 7483 G2 LED1900-840 ET OF TRILUX OR EQUIVALENT | Nos | 150.00 | 42 | 6,300 |
| 2.12 | NDSR | 28W RECESSED DECORATIVE TWO RING INDIRECT CIRCULAR LUMINAIRE SIMILAR TO PolaronIQ WD1-2 LED3000-840 + WD2 C2 ET OF TRILUX OR EQUIVALENT | Nos | 150.00 | 66 | 9,900 |
| 2.13 | NDSR | 100W, IP65 LED CIRCULAR HIGH BAY LUMINAIRE SIMILAR TO Mirona RL TB LED12000-840 ET OF TRILUX OR EQUIVALENT | Nos | 100.00 | 96 | 9,600 |
| 2.14 | NDSR | 2 X 5W WALL MOUNTED UP AND DOWN LIGHTER WITH GU10 BASE MADE OF DIE CAST ALUMINUM SIMILAR TO HX 3003 OF HALOMAX OR EQUIVALENT | Nos | 100.00 | 21 | 2,100 |
| 2.15 | NDSR | 29W CHANNEL LIGHT (Recessed) IN EXTRUDED ALUMINIUM HOUSING WITH PMMA DIFFUSER SIMILAR TO ALINDI C OTA LED2900 NW ET 01 OF TRILUX OR EQUIVALENT | Nos | 150.00 | 977 | 146,550 |
| 2.16 | NDSR | 6W WALL RECESSED LIGHT FOR FLOOR ILLUMINATION SIMILAR TO Pareda R Plan LEDww ET 26 OF TRILUX OR EQUIVALENT | Nos | 250.00 | 134 | 33,500 |
| 2.17 | NDSR | 8.3W MIRROR LIGHT FIXTURE SIMILAR TO Acuro LED1000nw ET 01 OF TRILUX OR EQUIVALENT | Nos | 150.00 | 110 | 16,500 |
| 2.18 | NDSR | 17W, INDIRECT LED SUSPENDED CIRCULAR LUMINAIRE SIMILAR TO POLARONIQ H2 LED2000-840 OF TRILUX OR EQUIVALENT | Nos. | 100.00 | 9 | 900 |
| 2.19 | NDSR | 58W SUSPENDED DIRECT/INDIRECT RECTANGULAR LED LUMINAIRE WITH BINARY LIGHT GUIDE SYSTEM SIMILAR TO LATERALOP H1 LED6000-840 01 ETDD OF TRILUX OR EQUIVALENT | Nos. | 300.00 | 10 | 3,000 |
| 2.20 | NDSR | 18W RECESS MOUNTED LED CIRCULAR DOWN LIGHTER WITH CDP DIFFUSER SIMILAR TO INPLANA C09 CDP19 2000-840 01 ET OF TRILUX OR EQUIVALENT | Nos. | 250.00 | 8 | 2,000 |
| 2.21 | NDSR | 2X28 W SURFACE MOUNTED COMPACT ENERGY SAVING CHANNEL WITH REFLECTOR SIMLAR TO WIF91228SGOF WIPRO OR EQUIVALENT | Nos. | 250.00 | 372 | 93,000 |
| 2.22 | NDSR | 1X28 W SURFACE MOUNTED COMPACT ENERGY SAVING CHANNEL WITH REFLECTOR SIMLAR TO WIF91128SGOF WIPRO OR EQUIVALENT | Nos. | 250.00 | 141 | 35,250 |
| 2.23 | NDSR | 21W RECESS MOUNTED LED CIRCULAR DOWN LIGHTER SIMILAR TO AVIELLA C07 OA 2000-840 01 ET OF TRILUX OR EQUIVALENT | Nos. | 100.00 | 354 | 35,400 |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| Sl. No | DSR Item No. | Description of Items | Unit | Rate | Total QTY | AMOUNT (INR) |
| 2.24 | NDSR | 30W LED LUMINAIRE (RECESSED) IN EXTRUDED ALUMINIUM HOUSING WITH PMMA DIFFUSER SUITABLE FOR TECZONE CEILING SIMILAR TO ALINDI C TZ OTA LED 2400 NW ET OF TRILUX OR EQUIVALENT | Nos. | 350.00 | 1738 | 608,300 |
| 2.25 | NDSR | 2 X 20 W LED LUMINAIRE TUBE MADE OF IMPACT DUST AND JET PROOF SIMILAR TO HX 6005 OF HALOMAX OR EQUIVALENT | Nos. | 350.00 | 108 | 37,800 |
| 2.26 | NDSR | 54W SUSPENDED DIRECT/INDIRECT CIRCULAR LED LUMINAIRE WITH BINARY LIGHT GUIDE SYSTEM SIMILAR TO LATERALOR H1 LED6000-840 01 ETDD OF TRILUX OR EQUIVALENT | Nos. | 350.00 | 8 | 2,800 |
| 2.27 | NDSR | 25 W LED LAMP DECORATIVE HANGING LIGHT FITTING MADE OF POWDER COATED ALUMINNIUM SIMILAR TO HALOMAX HX 5513 OR EQUIVALENT | Nos. | 250.00 | 79 | 19,750 |
| 2.28 | NDSR | 30 W COB TRACK MOUNTED SPOT LIGHT FIXTURE MADE OF DIE CAST ALUMINNIUM AND REFLACTOR ALONG WITH 1 METRE RECESSED TYPE 3 PHASE TRACK SIMILAR TO HX 6302 OF HALOMAX OR EQUIVALENT | Nos. | 250.00 | 20 | 5,000 |
| 2.29 | NDSR | 32.4W SURFACE MOUNTED CHANNEL LIGHT IN EXTRUDED ALUMINIUM HOUSING SIMILAR TO ALINDI H OTA LED2900 NW ET 01 OF TRILUX OR EQUIVALENT | Nos. | 150.00 | 14 | 2,100 |
| 2.30 | NDSR | 27W RECESS MOUNTED CIRCULAR LED DOWNLIGHTER SIMLAR TO CRDL11R033HP57 OF WIPRO OR EQUIVALENT | Nos. | 150.00 | 68 | 10,200 |
| 2.31 | NDSR | 11W RECESSED MOUNTED LED DOWNLIGHTER SIMLAR TO LD71-111-SMS-57-XX MINIIRIS OF WIPRO OR EQUIVALENT | Nos. | 100.00 | 807 | 80,700 |
| 2.32 | NDSR | 11W RECESSED MOUNTED LED DOWNLIGHTER SIMLAR TO LD71-111-SMS-65-XX MINIIRIS OF WIPRO OR EQUIVALENT | Nos. | 100.00 | 5195 | 519,500 |
| 2.33 | NDSR | 16W RECESSED MOUNTED LED DOWNLIGHTER SIMLAR TO LD71-161-SML-57-XX MINIIRIS OF WIPRO OR EQUIVALENT | Nos. | 100.00 | 1656 | 165,600 |
| 2.34 | NDSR | 33W RECESS MOUNTED 600mmX600mm LED LUMINAIRE SIMILAR TO CRCO10R036HP57G1 OF WIPRO OR EQUIVALENT | Nos. | 250.00 | 23 | 5,750 |
| 2.35 | NDSR | 34W SUSPENDED CIRCULAR LED DOWNLIGHTER SIMLAR TO LM71-441-XXX-40-XX OF WIPRO OR EQUIVALENT | Nos. | 100.00 | 140 | 14,000 |
| 2.36 | NDSR | 80W SURFACE MOUNTED LED DOWN LIGHTER SIMILAR TO LH06-931-120-57-PM LED OF WIPRO OR EQUIVALENT | Nos. | 100.00 | 26 | 2,600 |
| 2.37 | NDSR | 6W LED 2FET BATTEN SIMILAR TO LL20-550-XXX-60-XX TRIMLED OF WIPRO OR EQUIVALENT | Nos. | 150.00 | 191 | 28,650 |
| 2.38 | NDSR | 2 X 5W WALL MOUNTED UP AND DOWN LIGHTER WITH GU10 BASE MADE OF DIE CAST ALUMINUM SIMILAR TO HX 3003 OF HALOMAX OR EQUIVALENT | Nos. | 100.00 | 27 | 2,700 |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| Sl. No | DSR Item No. | Description of Items | Unit | Rate | Total QTY | AMOUNT (INR) |
| 2.39 | NDSR | 29W CONTAINS LED TUBE LIGHT (RECESSED) IN EXTENDED ALUMINIUM HOUSING WITH PPMA DIFFUSER SIMILAR TO LM35-361-XXX-57-XX OF WIPRO OR EQUIVALENT | Nos. | 250.00 | 24 | 6,000 |
| 2.40 | NDSR | 32W CONTAINS LED TUBE LIGHT (RECESSED) IN EXTENDED ALUMINIUM HOUSING WITH PPMA DIFFUSER SIMILAR TO LM30-401-XXX-57-XX OF WIPRO OR EQUIVALENT | Nos. | 250.00 | 2991 | 747,750 |
| 2.41 | NDSR | 32W CONTAINS LED TUBE LIGHT (RECESSED) IN EXTENDED ALUMINIUM HOUSING WITH PPMA DIFFUSER SIMILAR TO LM30-401-XXX-57-XX OF WIPRO OR EQUIVALENT | Nos. | 250.00 | 1163 | 290,750 |
| 2.42 | NDSR | 58W CONTAINS LED TUBE LIGHT (RECESSED) IN EXTENDED ALUMINIUM HOUSING WITH PPMA DIFFUSER SIMILAR TO LM35-761DALI-57-CT OF WIPRO OR EQUIVALENT | Nos. | 250.00 | 207 | 51,750 |
| 2.43 | NDSR | 58W CONTAINS LED TUBE LIGHT (RECESSED) IN EXTENDED ALUMINIUM HOUSING WITH PPMA DIFFUSER SIMILAR TO LM35-761DALI-57-G1 OF WIPRO OR EQUIVALENT | Nos. | 350.00 | 28 | 9,800 |
| 2.44 | NDSR | 15W RECESS MOUNTED LED CIRCULAR DOWN LIGHTER SIMILAR TO AMBIELLA IND G3 LED1500-840 ET OF TRILUX OR EQUIVALENT | Nos. | 100.00 | 194 | 19,400 |
| 2.45 | NDSR | 15W SURFACE MOUNTED LED DOWN LIGHTER SIMILAR TO LD81-131-XXX-60SM IRIS OF WIPRO OR EQUIVALENT | Nos. | 100.00 | 485 | 48,500 |
| 2.46 | NDSR | 39W 4FTX1FT RECESS MOUNTED LIGHT FIXTURE SIMILAR TO LE20-491-XXX-57-XX CAPSULE OF WIPRO OR EQUIVALENT | Nos. | 150.00 | 27 | 4,050 |
| 2.47 | NDSR | 13W SURFACE MOUNTED IP 65 RATED LED DOWN LIGHTER SIMILAR TO LW01-101-XXX-60-XX OF WIPRO OR EQUIVALENT | Nos. | 150.00 | 35 | 5,250 |
| 2.48 | NDSR | 1X28 W WALL MOUNTED T5 LAMP SIMILAR TO WIF 20128 SAVIOUR SLIM ENERGY SAVING CHANNEL OF WIPRO OR EQUIVALENT | Nos. | 140.00 | 158 | 22,120 |
| 2.49 | NDSR | 31W RECESS MOUNTED 2X2 LED LUMINAIRE WITH DIFFUSER SIMLAR TO CLEANRAY CRCO10R038HP57G1 IMMACULATE OF WIPRO OR EQUIVALENT | Nos. | 250.00 | 5 | 1,250 |
| 2.50 | NDSR | 18W SURFACE MOUNTED CIRCULAR LED DOWNLIGHTER SIMLAR TO CRDL11S023HP57 OF WIPRO OR EQUIVALENT | Nos. | 200.00 | 16 | 3,200 |
| 2.51 | NDSR | 29W LED CHANNEL LIGHT FITTING SIMLAR TO LM35-361-XXX-57-XX RECESS MOUNTED LED LINEAR LUMINAIRE SUITABLE FOR TECHZONE WIPRO | Nos. | 180.00 | 147 | 26,460 |
| 2.52 | NDSR | 32W LED CHANNEL LIGHT FITTING SIMLAR TO LM30-401-XXX-57-XX RECESS MOUNTED LED LINEAR LUMINAIRE SUITABLE FOR TECHZONE WIPRO | Nos. | 180.00 | 28 | 5,040 |
| 2.53 | NDSR | 80W SURFACE MOUNTED LED DOWN LIGHTER SIMILAR TO LH06-931-120-57-PM LED OF WIPRO OR EQUIVALENT | Nos. | 250.00 | 60 | 15,000 |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| 2.54 | NDSR | 36W SURFACE MOUNTED 1FT X 4FT LED SIMILAR TO CLEANRAY CRCO13S036HP57 AURA PLUS OF WIPRO OR EQUIVALENT | Nos. | 250.00 | 50 | 12,500 |
| 2.55 | NDSR | 13W WALL LIGHT SUITABLE FOR TRUE CEILING SIMLAR TO LW02-101-XXX-60-XX MoonLED SQ IP65 Circular OF WIPRO OR EQUIVALENT | Nos. | 150.00 | 29 | 4,350 |
| 2.56 | NDSR | 18W SURFACE MOUNTED CIRCULAR LED DOWNLIGHTER SIMLAR TO CRDL11S023HP57 OF WIPRO OR EQUIVALENT | Nos. | 100.00 | 2 | 200 |
| 2.57 | NDSR | 30 W COB TRACK MOUNTED SPOT LIGHT FIXTURE MADE OF DIE CAST ALUMINNIUM AND REFLACTOR ALONG WITH 1 METRE RECESSED TYPE 3 PHASE TRACK SIMILAR TO HX 6302 OF HALOMAX OR EQUIVALENT | Nos. | 150.00 | 149 | 22,350 |
| 2.58 | NDSR | 30 W COB TRACK MOUNTED SPOT LIGHT FIXTURE MADE OF DIE CAST ALUMINNIUM AND REFLACTOR ALONG WITH 1 METRE RECESSED TYPE 3 PHASE TRACK SIMILAR TO HX 6302 OF HALOMAX OR EQUIVALENT | Nos. | 250.00 | 89 | 22,250 |
| 2.59 | NDSR | 36W RECESS MOUNTED 600mmX600mm LED LUMINAIRE SIMILAR TO ENTERIO IND M73 OA LED 3600 840 ET OF TRILUX OR EQUIVALENT | Nos. | 250.00 | 7 | 1,750 |
| 2.60 | NDSR | 28W RECESSED DECORATIVE TWO RING INDIRECT CIRCULAR LUMINAIRE SIMILAR TO PolaronIQ WD1-2 LED3000-840 + WD2 C2 ET OF TRILUX OR EQUIVALENT | Nos. | 160.00 | 40 | 6,400 |
| 2.61 | NDSR | 54W, IP65 LED CIRCULAR HIGH BAY LUMINAIRE SIMILAR TO Mirona RL B LED6000-840 ET OF TRILUX OR EQUIVALENT | Nos. | 100.00 | 6 | 600 |
| 2.62 | NDSR | 8.3W MIRROR LIGHT FIXTURE SIMILAR TO Acuro LED1000nw ET 01 OF TRILUX OR EQUIVALENT | Nos. | 150.00 | 33 | 4,950 |
| | | **Notes :-** | | | | |
| | | Type of Light fittings may get change asethetically in other equivalent make apart from mentioned in the item. However, rate quoted shall hold good for a similar type of fittings and no extra charge will be paid on this account. | | | | |
| | | The rates shall include all components that may be required to make the installation complete in all respects such as suitable length of GI down rod, hanger and connecting wires, internal wiring between accessories, wires for connecting the fixtures to the point through connector block complete as required. | | | | |
| | | Drilling holes in supports wherever required. Fixing clamps, GI bolts and nuts, brass screws, saddles, rawl bolts and other fixing accessories as required. | | | | |
| | | Testing of all fixtures & fans before and after installation. | | | | |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| 3 | | **CABLING AND INSTALLATION OF LIGHTING FIXTURES FOR EXTERNAL / LANDSCAPE LIGHTING** | | | | |
| | | Rate for supply and installation of fixtures shall also include the following : | | | | |
| | | All component that may be required to make the installation complete in all respects, such as : | | | | |
| | | a. Suitable length of connecting wires. | | | | |
| | | b. Connecting wires to the point through connection block. | | | | |
| | | c. Bonding to earth wires. | | | | |
| | | Drilling holes in supports wherever required. | | | | |
| | | Fixing clamps, GI bolts and nuts/brass screws, saddles, rawl bolts and other fixing accessories as required. | | | | |
| | | Painting with enamel paint of clamps and other fixing accessories. | | | | |
| | | Suitable size junction boxes with connector block for loop in loop out where ever applicable. | | | | |
| | | Testing of all fixture and after installation. | | | | |
| | | | | | | |
| | | **CABLING AND INSTALLATION OF LIGHTING FIXTURES FOR EXTERNAL / LANDSCAPE & FAÇADE LIGHTING** | | | | |
| 3.1 | | Supply, receiving, installation, testing and commissioning of the following lighting fixtures and poles including excavation and back filling as required | | | | |
| a | NDSR | One meter high Bollard light fitting with 6W LED lamp similar to HX 2028 of Halomax ore equivalent | Nos. | 7,313.00 | 113 | 826,369 |
| b | NDSR | 4m high MS tubular pole of 140 & 60mm dia, GI base plate in 300x300x12mm thick, looping junction box with 26W LED in extruded aluminium housing, similar to BRIKA-16LED-26W-5102 NW+300mm BRIKA bracket single of Schreder or equivalent | Nos. | 21,134.00 | 57 | 1,204,638 |
| c | NDSR | 13W IP 65, circular LED Luminaire suitable for true ceiling Lighting similar to LW01-101-XXX-60-XX MoonLED -<br>IP65 of WIPRO or equivalent | Nos. | 2,682.00 | 125 | 335,250 |
| 3.2 | NDSR | Supply, laying, testing and commissioning of following size XLPE insulated, PVC inner sheathed, outer sheath FRLS, copper conductor 1100 V grade armoured cable, confirming to IS-7098 (Part-I), 1988 including excavation of earth, sand/brick protection refilling, watering & ramming complete. | | | | |
| a | | 3 C x 6 Sq. mm. (Red, Black & Green) | Mtrs | 342.00 | 15350 | 5,249,700 |
| b | | 3 C x 6 Sq. mm. (Yellow, Black & Green) | Mtrs | 342.00 | 15350 | 5,249,700 |
| c | | 3 C x 6 Sq. mm. (Blue, Black & Green) | Mtrs | 342.00 | 15350 | 5,249,700 |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| 3.3 | NDSR | Supply and making end termination & jointing of following size XLPE insulated copper conductor 1100 V grade armored cable including cost of crimped copper lugs, sockets, insulation tapes, double compression glands etc. complete. | | | | |
| a | | 3C x 6 Sq. mm. | No. | 120.00 | 940 | 112,800 |
| | | | | | | |
| 3.4 | NDSR | Supplying all the material for wiring with 3 x 2.5 sq. mm. XLPE insulated copper conductor 1100 V in 16 gauge 25 mm dia GI conduit including connecting at terminals of lighting fixtures complete. The cost shall include supply and installation of conduit pipe, chasing of wall and making good. | Mtrs | 250.00 | 2980 | 745,000 |
| 3.5 | | Supply, installation and fixing of Weather proof IP65 type M.S. junction box with 2 Nos. earthing terminal to receive 2 x 10sq.mm Aluminum Armoured cable (2 Nos.) .The scope also includes supply and pulling of 3Nos. 2.5 sq.mm stranded copper flexible cables from Junction box to Lighting luminaries with supply ,fixing of 10Amp SP -C-CL,10k.A.MCB , elmex terminals etc (Minimum size of Junction box is 215 mm x 125 mm x88 mm). | Nos. | 3,500.00 | 374 | 1,309,000 |
| | | **Total For- LIGHTING FIXTURES AND FANS** | | | | **159270281** |
| | | | | | | |
| E | | **UPS SYSTEM** | | | | |
| | NDSR | Supply,Transprtation, storing at site, shifting at work place, installation, Testing and commissioning of the following rating UPS/Inverter as per specifications and complete in all respects.The scope also includes supply, Installation, Testing and Commissioning of Sealed Maintenance Free lead acid Batteries complete with intercell connectors & copper cables, Battery breaker, battery stand made out of Powder Coated MS Angles with adequate supports to carry the load of the batteries.& also TVSS at the input of each UPS to protect against transients, surges & Noise as per the tender specifications | | | | |
| 1 | NDSR | Supply, installation, Testing & commissioning of 100 kVA on line 415 V AC UPS with 30 minutes balancing battery back up. | Set | 2,646,030.00 | 4 | 10,584,120 |
| 2 | NDSR | Supply, installation, Testing & commissioning of 80 kVA on line 415 V AC UPS with 30 minutes balancing battery back up. | Set | 2,208,535.00 | 9 | 19,876,815 |
| 3 | NDSR | Supply, installation, Testing & commissioning of 40 kVA on line 415 V AC UPS with 30 minutes balancing battery back up. | Set | 1,773,408.00 | 2 | 3,546,816 |
| 4 | NDSR | Supply, installation, Testing & commissioning of 50 kVA on line 415 V AC UPS with 30 minutes balancing battery back up. | Set | 1,255,031.00 | 2 | 2,510,062 |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| 5 | NDSR | Supply, installation, Testing & commissioning of 30kVA on line 415 V AC UPS with 30 minutes balancing battery back up. | Set | 1,042,936.00 | 2 | 2,085,872 |
| 6 | NDSR | Supply, installation, Testing & commissioning of 20 kVA on line 415 V AC UPS with 30 minutes balancing battery back up. | Set | 881,763.00 | 8 | 7,054,104 |
| 7 | NDSR | Supply, installation, Testing & commissioning of 10 kVA on line 415 V AC UPS with 30 minutes balancing battery back up. | Set | 638,810.00 | 5 | 3,194,050 |
| | | | | | | |
| 8 | | Supply,Transprtation, storing at site, shifting at work place, installation, Testing and commissioning of the following rating UPS as per specifications and complete in all respects.The scope also includes supply, Installation, Testing and Commissioning of Sealed Maintenance Free lead acid Batteries complete with intercell connectors & copper cables, battery stand made out of Powder Coated MS Angles with adequate supports to carry the load of the batteries.& also TVSS at the input of each UPS to protect against transients, surges & Noise as per the tender specifications | Set | 238,707.00 | 4 | 954,828 |
| | | Supply, installation, Testing & commissioning of 5 kVA on line 240 V AC UPS with 30 minutes balancing battery back up. | | | | |
| | | **TOTAL CARRIED OVER TO SUMMARY OF UPS SYSTEM** | | | | **49,806,667** |
| | | | | | | |
| F | | **EARTHING SYSTEM** | | | | |
| 1.0 | **NDSR** | Low Impedence chemical GEL earthing: Supply of Maintenance Free Chemical Earth pit sets and installation complete with consisting of 1 no. 3 meters long 17.2 mm dia MS Rod moleculerly bonded with 250 micron copper as per UL 467 and treated with 27 kgs (Minmum ) of Ground Enhancing compound as per IEEE 80 14.5 D per earth pit as per approved make. The Installation procedures should be followed as instructed by the Earth Electrode Supplier. One set of earth pit would consists of 1 No. of rod , 27 Kgs of earth enhancer Carbon / Graphite based earth enhancer compound and 1 no. of suitable Double side GI clamp with SS ACCS . | Set | 6,391.00 | 124 | 792,484 |
| | | | | | | |
| 2 | **NDSR** | **Supply, installation, testing & commissioning of following sizes of G.I. strip/wire clamped to walls, cable trays, bus ducts, cables in recess or surface etc for equipment /system earthing complete as required including inter connection between length at joints, all fixing accessories saddles clamps etc, and other fixing hardware material as required for proper installation.** | | | | |
| a | NDSR | 80 x 8 mm GI | RM | 600.00 | 170 | 102,000 |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| b | NDSR | 50 x 10 mm strip GI | RM | 450.00 | 1090 | 490,500 |
| c | NDSR | 40 x 10 mm strip GI | RM | 300.00 | 350 | 105,000 |
| d | NDSR | 40 x 6 mm strip GI | RM | 275.00 | 450 | 123,750 |
| e | NDSR | 32 x 6 mm strip GI | RM | 230.00 | 1232 | 283,360 |
| f | NDSR | 25 x 6 mm strip GI | RM | 100.00 | 8550 | 855,000 |
| g | NDSR | 10 SWG GI Wire GI | RM | 50.00 | 2600 | 130,000 |
| | | | | | | |
| 3 | NDSR | **Copper Earthing Strip** | | | | |
| | | Supply, installation, testing & commissioning of following sizes of copper strip/wire clamped to walls, cable trays, bus ducts, cables in recess or surface etc for equipment /system earthing complete as required including inter connection between length at joints, all fixing accessories saddles clamps etc, and other fixing hardware material as required for proper installation. | | | | |
| a | NDSR | 50 x 6 mm strip | RM | 2,200.00 | 480 | 1,056,000 |
| b | NDSR | 25 x 6 mm strip | RM | 100.00 | 430 | 43,000 |
| c | NDSR | 40 x 6 mm strip | RM | 1,500.00 | 290 | 435,000 |
| | | | | | | |
| 4 | NDSR | Supply and laying of following 1100 volts grade FRLS PVC insulated copper conductor wire including copper thimbles, fixing hardware as required. | | | | |
| a | NDSR | Single core 10 sq.mm Green colour | RM | 135.00 | 2210 | 298,350 |
| b | NDSR | Single core 6 sq.mm Green colour | RM | 75.00 | 700 | 52,500 |
| | | | | | | |
| | | **Note :-** | | | | |
| | | Rates shall also include the following : | | | | |
| 1 | | All fixing accessories such as brass saddles, brass screws raw plugs etc. | | | | |
| 2 | | Jointing by rivetting and brazing after rivetting in case of copper and welding / bolting in case of GI earthing. | | | | |
| 3 | | Cutting chases holes and making good the same wherever required. | | | | |
| 4 | | Effecting adequate and proper interconnections. | | | | |
| 5 | | Use of copper thimbles. | | | | |
| 6 | | Earthing system shall comply to IS:3043-1987. | | | | |
| 7 | | All earthing pits shall be interconnected. | | | | |
| 8 | | Earthing C- | | | | |
| | | **TOTAL FOR EARTHING SYSTEM CARRIED TO SUMMARY** | | | | **4,766,944** |
| | | | | | | |
| G | | **LIGHTENING PROTECTION SYSTEM** | | | | |
| 1 | NDSR | **Air Terminal** | | | | |
| a | | Design, supply, installation, testing and commissioning of 1.5 meter long air terminal made of aluminum or its alloy to be installed at parapet wall. The terminal shall withstand wind velocity of 145 KM/hour (The drilling on the top of rod to be avoided) complete for installation similar to part no. 104150 of DEHN or equivalent | Nos | 1,531.00 | 11 | 16,841 |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| b | | Design, supply, installation, testing and commissioning of 2 meter long air terminal made of aluminum or its alloy to be installed at parapet wall. The terminal shall withstand wind velocity of 145 KM/hour (The drilling on the top of rod to be avoided) complete for installation similar to part no. 104200 of DEHN or equivalent | Nos | 1,937.00 | 38 | 73,606 |
| c | | Design, supply, installation, testing and commissioning of 2.5 meter long air terminal made of aluminum or its alloy to be installed at parapet wall. The terminal shall withstand wind velocity of 145 KM/hour (The drilling on the top of rod to be avoided) complete for installation similar to part no. 104250 of DEHN or equivalent | Nos | 2,610.00 | 17 | 44,370 |
| d | | Concrete base part for Air Terminal (17 kg) | Nos | 599.00 | 8 | 4,792 |
| f | | Plastic base cover similar to part no. 102050 of DEHN or equivalent | Nos | 419.00 | 8 | 3,352 |
| | | | | | | |
| 2 | NDSR | Supply, installation, testing and commissioning of Roof Conductor complete with inter-connection, clamps etc including the following | | | | |
| a | | Roof Conductor - 8 mm Aluminium Round Conductor | Mtrs | 113.00 | 2730 | 308,490 |
| b | | 700 mm Long Air Terminal with parallel clamp similar to part no. 306029 of DEHN or equivalent | Nos | 573.00 | 70 | 40,110 |
| c | | 500 mm Long Air Terminal with parallel clamp similar to part no. 306029 of DEHN or equivalent | Nos | 573.00 | 116 | 66,468 |
| d | | Clamp for connecting Air Terminal to roof conductor similar to part no. 380116 of DEHN or equivalent | Nos | 293.00 | 47 | 13,771 |
| e | | Clamp for connecting Air Terminal to roof conductor similar to part no. 380029 of DEHN or equivalent | Nos | 233.00 | 30 | 6,990 |
| f | | Round Conductor holder for flat roof similar to part no. 253050 of DEHN or equivalent | Nos | 159.77 | 730 | 116,632 |
| g | | Round Conductor holder at parapet wall similar to part no. 274150 of DEHN or equivalent | Nos | 160.00 | 1400 | 224,000 |
| g | | Round Conductor holder at side wall similar to part no. 274150 of DEHN or equivalent | Nos | 160.00 | 1970 | 315,200 |
| h | | Clamp for holding air terminal on parapet wall | Nos | 799.00 | 18 | 14,382 |
| i | | Round conductor holder at metal roof similar to part no. 223020 of DEHN or equivalent | Nos. | 160.00 | 480 | 76,800 |
| | | | | | | |
| 3 | NDSR | Supply, installation, testing and commissioning of down Conductor including the following | | | | |
| a | | Down Conductor 8 mm Aluminium (10 Nos) | Mtrs | 113.00 | 120 | 13,560 |
| b | | Down Conductor 8 mm Aluminium (8 Nos) | Mtrs | 113.17 | 1200 | 135,804 |
| c | | Down Conductor 8 mm Aluminium (12 Nos) | Mtrs | 113.17 | 350 | 39,610 |
| d | | Down Conductor 8 mm Aluminium (21 Nos) | Mtrs | 113.17 | 580 | 65,639 |
| e | | Down Conductor 8 mm Aluminium (23 Nos) | Mtrs | 113.00 | 1100 | 124,300 |
| f | | Down Conductor holder at wall similar to part no. 274150 of DEHN or equivalent | Nos | 160.00 | 1720 | 275,200 |
| g | | Universal clamp similar to part no. 315119 of DEHN or equivalent | Nos. | 433.00 | 195 | 84,435 |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| 4 | NDSR | Supply, installation, testing and commissioning of Earthing system complete with inter connections between length at joints, all fixing accessories etc including the following required as for complete installation | | | | |
| a | | Test clamp (To be installed 2 meter above ground level) similar to part no. 459139 of DEHN or equivalent | Nos | 340.00 | 113 | 38,420 |
| b | | GI Strip (25x6 mm) | Mtrs | 160.00 | 510 | 81,600 |
| c | | GI Strip (25x6 mm) holder at wall | Nos | 200.00 | 222 | 44,400 |
| d | **NDSR** | Low Impedence chemical GEL earthing: Supply of Maintenance Free Chemical Earth pit sets and installation complete with consisting of 1 no. 3 meters long 17.2 mm dia MS Rod moleculerly bonded with 250 micron copper as per UL 467 and treated with 27 kgs (Minmum ) of Ground Enhancing compound as per IEEE 80 14.5 D per earth pit as per approved make. The Installation procedures should be followed as instructed by the Earth Electrode Supplier. One set of earth pit would consists of 1 No. of rod , 27 Kgs of earth enhancer Carbon / Graphite based earth enhancer compound and 1 no. of suitable Double side GI clamp with SS ACCS . | Nos. | 6,391.00 | 269 | 1,719,179 |
| | | | | | | |
| 5.0 | | Providing and fixing of lightning conductor finial, made of 25 mm dia 300mm long, G.I. tube, having single prong at top, with 85 mm dia 6 mm thick G.I. base plate including holes etc. complete as required. | Each | 352.00 | 4 | 1,408 |
| | | | | | | |
| 6.0 | | Jointing copper / G.I. tape (with another copper/ G I tape, base of the finial or any other metallic object) by riveting / nut bolting/ sweating and soldering etc as required. | Each | 68.00 | 24 | 1,632 |
| | | | | | | |
| 7.0 | | Providing and fixing G.I. tape 20 mm X 3 mm thick on parapet or surface of wall for lightning conductor complete as required.(For horizontal run) | metre | 64.00 | 50 | 3,200 |
| | | | | | | |
| 8.0 | | Providing and fixing G.I. tape 20 mm X 3 mm thick on parapet or surface of wall for lightning conductor complete as required.(For vertical run) | metre | 91.00 | 200 | 18,200 |
| | | | | | | |
| 9.0 | | Providing and fixing testing joint, made of 20 mm X 3 mm thick G.I. strip, 125 mm long, with 4 nos. of G.I. bolts, nuts, chuck,nuts and spring washers etc. complete as required. | Each | 69.00 | 20 | 1,380 |
| | | | | | | |
| | | | | | | |
| | | **Note :-** | | | | |
| | | Rates shall also include the following : | | | | |
| 1 | | All fixing accessories such as brass saddles, brass screws rawl plugs etc. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| 2 | | Jointing by rivetting and brazing after rivetting in case of copper and by welding / bolting in case of GI. | | | | |
| 3 | | Cutting chases, holes and making good the same wherever required. | | | | |
| 4 | | Effecting adequate and proper interconnections. | | | | |
| 5 | | Use of copper thimbles. | | | | |
| 6 | | Lightning protection system shall comply to IS/IEC-62305. | | | | |
| 7 | | All earthing pits shall be interconnected. | | | | |
| | | **TOTAL FOR ADVANCED LIGHTENING PROTECTION SYSTEM CARRIED TO SUMMARY** | | | | 3,973,770 |
| | | | | | | |
| H | | **ELEVATORS** | | | | |
| | | **Supply, installation, testing and commissioning of the following elevators as per specifications** | | | | |
| | | | | | | |
| 1 | | **Passenger Elevator 1 & 2 (Admin Building) AD1** | | | | |
| 1.1 | NDSR | **Passenger Elevator ( 884 Kg) with Car with Stainless steel in dot matrix (Scratch less), gearless, with SS hand rail & with Machine Room Less.** | | | | |
| | | 13 Persons, 7 stops , 1.5 mps & rise 22.925 mtr. | | | | |
| | | Available hoistway size | Nos. | 2,300,000.00 | 2 | 4,600,000 |
| | | a) 1975 mm D x 2500 mm W | | | | |
| | | | | | | |
| 1.2 | NDSR | **Passenger Elevator 3 (Admin Building) AD1** | | | | |
| | | **Passenger Elevator ( 680 Kg) with Car with Stainless steel in dot matrix (Scratch less), gearless, with SS hand rail & with Machine Room Less.** | | | | |
| | | 10 Persons, 7 stops , 1.5 mps & rise 22.925 mtr. | | | | |
| | | Available hoistway size | Nos. | 2,500,000.00 | 1 | 2,500,000 |
| | | a) 2000 mm D x 2000 mm W | | | | |
| | | | | | | |
| 2 | | **Passenger Elevator (Library Building) L1** | | | | |
| 2.1 | NDSR | **Passenger Elevator ( 680 Kg) with Car with Stainless steel in dot matrix (Scratch less), gearless, with SS hand rail & with Machine Room Less.** | | | | |
| | | 10 Persons, 7 stops , 1.5 mps & rise 22.925 mtr. | | | | |
| | | Available hoistway size | Nos. | 2,175,000.00 | 2 | 4,350,000 |
| | | a) 2175 mm D x 2100 mm W | | | | |
| | | | | | | |
| 2.2 | NDSR | **Passenger Elevator 6 (Library Building) L1** | | | | |
| | | **Passenger Elevator (1632 Kg) with Car with Stainless steel in dot matrix (Scratch less), gearless, with SS hand rail & with Machine Room Less.** | | | | |
| | | 24 Persons, 7 stops , 1.5 mps & rise 22.925 mtr. | | | | |
| | | Available hoistway size | Nos. | 4,200,000.00 | 1 | 4,200,000 |
| | | a) 2900 mm D x 2900 mm W | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | | | | | |
| 3 | | **Passenger Elevator 1 & 2 (SAARC Studies) AC9** | | | | |
| 3.1 | NDSR | **Passenger Elevator ( 884 Kg) with Car with Stainless steel in dot matrix (Scratch less), gearless, with SS hand rail & with Machine Room Less.** | | | | |
| | | 13 Persons, 9 stops , 1.5 mps & rise 31.8 mtr. | | | | |
| | | Available hoistway size | Nos. | 2,350,000.00 | 2 | 4,700,000 |
| | | a) 1975 mm D x 2500 mm W | | | | |
| | | | | | | |
| 4 | | **Passenger Elevator 1 & 2 ( Law & Humanity) AC4** | | | | |
| 4.1 | NDSR | **Passenger Elevator (1088 Kg) with Car with Stainless steel in dot matrix (Scratch less), gearless, with SS hand rail & with Machine Room Less.** | | | | |
| | | 16 Persons, 5 stops , 1.5 mps & rise 17.100 mtr. | | | | |
| | | Available hoistway size | Nos. | 2,450,000.00 | 2 | 4,900,000 |
| | | a) 2300 mm D x 2475 mm W | | | | |
| | | | | | | |
| 4.2 | NDSR | **Passenger Elevator 3 & 4 ( Law & Humanity) AC4** | | | | |
| | | **Passenger Elevator ( 1088 Kg) with Car with in Stainless steel hailine finish, gearless, with SS hand rail & with Machine Room Less.** | | | | |
| | | 16 Persons, 5 stops , 1.5 mps & rise 17.1 mtr. | | | | |
| | | Available hoistway size | Nos. | 2,450,000.00 | 2 | 4,900,000 |
| | | a) 2300 mm D x 2475 mm W | | | | |
| | | | | | | |
| 5 | | **Elevator No. 1 & 2 (Chem, Math, Phy & IT) AC3** | | | | |
| 5.1 | NDSR | **Passenger Elevator ( 1088 Kg) with Car with in Stainless steel hailine finish, gearless, with SS hand rail & with Machine Room Less.** | | | | |
| | | 16 Persons, 6 stops , 1.5 mps & rise 21.3 mtr. | | | | |
| | | Available hoistway size | Nos. | 2,555,000.00 | 2 | 5,110,000 |
| | | a) 2300 mm D x 2475 mm W | | | | |
| | | | | | | |
| 6 | | **Elevator No. 3 & 4 (AC3)** | | | | |
| 6.1 | NDSR | **Passenger Elevator ( 1088 Kg) with Car with Stainless steel in dot matrix (Scratch less), gearless, with SS hand rail & with Machine Room Less.** | | | | |
| | | 16 Persons, 5 stops , 1.5 mps & rise 17.1 mtr. | | | | |
| | | Available hoistway size | Nos. | 2,450,000.00 | 2 | 4,900,000 |
| | | a) 2300 mm D x 2475 mm W | | | | |
| | | | | | | |
| 7.0 | | **Passenger Elevator 1 & 2 (Arts Design) AC1** | | | | |
| 7.1 | NDSR | **Passenger Elevator ( 1088 Kg) with Car with Stainless steel in dot matrix (Scratch less), gearless, with SS hand rail & with Machine Room Less.** | | | | |
| | | 16 Persons, 7 stops , 1.5 mps & rise 25.0 mtr. | | | | |
| | | Available hoistway size | Nos. | 2,650,000.00 | 2 | 5,300,000 |
| | | a) 2300 mm D x 2335 mm W | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | | | | | |
| 7.2 | NDSR | **Passenger Elevator 3 (Arts Design) AC1** | | | | |
| | | **Passenger Elevator ( 1632 Kg) with Car of Stainless steel in dot matrix (Scratch less), gearless, with SS hand rail & with Machine Room Less.** | | | | |
| | | 24 Persons, 7 stops , 1.5 mps & rise 25.0 mtr. | | | | |
| | | Available hoistway size | Nos. | 4,250,000.00 | 1 | 4,250,000 |
| | | a) 2700 mm D x 2600 mm W | | | | |
| | | | | | | |
| 8.0 | NDSR | **Passenger Elevator 1, 2, 3, 4, 5 & 6 (Conventional Centre) C1** | | | | |
| | | **Passenger Elevator ( 1632 Kg) with Car of Stainless steel in dot matrix (Scratch less), gearless, with SS hand rail & with Machine Room Less.** | | | | |
| | | 24 Persons, 6 stops , 1.5 mps & rise 25.0 mtr. | | | | |
| | | a) 2600 mm D x 2465 mm W | Nos. | 4,350,000.00 | 6 | 26,100,000 |
| | | | | | | |
| 8.1 | NDSR | **Service Elevator 7 (Conventional Centre) C1** | | | | |
| | | **Service Elevator ( 1088 Kg) with Car Stainless steel in dot matrix (Scratch less), gearless, with SS hand rail & with Machine Room Less.** | | | | |
| | | 16 Persons, 6 stops , 1.5 mps & rise 25.5 mtr. | | | | |
| | | Available hoistway size | Nos. | 2,600,000.00 | 1 | 2,600,000 |
| | | a) 2425 mm D x 2450 mm W | | | | |
| | | | | | | |
| 8.2 | NDSR | **Service Elevator 8 (Conventional Centre) C1** | | | | |
| | | **Service Elevator ( 1088 Kg) with Car of Stainless steel in dot matrix (Scratch less), gearless, with SS hand rail & with Machine Room Less.** | | | | |
| | | 16 Persons, 6 stops , 1.5 mps & rise 25.5 mtr. | | | | |
| | | Available hoistway size | Nos. | 2,600,000.00 | 1 | 2,600,000 |
| | | a) 3000 mm D x 2500 mm W | | | | |
| | | | | | | |
| 9.0 | NDSR | **Service Elevator (Utility Building)** | | | | |
| | | **Service Elevator ( 1768 Kg) with Car with Stainless steel in dot matrix (Scratch less), gearless, with SS hand rail & with Machine Room Less.** | | | | |
| | | 2 stops , 1 mps & rise 6 mtr. | | | | |
| | | Available hoistway size | Nos. | 3,800,000.00 | 1 | 3,800,000 |
| | | a) 3000mm D x 3000 mm W | | | | |
| | | | | | | |
| | | **TOTAL FOR ELEVATORS CARRIED TO SUMMARY** | | | | **84,810,000** |
| | | | | | | |
| I | | **CONDUITING & CABLING FOR TELEPHONE, DATA & MATV SYSTEM** | | | | |
| | | Providing and installing of all conduiting, structured cabling for telephone, data and MATV system including providing and fixing of the following: | | | | |
| 1 | | All necessary specials and fittings. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| 2 | | Approved cover plates for inspection, junction and outlet boxes. | | | | |
| 3 | | 2 mm thick outlet boxes and junction boxes. | | | | |
| 4 | | All fixing accessories such as clips, brass bushes, nails, screws etc. | | | | |
| 5 | | Providing and fixing approved saddles, hooks and grouting the same as required, in the case of all exposed conduit work. | | | | |
| 6 | | Embedding conduits and accessories in wall, floors etc. during construction and / or cutting chases and making good as necessary in the case of all concealed conduit work. | | | | |
| 7 | | Providing 14 SWG GI pull wire in all conduit work. | | | | |
| 8 | | Repainting of MS conduits, outlet boxes and junction boxes where ever damaged. | | | | |
| | | | | | | |
| (i) | | **TELEPHONE SYSTEM** | | | | |
| 1 | NDSR | Supply, installation, testing and commissioning of Krone make Protector panel with swivel input stub and splice chamber as required, for the incoming P & T lines. The panel shall have provision for both top and bottom cable feeding. The conductors in the swivel stub and splice chamber shall have 24 AWG conductors and satisfy the fuse link requirement. 5 No. test cards shall also be provided. | | | | |
| a | | 50 Pair protector panel | Nos. | 1,977.00 | 8 | 15,816 |
| b | | 100 Pair protector panel | Nos. | 4,000.00 | 15 | 60,000 |
| c | | 250 Pair protector panel | Nos. | 4,613.00 | 6 | 27,678 |
| d | | 350 Pair protector panel | Nos. | 7,249.00 | 6 | 43,494 |
| e | | 500 Pair protector panel | Nos. | 16,474.00 | 3 | 49,422 |
| | | | | | | |
| 2 | NDSR | Supply, installation, testing and commissioning of Category 5 Riser cable consisting of multiple core or solid copper conductors of 24 AWG size insulated with expanded polyethylene covered by a PVC skin and inner shielding for grounding. The core shall be covered by a layer of plastic tape and overlaid with a corrugated PVC plastic. The cable shall be as per the specifications laid down in the tender | | | | |
| a | | 25 pair armoured riser cable | Mtrs. | 208.00 | 530 | 110,240 |
| b | | 10 pair armoured riser cable | Mtrs. | 35.00 | 640 | 22,400 |
| c | | 50 pair armoured riser cable | Mtrs. | 150.00 | 720 | 108,000 |
| | | | | | | |
| 3 | NDSR | Supply, installation, testing and commissioning of 4 pair Category 6 UTP cable consisting of 23 AWG solid copper conductors and as per the specification. The cable should have flexible jacket and ripcord for easy stripability. | RM | 42.00 | 72500 | 3,045,000 |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| 4 | NDSR | Supply, installation, testing and commissioning of Category 6 IDC cross connect panel prepackaged with wiring block with legs, insert labels, label holders, jumper troughs, metal back panel duct assembly, screws washers and an instruction sheet for termination of incoming pairs. Rate shall include suitable size of lockable 1.6mm thick CRCA sheet steel enclosure duly powder coated. | | | | |
| a | | 250 FT Cross Connect Panel | Nos. | 35,000.00 | 3 | 105,000 |
| b | | 200 FT Cross Connect Panel | Nos. | 28,000.00 | 29 | 812,000 |
| c | | 150 FT Cross Connect Panel | Nos. | 20,428.00 | 10 | 204,280 |
| d | | 100 FT Cross Connect Panel | Nos. | 8,567.00 | 23 | 197,041 |
| e | | 50 FT Cross Connect Panel | Nos. | 7,249.00 | 40 | 289,960 |
| | | | | | | |
| 5 | NDSR | Supply and installation, testing and commissioning following size KRONE make telephone tag block in lockable 16 gauge sheet steel enclosure complete as required. | | | | |
| a | | 10 pair Krone type tag block | No. | 725.00 | 318 | 230,550 |
| b | | 20 pair Krone type tag block | No. | 1,384.00 | 6 | 8,304 |
| | | | | | | |
| 6 | NDSR | Supply and installation of flush mounted Category 6 T 568 A or B outlet. The plastic shall be high impact, flame-retardant UL rated thermoplastic. Dust cover / Blank shall be provided to protect unused face plate openings. Termination cap and plastic cover shall be provided to protect jack wiring. | | | | |
| a | | Single outlet face plate with RJ-11 jack | No. | 330.00 | 1467 | 484,110 |
| | | | | | | |
| 7 | NDSR | Providing and laying the following HDPE pipe of 6 Kg/ Cm2 working pressure laid in ground including cost of digging, 150 mm sand all around the pipe, brick protection and back filling including all accessories i.e. bends, reducers, flanges of approved make and design complete as required. | | | | |
| a | | 50 mm OD with 2.9 mm wall thickness | Mtrs. | 271.00 | 460 | 124,660 |
| | | | | | | |
| 8 | NDSR | Supply, installation, testing and commisioning of the following incoming telephone cables. | | | | |
| a | | 200 pair 0.61 mm dia tinned copper armoured cable | Mtrs. | 514.00 | 50 | 25,700 |
| b | | 100 pair 0.61 mm dia tinned copper armoured cable | Mtrs. | 275.00 | 50 | 13,750 |
| c | | 25 pair 0.61 mm dia tinned copper armoured cable | Mtrs. | 208.00 | 50 | 10,400 |
| | | | | | | |
| 9 | NDSR | Supply, installation, testing and commissioning of IPDA to connect building blocks on fiber with TDM hardware along with 300FT connections to connect phones with all accessories as required | No. | 1,800,000.00 | 7 | 12,600,000 |
| | | **TOTAL CARRIED TO SUMMARY (i)** | | | | 18,587,805 |
| | | | | | | |
| (ii) | | **DATA SYSTEM** | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| 1 | NDSR | Supply, installation, testing and commissioning of following Ethernet work station switch as per specification. | | | | |
| a | | 48 Port stackable 1G/ 10G SFP (including Multi-mode fiber module) | Nos. | 170,000.00 | 56 | 9,520,000 |
| b | | 24 Port stackable 1G/ 10G SFP (including Multi-mode fiber module) | Nos. | 110,000.00 | 58 | 6,380,000 |
| c | | 16 Port stackable 1G/ 10G SFP (including Multi-mode fiber module) | Nos. | 80,000.00 | 1 | 80,000 |
| d | | 12 Port stackable 1G/ 10G SFP (including Multi-mode fiber module) | Nos. | 80,000.00 | 4 | 320,000 |
| | | | | | | |
| 2 | NDSR | Supply and installation of following 19 inch rack for ethernet switches with A.C. distribution box, wire manager, fan tray, lockable front tinted glass door and two pair angle to support the switch installed in the rack. | | | | |
| a | | 42 U Rack | No. | 57,862.00 | 12 | 694,344 |
| b | | 15 U Rack | No. | 21,304.00 | 24 | 511,296 |
| c | | 21 U Rack | No. | 35,000.00 | 4 | 140,000 |
| | | | | | | |
| 3 | NDSR | Supply, installation, testing and commissioning of following Category 6, IDC patch panel prepackaged with wiring block with legs with legs insert labels, label holders, jumper troughs, metal back panel, duct assembly, screws, washers and an instruction sheet for termination of incoming pairs. | | | | |
| a | | 48 Port jack panel | Nos. | 35,000.00 | 56 | 1,960,000 |
| b | | 24 Port jack panel | Nos. | 23,590.00 | 58 | 1,368,220 |
| c | | 16 Port jack panel | Nos. | 19,900.00 | 1 | 19,900 |
| d | | 12 Port jack panel | Nos. | 17,792.00 | 4 | 71,168 |
| | | | | | | |
| 4 | NDSR | Supply and installatlion of wire manager suitable for mounted on 19 inch rack. | Nos. | 11,202.00 | 66 | 739,332 |
| | | | | | | |
| 5 | NDSR | Supply, installation, testing and commissioning of 4 pair Category 6 LAN cable consisting of 24 AWG solid copper conductors and as per the specification. The cable shall have flexible jacket and ripcord for easy Stripability. | Mtrs | 42.00 | 188475 | 7,915,950 |
| | | | | | | |
| 6 | NDSR | Supply and installation of flush mounted Enhanced Category 6 T 568 A or B) outlet. The plastic shall be high impact, flame-retardant, UL rate thermoplastic. Dust cover / blank shall be provided to protect unused faceplate openings. Termination caps and plastic cover shall be provided to protect jack wiring. | | | | |
| a | | Single outlet faceplate with RJ-45 jack with information outlet | No. | 521.00 | 2835 | 1,477,035 |
| | | | | | | |
| 7 | NDSR | Supply and installation of 6 core Multi-M0de 50/125 micron OM4 indoor, LSZH, Fibers multitube type Optical Fiber Cable - Armoured | Mtrs | 142.00 | 1550 | 220,100 |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | | | | | |
| 8 | NDSR | Supply and installation of following Enhanced Category 6 mounting Patch cord for connecting the outlets to the data station (computer/printer etc). It shall have male RJ 45 connector on one end and male RJ45 connector or open ended wire or a connector suitable for data outlet at the other end. It shall be a 8 conductor. 4 pair cord with each conductor of 24 AWG stranded wire. | | | | |
| a | | 1 m long | Nos. | 923.00 | 119 | 109,837 |
| b | | 2 m long | Nos. | 1,186.00 | 133 | 157,738 |
| | | | | | | |
| 9. | NDSR | 24 Port, layer 2, managed 1 Ghz, Network Switch with POE+ facility and 2 Nos. of Fiber Ports. (including multi-mode fiber module with 370W) | Nos. | 140,000.00 | 8 | 1,120,000 |
| | | | | | | |
| 7. | NDSR | 12 Port, layer 2, managed 1 Ghz, Network Switch with POE+ facility and 2 Nos. of Fiber Ports. (including multi-mode fiber module with 180W) | Nos. | 90,000.00 | 29 | 2,610,000 |
| | | | | | | |
| 9. | NDSR | Providing and fixing of Line Interfac Unit (LIU) including Patch Chord of required length for optical fiber cable with appropriate terminal connectors for 24 port, switch complete as required | Nos. | 1,200.00 | 19 | 22,800 |
| | | | | | | |
| | | | | | | |
| | | **TOTAL CARRIED TO SUMMARY (ii)** | | | | 35,437,720 |
| | | | | | | |
| (iii) | | **MATV SYSTEM** | | | | |
| 1 | NDSR | Supply, erection, testing and commissioning of following tap off with boxes for CATV system | | | | |
| a | | One Way (T-1) | Nos. | 700.00 | 8 | 5,600 |
| b | | Two Way (T-3) | Nos. | 750.00 | 1 | 750 |
| | | | | | | |
| 2 | NDSR | Supply, erection, testing and commissioning of spliter with boxes. | | | | |
| a | | Three Way (S-3) | Nos. | 750.00 | 1 | 750 |
| | | | | | | |
| 3 | NDSR | Supply, laying, connecting and commissioning of RG-11 Foam Series Tinned Copper co-axial cable of SMATV as per specification in existing heavy duty PVC conduit. | Mtrs. | 40.00 | 450 | 18,000 |
| | | | | | | |
| 4 | NDSR | Supply, laying, connecting and commissioning of 500 series (0.5 inch) Tinned Copper co-axial cable of SMATV as per specification. | Mtrs. | 72.00 | 50 | 3,600 |
| | | | | | | |
| 5 | NDSR | Supply and fixing modular socket TV Outlets on the existing modular plate & switch box including connections but excluding modular plate etc as required suitable for RG 6 Co axial cable connectivity | Nos. | 108.00 | 19 | 2,052 |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| 6 | NDSR | Supply and fixing of Line extender amplifier as per specification housed in suitable size of 16 gauge CRCA sheet enclosed. | No. | 12,000.00 | 7 | 84,000 |
| | | | | | | |
| 7 | NDSR | Supply, installation, testing and commissioning of Optical node with optical splitter & accessories (SC-APC adaptor, pigtail etc) for connecting fiber cable (single mode) with switch with all accessories required for complete installation | Nos. | 25,000.00 | 1 | 25,000 |
| | | | | | | |
| 8 | NDSR | Supply, installation, testing & commissioning of Set Top Box complete with all accessories required for complete installation | Nos | 2,500.00 | 17 | 42,500 |
| | | **TOTAL CARRIED TO SUMMARY (ii)** | | | | 182,252 |
| | | **TOTAL CARRIED TO SUMMARY (I +ii +iii)** | | | | **54,207,777** |
| | | | | | | |
| J | | **FIRE DETECTION , ALARM AND PA SYSTEM** | | | | |
| 1 | | **FIRE ALARM CONTROL PANEL** | Job | 1,585,690.00 | 2 | 3,171,380 |
| a | NDSR | Microprocessor based 10 loop capacity,Networkable analogue addressable type UL/EN listed fire alarm control panel with minimum 80 character LCD display. The panel should be equipped with sufficient numbers of loop with 20% spare capacity with each loop shall have a capacity to take 198 analogue addressable devices (99 Detectors + 99 modules) in one loop. The system shall have the capability to support over 12,000+ points on a single network.of minimum 198 analog addressable devices in one loop. Four access levels, capable of taking Flash Scan devices, flash EPROM sufficient numbers of programmable relay controls for controlling AHUs, pressurization fans, ventilation fans at fire pump room, monitoring of fire sprinkler and fire hydrant pump, 240 volts AC power supply, automatic battery charger, 24 volts | | | | |
| | | sealed lead acid batteries sufficient for 24 hours normal working and then be capable of operating the system for 2 hours during an emergency conditions as required. The panel shall have an Integrated/Standalone Digital Voice Evacuation and 2 way Communication Fire Fighters System capable to supervision of all the speaker circuits and accessories required to complete the system. The equipment shall be with the provision to integrate with Fire alarm panel in case of standalone system. The Panel shall have Digital Audio Amplifiers with suitable wattage to cater given number of speakers at 70.7 VRMS output along with necessary enclosures. The panel complies with latest Fire codes and standards, (UL 864, 9th Edition) & FM Approved or LPCB. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | (Bidder may propose a different panel / loop configuration to accommodate 800 detectors and 800 modules depending on the manufactuer's capacity) The panel shall be LAN compatible with Bacnet/ Modbus software. | | | | |
| | | Incase of equivalent stand alone PA system, the cost of all PA interface including cost of PA panel shall be included in cost of main fire panel. | | | | |
| | | | | | | |
| b | NDSR | Microprocessor based 8 loop capacity,Networkable analogue addressable type UL/EN listed fire alarm control panel with minimum 80 character LCD display. The panel should be equipped with sufficient numbers of loop with 20% spare capacity with each loop shall have a capacity to take 198 analogue addressable devices (99 Detectors + 99 modules) in one loop. The system shall have the capability to support over 12,000+ points on a single network.of minimum 198 analog addressable devices in one loop. Four access levels, capable of taking Flash Scan devices, flash EPROM sufficient numbers of programmable relay controls for controlling AHUs, pressurization fans, ventilation fans at fire pump room, monitoring of fire sprinkler and fire hydrant pump, 240 volts AC | Job | 1,320,299.00 | 3 | 3,960,897 |
| | | power supply, automatic battery charger, 24 volts sealed lead acid batteries sufficient for 24 hours normal working and then be capable of operating the system for 2 hours during an emergency conditions as required. The panel shall have an Integrated/Standalone Digital Voice Evacuation and 2 way Communication Fire Fighters System capable to supervision of all the speaker circuits and accessories required to complete the system. The equipment shall be with the provision to integrate with Fire alarm panel in case of standalone system. The Panel shall have Digital Audio Amplifiers with suitable wattage to cater given number of speakers at 70.7 VRMS output along with necessary enclosures. The panel complies with latest Fire codes and standards, (UL 864, 9th Edition) & FM Approved or LPCB. | | | | |
| | | (Bidder may propose a different panel / loop configuration to accommodate 800 detectors and 800 modules depending on the manufactuer's capacity) The panel shall be LAN compatible with Bacnet/ Modbus software. | | | | |
| | | Incase of equivalent stand alone PA system, the cost of all PA interface including cost of PA panel shall be included in cost of main fire panel. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| c | NDSR | Microprocessor based 6 loop capacity,Networkable analogue addressable type UL/EN listed fire alarm control panel with minimum 80 character LCD display. The panel should be equipped with sufficient numbers of loop with 20% spare capacity with each loop shall have a capacity to take 198 analogue addressable devices (99 Detectors + 99 modules) in one loop. The system shall have the capability to support over 12,000+ points on a single network.of minimum 198 analog addressable devices in one loop. Four access levels, capable of taking Flash Scan devices, flash EPROM sufficient numbers of programmable relay controls for controlling AHUs, pressurization fans, ventilation fans at fire pump room, monitoring of fire sprinkler and fire hydrant pump, 240 volts AC | Nos. | 1,187,604.00 | 3 | 3,562,812 |
| | | The equipment shall be with the provision to integrate with Fire alarm panel in case of standalone system. The Panel shall have Digital Audio Amplifiers with suitable wattage to cater given number of speakers at 70.7 VRMS output along with necessary enclosures. The panel complies with latest Fire codes and standards, (UL 864, 9th Edition) & FM Approved or LPCB. | | | | |
| | | (Bidder may propose a different panel / loop configuration to accommodate 600 detectors and 600 modules depending on the manufactuer's capacity) The panel shall be LAN compatible with Bacnet/ Modbus software. | | | | |
| | | Incase of equivalent stand alone PA system, the cost of all PA interface including cost of PA panel shall be included in cost of main fire panel. | | | | |
| | | | | | | |
| 2 | NDSR | Compatible addressable loop module for extending/ deletion of the loops in main Fire alarm control panel | Nos. | 74,305.00 | 6 | 445,830 |
| | | | | | | |
| 3 | NDSR | Supplying, Installation, Testing & Commissiong of intelligent addressable Plug-in type rate of rise Heat Detector, 360 Degree View LED, Rotary Address Switch/Soft to programme the detectors from 01-99, with BASE complete with MS Powder coated Junction Box for mouting on Surface / on False Ceiling / Below False Floor, Cable lugs at Ends, cable compression glands, cable tags and Ferruling.<br>Both the Detectors & Base shall be UL Listed & FM /LPCB Approved. | Nos | 3,947.00 | 43 | 169,721 |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| 4 | | Supply, Installation,Testing & Commissioning of Analog Addressable Intelligent Multi-criteria (Photo smoke + ROR heat + Fixed temp heat) detector with decentralize intelligence, soft/Hard addressable complete with fault isolator either built-in or seperate with piezo base sounder as required . Both the Detectors & Base shall be UL Listed & FM/LPCB Approved. | Nos. | 3,947.00 | 616 | 2,431,352 |
| | | | | | | |
| 5 | NDSR | Supplying, Installation, Testing & Commissiong of intelligent addressable Plug-in type Photoelectric/Optical smoke detector, LED, soft addressable/ Rotary Address Switch to programme the detectors from 01-99, with BASE complete with MS Powder coated Junction Box for mouting on Surface / on False Ceiling (below) /above false ceiling/ Below False Floor, Cable lugs at Ends, cable compression glands, cable tags and Ferruling. Both the Detectors & Base shall be UL Listed & FM/LPCB Approved. | Nos. | 3,947.00 | 5443 | 21,483,521 |
| | | | | | | |
| 6 | NDSR | Supplying, Installation, Testing & Commissiong of Response indicators | Nos | 298.00 | 85 | 25,330 |
| | | | | | | |
| 7 | NDSR | Supply, Installation, Testing & Commissioning of Analogue Addressable Intelligent Beam detector with decentralize intelligence, soft addressable type with receiver complete with base as required. The detector shall be UL Listed & FM /EN Approved<br><br>(Bidder to provide a seperate addressable control module in case of conventional beam detectors to integrate it with addressable loop) | Nos | 47,105.00 | 15 | 706,575 |
| | | | | | | |
| 8 | NDSR | Supply, Installation, Testing & Commissioning of Addressable Single/Dual Action Manual Pull Station complete with all mounting accessories.The Devices shall be UL Listed & FM/LPCB Approved. | Nos | 3,947.00 | 269 | 1,061,743 |
| | | | | | | |
| 9 | NDSR | Supply, Installation,Testing & Commissioning of Addressable Control Modules for hooter cum strobe complete as required. The Devices shall be UL Listed & FM/LPCB Approved.<br><br>(Need not be quoted in case of Loop powered hooter cum strobe considering the loop loading) | Nos | 2,123.00 | 269 | 571,087 |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| 10 | NDSR | Supply, Installation,Testing & Commissioning of Sounder with 90 db output at 1 metre distance cum Strobe Lights with 90 to 110 Lux. The strobes shall be synchoronized for better evacuation as per specification complete as required.The Devices shall be UL or FM/LPCB Approved. | Nos | 5,506.00 | 269 | 1,481,114 |
| 11 | NDSR | Supply, Installation,Testing & Commissioning of 24 VDC Power supply unit with cable supervison and monitoring facility, battery back-up with charging and fault monitoring. The Devices shall be UL or FM/LPCB Approved and of the same make as fire alarm panel. At least one PSU for every zone needs to be considered for hooter cum strobes.<br><br>(Need not be quoted in case of Loop powered hooter cum strobe considering the loop loading) | Nos | 13,931.00 | 46 | 640,826 |
| | | | | | | |
| 12 | NDSR | Supply, Installation,Testing & Commissioning of Addressable monitor module to monitor the heath status of the power supply unit through fire alarm panel. The Devices shall be UL or FM/LPCB Approved. | Nos | 1,924.00 | 46 | 88,504 |
| | | | | | | |
| 13 | NDSR | Supply, Installation,Testing & Commissioning of 2 way communication Fire Fighter's Telephone Jack with Control Module. | Nos | 2,720.00 | 269 | 731,680 |
| | | | | | | |
| 14 | | Supply, Installation,Testing & Commissioning of 2 way communication Fire Fighter's Handset . | Nos. | 2,123.00 | 18 | 38,214 |
| | | | | | | |
| 15 | NDSR | GSM based Auto dialer with dialing and SMS facility | Nos. | 47,102.00 | 6 | 282,612 |
| | | | | | | |
| 16 | NDSR | Addressable monitor modules for Sprinkler Flow Switch and Door Holders and it may be a part of the detectors as specified. | Nos. | 1,924.00 | 480 | 923,520 |
| | | | | | | |
| 17 | NDSR | Supply, Installation,Testing & Commissioning 70db-84db Ceiling Mounted Speakers as specified. | Nos. | 1,194.00 | 2242 | 2,676,948 |
| | | | | | | |
| 18 | NDSR | Supply, Installation,Testing & Commissioning 70db-84db Wall Mounted Speakers as specified. | Nos. | 1,924.00 | 89 | 171,236 |
| | | | | | | |
| 19 | NDSR | Supply, Installation, Testing & Commissioning of Addressable Monitor Module with Adddress Switch and all mounting accessories, complete with MS Powder coated Junction Box for mouting on Surface, Cable lugs at Ends, cable compression glands, cable tags and Ferruling and it may be a part of the detectors as specified. | Nos. | 1,924.00 | 255 | 490,620 |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| 20 | NDSR | Addressable control relay modules for AHU, Access control Integration & stairs Pressurization Fan and it may be a part of the detectors as specified.. | Nos. | 2,123.00 | 476 | 1,010,548 |
| | | | | | | |
| 21 | NDSR | Supply, Installation, Testing & Commissioning of Fault Isolator Module , complete with MS Powder coated Junction Box for mouting on Surface, Cable lugs at Ends, cable compression glands, cable tags and Ferruling.The Devices shall be UL Listed & FM/LPCB Approved.<br><br>(Need not be quotated in case the detectors supplied are with built-in fault isolators or with fault isolators bases) | Nos. | 2,853.00 | 365 | 1,041,345 |
| | | | | | | |
| | | **Conduiting & Cabling :-** | | | | |
| 22 | NDSR | Supply, Installation, Testing & Commissioning of 2C x 1.5 sq.mm BRE Global certified Fire Survival screened cable of 300/500 Volts rated with Class-2 annealed Copper conductor having Halogen Free Ceramified Silicone insulation as per BS EN 50363 along with uninsulated ATC drain wire of 1.5 sq.mm,<br>aluminium tape screening and flame retardant low smoke zero halogen outer sheath as per BS:7629-1 & BS:5839-1 (latest edition). LPCB-FPC certificate to be provided. Outer sheath should be Anti Rodent/Anti-Termite. Should retain circuit integrity as per BS 6387 CWZ & BS EN 50200 PH-60 + Annex-E. To be clamped directly to the robust ceiling complete with termination and testing as per requirement. (For fire alarm and PA system) | Mtrs | 139.00 | 152500 | 21,197,500 |
| | | | | | | |
| 23 | NDSR | Supply, Installation, Testing & Commissioning of 2C x 1.5 sq.mm BRE Global**/ NABL** certified Fire Survival screened cable of 300/500 Volts rated with Class-2 annealed Copper conductor having Halogen Free Ceramified Silicone insulation as per BS EN 50363 along with uninsulated ATC drain wire of 1.5 sq.mm,<br>aluminium tape screening and flame retardant low smoke zero halogen outer sheath as per BS:7629-1 & BS:5839-1 (latest edition). LPCB-FPC certificate to be provided. Outer sheath should be Anti Rodent/Anti-Termite. Should retain circuit integrity as per BS 6387 CWZ & BS EN 50200 PH-60 + Annex-E. To be clamped directly to the robust ceiling complete with termination and testing as per requirement.. (Hooter cum strobes) | Mtrs | 139.00 | 45800 | 6,366,200 |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| 24 | | SITC of 2C x 1.5 sq.mm Fire Survival armoured Cable with class-2 Copper conductor as per BS EN 60228, twisted, with mineral ceramic glass fire barrier tape covered by an extruded layer of cross-linkable low smoke zero halogen (LSZH) insulation as per BS EN 50363 and LSZH inner & outer sheath as per BS: 7846 (Latest edition). The cable should retain circuit integrity as per clause 26.2e of BS 5839-1 . LPCB-FPC & BRE Global**/ NABL** certificates to be provided. Outer sheath should be Anti Rodent. | Mtrs | 172.00 | 4500 | 774,000 |
| | | | | | | |
| 25 | | Supply, installation, testing & commissioning of intelligent Flame,smoke,Reflected fire detector with motion detection capabilities.Detector should have onboard relay capabilities for 3rd party integration. There must be a provision for providing power through POE switches or through external PSU. Detector should have a open protocall connction to connect to 3rd party DVR.There must be a provision to access camera over the ethernet to view live feeds as well as to download recorded events. (UL and FM Approved) | No. | 415,000.00 | 4 | 1,660,000 |
| | | | | | | |
| 26 | | Supply, installation, testing & commissioning of the Network video recorder minimum configuration should be 2.7 GHz, 4 Gb RAM, 2 USB ports, serial port, parallel Port, Touch screen, keyboard and mouse, audio capable to connect upto 4 Fire detectors | Set | 784,000.00 | 1 | 784,000 |
| | | | | | | |
| 27 | | Supply, installation, testing & configuring of 3rd party industrial grade POE switches with minimum 8 ports complete as required. | No. | 15,500.00 | 1 | 15,500 |
| | | | | | | |
| 28 | | Supply, installation, testing & commissioning of 22 inches Flat LED Screen complete as required. | Nos. | 12,500.00 | 2 | 25,000 |
| | | | | | | |
| 29 | | Supply installation testing and configuring of licensed Remote access software to access live feeds & to download recorded feeds over the IP network for the required applications. | Set | 250,000.00 | 1 | 250,000 |
| | | | | | | |
| 30 | | | | | | |
| a | | PC Hardware as per specifcation with mouse & keyboard compatible to fire graphic software | | | | |
| | | 1 Set | | | | |
| b | | 21" color monitor flat screen LCD display as per specfications. | | | | |
| | | 1 Set | | | | |
| c | | Printer as per specifcation | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Graphical software for fire detection & alarm system to be connected to the main for fire alarm panel. The software shall be capable of the following inculding licence as per specifcation. | | | | |
| | | Graphics User interface with Monitoring and control options with following specifications | | | | |
| | | Shall provide "Take Action" messages to first responders with specific, real-time information about alarms at the site including notes about hazardous materials, vulnerable building occupants, and management contacts | | | | |
| | | Upload/download configuration files without taking the whole system off-line | | | | |
| | | Shall have auto-watch option to allows the operator to automatically scan individual buildings | Set | 400,000.00 | 3 | 1,200,000 |
| | | **TOTAL CARRIED TO SUMMARY** | | | | **79,439,615** |
| | | | | | | |
| K | | **CONDUITING FOR CCTV SYSTEM** | | | | |
| | | **ITEM DESCRIPTION** | | | | |
| | | Supply, Installation, Testing & commissioning of the below mentioned Items: | | | | |
| | | | | | | |
| 1 | NDSR | Supply and installation of flush mounted Enhanced Category 6 T 568 A or B) outlet. The plastic shall be high impact, flame-retardant, UL rate thermoplastic. Dust cover / blank shall be provided to protect unused faceplate openings. Termination caps and plastic cover shall be provided to protect jack wiring. | | | | |
| a | | Single outlet faceplate with RJ-45 jack with information outlet | Nos. | 521.00 | 268 | 139,628 |
| | | | | | | |
| 2. | NDSR | Supply & installation of 6 core MM 50/125 micron OM4 indoor, LSZH, Fibers multitube type Optical Fiber Cable - Armoured complete in all respect. | Mtrs. | 142.00 | 950 | 134,900 |
| | | | | | | |
| 3 | NDSR | Providing and laying the following HDPE pipe of 6 Kg/ Cm2 working pressure laid in ground including cost of digging, 150 mm sand all around the pipe, brick protection and back filling including all accessories i.e. bends, reducers, flanges of approved make and design complete as required. | | | | |
| a | | 50 mm OD with 2.9 mm wall thickness | Mtrs. | 586.00 | 3850 | 2,256,100 |
| 4 | NDSR | Supply, installation, testing and commissioning of 4 pair Category 6 UTP cable consisting of 23 AWG solid copper conductors and as per the specification. The cable should have flexible jacket and ripcord for easy stripability. | Mtr. | 63.00 | 14350 | 904,050 |
| | | | | | | |
| | | **TOTAL FOR IP based CCTV System SYSTEM CARRIED TO SUMMARY** | | | | 3,434,678 |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| L | | **ACCESS CONTROL SYSTEM** | | | | |
| | | | | | | |
| 1 | NDSR | Supplying & laying of 8 core X 0.75 sq. mm ATC conductor PVC insulated & overall sheathed Cable in existing conduit. | Mtrs. | 125.00 | 1500 | 187,500 |
| | | | | | | |
| | | | | | | |
| 2 | NDSR | Supply, installation, testing and commissioning of 4 pair Category 6 UTP cable consisting of 23 AWG solid copper conductors and as per the specification. The cable should have flexible jacket and ripcord for easy stripability. | Mtr. | 63.00 | 750 | 47,250 |
| | | | | | | |
| 3 | | **BOOM BARRIER** | | | | |
| 3.1 | NDSR | Supply , Installation , testing and commissioning of proximity smart cards as per specifications:- | Nos. | 67.00 | 770 | 51,590 |
| 3.2 | NDSR | Supplying, installation & commissioning of Boom barriers unit with 3 mtr Boom length complete with base unit, mounted on suitable Civil foundation. The unit shall also include suitable loop sensor and long range readers for automatic opening of the barrier for authorized cars complete with controller and to be integrated into main access control system for reporting. Any power supply unit required for the above unit to be included in the prices. The system shall capable of integerating with Main access control system. | Nos. | 213,393.00 | 4 | 853,572 |
| 3.3 | NDSR | Supplying, installation & commissioning of Boom barriers unit with 7 mtr Boom length complete with base unit, mounted on suitable Civil foundation. The unit shall also include suitable loop sensor and long range readers for automatic opening of the barrier for authorized cars complete with controller and to be integrated into main access control system for reporting. Any power supply unit required for the above unit to be included in the prices. The system shall capable of integerating with Main access control system. | Nos. | 600,000.00 | 8 | 4,800,000 |
| a | | Proximity smart reader with read range 27" -28" with housing | Nos. | 20,572.00 | 10 | 205,720 |
| b | | Supply, Installation, testing and commissioning of stainless stell tripod turnstiles complete with access reader and controller and to be integrated into main access control system. The system shall capable of integerating with Main access control system. | Nos. | 161,240.00 | 3 | 483,720 |
| | | | | | | |
| 4 | | Supply, installation, testing & commissioning of self powered hand held metal detectors | Nos. | 20,000.00 | 10 | 200,000 |
| | | | | | | |
| | | **TOTAL FOR ACCESS CONTROL SYSTEM CARRIED TO SUMMARY** | | | | 6,829,352 |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| M | | **BUS DUCT (IN SANDWICH CONSTRUCTION)** | | | | |
| | | | | | | |
| 1 | NDSR | Design, manufacturer, supply, installation, testing and commissioning of the following sandwich construction bus duct suitable for 415 volts , 50Hz of following ratings four pole (50 KA for 1 Sec) aluminium bus bars insulated with 100 % neutral & 100% earth bus, expansion joints. | | | | |
| | | | | | | |
| | | Fire barriers including necessary supports and louvers for ventilation, fabricated out of extruded alumminium painted with approved paint shade as per specification including in built earthing conductor throughout the length of the bus duct. (Phase sequence shall be matched). | | | | |
| a | | 3200 amps | RM | 35,084.00 | 20 | 701,680 |
| b | | 2500 amps | RM | 30,817.00 | 10 | 308,170 |
| | | | | | | |
| 2 | NDSR | Following four pole copper flexible end connections on transformers & LT Isolator Panels. | | | | |
| a | | 3200 amps | Nos. | 47,095.00 | 8 | 376,760 |
| b | | 2500 amps | Nos. | 62,741.00 | 4 | 250,964 |
| | | | | | | |
| 3 | NDSR | Providing & fixing of 90 degree bend with above busducts complete with all necessary accessories required for complete installation. | | | | |
| a | | 3200 amps | Nos. | 23,073.00 | 8 | 184,584 |
| b | | 2500 amps | Nos. | 25,623.00 | 4 | 102,492 |
| | | | | | | |
| | | **TOTAL FOR RISING MAIN (SANDWICHED TYPE) SYSTEM CARRIED TO SUMMARY** | | | | 1,924,650 |
| | | | | | | |
| N | | **DISTRIBUTION BOARDS & PANELS** | | | | |
| | | | | | | |
| 1 | | Providing cable clamps / supports within distribution boards cable alley. | | | | |
| 2 | | TPN ACB's / MCCB's shall mean 3 pole ACB's / MCCB's with adequate size of neutral link. | | | | |
| 3 | | All MCB's shall be of minimum 10 KA breaking capacity. | | | | |
| 4 | | The breaking capacity of MCCB's are mentioned panel wise. All MCCB's shall be with thermal & magnetic releases up to 250A & with electronic trip unit above 250A as per BOQ & specifications. | | | | |
| 5 | | Distribution panels shall be Powder Coated with Siemens gray paint shade no. RAL-7032 of IS.. | | | | |
| 6 | | Degree of protection for following type of distribution panel enclosure shall be as per IS:13947-1993. | | | | |
| a | | i. IP 52 for indoor panels. | | | | |
| b | | ii. IP 55 for outdoor panels. | | | | |
| | | | | | | |
| 7 | | All MCCB's shall be provided with operating mechanism for door interlock. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| 8 | | GI earth bus shall be provided through out the length of each board as per schematic diagram. | | | | |
| 9 | | All measuring instruments (Meters) shall be of digital electronic (LED Type) of approved make. | | | | |
| 10 | | All hinged door shall be earthed through 2.5 sq mm tinned braided copper wire. | | | | |
| 11 | | All panels shall have provision of the following: | | | | |
| a | | Addressable Monitor Modules | | | | |
| b | | Addressable Control Modules | | | | |
| | | | | | | |
| 12 | | Analog Addressable Intelligent optical smoke detector with sounder | | | | |
| 13 | | CT's shall be properally mounted and clamped. Connection of CT's for measuring instrument / relays shall be done through connector / terminals. | | | | |
| 14 | | Model, current capacity location and frame size of switchgear shall be written inside of the panel doors with paint / permanent marker as approved shop drawings / site requirement. | | | | |
| 15 | | Compliance to the technical specifications. | | | | |
| 16 | | All MS works to have two coats of zinc chromate primer & coat of epoxy paint. | | | | |
| 17 | | All panels shall have provision of the following: | | | | |
| a | | Pad locking of Switch board doors. | | | | |
| b | | Pad locking of MCCB's handles in "OFF" Position. | | | | |
| | | | | | | |
| 18 | | Additional set of C.T.s, potential free contacts, connectors, contactors with wiring etc are to be provided for BAS including space required for various transducers in Main Switch Board sections. Only transducers shall be supplied by BAS contractor. | | | | |
| 19 | | All MCB's used for protection of resistive and lightly inductive load shall be type "B" characteristic and inductive (motor) load shall be of type "C" characteristic and discharge IA and UPS etc. shall be of type D characteristic. | | | | |
| 20 | | All incoming and outgoing air circuit breakers shall be placed on middle portion of the vertical in single tier formation. | | | | |
| 21 | | All MS works to have two coats of zinc chromate primer & coat of epoxy paint. | | | | |
| | | | | | | |
| A | | **DISTRIBUTION PANELS AND BOARDS (TOTALLY TYPE TESTED PANELS)** | | | | |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Design, fabrication, assembling, wiring, testing, supply, forwarding to site, unloading, shifting to location, inspection, installation, testing and commissioning of Floor standing LT Cum Changeover panel/Main distribution panels/ sub-distribution panels fabricated out of 14 gauge CRCA sheet steel in cubicle formation, compartmentalized, from 4b consutruction, free standing floor mounted (IP52), dust and vermin proof with reinforcement of suitable size angle iron, channel, `T' sections and/ or flats wherever necessary. 16 gauge CRCA sheet steel shall be used for final distribution panels & 2.5mm for load bearing member. 3 mm thick cable gland plates shall be provided on top as well as at the bottom of the panels. Panels shall be treated with all | | | | |
| | | anticorrosive process before powder coating as per specifications and final approved shade. 2 No. earthing terminals shall be provided for all distrtibution panels. Panels shall be suitable for 415V, 3 phase, 4 wire, 50 HZ supply system. Lifting hooks shall also be provided in case of large panels. Approval shall be taken for each panel in the form of shop drawings before fabrication. Approval shall be taken for the panel in the form of shop drawings before fabrication. Galvanised hardwares with zinc passivation shall be used in fabrication of panel. | | | | |
| | | | | | | |
| | | **DISTRIBUTION PANELS** | | | | |
| | | **FACULTY OF ADMINISTRATION BUILDING** | | | | |
| | | | | | | |
| | | **ADMINISTRATION BUILDING (AD1) BUILDING** | | | | |
| 1 | NDSR | **MDB - N (AD1 BUILDING)** | | | | |
| | **A** | **Incoming** | | | | |
| | (i) | 400 amps 4 pole MCCB (35KA) with built in microprocessor based release unit for short circuit, over current and earth fault protection with adjustable setting as per specification and with following accessories : | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | (iii) | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (iv) | Auxiliary contacts required for necessary interlocking of breakers.mechanical interlocking to be provided. | | | | |
| | | 1 Set | | | | |
| | (v) | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. & phase indicating lamps connected through 415 V √ 3 : 110 V √ 3 PT's, Primary and Secondary of PT's shall be protected by 2 amp TP MCB's | | | | |
| | | 1 Set | | | | |
| | (vi) | 0-400 Amps digital electronic ammeter with selector switch with 3 nos. 400/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | (vii) | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | **B** | **Bus Bars** | | | | |
| | | 500 amps TPN aluminium bus bars (35 kA/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 100 amp TPN MCCB(35KA)<br>6 Nos. | | | | |
| | (iv) | **Bus Coupler** | | | | |
| | | 400 amps 4 pole indicating lamps with control MCB's. | | | | |
| | | | | | | |
| | | **SECTION-II** | | | | |
| | (C ) | **Incoming** | | | | |
| | (i) | 400 amps 4 pole MCCB (35KA) with built in microprocessor based release unit for short circuit, over current and earth fault protection with adjustable setting as per specification and with following accessories : | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | (iii) | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | (iv) | Auxiliary contacts required for necessary interlocking of breakers.mechanical interlocking to be provided. | | | | |
| | | 1 Set | | | | |
| | (v) | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. & phase indicating lamps connected through 415 V √ 3 : 110 V √ 3 PT's, Primary and Secondary of PT's shall be protected by 2 amp TP MCB's | | | | |
| | | 1 Set | | | | |
| | (vi) | 0-400 Amps digital electronic ammeter with selector switch with 3 nos. 400/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | (vii) | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 500 amps TPN aluminium bus bars (35 kA/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 315 amp TPN MCCB(35KA)<br>1 Nos. | | | | |
| | | 100 amp TPN MCCB(35KA)<br>6 Nos. | | | | |
| | | **MDB - N (AD1 BUILDING) as described above** | Set | 760,147.31 | 1 | 760,147 |
| | | | | | | |
| 2 | NDSR | **MDB - E (AD1 BUILDING)** | | | | |
| | **A** | **Incoming** | | | | |
| | (i) | 2 Nos. 400 amps 4 pole MCCB (35KA) with built in microprocessor based release unit for short circuit, over current and earth fault protection with adjustable setting as per specification and with following accessories : | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class 0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | (iii) | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (iv) | Auxiliary contacts required for necessary interlocking of breakers.mechanical interlocking to be provided | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 1 Set | | | | |
| | (v) | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. & phase indicating lamps connected through 415 V √ 3 : 110 V √ 3 PT's, Primary and Secondary of PT's shall be protected by 2 amp TP MCB's | | | | |
| | | 1 Set | | | | |
| | (vi) | 0-400 Amps digital electronic ammeter with selector switch with 3 nos. 400/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | (vii) | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | **B** | **Bus Bars** | | | | |
| | | 500 amps TPN aluminium bus bars (35 kA/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 125 amp TPN MCCB (35KA)<br>4 no. | | | | |
| | | 160 amp TPN MCCB (35KA)<br>2 no. | | | | |
| | | 100 amp TPN MCCB (35KA)<br>2 No. | | | | |
| | | | | | | |
| | (iv) | **Bus Coupler** | | | | |
| | | 400 amps 4 pole MCCB (35KA) microprocessor based indicating lamps with control MCB's. | | | | |
| | | 1 Set | | | | |
| | | **SECTION-II** | | | | |
| | (C ) | **Incoming** | | | | |
| | (i) | 2 nos. 400 amps 4 pole MCCB (35KA) built in microprocessor based release unit for short circuit, over current and earth fault protection with adjustable setting as per specification and with following accessories : | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | | | | | |
| | (iii) | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | (iv) | Auxiliary contacts required for necessary interlocking of breakers.mechanical interlocking to be provided | | | | |
| | | 1 Set | | | | |
| | (v) | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. & phase indicating lamps connected through 415 V √ 3 : 110 V √ 3 PT's, Primary and Secondary of PT's shall be protected by 2 amp TP MCB's | | | | |
| | | 1 Set | | | | |
| | (vi) | 0-400Amps digital electronic ammeter with selector switch with 3 nos. 400/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | (vii) | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 500 amps TPN aluminium bus bars (35 kA/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 125 amp TPN MCCB (35KA) 3Nos. | | | | |
| | | 315 amp TPN MCCB (35KA) 1 Nos. | | | | |
| | | 160 amp TPN MCCB (35KA) 2 Nos. | | | | |
| | | 100 amp TPN MCCB (35KA) 4 No. | | | | |
| | | **MDB - E (AD1 BUILDING) as described above** | Set | 1,302,449.28 | 1 | 1,302,449 |
| | | | | | | |
| 3 | NDSR | **MDB UPS-1 (ADMIN BUILDING)** | | | | |
| | (i) | **Incoming** | | | | |
| | | 2 nos. 315 amps 4P MCCB (25KA) with in-built earth fault protection following accessories: | | | | |
| | | 1 set | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 0-250 Amps digital electronic ammeter with selector switch with 3 nos. 250/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 415 amps FP aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 250 amp TPN MCCB 3 No. | | | | |
| | | For detail refer SLD. | | | | |
| | | **MDB UPS as described above** | Set | 452,303.54 | 1 | 452,304 |
| | | | | | | |
| 4 | NDSR | **MDB UPS - 2 (ADMIN BUILDING)** | | | | |
| | (i) | **Incoming** | | | | |
| | | 2 nos. 250 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 set | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-250 Amps digital electronic ammeter with selector switch with 3 nos. 250/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 300 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 100 amp TPN MCCB 9 No. | | | | |
| | | For detail refer SLD. | | | | |
| | | **MDB UPS 2 as described above** | Set | 455,481.65 | 1 | 455,482 |
| | | | | | | |
| 5 | NDSR | **MDB - N (SAARC BUILDING)** | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | **A** | **Incoming** | | | | |
| | (i) | 400 amps 4 pole with built in microprocessor based release unit for short circuit, over current and earth fault protection with adjustable setting as per specification and with following accessories : | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | (iii) | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (iv) | Auxiliary contacts required for necessary interlocking of breakers.also mechanical interlocked to be provided. | | | | |
| | | 1 Set | | | | |
| | (v) | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. & phase indicating lamps connected through 415 V √ 3 : 110 V √ 3 PT's, Primary and Secondary of PT's shall be protected by 2 amp TP MCB's | | | | |
| | | 1 Set | | | | |
| | (vi) | 0-400 Amps digital electronic ammeter with selector switch with 3 nos. 400/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | (vii) | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | **B** | **Bus Bars** | | | | |
| | | 500 amps TPN aluminium bus bars (35 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (i) | **Outgoing** | | | | |
| | | 125 amp TPN MCCB<br>1 Nos. | | | | |
| | | 100 amp TPN MCCB<br>6 Nos. | | | | |
| | (ii) | **<u>Bus Coupler</u>** | | | | |
| | | 400 amps 4 pole MCCB(35KA) ON / OFF / TRIP indicating lamps with | | | | |
| | | | | | | |
| | | **SECTION-II** | | | | |
| | (C ) | **Incoming** | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | (i) | 400 amps 4 pole MCCB(35KA) with built in microprocessor based release unit for short circuit, over current and earth fault protection with adjustable setting as per specification and with following accessories : | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | (iii) | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (iv) | Auxiliary contacts required for necessary interlocking of breakers.mechanical interlocks also to be provided. | | | | |
| | | 1 Set | | | | |
| | (v) | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. & phase indicating lamps connected through 415 V √ 3 : 110 V √ 3 PT's, Primary and Secondary of PT's shall be protected by 2 amp TP MCB's | | | | |
| | | 1 Set | | | | |
| | (vi) | 0-400 Amps digital electronic ammeter with selector switch with 3 nos. 400/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | (viii) | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 500 amps TPN aluminium bus bars (35 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 250 amp TPN MCCB 2 Nos. | | | | |
| | | 100 amp TPN MCCB 5 Nos. | | | | |
| | | **MDB - N (SAARC BUILDING) as described above** | Set | 783,116.41 | 1 | 783,116 |
| | | | | | | |
| 6 | NDSR | **MDB - E (SAARC BUILDING)** | | | | |
| | **A** | **Incoming** | | | | |
| | (i) | 2 Nos. 400 amps 4 pole MCCB(35KA) with built in microprocessor based release unit for short circuit, over current and earth fault protection with adjustable setting as per specification and with following accessories : | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | (iii) | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (iv) | Auxiliary contacts required for necessary interlocking of breakers.Also mechanical Interlocking to be provided. | | | | |
| | | 1 Set | | | | |
| | (v) | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. & phase indicating lamps connected through 415 V √ 3 : 110 V √ 3 PT's, Primary and Secondary of PT's shall be protected by 2 amp TP MCB's | | | | |
| | | 1 Set | | | | |
| | (vi) | 0-400 Amps digital electronic ammeter with selector switch with 3 nos.400/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | (vii) | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | **B** | **Bus Bars** | | | | |
| | | 500 amps TPN aluminium bus bars (35 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 160 amp TPN MCCB<br>1 Nos. | | | | |
| | | 125 amp TPN MCCB<br>5 Nos. | | | | |
| | | 100 amp TPN MCCB<br>3 Nos. | | | | |
| | (iv) | **Bus Coupler** | | | | |
| | | 400 amps 4 pole MCCB with ON / OFF / TRIP indicating lamps with control MCB's. | | | | |
| | | 1 Set | | | | |
| | | **SECTION-II** | | | | |
| | (C ) | **Incoming** | | | | |
| | (i) | 2 Nos. 400 amps 4 pole MCCB(35KA) with built in microprocessor based release unit for short circuit, over current and earth fault protection with adjustable setting as per specification and with following accessories : | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | (iii) | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (iv) | Auxiliary contacts required for necessary interlocking of breakers. | | | | |
| | | 1 Set | | | | |
| | (v) | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. & phase indicating lamps connected through 415 V √ 3 : 110 V √ 3 PT's, Primary and Secondary of PT's shall be protected by 2 amp TP MCB's | | | | |
| | | 1 Set | | | | |
| | (vi) | 0-400 Amps digital electronic ammeter with selector switch with 3 nos. 400/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | (vii) | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 500 amps TPN aluminium bus bars (35 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 250 amp TPN MCCB 1 Nos. | | | | |
| | | 160 amp TPN MCCB 3 Nos. | | | | |
| | | 100 amp TPN MCCB 7 Nos. | | | | |
| | | **MDB - E (SAARC BUILDING) as described above** | Set | 1,308,516.59 | 1 | 1,308,517 |
| | | | | | | |
| 7 | NDSR | **MDB - N (LIBRARY BUILDING)** | | | | |
| | **A** | **Incoming** | | | | |
| | (i) | 315 amps 4 pole MCCB (35KA) with built in microprocessor based release unit for short circuit, over current and earth fault protection with adjustable setting as per specification and with following accessories : | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | (iii) | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (iv) | Auxiliary contacts required for necessary interlocking of breakers.mechanical interlocks to be provided. | | | | |
| | | 1 Set | | | | |
| | (v) | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. & phase indicating lamps connected through 415 V √ 3 : 110 V √ 3 PT's, Primary and Secondary of PT's shall be protected by 2 amp TP MCB's | | | | |
| | | 1 Set | | | | |
| | (vi) | 0-400 Amps digital electronic ammeter with selector switch with 3 nos. 400/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | (vii) | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | **B** | **Bus Bars** | | | | |
| | | 500 amps TPN aluminium bus bars (35 Ka/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | (i) | **Outgoing** | | | | |
| | | 125 amp TPN MCCB<br>4 Nos. | | | | |
| | | 100 amp TPN MCCB<br>2 Nos. | | | | |
| | (ii) | **Bus Coupler** | | | | |
| | | 400 amps 4 pole MCCB(35KA) ON / OFF / TRIP indicating lamps with | | | | |
| | | | | | | |
| | | **SECTION-II** | | | | |
| | (C ) | **Incoming** | | | | |
| | (i) | 400 amps 4 pole MCCB(35KA) with built in microprocessor based release unit for short circuit, over current and earth fault protection with adjustable setting as per specification and with following accessories : | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class 0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | (iii) | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (iv) | Auxiliary contacts required for necessary interlocking of breakers.mechanical interlocking to be provided. | | | | |
| | | 1 Set | | | | |
| | (v) | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. & phase indicating lamps connected through 415 V √3 : 110 V √3 PT's, Primary and Secondary of PT's shall be protected by 2 amp TP MCB's | | | | |
| | | 1 Set | | | | |
| | (vi) | 0-400 Amps digital electronic ammeter with selector switch with 3 nos. 400/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | (viii) | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 500 amps TPN aluminium bus bars (35 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 200 amp TPN MCCB 1 Nos. | | | | |
| | | 125 amp TPN MCCB 3 Nos. | | | | |
| | | 100 amp TPN MCCB 2 Nos. | | | | |
| | | **MDB - N (LIBRARY BUILDING) as described above** | Set | 765,347.86 | 1 | 765,348 |
| | | | | | | |
| 8 | NDSR | **MDB - E (LIBRARY BUILDING) L1** | | | | |
| | **A** | **Incoming** | | | | |
| | (i) | 400 amps 4 pole MCCB(35KA) with built in microprocessor based release unit for short circuit, over current and earth fault protection with adjustable setting as per specification and with following accessories : | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | (iii) | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (iv) | Auxiliary contacts required for necessary interlocking of breakers.mechanical interlocking to be provided. | | | | |
| | | 1 Set | | | | |
| | (v) | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. & phase indicating lamps connected through 415 V √ 3 : 110 V √ 3 PT's, Primary and Secondary of PT's shall be protected by 2 amp TP MCB's | | | | |
| | | 1 Set | | | | |
| | (vi) | 0-400 Amps digital electronic ammeter with selector switch with 3 nos.400/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | (vii) | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | **B** | **Bus Bars** | | | | |
| | | 500 amps TPN aluminium bus bars (35 kA/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 200 amp TPN MCCB<br>1 Nos. | | | | |
| | | 125 amp TPN MCCB<br>3 Nos. | | | | |
| | | 100 amp TPN MCCB<br>5 Nos. | | | | |
| | (iv) | **Bus Coupler** | | | | |
| | | 400 amps 4 pole MCCB with ON / OFF / TRIP indicating lamps with control MCB's. | | | | |
| | | 1 Set | | | | |
| | | **SECTION-II** | | | | |
| | (C ) | **Incoming** | | | | |
| | (i) | 400 amps 4 pole MCCB(35KA) with built in microprocessor based release unit for short circuit, over current and earth fault protection with adjustable setting as per specification and with following accessories : | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | (iii) | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (iv) | Auxiliary contacts required for necessary interlocking of breakers.mechanical interlocking to be provided. | | | | |
| | | 1 Set | | | | |
| | (v) | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. & phase indicating lamps connected through 415 V √ 3 : 110 V √ 3 PT's, Primary and Secondary of PT's shall be protected by 2 amp TP MCB's | | | | |
| | | 1 Set | | | | |
| | (vi) | 0-400 Amps digital electronic ammeter with selector switch with 3 nos. 400/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | (vii) | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 500 amps TPN aluminium bus bars (35 kA/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 200 amp TPN MCCB 2 Nos. | | | | |
| | | 125 amp TPN MCCB 4 Nos. | | | | |
| | | 100 amp TPN MCCB 2 Nos. | | | | |
| | | 63 amp TPN MCCB 1 Nos. | | | | |
| | | **MDB - E (LIBRARY BUILDING) as described above** | Set | 945,922.57 | 1 | 945,923 |
| | | | | | | |
| 9 | NDSR | **MDB - N (Phy, Chem-AC3 Bldg)** | | | | |
| | **A** | **Incoming** | | | | |
| | (i) | 800 amps 4 pole electrically operated fully drawout type air circuit breaker with built in microprocessor based release unit for short circuit, over current and earth fault protection with adjustable setting as per specification and with following accessories : | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5. to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 1 No. | | | | |
| | (iii) | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (iv) | Spring charge / trip circuit healthy indication | | | | |
| | (v) | DC "ON" indication | | | | |
| | (vi) | Under voltage release for above breaker | | | | |
| | | 1 Set | | | | |
| | (vii) | 24 V DC Shunt trip coil for above breaker | | | | |
| | | 1 Set | | | | |
| | (viii) | Breaker control switch | | | | |
| | | 1 Set | | | | |
| | (ix) | Auto-manual selector switch | | | | |
| | | 1 Set | | | | |
| | (x) | Auxiliary contacts required for necessary interlocking of breakers.mechanical interlocking to be provided. | | | | |
| | | 1 Set | | | | |
| | (xi) | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. & phase indicating lamps connected through 415 V √ 3 : 110 V √ 3 PT's, Primary and Secondary of PT's shall be protected by 2 amp TP MCB's | | | | |
| | | 1 Set | | | | |
| | (xii) | 0-800 Amps digital electronic ammeter with selector switch with 3 nos. 800/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | (xiii) | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | **B** | **Bus Bars** | | | | |
| | | 1000 amps TPN aluminium bus bars (35 kA/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 160 amp TPN MCCB 3 Nos. | | | | |
| | | 100 amp TPN MCCB 1 No. | | | | |
| | | 63 amp TPN MCCB 1 No. | | | | |
| | | | | | | |
| | (iv) | **Bus Coupler** | | | | |
| | | 800 amps 4 pole electrically operated fully drawout type air circuit breaker with ON / OFF / TRIP indicating lamps with control MCB's, shunt trip, 415V under voltage release, 1 No. 230 V AC closing coil breaker control switch etc. | | | | |
| | | 1 Set | | | | |
| | | 230Volt AC/ 24Volt 30A DC Battery Charger with 200 AH Batteries SMF for ACBs tripping circuit | | | | |
| | | Note : This battery charger is for both Normal & Emergency Panels. | | | | |
| | | | | | | |
| | | **SECTION-II** | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | (C ) | **Incoming** | | | | |
| | (i) | 800 amps 4 pole electrically operated fully drawout type air circuit breaker with built in microprocessor based release unit for short circuit, over current and earth fault protection with adjustable setting as per specification and with following accessories : | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | (iii) | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (iv) | Spring charge / trip circuit healthy indication | | | | |
| | (v) | DC "ON" indication | | | | |
| | (vi) | Under voltage release for above breaker | | | | |
| | | 1 Set | | | | |
| | (vii) | 24 V DC Shunt trip coil for above breaker | | | | |
| | | 1 Set | | | | |
| | (viii) | Breaker control switch | | | | |
| | | 1 Set | | | | |
| | (ix) | Auto-manual selector switch | | | | |
| | | 1 Set | | | | |
| | (x) | Auxiliary contacts required for necessary interlocking of breakers.mechanical interlocking to bre provided. | | | | |
| | | 1 Set | | | | |
| | (xi) | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. & phase indicating lamps connected through 415 V √ 3 : 110 V √ 3 PT's, Primary and Secondary of PT's shall be protected by 2 amp TP MCB's | | | | |
| | | 1 Set | | | | |
| | (xii) | 0-800 Amps digital electronic ammeter with selector switch with 3 nos. 800/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | (xiii) | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 1000 amps TPN aluminium bus bars (35 kA/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | (iii) | **Outgoing** | | | | |
| | | 315 amp TPN MCCB 1 No. | | | | |
| | | 160 amp TPN MCCB 3 Nos. | | | | |
| | | 125 amp TPN MCCB 2 Nos. | | | | |
| | | | | | | |
| | | **MDB - N (Phy, Chem-AC3 Bldg) as described above** | Set | 1,989,355.48 | 1 | 1,989,355 |
| | | | | | | |
| 10 | NDSR | **MDB - E (Phy, Chem-AC3 Bldg)** | | | | |
| | (i) | **Incoming** | | | | |
| | | 2 nos. 630 amps 4 pole MCCB(35KA) with built in microprocessor based release unit for short circuit, over current and earth fault protection with adjustable setting as per specification and with following accessories : | | | | |
| | | 2 Nos. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | 0-500 volts digital electronic volt meter with selector switch protected by 2 amps TP MCB's. | | | | |
| | | 1 Set | | | | |
| | | 0-630 Amps digital electronic ammeter with selector switch with 3 nos. 630/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 700 amps TPN aluminium bus bars (35 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 2 Nos. | | | | |
| | | 160 amp TPN MCCB 5 Nos. | | | | |
| | | 100 amp TPN MCCB 1 Nos. | | | | |
| | | | | | | |
| | | **BUS COUPLER** | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 630 amps 4 pole MCCB(35KA) ON / OFF / TRIP indicating lamps with control MCB's. | | | | |
| | | | | | | |
| | | **SECTION - II** | | | | |
| | (i) | **Incoming** | | | | |
| | | 2 nos. 630 amps 4 pole MCCB (35KA) with built in microprocessor based release unit for short circuit, over current and earth fault protection with adjustable setting as per specification and with following accessories : | | | | |
| | | 2 Nos. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | 0-500 volts digital electronic volt meter with selector switch protected by 2 amps TP MCB's. | | | | |
| | | 1 Set | | | | |
| | | 0-630 Amps digital electronic ammeter with selector switch with 3 nos. 630/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB’s. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 700 amps TPN aluminium bus bars (35 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 315 amp TPN MCCB 1 No. | | | | |
| | | 160 amp TPN MCCB 4 Nos. | | | | |
| | | 125 amp TPN MCCB 1 Nos. | | | | |
| | | 100 amp TPN MCCB 3 No. | | | | |
| | | For details, please refer SLD. | | | | |
| | | **MDB - E (Phy, Chem-AC3 Bldg) as described above** | Set | 1,349,254.24 | 1 | 1,349,254 |
| | | | | | | |
| 11 | NDSR | **MDB - N (Math , IT-AC3 Bldg)** | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | **A** | **Incoming** | | | | |
| | (i) | 800 amps 4 pole electrically operated fully drawout type air circuit breaker with built in microprocessor based release unit for short circuit, over current and earth fault protection with adjustable setting as per specification and with following accessories : | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | (iii) | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (iv) | Spring charge / trip circuit healthy indication | | | | |
| | (v) | DC "ON" indication | | | | |
| | (vi) | Under voltage release for above breaker | | | | |
| | | 1 Set | | | | |
| | (vii) | 24 V DC Shunt trip coil for above breaker | | | | |
| | | 1 Set | | | | |
| | (viii) | Breaker control switch | | | | |
| | | 1 Set | | | | |
| | (ix) | Auto-manual selector switch | | | | |
| | | 1 Set | | | | |
| | (x) | Auxiliary contacts required for necessary interlocking of breakers.mechanical interlocking to be provided. | | | | |
| | | 1 Set | | | | |
| | (xi) | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. & phase indicating lamps connected through 415 V √3 : 110 V √3 PT's, Primary and Secondary of PT's shall be protected by 2 amp TP MCB's | | | | |
| | | 1 Set | | | | |
| | (xii) | 0-800 Amps digital electronic ammeter with selector switch with 3 nos. 800/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | (xiii) | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | **B** | **Bus Bars** | | | | |
| | | 1000 amps TPN aluminium bus bars (35 kA/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 160 amp TPN MCCB 3 Nos. | | | | |
| | | 100 amp TPN MCCB 2 Nos. | | | | |
| | | | | | | |
| | (iv) | **Bus Coupler** | | | | |
| | | 800 amps 4 pole electrically operated fully drawout type air circuit breaker with ON / OFF / TRIP indicating lamps with control MCB's, shunt trip, 415V under voltage release, 1 No. 230 V AC closing coil breaker control switch etc. | | | | |
| | | 1 Set | | | | |
| | | 230Volt AC/ 24Volt 30A DC Battery Charger with 200 AH Batteries SMF for ACBs tripping circuit | | | | |
| | | Note : This battery charger is for both Normal & Emergency Panels. | | | | |
| | | | | | | |
| | | **SECTION-II** | | | | |
| | (C ) | **Incoming** | | | | |
| | (i) | 800 amps 4 pole electrically operated fully drawout type air circuit breaker with built in microprocessor based release unit for short circuit, over current and earth fault protection with adjustable setting as per specification and with following accessories : | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | (iii) | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (iv) | Spring charge / trip circuit healthy indication | | | | |
| | (v) | DC "ON" indication | | | | |
| | (vi) | Under voltage release for above breaker | | | | |
| | | 1 Set | | | | |
| | (vii) | 24 V DC Shunt trip coil for above breaker | | | | |
| | | 1 Set | | | | |
| | (viii) | Breaker control switch | | | | |
| | | 1 Set | | | | |
| | (ix) | Auto-manual selector switch | | | | |
| | | 1 Set | | | | |
| | (x) | Auxiliary contacts required for necessary interlocking of breakers.mechanical interlocking to be provided. | | | | |
| | | 1 Set | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | (xi) | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. & phase indicating lamps connected through 415 V √ 3 : 110 V √ 3 PT's, Primary and Secondary of PT's shall be protected by 2 amp TP MCB's | | | | |
| | | 1 Set | | | | |
| | (xii) | 0-800 Amps digital electronic ammeter with selector switch with 3 nos. 800/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | (xiii) | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 1000 amps TPN aluminium bus bars (35 kA/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 315 amp TPN MCCB 1 No. | | | | |
| | | 160 amp TPN MCCB 4 Nos. | | | | |
| | | 125 amp TPN MCCB 1 Nos. | | | | |
| | | **MDB - N (Math , IT-AC3 Bldg) as described above** | Set | 1,990,944.54 | 1 | 1,990,945 |
| | | | | | | |
| 12 | NDSR | **MDB - E (Math, IT-AC3 Bldg)** | | | | |
| | (i) | **Incoming** | | | | |
| | | 2 nos. 630 amps 4 pole MCCB(35KA) with built in microprocessor based release unit for short circuit, over current and earth fault protection with adjustable setting as per specification and with following accessories : | | | | |
| | | 2 Nos. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | 0-500 volts digital electronic volt meter with selector switch protected by 2 amps TP MCB's. | | | | |
| | | 1 Set | | | | |
| | | 0-630 Amps digital electronic ammeter with selector switch with 3 nos. 630/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 700 amps TPN aluminium bus bars (35 kA/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 160 amp TPN MCCB 5 Nos. | | | | |
| | | 100 amp TPN MCCB 3 Nos. | | | | |
| | | | | | | |
| | | **BUS COUPLER** | | | | |
| | | 630 amps 4 pole MCCB(35KA) with ON/OFF/ TRIP indicating lamps with control MCB's. | | | | |
| | | | | | | |
| | | **SECTION - II** | | | | |
| | (i) | **Incoming** | | | | |
| | | 2 nos. 630 amps 4 pole MCCB (35KA) with built in microprocessor based release unit for short circuit, over current and earth fault protection with adjustable setting as per specification and with following accessories : | | | | |
| | | 2 Nos. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | 0-500 volts digital electronic volt meter with selector switch protected by 2 amps TP MCB's. | | | | |
| | | 1 Set | | | | |
| | | 0-630 Amps digital electronic ammeter with selector switch with 3 nos. 630/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 700 amps TPN aluminium bus bars (35 kA/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 315 amp TPN MCCB 1 No. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 160 amp TPN MCCB 4 Nos. | | | | |
| | | 125 amp TPN MCCB 1 No. | | | | |
| | | 100 amp TPN MCCB 2 No. | | | | |
| | | For details, please refer SLD. | | | | |
| | | | | | | |
| | | **MDB - E (Math , IT-AC3 Bldg) as described above** | Set | 1,335,675.03 | 1 | 1,335,675 |
| | | | | | | |
| 13 | NDSR | **MDB - N (Law & Hum (AC4) Bldg** | | | | |
| | **A** | **Incoming** | | | | |
| | (i) | 630 amps 4 pole MCCB(35KA) with built in microprocessor based release unit for short circuit, over current and earth fault protection with adjustable setting as per specification and with following accessories : | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | (iii) | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (iv) | Spring charge / trip circuit healthy indication | | | | |
| | (v) | DC "ON" indication | | | | |
| | (vi) | Under voltage release for above breaker | | | | |
| | | 1 Set | | | | |
| | (vii) | 24 V DC Shunt trip coil for above breaker | | | | |
| | | 1 Set | | | | |
| | (viii) | Breaker control switch | | | | |
| | | 1 Set | | | | |
| | (ix) | Auto-manual selector switch | | | | |
| | | 1 Set | | | | |
| | (x) | Auxiliary contacts required for necessary interlocking of breakers.mechanical interlocking to be provided. | | | | |
| | | 1 Set | | | | |
| | (xi) | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. & phase indicating lamps connected through 415 V √ 3 : 110 V √ 3 PT's, Primary and Secondary of PT's shall be protected by 2 amp TP MCB's | | | | |
| | | 1 Set | | | | |
| | (xii) | 0-830 Amps digital electronic ammeter with selector switch with 3 nos. 830/5A, 15VA, CL-1.0 Current Transformer | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 1 Set | | | | |
| | (xiii) | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | | | | | | |
| | **B** | **Bus Bars** | | | | |
| | | 700 amps TPN aluminium bus bars (35 kA/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 160 amp TPN MCCB 1 Nos. | | | | |
| | | 100 amp TPN MCCB 5 Nos. | | | | |
| | | | | | | |
| | (iv) | **Bus Coupler** | | | | |
| | | 630 amps 4 pole MCCB(35KA) with ON / OFF / TRIP indicating lamps with control MCB's, shunt trip, 415V under voltage release, 1 No. 230 V AC closing coil breaker control switch etc. | | | | |
| | | 1 Set | | | | |
| | | 230Volt AC/ 24Volt 30A DC Battery Charger with 200 AH Batteries SMF for ACBs tripping circuit | | | | |
| | | Note : This battery charger is for both Normal & Emergency Panels. | | | | |
| | | | | | | |
| | | **SECTION-II** | | | | |
| | (C ) | **Incoming** | | | | |
| | (i) | 630 amps 4 pole MCCB(35KA) with built in microprocessor based release unit for short circuit, over current and earth fault protection with adjustable setting as per specification and with following accessories : | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | (iii) | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (iv) | Spring charge / trip circuit healthy indication | | | | |
| | (v) | DC "ON" indication | | | | |
| | (vi) | Under voltage release for above breaker | | | | |
| | | 1 Set | | | | |
| | (vii) | 24 V DC Shunt trip coil for above breaker | | | | |
| | | 1 Set | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | (viii) | Breaker control switch | | | | |
| | | 1 Set | | | | |
| | (ix) | Auto-manual selector switch | | | | |
| | | 1 Set | | | | |
| | (x) | Auxiliary contacts required for necessary interlocking of breakers.mechanical interlocking to be provided. | | | | |
| | | 1 Set | | | | |
| | (xi) | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. & phase indicating lamps connected through 415 V √ 3 : 110 V √ 3 PT's, Primary and Secondary of PT's shall be protected by 2 amp TP MCB's | | | | |
| | | 1 Set | | | | |
| | (xii) | 0-630 Amps digital electronic ammeter with selector switch with 3 nos. 630/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | (xiii) | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 700 amps TPN aluminium bus bars (35 kA/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 315 amp TPN MCCB 1 No. | | | | |
| | | 160 amp TPN MCCB 1 Nos. | | | | |
| | | 100 amp TPN MCCB 3 Nos. | | | | |
| | | | | | | |
| | | **MDB - N as described above** | Set | 788,172.50 | 1 | 788,173 |
| | | | | | | |
| 14 | NDSR | **MDB - E (Law & Hum (AC4) Bldg** | | | | |
| | (i) | **Incoming** | | | | |
| | | 2 nos.630 amps 4 pole MCCB(35KA) with built in microprocessor based release unit for short circuit, over current and earth fault protection with adjustable setting as per specification and with following accessories : | | | | |
| | | 2 Nos. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 0-500 volts digital electronic volt meter with selector switch protected by 2 amps TP MCB's. | | | | |
| | | 1 Set | | | | |
| | | 0-630 Amps digital electronic ammeter with selector switch with 3 nos. 630/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 700 amps TPN aluminium bus bars (35 kA/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 125 amp TPN MCCB 5 Nos. | | | | |
| | | 100 amp TPN MCCB 2 Nos. | | | | |
| | | | | | | |
| | | **BUS COUPLER** | | | | |
| | | 630 amps 4 pole MCCB(35KA) with built in microprocessor based release unit for short circuit, over current and earth fault protection with adjustable setting. | | | | |
| | | | | | | |
| | | **SECTION - II** | | | | |
| | (i) | **Incoming** | | | | |
| | | 2 nos. 630 amps 4 pole MCCB(35KA) with built in microprocessor based release unit for short circuit, over current and earth fault protection with adjustable setting as per specification and with following accessories : | | | | |
| | | 2 Nos. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | 0-500 volts digital electronic volt meter with selector switch protected by 2 amps TP MCB's. | | | | |
| | | 1 Set | | | | |
| | | 0-630 Amps digital electronic ammeter with selector switch with 3 nos. 630/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 700 amps TPN aluminium bus bars (35 kA/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 315 amp TPN MCCB 1 No. | | | | |
| | | 200 amp TPN MCCB Nos. | | | | |
| | | 160 amp TPN MCCB 2 Nos. | | | | |
| | | 125 amp TPN MCCB 3 Nos. | | | | |
| | | 100 amp TPN MCCB 1 No. | | | | |
| | | 63 amp TPN MCCB 1 No. | | | | |
| | | For details, please refer SLD. | | | | |
| | | | | | | |
| | | **MDB - E as described above** | Set | 1,338,419.76 | 1 | 1,338,420 |
| | | | | | | |
| 15 | NDSR | **MDB - N ART DESIGN (AC1) Bldg** | | | | |
| | **A** | **Incoming** | | | | |
| | (i) | 400 amps 4 pole MCCB with built in microprocessor based release unit for short circuit, over current and earth fault protection with adjustable setting as per specification and with following accessories : | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | (iii) | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (iv) | Auxiliary contacts required for necessary interlocking of breakers.mechanical interlocking to be provided | | | | |
| | | 1 Set | | | | |
| | (v) | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. & phase indicating lamps connected through 415 V √3 : 110 V √3 PT's, Primary and Secondary of PT's shall be protected by 2 amp TP MCB's | | | | |
| | | 1 Set | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | (vi) | 0-400 Amps digital electronic ammeter with selector switch with 3 nos. 400/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | (vii) | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | **B** | **Bus Bars** | | | | |
| | | 500 amps TPN aluminium bus bars (35 kA/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | (i) | **Outgoing** | | | | |
| | | 125 amp TPN MCCB<br>1 Nos. | | | | |
| | | 100 amp TPN MCCB<br>5 Nos. | | | | |
| | (ii) | **Bus Coupler** | | | | |
| | | 400 amps 4 pole MCCB(35KA) ON / OFF / TRIP indicating lamps with | | | | |
| | | | | | | |
| | | **SECTION-II** | | | | |
| | (C ) | **Incoming** | | | | |
| | (i) | 400 amps 4 pole MCCB(35KA) with built in microprocessor based release unit for short circuit, over current and earth fault protection with adjustable setting as per specification and with following accessories : | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | (iii) | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (iv) | Auxiliary contacts required for necessary interlocking of breakers.mechanical interlocking to be provided. | | | | |
| | | 1 Set | | | | |
| | (v) | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. & phase indicating lamps connected through 415 V √ 3 : 110 V √ 3 PT's, Primary and Secondary of PT's shall be protected by 2 amp TP MCB's | | | | |
| | | 1 Set | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | (vi) | 0-400 Amps digital electronic ammeter with selector switch with 3 nos. 400/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | (viii) | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 500 amps TPN aluminium bus bars (35 kA/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 250 amp TPN MCCB 2 Nos. | | | | |
| | | 100 amp TPN MCCB 1 No. | | | | |
| | | 125 amp TPN MCCB 3 Nos. | | | | |
| | | **MDB - N as described above** | Set | 769,681.65 | 1 | 769,682 |
| | | | | | | |
| 16 | NDSR | **MDB - E ART DESIGN (AC1) Bldg** | | | | |
| | **A** | **Incoming** | | | | |
| | (i) | 2 nos. 400 amps 4 pole MCCB (35KA) with built in microprocessor based release unit for short circuit, over current and earth fault protection with adjustable setting as per specification and with following accessories : | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-05 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | (iii) | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (iv) | Auxiliary contacts required for necessary interlocking of breakers. mechanical interlocking to be provided. | | | | |
| | | 1 Set | | | | |
| | (v) | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. & phase indicating lamps connected through 415 V √ 3 : 110 V √ 3 PT's, Primary and Secondary of PT's shall be protected by 2 amp TP MCB's | | | | |
| | | 1 Set | | | | |
| | (vi) | 0-400 Amps digital electronic ammeter with selector switch with 3 nos.400/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | (vii) | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | **B** | **Bus Bars** | | | | |
| | | 500 amps TPN aluminium bus bars (35 kA/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 160 amp TPN MCCB<br>1 Nos. | | | | |
| | | 125 amp TPN MCCB<br>3 Nos. | | | | |
| | | 100 amp TPN MCCB<br>4 Nos. | | | | |
| | (iv) | **Bus Coupler** | | | | |
| | | 400 amps 4 pole MCCB with ON / OFF / TRIP indicating lamps with control MCB's. | | | | |
| | | 1 Set | | | | |
| | | **SECTION-II** | | | | |
| | (C ) | **Incoming** | | | | |
| | (i) | 2 nos. 400 amps 4 pole MCCB(35KA) with built in microprocessor based release unit for short circuit, over current and earth fault protection with adjustable setting as per specification and with following accessories : | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | (iii) | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (iv) | Auxiliary contacts required for necessary interlocking of breakers.mechanical interlocking to be provided. | | | | |
| | | 1 Set | | | | |
| | (v) | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. & phase indicating lamps connected through 415 V √ 3 : 110 V √ 3 PT's, Primary and Secondary of PT's shall be protected by 2 amp TP MCB's | | | | |
| | | 1 Set | | | | |
| | (vi) | 0-400 Amps digital electronic ammeter with selector switch with 3 nos. 400/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | (vii) | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 500 amps TPN aluminium bus bars (35 kA/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 250 amp TPN MCCB 1 No. | | | | |
| | | 200 amp TPN MCCB 1 No. | | | | |
| | | 125 amp TPN MCCB 2 Nos. | | | | |
| | | 100 amp TPN MCCB 5 Nos. | | | | |
| | | **MDB - E as described above** | Set | 1,267,345.56 | 1 | 1,267,346 |
| | | | | | | |
| 17 | NDSR | **MDB - N Convention (C1) Bldg** | | | | |
| | **A** | **Incoming** | | | | |
| | (i) | 400 amps 4 pole MCCB in microprocessor based release unit for short circuit, over current and earth fault protection with adjustable setting as per specification and with following accessories : | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | (iii) | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (iv) | Auxiliary contacts required for necessary interlocking of breakers.mechanical interlocking to be provided. | | | | |
| | | 1 Set | | | | |
| | (v) | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. & phase indicating lamps connected through 415 V √ 3 : 110 V √ 3 PT's, Primary and Secondary of PT's shall be protected by 2 amp TP MCB's | | | | |
| | | 1 Set | | | | |
| | (vi) | 0-400 Amps digital electronic ammeter with selector switch with 3 nos. 400/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | (vii) | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | **B** | **Bus Bars** | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 500 amps TPN aluminium bus bars (35 kA/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | (i) | **Outgoing** | | | | |
| | | 125 amp TPN MCCB<br>1 Nos. | | | | |
| | | 100 amp TPN MCCB<br>4 Nos. | | | | |
| | (ii) | **Bus Coupler** | | | | |
| | | 400 amps 4 pole MCCB(35KA) ON / OFF / TRIP indicating lamps with | | | | |
| | | | | | | |
| | | **SECTION-II** | | | | |
| | (C ) | **Incoming** | | | | |
| | (i) | 400 amps 4 pole MCCB (35KA) with built in microprocessor based release unit for short circuit, over current and earth fault protection with adjustable setting as per specification and with following accessories : | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | (iii) | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (iv) | Auxiliary contacts required for necessary interlocking of breakers. | | | | |
| | | 1 Set | | | | |
| | (v) | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. & phase indicating lamps connected through 415 V √ 3 : 110 V √ 3 PT's, Primary and Secondary of PT's shall be protected by 2 amp TP MCB's | | | | |
| | | 1 Set | | | | |
| | (vi) | 0-400 Amps digital electronic ammeter with selector switch with 3 nos. 400/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | (viii) | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 500 amps TPN aluminium bus bars (35 kA/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 160 amp TPN MCCB 2 Nos. | | | | |
| | | 100 amp TPN MCCB 4 Nos. | | | | |
| | | **MDB - N as described above** | Set | 721,576.55 | 1 | 721,577 |
| | | | | | | |
| 18 | NDSR | **MDB - E Convention (C1) Bldg** | | | | |
| | **A** | **Incoming** | | | | |
| | (i) | 2 NOS. 400 amps 4 pole MCCB(35KA) with built in microprocessor based release unit for short circuit, over current and earth fault protection with adjustable setting as per specification and with following accessories : | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | (iii) | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (iv) | Auxiliary contacts required for necessary interlocking of breakers.mechanical interlocking to be provided. | | | | |
| | | 1 Set | | | | |
| | (v) | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. & phase indicating lamps connected through 415 V √ 3 : 110 V √ 3 PT's, Primary and Secondary of PT's shall be protected by 2 amp TP MCB's | | | | |
| | | 1 Set | | | | |
| | (vi) | 0-400 Amps digital electronic ammeter with selector switch with 3 nos.400/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | (vii) | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | **B** | **Bus Bars** | | | | |
| | | 500 amps TPN aluminium bus bars (35 kA/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 200 amp TPN MCCB 2 Nos. | | | | |
| | | 125 amp TPN MCCB 2 Nos. | | | | |
| | | 100 amp TPN MCCB 3 Nos. | | | | |
| | (iv) | **Bus Coupler** | | | | |
| | | 400 amps 4 pole MCCB with ON / OFF / TRIP indicating lamps with control MCB's. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 1 Set | | | | |
| | | **SECTION-II** | | | | |
| | (C ) | **Incoming** | | | | |
| | (i) | 400 amps 4 pole MCCB(35KA) with built in microprocessor based release unit for short circuit, over current and earth fault protection with adjustable setting as per specification and with following accessories : | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | (iii) | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (iv) | Auxiliary contacts required for necessary interlocking of breakers.mechanical interlocking to be provided. | | | | |
| | | 1 Set | | | | |
| | (v) | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. & phase indicating lamps connected through 415 V √ 3 : 110 V √ 3 PT's, Primary and Secondary of PT's shall be protected by 2 amp TP MCB's | | | | |
| | | 1 Set | | | | |
| | (vi) | 0-400 Amps digital electronic ammeter with selector switch with 3 nos. 400/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | (vii) | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 500 amps TPN aluminium bus bars (35 kA/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 200 amp TPN MCCB 2 Nos. | | | | |
| | | 160 amp TPN MCCB 1 Nos. | | | | |
| | | 100 amp TPN MCCB 5 Nos. | | | | |
| | | **MDB - E as described above** | Set | 1,256,511.07 | 1 | 1,256,511 |
| | | | | | | |
| | | **NON TTA DISTRIBUTION PANELS** | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| B | | Design, fabrication, assembling, wiring, testing, supply, forwarding to site, unloading, shifting to location, inspection, installation, testing and commissioning of Floor standing LT Cum Changeover panel/Main distribution panels/ sub-distribution panels fabricated out of 14 gauge CRCA sheet steel in cubicle formation, compartmentalized, **form 3b construction**, free standing floor mounted (IP52), dust and vermin proof with reinforcement of suitable size angle iron, channel, `T' sections and/ or flats wherever necessary. 16 gauge CRCA sheet steel shall be used for final distribution panels & 2.5mm for load bearing member. 3 mm thick cable gland plates shall be provided on top as well as at the bottom of the panels. before fabrication. | | | | |
| | | Panels shall be treated with all anticorrosive process before powder coating as per specifications and final approved shade. 2 No. earthing terminals shall be provided for all distrtibution panels. Panels shall be suitable for 415V, 3 phase, 4 wire, 50 HZ supply system. Lifting hooks shall also be provided in case of large panels. Approval shall be taken for each panel in the form of shop drawings Approval shall be taken for the panel in the form of shop drawings before fabrication. Galvanised hardwares with zinc passivation shall be used in fabrication of panel. | | | | |
| | | | | | | |
| 1 | NDSR | **SDB B- 1 (N) (BASEMENT FLOOR) ADMIN BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 1 No. | | | | |
| | | 100 amps 4P MCCB (25KA) with in-built earth fault protection following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 1 Set | | | | |
| | | 0-100 Amps digital electronic ammeter with selector switch with 3 nos. 100/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCB 4 Nos. | | | | |
| | | 40 amp TPN MCB 2 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - B 1 (N) (BASEMENT FLOOR)AD1 BUILDING as described above** | Set | 115,856.73 | 1 | 115,857 |
| | | | | | | |
| 2 | NDSR | **SDB - G (N) (GROUND FLOOR) AD1 BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100amps 4P MCCB (25KA) with in-built earth fault protection following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-100 Amps digital electronic ammeter with selector switch with 3 nos. 100./5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 Nos. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 63 amp TPN MCB 3 Nos. | | | | |
| | | 40 amp TPN MCB 4 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - G (N) (GROUND FLOOR) AD1 BUILDING as described above** | Set | 138,536.92 | 1 | 138,537 |
| | | | | | | |
| 3 | NDSR | **SDB - 1 (N) (FIRST FLOOR) ADMIN BUILDING** | | | | |
| | | | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with in-built earth fault protection following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-100 Amps digital electronic ammeter with selector switch with 3 nos. 100/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 3 Nos. | | | | |
| | | 40 amp TPN MCB 3 Nos. | | | | |
| | | 25 amp TPN MCB 1 No. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 1 (N) (FIRST FLOOR) ADMIN BUILDING as described above** | Set | 137,525.70 | 1 | 137,526 |
| | | | | | | |
| 4 | NDSR | **SDB - 2 (N) (SECOND FLOOR) ADMIN BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with in-built earth fault protection following accessories: | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-100 Amps digital electronic ammeter with selector switch with 3 nos. 100/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 3 Nos. | | | | |
| | | 40 amp TPN MCB 3 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 2(N) (SECOND FLOOR) ADMIN BUILDING as described above** | Set | 134,780.96 | 1 | 134,781 |
| | | | | | | |
| 5 | NDSR | **SDB - 3 (N) (THIRD FLOOR) ADMIN BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with in-built earth fault protection following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-100 Amps digital electronic ammeter with selector switch with 3 nos. 100/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 3 Nos. | | | | |
| | | 40 amp TPN MCB 3 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 3 (N) (THIRD FLOOR) ADMIN BUILDING as described above** | Set | 134,780.96 | 1 | 134,781 |
| | | | | | | |
| 6 | NDSR | **SDB - 4 (N) (FOURTH FLOOR) ADMIN BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with in-built earth fault protection following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-100 Amps digital electronic ammeter with selector switch with 3 nos. 100/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 3 Nos. | | | | |
| | | 40 amp TPN MCB 3 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 4 (N) (FOURTH FLOOR) ADMIN BUILDING as described above** | Set | 134,780.96 | 1 | 134,781 |
| | | | | | | |
| 7 | NDSR | **SDB - 5 (N) (FIFTH FLOOR) ADMIN BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with in-built earth fault protection following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-100 Amps digital electronic ammeter with selector switch with 3 nos. 100/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 3 Nos. | | | | |
| | | 40 amp TPN MCB 3 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 5 (N) (FIFTH FLOOR) ADMIN BUILDING as described above** | Set | 134,780.96 | 1 | 134,781 |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | | | | | |
| 8 | NDSR | **SDB - G (E) (GROUND FLOOR) ADMIN BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 125 amps 4P MCCB (25KA) with in-built earth fault protection following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-125 Amps digital electronic ammeter with selector switch with 3 nos. 125/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 4 Nos. | | | | |
| | | 40 amp TPN MCB 3 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - G(E) (GROUND FLOOR)ADMIN BUILDING as described above** | Set | 147,926.80 | 1 | 147,927 |
| | | | | | | |
| 9 | NDSR | **SDB - 1 (E) (FIRST FLOOR) ADMIN BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 125 amps 4P MCCB (25KA) with in-built earth fault protection following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-125 Amps digital electronic ammeter with selector switch with 3 nos. 125/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 4 Nos. | | | | |
| | | 40 amp TPN MCB 3 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 1 (E) (FIRST FLOOR) ADMIN BUILDING as described above** | Set | 147,926.80 | 1 | 147,927 |
| | | | | | | |
| 10 | NDSR | **SDB - 2 (E) (SECOND FLOOR) ADMIN BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 1 No. | | | | |
| | | 125 amps 4P MCCB (25KA) with in-built earth fault protection following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-125 Amps digital electronic ammeter with selector switch with 3 nos. 125/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 4 Nos. | | | | |
| | | 40 amp TPN MCB 3 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 2 (E) (SECOND FLOOR) ADMIN BUILDING as described above** | Set | 147,926.80 | 1 | 147,927 |
| | | | | | | |
| 11 | NDSR | **SDB - 3 (E) (THIRD FLOOR) ADMIN BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 125 amps 4P MCCB (25KA) with in-built earth fault protection following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-125 Amps digital electronic ammeter with selector switch with 3 nos. 125/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 160 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 4 Nos. | | | | |
| | | 40 amp TPN MCB 3 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 3 (E) (THIRD FLOOR) ADMIN BUILDING as described above** | Set | 147,926.80 | 1 | 147,927 |
| | | | | | | |
| 12 | NDSR | **SDB - 4 (E) FOURTH FLOOR) ADMIN BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 125 amps 4P MCCB (25KA) with in-built earth fault protection following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-125 Amps digital electronic ammeter with selector switch with 3 nos. 125/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 4 Nos. | | | | |
| | | 40 amp TPN MCB 3 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 4 (E) (FOURTH FLOOR) ADMIN BUILDING as described above** | Set | 147,926.80 | 1 | 147,927 |
| | | | | | | |
| 13 | NDSR | **SDB - 5 (E) (FIFTH FLOOR) ADMIN BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with in-built earth fault protection following accessories: | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-125 Amps digital electronic ammeter with selector switch with 3 nos. 125/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 4 Nos. | | | | |
| | | 40 amp TPN MCB 3 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 5 (E) (FIFTH FLOOR) LS BUILDING as described above** | Set | 139,259.22 | 1 | 139,259 |
| | | | | | | |
| 14 | NDSR | **SDB - G UPS ( GROUND FLOOR) ADMIN BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 125 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-125 Amps digital electronic ammeter with selector switch with 3 nos. 125/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 40 amp TPN MCB 8 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB -G UPS (GROUND FLOOR) ADMIN BUILDING as described above** | Set | 128,713.65 | 1 | 128,714 |
| | | | | | | |
| 15 | NDSR | **SDB - 2 UPS (SECOND FLOOR) ADMIN BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-100 Amps digital electronic ammeter with selector switch with 3 nos. 100/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 150 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 40 amp DP MCB 6 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 2 UPS (SECOND FLOOR) ADMIN BUILDING as described above** | Set | 108,633.75 | 1 | 108,634 |
| | | | | | | |
| 16 | NDSR | **SDB - 4 UPS (FOURTH FLOOR) ADMIN BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-100 Amps digital electronic ammeter with selector switch with 3 nos. 100/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 40 amp DP MCB 6 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 4 (FOURTH FLOOR) ADMIN BUILDING as described above** | Set | 108,633.75 | 1 | 108,634 |
| | | | | | | |
| 17 | NDSR | **SERVER DB-1 & SERVER DB-2 (ADMIN BUILDINGS)** | | | | |
| | (i) | **Incoming** | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 100 amps TPN MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-100 Amps digital electronic ammeter with selector switch with 3 nos. 100/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 32 amp DP MCB 19 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SERVER DB-1 & SERVER DB-2 (AD1 BUILDINGS) as described above** | Set | 127,557.98 | 2 | 255,116 |
| | | | | | | |
| 18 | NDSR | **Lift Panel AD1 BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 1 No. 160 amps 4p change over switch (on load) | | | | |
| | | 160 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-160 Amps digital electronic ammeter with selector switch with 3 nos. 160/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 4 Nos. | | | | |
| | | 40 amp TPN MCB 2 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **Lift Panel AD1 BUILDING as described above** | Set | 217,556.41 | 1 | 217,556 |
| | | | | | | |
| | | **SAARC (AC9) BUILDING** | | | | |
| | | | | | | |
| 19 | NDSR | **SDB - B (N) (BASEMENT) SAARC BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCB 4 Nos. | | | | |
| | | 40 amp TPN MCB 2 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - B (N) (BASEMENT) SAARC BUILDING as described above** | Set | 113,545.38 | 1 | 113,545 |
| | | | | | | |
| 20 | NDSR | **SDB - G (N) (GROUND FLOOR) SAARC BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCB 3 Nos. | | | | |
| | | 40 amp TPN MCB 2 Nos. | | | | |
| | | 40 amp DP MCB 1 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - G (N) (GROUND FLOOR) SAARC BUILDING as described above** | Set | 111,667.40 | 1 | 111,667 |
| | | | | | | |
| 21 | NDSR | **SDB - 1 (N) (FIRST FLOOR) SAARC BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA/1 sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 No. | | | | |
| | | 63 amp TPN MCB 3 Nos. | | | | |
| | | 40 amp TPN MCB 3 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 1 (N) (FIRST FLOOR) SAARC BUILDING as described above** | Set | 132,469.61 | 1 | 132,470 |
| | | | | | | |
| 22 | NDSR | **SDB - 2 (N) (SECOND FLOOR) SAARC BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0..5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 No. | | | | |
| | | 63 amp TPN MCB 3 Nos. | | | | |
| | | 40 amp TPN MCB 3 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 2 (N) (SECOND FLOOR) SAARC BUILDING as described above** | Set | 132,469.61 | 1 | 132,470 |
| | | | | | | |
| 23 | NDSR | **SDB - 3 (N) (THIRD FLOOR) SAARC BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 No. | | | | |
| | | 63 amp TPN MCB 3 Nos. | | | | |
| | | 40 amp TPN MCB 3 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 3 (N) (THIRD FLOOR) SAARC BUILDING as described above** | Set | 132,469.61 | 1 | 132,470 |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| 24 | NDSR | **SDB - 4 (N) (FOURTH FLOOR) SAARC BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 No. | | | | |
| | | 63 amp TPN MCB 1 Nos. | | | | |
| | | 40 amp TPN MCB 3 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 4 (N) (FOURTH FLOOR) SAARC BUILDING as described above** | Set | 119,901.61 | 1 | 119,902 |
| | | | | | | |
| 25 | NDSR | **SDB - 5 (N) (FIFTH FLOOR) SAARC BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 No. | | | | |
| | | 63 amp TPN MCB 2 Nos. | | | | |
| | | 40 amp TPN MCB 2 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 5 (N) (FIFTH FLOOR) SAARC BUILDING as described above** | Set | 119,901.61 | 1 | 119,902 |
| | | | | | | |
| 26 | NDSR | **SDB - 6 (N) (SIXTH FLOOR) SAARC BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | | | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 No. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 63 amp TPN MCB 2 Nos. | | | | |
| | | 40 amp TPN MCB 2 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 6 (N) (SIXTH FLOOR) SAARC BUILDING as described above** | Set | 119,901.61 | 1 | 119,902 |
| | | | | | | |
| 27 | NDSR | **SDB - 7 (N) (SEVENTH FLOOR) SAARC BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 No. | | | | |
| | | 63 amp TPN MCB 2 Nos. | | | | |
| | | 40 amp TPN MCB 2 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 7 (N) (FOURTH FLOOR) SAARC BUILDING as described above** | Set | 119,901.61 | 1 | 119,902 |
| | | | | | | |
| 28 | NDSR | **SDB - G (E) (GROUND FLOOR) SAARC BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 125 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 3 Nos. | | | | |
| | | 40 amp TPN MCB 2 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - G (E) (GROUND FLOOR) SAARC BUILDING as described above** | Set | 138,103.54 | 1 | 138,104 |
| | | | | | | |
| 29 | NDSR | **SDB - 1 (E) (FIRST FLOOR) SAARC BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 125 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | ON / OFF / TRIP indicating lights with control MCB's. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 Ka/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 4 Nos. | | | | |
| | | 40 amp TPN MCB 3 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 1 (E) (FIRST FLOOR) SAARC BUILDING as described above** | Set | 145,615.45 | 1 | 145,615 |
| | | | | | | |
| 30 | NDSR | **SDB - 2 (E) (SECOND FLOOR) SAARC BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 125 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 4 Nos. | | | | |
| | | 40 amp TPN MCB 3 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 2 (E) (SECOND FLOOR) SAARC BUILDING as described above** | Set | 145,615.45 | 1 | 145,615 |
| | | | | | | |
| 31 | NDSR | **SDB - 3 (E) (THIRD FLOOR) SAARC BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 125 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 4 Nos. | | | | |
| | | 40 amp TPN MCB 4 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 3(E) (THIRD FLOOR) SAARC BUILDING as described above** | Set | 150,527.08 | 1 | 150,527 |
| | | | | | | |
| 32 | NDSR | **SDB - 4 (E) (FOURTH FLOOR) SAARC BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 3 Nos. | | | | |
| | | 40 amp TPN MCB 2 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 4 (E) (FOURTH FLOOR) SAARC BUILDING as described above** | Set | 130,158.25 | 1 | 130,158 |
| | | | | | | |
| 33 | NDSR | **SDB - 5 (E) (FIFTH FLOOR) SAARC BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB<br>1 Nos. | | | | |
| | | 63 amp TPN MCB 3 Nos. | | | | |
| | | 40 amp TPN MCB 2 Nos. | | | | |
| | | For detail refer SLD. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | **SDB - 5 (E) (FIFTH FLOOR) SAARC BUILDING as described above** | Set | 130,158.25 | 1 | 130,158 |
| | | | | | | |
| 34 | NDSR | **SDB - 6 (E) (SIXTH FLOOR) SAARC BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5. to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 3 Nos. | | | | |
| | | 40 amp TPN MCB 2 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 6 (E) (SIXTH FLOOR) SAARC BUILDING as described above** | Set | 130,158.25 | 1 | 130,158 |
| | | | | | | |
| 35 | NDSR | **SDB - 7 (E) (SEVENTH FLOOR) SAARC BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 3 Nos. | | | | |
| | | 40 amp TPN MCB 2 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 7 (E) (SEVENTH FLOOR) SAARC BUILDING as described above** | Set | 130,158.25 | 1 | 130,158 |
| | | | | | | |
| 36 | NDSR | **MDB-UPS-1 SAARC BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 2 nos. 250 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | Earth incomers to be interconnected. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-125 Amps digital electronic ammeter with selector switch with 3 nos. 125/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | ON / OFF / TRIP indicating lights with control MCB's. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 300 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 125 amp 4P MCCB 3 No. | | | | |
| | | For detail refer SLD. | | | | |
| | | **MDB UPS- 1 SAARC BUILDING as described above** | Set | 385,418.66 | 1 | 385,419 |
| | | | | | | |
| 37 | NDSR | **MDB UPS-2 SAARC BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 125 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | (UPS to run in parallel mode) 2 No. | | | | |
| | | | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-125 Amps digital electronic ammeter with selector switch with 3 nos. 125/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 300 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 160 amp TPN MCCB 2 No. | | | | |
| | | 125 amp TPN MCCB 1 Nos. | | | | |
| | | 100 amp TPN MCCB 3 Nos. | | | | |
| | | 32 amp TPN MCB 3 No. | | | | |
| | | For detail refer SLD. | | | | |
| | | **MDB UPS- 2 SAARC BUILDING as described above** | Set | 373,861.88 | 1 | 373,862 |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| 38 | NDSR | **SDB - B UPS ( BASEMENT) & SDB- 2 UPS (2ND FLOOR) SAARC BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 160 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-160 Amps digital electronic ammeter with selector switch with 3 nos. 160/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 40 amp TPN MCB 7 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - B UPS ( BASEMENT) & SDB- 2 UPS (2ND FLOOR) SAARC BUILDING as described above** | Set | 128,858.11 | 2 | 257,716 |
| | | | | | | |
| 39 | NDSR | **SDB - 5 UPS (FIFTH FLOOR) SAARC BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 125 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-125 Amps digital electronic ammeter with selector switch with 3 nos. 125/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 250 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 40 amp TPN MCB 5 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB -5 UPS (FIFTH FLOOR) SAARC BUILDING as described above** | Set | 120,768.37 | 1 | 120,768 |
| | | | | | | |
| 40 | NDSR | **Lift Panel SAARC BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 1 No. 160 amps 4p change over switch (on load) | | | | |
| | | 160 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 0-160 Amps digital electronic ammeter with selector switch with 3 nos. 160/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 3 Nos. | | | | |
| | | 40 amp TPN MCB 2 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **Lift Panel SAARC BUILDING as described above** | Set | 205,710.71 | 1 | 205,711 |
| | | | | | | |
| | | **LIBRARY (L1) BUILDING** | | | | |
| | | | | | | |
| 41 | NDSR | **SDB - B (N) (BASEMENT) LIBRARY BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 125 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-125 amps digital electronic ammeter with switch selector with 3 nos. 125/5A 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA/sec) with coloured heat shrinkable insulation sleeve. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCB 3 Nos. | | | | |
| | | 40 amp TPN MCB 4 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - B (N) (BASEMENT) LIBRARY BUILDING as described above** | Set | 126,257.84 | 1 | 126,258 |
| | | | | | | |
| 42 | NDSR | **SDB - G (N) (GROUND FLOOR) LIBRARY BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 125 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-125 amps digital electronic ammeter with switch selector with 3 nos. 125/5A 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | 200 amps TPN aluminium bus bars(25kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCB 3 Nos. | | | | |
| | | 40 amp TPN MCB 4 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - G (N) (GROUND FLOOR) LIBRARY BUILDING as described above** | Set | 126,257.84 | 1 | 126,258 |
| | | | | | | |
| 43 | NDSR | **SDB - 1 (N) (FIRST FLOOR) LIBRARY BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 125 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-125 amps digital electronic ammeter with switch selector with 3 nos. 125/5A 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCB 3 Nos. | | | | |
| | | 40 amp TPN MCB 4 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 1 (N) (FIRST FLOOR) LIBRARY BUILDING as described above** | Set | 126,257.84 | 1 | 126,258 |
| | | | | | | |
| 44 | NDSR | **SDB - 2 (N) (SECOND FLOOR) LIBRARY BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 125 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-125 amps digital electronic ammeter with switch selector with 3 nos. 125/5A 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCB 3 Nos. | | | | |
| | | 40 amp TPN MCB 4 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 2 (N) (SECOND FLOOR) LIBRARY BUILDING as described above** | Set | 126,257.84 | 1 | 126,258 |
| | | | | | | |
| 45 | NDSR | **SDB - 3 (N) (THIRD FLOOR) LIBRARY BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 125 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-125 amps digital electronic ammeter with switch selector with 3 nos. 125/5A 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCB 3 Nos. | | | | |
| | | 40 amp TPN MCB 4 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 3 (N) (THIRD FLOOR) LIBRARY BUILDING as described above** | Set | 126,257.84 | 1 | 126,258 |
| | | | | | | |
| 46 | NDSR | **SDB - 4 (N) (FOURTH FLOOR) LIBRARY BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | | | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-125 amps digital electronic ammeter with switch selector with 3 nos. 125/5A 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCB 3 Nos. | | | | |
| | | 40 amp TPN MCB 4 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 4 (N) (FOURTH FLOOR) LIBRARY BUILDING as described above** | Set | 120,479.45 | 1 | 120,479 |
| | | | | | | |
| 47 | NDSR | **SDB - 5 (N) (FIFTH FLOOR) LIBRARY BUILDING** | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | (i) | **Incoming** | | | | |
| | | 125 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-125 amps digital electronic ammeter with switch selector with 3 nos. 125/5A 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCB 4 Nos. | | | | |
| | | 40 amp TPN MCB 4 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 5 (N) (FIFTH FLOOR) LIBRARY BUILDING as described above** | Set | 131,313.93 | 1 | 131,314 |
| | | | | | | |
| 48 | NDSR | **SDB - G (E) (GROUND FLOOR) LIBRARY BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 125 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-125 amps digital electronic ammeter with switch selector with 3 nos. 125/5A 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 3 Nos. | | | | |
| | | 40 amp TPN MCB 4 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - G (E) (GROUND FLOOR) LIBRARY BUILDING as described above** | Set | 145,615.45 | 1 | 145,615 |
| | | | | | | |
| 49 | NDSR | **SDB - 1 (E) (FIRST FLOOR) LIBARRY BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 125 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 0-125 amps digital electronic ammeter with switch selector with 3 nos. 125/5A 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 3 Nos. | | | | |
| | | 40 amp TPN MCB 4 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 1 (E) (FIRST FLOOR) LIBRARY BUILDING as described above** | Set | 145,615.45 | 1 | 145,615 |
| | | | | | | |
| 50 | NDSR | **SDB - 2 (E) (SECOND FLOOR) LIBARRY BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 125 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-125 amps digital electronic ammeter with switch selector with 3 nos. 125/5A 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 3 Nos. | | | | |
| | | 40 amp TPN MCB 4 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 2 (E) (SECOND FLOOR) LIBRARY BUILDING as described above** | Set | 145,615.45 | 1 | 145,615 |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| 51 | NDSR | **SDB - 3 (E) (THIRD FLOOR) LIBARRY BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 125 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-125 amps digital electronic ammeter with switch selector with 3 nos. 125/5A 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 Nos | | | | |
| | | 63 amp TPN MCB 4 Nos. | | | | |
| | | 40 amp TPN MCB 4 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 3 (E) (THIRD FLOOR) LIBRARY BUILDING as described above** | Set | 150,527.08 | 1 | 150,527 |
| | | | | | | |
| 52 | NDSR | **SDB - 4 (E) (FOURTH FLOOR) LIBARRY BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 125 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-125 amps digital electronic ammeter with switch selector with 3 nos. 125/5A 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 3 Nos. | | | | |
| | | 40 amp TPN MCB 4 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 4 (E) (FOURTH FLOOR) LIBRARY BUILDING as described above** | Set | 145,615.45 | 1 | 145,615 |
| | | | | | | |
| 53 | NDSR | **SDB - 5 (E) (FIFTH FLOOR) LIBARRY BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 125 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-125 amps digital electronic ammeter with switch selector with 3 nos. 125/5A 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 4 Nos. | | | | |
| | | 40 amp TPN MCB 4 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 5 (E) (FIFTH FLOOR) LIBRARY BUILDING as described above** | Set | 150,527.08 | 1 | 150,527 |
| | | | | | | |
| 54 | NDSR | **MDB UPS-1 LIBRARY BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 2 NOS. 200 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | (UPS to run in parallel mode) 2 No. | | | | |
| | | | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-200 Amps digital electronic ammeter with selector switch with 3 nos. 125/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 300 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 160 amp TPN MCCB 3 No. | | | | |
| | | For detail refer SLD. | | | | |
| | | **MDB UPS- 1 LIBRARY BUILDING as described above** | Set | 375,450.94 | 1 | 375,451 |
| | | | | | | |
| 55 | NDSR | **MDB UPS-2 LIBRARY BUILDING** | | | | |
| | | | | | | |
| | (i) | **Incoming** | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 2 NOS.160 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | (UPS to run in parallel mode) 2 No. | | | | |
| | | | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-160 Amps digital electronic ammeter with selector switch with 3 nos. 160/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 300 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 100 amp TPN MCCB 9 No. | | | | |
| | | For detail refer SLD. | | | | |
| | | **MDB UPS- 2 LIBRARY BUILDING as described above** | Set | 382,962.85 | 1 | 382,963 |
| | | | | | | |
| 56 | NDSR | **SDB - G.1 UPS ( GROUND FLOOR) LIBRARY BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-100Amps digital electronic ammeter with selector switch with 3 nos. 100/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 40 amp TPN MCB 8 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - G.1 UPS GROUND FLOOR LIBRARY BUILDING AS DESCRIBED ABOVE** | Set | 131,891.77 | 1 | 131,892 |
| | | | | | | |
| 57 | NDSR | **SDB - 2.1 UPS (SECOND FLOOR) LIBRARY BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-100 Amps digital electronic ammeter with selector switch with 3 nos. 100/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 40 amp TPN MCB 6 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB -2.1UPS (SECOND FLOOR) LIBRARY BUILDING as described above** | Set | 125,102.16 | 1 | 125,102 |
| | | | | | | |
| 58 | NDSR | **SDB - 4.1 UPS (FOURTH FLOOR) LIBRARY BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-100 Amps digital electronic ammeter with selector switch with 3 nos. 100/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 40 amp TPN MCB 6 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB -4.1UPS (FOURTH FLOOR) LIBRARY BUILDING as described above** | Set | 125,102.16 | 1 | 125,102 |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| 59 | NDSR | **Lift Panel LIBRARY BUILDING** | | | | |
| | | | | | | |
| | (i) | **Incoming** | | | | |
| | | 200 amps 4P MCCB (25KA) changeover switchboard | | | | |
| | | 200 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-160 Amps digital electronic ammeter with selector switch with 3 nos. 160/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCB 5 Nos. | | | | |
| | | 40 amp DP MCB 2 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **Lift Panel LIBRARY BUILDING as described above** | Set | 209,177.75 | 6 | 1,255,066 |
| | | | | | | |
| 60 | NDSR | **SERVER DB-1 & SERVER DB-2 LIBRARY BUILDING** | | | | |
| | | | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-100 Amps digital electronic ammeter with selector switch with 3 nos. 100/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 32 amp DP MCB 3 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **Lift Panel SAARC BUILDING as described above** | Set | 102,566.44 | 1 | 102,566 |
| | | | | | | |
| | | **PHY, CHEM (AC3) BUIDLING** | | | | |
| 61 | NDSR | **SDB - B1 (N) (Phy, Chem-AC3 Bldg)** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (15KA) with following accessories: | | | | |
| | | 1 No. | | | | |
| | | 0-500 volts digital electronic volt meter with selector switch protected by 2 amps TP MCB's. | | | | |
| | | 1 Set | | | | |
| | | 0-100 Amps digital electronic ammeter with selector switch with 3 nos. 100/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 and with 3 nos. 100/5Amp, 15VA, Class - 1, current transformers to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (15 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 3 Nos. | | | | |
| | | 40 amp TPN MCB 5 Nos. | | | | |
| | | 32 amp TPN MCB 2 Nos. | | | | |
| | | **SDB - B1 (N) (Phy, Chem-AC3 Bldg) as described above** | Set | 150,671.54 | 1 | 150,672 |
| | | | | | | |
| 62 | NDSR | **SDB - G1 (N) (Phy, Chem AC3 Bldg)** | | | | |
| | (i) | **Incoming** | | | | |
| | | 160 amps 4P MCCB (15KA) with following accessories: | | | | |
| | | 1 No. | | | | |
| | | 0-500 volts digital electronic volt meter with selector switch protected by 2 amps TP MCB's. | | | | |
| | | 1 Set | | | | |
| | | 0-100 Amps digital electronic ammeter with selector | | | | |
| | | 1 Set | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 and with 3 nos. 125/5Amp, 15VA, Class - 1, current transformers to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars with coloured heat shrinkable insulation sleeve. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 2 Nos. | | | | |
| | | 63 amp TPN MCB 3 Nos. | | | | |
| | | 40 amp, TPN MCB 6 Nos. | | | | |
| | | 32 amp, TPN MCB 2 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - G1 (N) as described above** | Set | 206,144.09 | 1 | 206,144 |
| | | | | | | |
| 63 | NDSR | **SDB - 1.1 (N) FIRST FLOOR (TYPICAL FOR SDB - 2.1 & SDB 3.1)** | | | | |
| | (i) | **Incoming** | | | | |
| | | 160 amps 4P MCCB (25KA) with following accessories: | | | | |
| | | 1 No. | | | | |
| | | 0-500 volts digital electronic volt meter with selector switch protected by 2 amps TP MCB's. | | | | |
| | | 1 Set | | | | |
| | | 0-160 Amps digital electronic ammeter with selector switch | | | | |
| | | 1 Set | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 and with 3 nos. 160/5Amp, 15VA, Class - 1, current transformers to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 2 Nos. | | | | |
| | | 63 amp TPN MCB 3 Nos. | | | | |
| | | 40 amp, TPN MCB 5 Nos. | | | | |
| | | 32 amp, TPN MCB 2 Nos. | | | | |
| | | | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 1.1 (N) FIRST FLOOR (TYPICAL FOR SDB - 2.1 & SDB 3.1) (N)) as described above** | Set | 202,388.14 | 3 | 607,164 |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| 64 | NDSR | **SDB - 4.1 (N) (Chem, Phys AC3 Bldg)** | | | | |
| | (i) | **Incoming** | | | | |
| | | 125 amps 4P MCCB (25KA) with following accessories: | | | | |
| | | 1 No. | | | | |
| | | 0-500 volts digital electronic volt meter with selector switch protected by 2 amps TP MCB's. | | | | |
| | | 1 Set | | | | |
| | | 0-125 Amps digital electronic ammeter with selector switch | | | | |
| | | 1 Set | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 and with 3 nos. 100/5Amp, 15VA, Class - 1, current transformers to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 2 Nos. | | | | |
| | | 63 amp TPN MCB 3 Nos. | | | | |
| | | 40 amp, TPN MCB 5 Nos. | | | | |
| | | 32 amp, TPN MCB 2 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 4.1 (N) Fourth Floor (AC-3, Phy, Chem Bldg) as described above** | Set | 202,388.14 | 1 | 202,388 |
| | | | | | | |
| 65 | NDSR | **SDB - G.1 (E) (TYPICAL FOR SDB - 1.1 (E), SDB - 2.1(E), SDB - 3.1 (E) )** | | | | |
| | (i) | **Incoming** | | | | |
| | | 160 amps 4P MCCB (25KA) with following accessories: | | | | |
| | | 1 No. | | | | |
| | | 0-500 volts digital electronic volt meter with selector switch protected by 2 amps TP MCB's. | | | | |
| | | 1 Set | | | | |
| | | 0-160 Amps digital electronic ammeter with selector switch | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 1 Set | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 and with 3 nos. 160/5Amp, 15VA, Class - 1, current transformers to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 3 Nos. | | | | |
| | | 40 amp, TPN MCB 5 Nos. | | | | |
| | | 32 amp, TPN MCBs 2 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - G.1 (E) (TYPICAL FOR SDB - 1.1 (E), SDB - 2.1(E), SDB - 3.1 (E) ) as described above** | Set | 190,542.44 | 4 | 762,170 |
| | | | | | | |
| 66 | NDSR | **SDB-4.1 (Fourth Floor) (Chem, Phy AC3 Bldg)** | | | | |
| | (i) | **Incoming** | | | | |
| | | 125 amps 4P MCCB (25KA) with following accessories: | | | | |
| | | 2 Nos. | | | | |
| | | 0-500 volts digital electronic volt meter with selector switch protected by 2 amps TP MCB's. | | | | |
| | | 1 Set | | | | |
| | | 0-125 Amps digital electronic ammeter with selector switch | | | | |
| | | 1 Set | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 and with 3 nos. 125/5Amp, 15VA, Class - 1, current transformers to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB<br>1 Nos. | | | | |
| | | 63 amp TPN MCB<br>3 Nos. | | | | |
| | | 40 amp TPN MCB<br>5 Nos. | | | | |
| | | 32 amp, TPN Contactor<br>2 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 4.1 (E) as described above** | Set | 190,542.44 | 1 | 190,542 |
| | | | | | | |
| 67 | NDSR | **MDB- UPS-1 (Phy, Chem AC3 Bldg)** | | | | |
| | (i) | **Incoming** | | | | |
| | | 2 NOS. 315 amps 4P MCCB (25KA) with following accessories: | | | | |
| | | 2 Nos. | | | | |
| | | 0-500 volts digital electronic volt meter with selector switch protected by 2 amps TP MCB's. | | | | |
| | | 1 Set | | | | |
| | | 0-315 Amps digital electronic ammeter with selector switch | | | | |
| | | 1 Set | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 and with 3 nos. 315/5Amp, 15VA, Class - 1, current transformers to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 400 amps TPN aluminium bus bars (15 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 160 amp TPN MCCB 4 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **MDB UPS 1 as described above** | Set | 396,830.99 | 1 | 396,831 |
| | | | | | | |
| 68 | NDSR | **MDB- UPS-2 (Phy, Chem AC3 Bldg)** | | | | |
| | (i) | **Incoming** | | | | |
| | | 160 amps 4P MCCB (25KA) with following accessories: | | | | |
| | | 3 Nos. | | | | |
| | | 0-500 volts digital electronic volt meter with selector switch protected by 2 amps TP MCB's. | | | | |
| | | 1 Set | | | | |
| | | 0-400 Amps digital electronic ammeter with selector switch | | | | |
| | | 1 Set | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 and with 3 nos. 400/5Amp, 15VA, Class - 1, current transformers to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 400 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 160 amp TPN MCCB 4 Nos. | | | | |
| | | 100 amp TPN MCCB 2 No. | | | | |
| | | 63 amp, TPN MCCB 3 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **MDB UPS-2 as described above** | Set | 496,219.31 | 1 | 496,219 |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| 69 | NDSR | **SDB - G.1 (UPS) GROUND FLOOR (Phy, Chem AC3 Bldg)** | | | | |
| | (i) | **Incoming** | | | | |
| | | 160 amps 4P MCCB (25KA) with following accessories: | | | | |
| | | 1 No. | | | | |
| | | 0-500 volts digital electronic volt meter with selector switch protected by 2 amps TP MCB's. | | | | |
| | | 1 Set | | | | |
| | | 0-63 Amps digital electronic ammeter with selector switch | | | | |
| | | 1 Set | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 and with 3 nos. 63/5Amp, 15VA, Class - 1, current transformers to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 100 amps TPN aluminium bus bars (15 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 40 amp TPN MCB 6 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - G.1 GROUND FLOOR as described above** | Set | 125,102.16 | 1 | 125,102 |
| | | | | | | |
| 70 | NDSR | **SDB - 1.1 (UPS) (Typical for SDB - 3.1 (UPS) AC3 PHY CHEM BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 160 amps 4P MCCB (25KA) with following accessories: | | | | |
| | | 1 No. | | | | |
| | | 0-500 volts digital electronic volt meter with selector switch protected by 2 amps TP MCB's. | | | | |
| | | 1 Set | | | | |
| | | 0-160 Amps digital electronic ammeter with selector switch | | | | |
| | | 1 Set | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 and with 3 nos. 160/5Amp, 15VA, Class - 1, current transformers to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (15 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 40 amp TPN MCB 6 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 1.1 (UPS) (Typical for SDB - 3.1 (UPS)) Chem, Phy AC3 Bldg as described above** | Set | 125,102.16 | 2 | 250,204 |
| | | | | | | |
| 71 | NDSR | **SERVER DB-1 & SERVER DB-2 (AC3 PHY CHEM BUILDINGS)** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps TPN MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 0-100 Amps digital electronic ammeter with selector switch with 3 nos. 100/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 32 amp DP MCB 12 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SERVER DB-1 & SERVER DB-2 (PHY CHEM BUILDINGS) as described above** | Set | 108,200.37 | 2 | 216,401 |
| | | | | | | |
| 72 | NDSR | **Lift Panel AC3 BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 160 amps 4P changeover switch on load. | | | | |
| | | 160 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-160 Amps digital electronic ammeter with selector switch with 3 nos. 160/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 3 Nos. | | | | |
| | | 40 amp DP MCB 2 Nos. | | | | |
| | | For detail refer SLD. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | **Lift Panel AC3 BUILDING as described above** | Set | 200,943.54 | 1 | 200,944 |
| | | | | | | |
| | | **MATH , IT (AC3) BUIDLING** | | | | |
| | | | | | | |
| 73 | NDSR | **SDB - B1 (N) (Math , IT-AC3 Bldg)** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (15KA) with following accessories: | | | | |
| | | 1 No. | | | | |
| | | 0-500 volts digital electronic volt meter with selector switch protected by 2 amps TP MCB's. | | | | |
| | | 1 Set | | | | |
| | | 0-100 Amps digital electronic ammeter with selector switch with 3 nos. 100/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 and with 3 nos. 100/5Amp, 15VA, Class - 01, current transformers to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (15 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 3 Nos. | | | | |
| | | 40 amp TPN MCB 5 Nos. | | | | |
| | | 32 amp TPN MCB 2 Nos. | | | | |
| | | **SDB - B1 (N) (Math , IT-AC3 Bldg) as described above** | Set | 150,671.54 | 1 | 150,672 |
| | | | | | | |
| 74 | NDSR | **SDB - G1 (N) (Math , IT AC3 Bldg)** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (15KA) with following accessories: | | | | |
| | | 1 No. | | | | |
| | | 0-500 volts digital electronic volt meter with selector switch protected by 2 amps TP MCB's. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 1 Set | | | | |
| | | 0-100 Amps digital electronic ammeter with selector | | | | |
| | | 1 Set | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 and with 3 nos. 125/5Amp, 15VA, Class - 1, current transformers to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 2 Nos. | | | | |
| | | 63 amp, TPN MCB 3 Nos. | | | | |
| | | 40 amp, TPN MCB 6 Nos. | | | | |
| | | 32 amp, TPN MCB 2 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - G1 (N) as described above** | Set | 199,065.56 | 1 | 199,066 |
| | | | | | | |
| 75 | NDSR | **SDB - 1.1 (N) FIRST FLOOR (TYPICAL FOR SDB - 2.1 & SDB 3.1)** | | | | |
| | (i) | **Incoming** | | | | |
| | | 160 amps 4P MCCB (25KA) with following accessories: | | | | |
| | | 1 No. | | | | |
| | | 0-500 volts digital electronic volt meter with selector switch protected by 2 amps TP MCB's. | | | | |
| | | 1 Set | | | | |
| | | 0-160 Amps digital electronic ammeter with selector switch | | | | |
| | | 1 Set | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 and with 3 nos. 160/5Amp, 15VA, Class - 1, current transformers to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 2 Nos. | | | | |
| | | 63 amp TPN MCB 3 Nos. | | | | |
| | | 40 amp, TPN MCB 5 Nos. | | | | |
| | | 32 amp, TPN MCB 2 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 1.1 (N) FIRST FLOOR (TYPICAL FOR SDB - 2.1 & SDB 3.1) (N)) as described above** | Set | 202,388.14 | 3 | 607,164 |
| | | | | | | |
| 76 | NDSR | **SDB - 4.1 (N) (Math , IT AC3 Bldg)** | | | | |
| | (i) | **Incoming** | | | | |
| | | 160 amps 4P MCCB (25KA) with following accessories: | | | | |
| | | 1 No. | | | | |
| | | 0-500 volts digital electronic volt meter with selector switch protected by 2 amps TP MCB's. | | | | |
| | | 1 Set | | | | |
| | | 0-125 Amps digital electronic ammeter with selector switch | | | | |
| | | 1 Set | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 and with 3 nos. 100/5Amp, 15VA, Class - 1, current transformers to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 2 Nos. | | | | |
| | | 63 amp TPN MCB 3 Nos. | | | | |
| | | 40 amp, TPN MCB 5 Nos. | | | | |
| | | 32 amp, TPN MCB 2 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | | | | | |
| | | **SDB - 4.1 (N) Fourth Floor (Math , IT AC-3 Bldg) as described above** | Set | 202,388.14 | 1 | 202,388 |
| | | | | | | |
| 77 | NDSR | **SDB - G.1 (E) (TYPICAL FOR SDB - 1.1 (E), SDB - 2.1(E), SDB - 3.1 (E) )** | | | | |
| | (i) | **Incoming** | | | | |
| | | 160 amps 4P MCCB (25KA) with following accessories: | | | | |
| | | 1 No. | | | | |
| | | 0-500 volts digital electronic volt meter with selector switch protected by 2 amps TP MCB's. | | | | |
| | | 1 Set | | | | |
| | | 0-160 Amps digital electronic ammeter with selector switch | | | | |
| | | 1 Set | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 and with 3 nos. 160/5Amp, 15VA, Class - 1, current transformers to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 Nos. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 63 amp TPN MCB 3 Nos. | | | | |
| | | 40 amp, TPN MCB 5 Nos. | | | | |
| | | 32 amp, TPN MCBs 2 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - G.1 (E) (TYPICAL FOR SDB - 1.1 (E), SDB - 2.1(E), SDB - 3.1 (E) ) as described above** | Set | 190,542.44 | 4 | 762,170 |
| | | | | | | |
| 78 | NDSR | **SDB-4.1 (Fourth Floor) (Math , IT AC3 Bldg)** | | | | |
| | (i) | **Incoming** | | | | |
| | | 125 amps 4P MCCB (25KA) with following accessories: | | | | |
| | | 2 Nos. | | | | |
| | | 0-500 volts digital electronic volt meter with selector switch protected by 2 amps TP MCB's. | | | | |
| | | 1 Set | | | | |
| | | 0-125 Amps digital electronic ammeter with selector switch | | | | |
| | | 1 Set | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 and with 3 nos. 125/5Amp, 15VA, Class - 1, current transformers to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 3 Nos. | | | | |
| | | 40 amp TPN MCB 5 Nos. | | | | |
| | | 32 amp, TPN Contactor 2 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 4.1 (E) as described above** | Set | 209,900.04 | 1 | 209,900 |
| | | | | | | |
| 79 | NDSR | **MDB- UPS-1 (Math , IT AC3 Bldg)** | | | | |
| | (i) | **Incoming** | | | | |
| | | 2 NOS. 315 amps 4P MCCB (25KA) with following accessories: | | | | |
| | | 2 Nos. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 0-500 volts digital electronic volt meter with selector switch protected by 2 amps TP MCB's. | | | | |
| | | 1 Set | | | | |
| | | 0-315 Amps digital electronic ammeter with selector switch | | | | |
| | | 1 Set | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 and with 3 nos. 315/5Amp, 15VA, Class - 1, current transformers to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 400 amps TPN aluminium bus bars (15 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 160 amp TPN MCCB<br>4 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **MDB UPS 1 as described above** | Set | 396,830.99 | 1 | 396,831 |
| | | | | | | |
| 80 | NDSR | **MDB- UPS-2 (Math, IT AC3 Bldg)** | | | | |
| | (i) | **Incoming** | | | | |
| | | 2 NOS.160 amps 4P MCCB (25KA) with following accessories: | | | | |
| | | 3 Nos. | | | | |
| | | 0-500 volts digital electronic volt meter with selector switch protected by 2 amps TP MCB's. | | | | |
| | | 1 Set | | | | |
| | | 0-400 Amps digital electronic ammeter with selector switch | | | | |
| | | 1 Set | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 and with 3 nos. 400/5Amp, 15VA, Class - 1, current transformers to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 400 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 160 amp TPN MCCB 4 Nos. | | | | |
| | | 100 amp TPN MCCB 2 No. | | | | |
| | | 63 amp, TPN MCCB 3 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **MDB UPS-2 as described above** | Set | 498,241.74 | 1 | 498,242 |
| | | | | | | |
| 81 | NDSR | **SDB - G.1 (UPS) GROUND FLOOR (Math, IT AC3 Bldg)** | | | | |
| | (i) | **Incoming** | | | | |
| | | 160 amps 4P MCCB (25KA) with following accessories: | | | | |
| | | 1 No. | | | | |
| | | 0-500 volts digital electronic volt meter with selector switch protected by 2 amps TP MCB's. | | | | |
| | | 1 Set | | | | |
| | | 0-63 Amps digital electronic ammeter with selector switch | | | | |
| | | 1 Set | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 and with 3 nos. 63/5Amp, 15VA, Class - 1, current transformers to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | (ii) | **Bus Bars** | | | | |
| | | 100 amps TPN aluminium bus bars (15 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 40 amp TPN MCB 5 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - G.1 GROUND FLOOR as described above** | Set | 121,490.67 | 1 | 121,491 |
| | | | | | | |
| 82 | NDSR | **SDB - 1.1 (UPS) (Typical for SDB - 3.1 (UPS))** | | | | |
| | (i) | **Incoming** | | | | |
| | | 160 amps 4P MCCB (25KA) with following accessories: | | | | |
| | | 1 No. | | | | |
| | | 0-500 volts digital electronic volt meter with selector switch protected by 2 amps TP MCB's. | | | | |
| | | 1 Set | | | | |
| | | 0-160 Amps digital electronic ammeter with selector switch | | | | |
| | | 1 Set | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 and with 3 nos. 160/5Amp, 15VA, Class - 1, current transformers to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (15 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 40 amp TPN MCB 5 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 1.1 (UPS) (Typical for SDB - 3.1 (UPS)) Math, IT AC3 Bldg as described above** | Set | 121,490.67 | 2 | 242,981 |
| | | | | | | |
| 83 | NDSR | **SERVER DB-1 & SERVER DB-2 (AC3 MATHS IT BUILDINGS)** | | | | |
| | (i) | **Incoming** | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 100 amps TPN MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-100 Amps digital electronic ammeter with selector switch with 3 nos. 100/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 32 amp DP MCB 18 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SERVER DB-1 & SERVER DB-2 (MATHS IT BUILDINGS) as described above** | Set | 118,745.93 | 2 | 237,492 |
| | | | | | | |
| 84 | NDSR | **Lift Panel AC3 BUILDING** | | | | |
| | (i) | **Incoming** | | | | |
| | | 160 amps 4P change over switch on load. | | | | |
| | | 160 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-160 Amps digital electronic ammeter with selector switch with 3 nos. 160/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 3 Nos. | | | | |
| | | 40 amp DP MCB 2 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **Lift Panel AC3 BUILDING as described above** | **Set** | 200,943.54 | 1 | 200,944 |
| | | | | | | |
| | | **LAW & HUMANITY (AC4) BUIDLING** | | | | |
| | | | | | | |
| 85 | NDSR | **SDB - B1 (N) (Law & Hum (AC4) Bldg - Basement** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (15KA) with following accessories: | | | | |
| | | 1 No. | | | | |
| | | 0-500 volts digital electronic volt meter with selector switch protected by 2 amps TP MCB's. | | | | |
| | | 1 Set | | | | |
| | | 0-100 Amps digital electronic ammeter with selector switch with 3 nos. 100/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 and with 3 nos. 100/5Amp, 15VA, Class - 1, current transformers to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (15 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 No. | | | | |
| | | 63 amp TPN MCB 3 Nos. | | | | |
| | | 40 amp TPN MCB 3 Nos. | | | | |
| | | **SDB - B1 as described above** | Set | 131,169.47 | 1 | 131,169 |
| | | | | | | |
| 86 | NDSR | **SDB - G1 (N) (Law & Hum (AC4) Bldg - Ground Floor** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (15KA) with following accessories: | | | | |
| | | 1 No. | | | | |
| | | 0-500 volts digital electronic volt meter with selector switch protected by 2 amps TP MCB's. | | | | |
| | | 1 Set | | | | |
| | | 0-100 Amps digital electronic ammeter with selector | | | | |
| | | 1 Set | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 and with 3 nos. 125/5Amp, 15VA, Class - 1, current transformers to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 No. | | | | |
| | | 63 amp TPN MCB 5 Nos. | | | | |
| | | 40 amp, TPN MCB 8 Nos. | | | | |
| | | For detail refer SLD. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | **SDB - G1 (N) as described above** | Set | 193,720.55 | 1 | 193,721 |
| | | | | | | |
| 87 | NDSR | **SDB - 1 (N) FIRST FLOOR (TYPICAL FOR SDB - 2 & 3 (Law & Hum (AC4) Bldg** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with following accessories: | | | | |
| | | 1 No. | | | | |
| | | 0-500 volts digital electronic volt meter with selector switch protected by 2 amps TP MCB's. | | | | |
| | | 1 Set | | | | |
| | | 0-160 Amps digital electronic ammeter with selector switch | | | | |
| | | 1 Set | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 and with 3 nos. 100/5Amp, 15VA, Class - 1, current transformers to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 5 Nos. | | | | |
| | | 40 amp, TPN MCB 5 Nos. | | | | |
| | | | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 1 (N) FIRST FLOOR (TYPICAL FOR SDB - 2 & 3 as described above** | Set | 156,161.01 | 3 | 468,483 |
| | | | | | | |
| 88 | NDSR | **SDB - G (E) (TYPICAL FOR SDB - 1, 2 & 3 (Law & Hum (AC4) Bldg** | | | | |
| | (i) | **Incoming** | | | | |
| | | 125 amps 4P MCCB (25KA) with following accessories: | | | | |
| | | 1 No. | | | | |
| | | 0-500 volts digital electronic volt meter with selector switch protected by 2 amps TP MCB's. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 1 Set | | | | |
| | | 0-125 Amps digital electronic ammeter with selector switch | | | | |
| | | 1 Set | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 and with 3 nos. 125/5Amp, 15VA, Class - 1, current transformers to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 No. | | | | |
| | | 63 amp TPN MCB 5 Nos. | | | | |
| | | 40 amp, TPN MCB 6 Nos. | | | | |
| | | **SDB - G (E) (TYPICAL FOR SDB -1, 2 & 3 as described above** | Set | 195,454.07 | 4 | 781,816 |
| | | | | | | |
| 89 | NDSR | **MDB- UPS-1 (Law & Hum (AC4) Bldg** | | | | |
| | (i) | **Incoming** | | | | |
| | | 2 NOS. 315 amps 4P MCCB (25KA) with following accessories: | | | | |
| | | 2 Nos. | | | | |
| | | 0-500 volts digital electronic volt meter with selector switch protected by 2 amps TP MCB's. | | | | |
| | | 1 Set | | | | |
| | | 0-315 Amps digital electronic ammeter with selector switch | | | | |
| | | 1 Set | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 and with 3 nos. 315/5Amp, 15VA, Class - 1, current transformers to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 400 amps TPN aluminium bus bars (15 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 160 amp TPN MCCB 4 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **MDB UPS 1 as described above** | Set | 415,321.84 | 1 | 415,322 |
| | | | | | | |
| 90 | NDSR | **MDB- UPS-2 (Law & Hum (AC4) Bldg** | | | | |
| | (i) | **Incoming** | | | | |
| | | 160 amps 4P MCCB (25KA) with following accessories: | | | | |
| | | 3 Nos. | | | | |
| | | 0-500 volts digital electronic volt meter with selector switch protected by 2 amps TP MCB's. | | | | |
| | | 1 Set | | | | |
| | | 0-400 Amps digital electronic ammeter with selector switch | | | | |
| | | 1 Set | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 and with 3 nos. 400/5Amp, 15VA, Class - 1, current transformers to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 400 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | (iii) | **Outgoing** | | | | |
| | | 100 amp TPN MCCB 7 Nos. | | | | |
| | | 125 amp TPN MCCB 2 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **MDB UPS-2 as described above** | Set | 471,661.15 | 1 | 471,661 |
| | | | | | | |
| 91 | NDSR | **SDB - B 1(UPS) BASEMENT FLOOR (Law & Hum (AC4) Bldg** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with following accessories: | | | | |
| | | 1 No. | | | | |
| | | 0-500 volts digital electronic volt meter with selector switch protected by 2 amps TP MCB's. | | | | |
| | | 1 Set | | | | |
| | | 0-63 Amps digital electronic ammeter with selector switch | | | | |
| | | 1 Set | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 and with 3 nos. 63/5Amp, 15VA, Class - 1, current transformers to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 100 amps TPN aluminium bus bars (15 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 40 amp TPN MCB 10 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - B1 as described above** | Set | 127,125.00 | 1 | 127,125 |
| | | | | | | |
| 92 | NDSR | **SDB - 1 (UPS) (Typical for SDB 2 & SDB- 3 (UPS)) (Law & Hum (AC4) Bldg** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with following accessories: | | | | |
| | | 1 No. | | | | |
| | | 0-500 volts digital electronic volt meter with selector switch protected by 2 amps TP MCB's. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 1 Set | | | | |
| | | 0-100 Amps digital electronic ammeter with selector switch | | | | |
| | | 1 Set | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 and with 3 nos. 100/5Amp, 15VA, Class - 1, current transformers to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (15 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 40 amp TPN MCB 6 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 1 (UPS) (Typical for SDB 2 & SDB- 3 (UPS)) as described above** | Set | 117,734.71 | 3 | 353,204 |
| | | | | | | |
| 93 | NDSR | **Lift Panel (Law & Hum (AC4) Bldg** | | | | |
| | (i) | **Incoming** | | | | |
| | | 160 amps 4P changeover switchboard. | | | | |
| | | 160 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-160 Amps digital electronic ammeter with selector switch with 3 nos. 160/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 5 Nos. | | | | |
| | | 40 amp DP MCB 2 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **Lift Panel as described above** | **Set** | 224,634.94 | 1 | 224,635 |
| | | | | | | |
| | | **ART DESIGN (AC1) BUILDING** | | | | |
| | | | | | | |
| 94 | NDSR | **SDB - B2 (N) (2nd BASEMENT) ART DESIGN (AC1) Bldg** | | | | |
| | | | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCB 4 Nos. | | | | |
| | | 40 amp TPN MCB 2 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - B2 (N) (2nd BASEMENT) as described above** | Set | 113,545.38 | 1 | 113,545 |
| | | | | | | |
| 95 | NDSR | **SDB B1 (N) (BASEMENT 1 ) ART DESIGN (AC1) Bldg** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 Ka/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 5 Nos. | | | | |
| | | 40 amp TPN MCB 3 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB B1 (BASEMENT 1 ) as described above** | Set | 146,482.21 | 2 | 292,964 |
| | | | | | | |
| 96 | NDSR | **SDB - G (N) ( GROUND FLOOR) ART DESIGN (AC1) Bldg** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 6 Nos. | | | | |
| | | 40 amp TPN MCB 3 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - G (GROUND FLOOR) as described above** | Set | 150,093.70 | 2 | 300,187 |
| | | | | | | |
| 97 | NDSR | **SDB - 1 (N) (FIRST FLOOR) ART DESIGN (AC1) Bldg** | | | | |
| | (i) | **Incoming** | | | | |
| | | 125 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 6 Nos. | | | | |
| | | 40 amp TPN MCB 3 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 1 (N) (FIRST FLOOR) as described above** | Set | 156,016.55 | 1 | 156,017 |
| | | | | | | |
| 98 | NDSR | **SDB - 2 (N) (SECOND FLOOR) ART DESIGN (AC1) Bldg** | | | | |
| | (i) | **Incoming** | | | | |
| | | 125 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 Ka/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 6 Nos. | | | | |
| | | 40 amp TPN MCB 3 Nos. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | For detail refer SLD. | | | | |
| | | **SDB - 2 (N) (SECOND FLOOR) as described above** | Set | 156,016.55 | 1 | 156,017 |
| | | | | | | |
| 99 | NDSR | **SDB - 3 (N) (THIRD FLOOR) ART DESIGN (AC1) Bldg** | | | | |
| | (i) | **Incoming** | | | | |
| | | 125 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 Ka/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 6 Nos. | | | | |
| | | 40 amp TPN MCB 3 Nos. | | | | |
| | | 25 amp TPN MCB 2 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 3 (N) (THIRD FLOOR) as described above** | Set | 161,506.02 | 1 | 161,506 |
| | | | | | | |
| 100 | NDSR | **SDB - 4 (N) (FOURTH FLOOR)ART DESIGN (AC1) Bldg** | | | | |
| | (i) | **Incoming** | | | | |
| | | 125 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | | | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 Ka/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCB 4 Nos. | | | | |
| | | 40 amp TPN MCB 4 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 4 (N) (FOURTH FLOOR) as described above** | Set | 128,135.82 | 1 | 128,136 |
| | | | | | | |
| 101 | NDSR | **SDB-B1 (E) & SDB - G (E) (BASEMENT 1 & GROUND FLOOR) ART DESIGN (AC1) Bldg** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | ON / OFF / TRIP indicating lights with control MCB's. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 2 Nos. | | | | |
| | | 40 amp TPN MCB 3 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB-B1 (E) & SDB - G (E) (BASEMENT 1 & GROUND FLOOR) as described above** | Set | 128,858.11 | 2 | 257,716 |
| | | | | | | |
| 102 | NDSR | **SDB - 1 (E) (FIRST FLOOR) ART DESIGN (AC1) Bldg** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 Ka/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 2 Nos. | | | | |
| | | 40 amp TPN MCB 3 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 1 (E) (FIRST FLOOR) as described above** | Set | 128,858.11 | 1 | 128,858 |
| | | | | | | |
| 103 | NDSR | **SDB - 2 (E) (SECOND FLOOR) ART DESIGN (AC1) Bldg** | | | | |
| | (i) | **Incoming** | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 100 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 2 Nos. | | | | |
| | | 40 amp TPN MCB 3 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 2 (E) (SECOND FLOOR) SAARC BUILDING as described above** | Set | 128,858.11 | 1 | 128,858 |
| | | | | | | |
| 104 | NDSR | **SDB - 3 (E) (THIRD FLOOR) ART DESIGN (AC1) Bldg** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 Ka/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 2 Nos. | | | | |
| | | 40 amp TPN MCB 3 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 3(E) (THIRD FLOOR) as described above** | Set | 128,858.11 | 1 | 128,858 |
| | | | | | | |
| 105 | NDSR | **SDB - 4 (E) (FOURTH FLOOR) ART DESIGN (AC1) Bldg** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5. to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 63 amp TPN MCCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 3 Nos. | | | | |
| | | 40 amp TPN MCB 3 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 4 (E) (FOURTH FLOOR) as described above** | Set | 132,469.61 | 1 | 132,470 |
| | | | | | | |
| 106 | NDSR | **MDB-UPS-1 ART DESIGN (AC1) Bldg** | | | | |
| | (i) | **Incoming** | | | | |
| | | 2 nos. 250 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | Earth incomers to be interconnected. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-125 Amps digital electronic ammeter with selector switch with 3 nos. 125/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 300 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 160 amp TPN MCCB : 2 No. | | | | |
| | | For detail refer SLD. | | | | |
| | | **MDB UPS- 1 as described above** | Set | 320,556.23 | 1 | 320,556 |
| | | | | | | |
| 107 | NDSR | **MDB UPS-2 ART DESIGN (AC1) Bldg** | | | | |
| | (i) | **Incoming** | | | | |
| | | 2 nos. 160 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | (UPS to run in parallel mode) 2 No. | | | | |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-125 Amps digital electronic ammeter with selector switch with 3 nos. 125/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 300 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 100 amp TPN MCB 2 Nos. | | | | |
| | | 32 amp TPN MCB 16 No. | | | | |
| | | For detail refer SLD. | | | | |
| | | **MDB UPS- 2 as described above** | Set | 344,825.47 | 1 | 344,825 |
| | | | | | | |
| 108 | NDSR | **SERVER DB-1 & SERVER DB-2 ART DESIGN (AC1) Bldg** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps TPN MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-100 Amps digital electronic ammeter with selector switch with 3 nos. 100/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 32 amp ADP MCB 12 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SERVER DB-1 & SERVER DB-2 as described above** | Set | 108,200.37 | 2 | 216,401 |
| | | | | | | |
| 109 | NDSR | **Lift Panel ART DESIGN (AC1) Bldg** | | | | |
| | | | | | | |
| | (i) | **Incoming** | | | | |
| | | 200 amps 4P change over switch (on load) | | | | |
| | | 200 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-160 Amps digital electronic ammeter with selector switch with 3 nos. 160/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 5 Nos. | | | | |
| | | 40 amp DP MCB 2 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **Lift Panel as described above** | Set | 278,518.44 | 1 | 278,518 |
| | | | | | | |
| | | **CONVENTION (C1) BUILDING** | | | | |
| | | | | | | |
| 110 | NDSR | **SDB - B2 (N) (2ND BASEMENT) Convention (C1) Bldg** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCB 4 Nos. | | | | |
| | | 40 amp TPN MCB 2 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - B2 (N) (2ND BASEMENT) as described above** | Set | 113,545.38 | 1 | 113,545 |
| | | | | | | |
| 111 | NDSR | **SDB - B1 (N) (1ST BASEMENT) Convention (C1) Bldg** | | | | |
| | (i) | **Incoming** | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 100 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 4 Nos. | | | | |
| | | 40 amp TPN MCB 3 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - B1 (N) (BASEMENT FLOOR) as described above** | Set | 136,225.56 | 1 | 136,226 |
| | | | | | | |
| 112 | NDSR | **SDB - G (N) (GROUND FLOOR) Convention (C1) Bldg** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 No. | | | | |
| | | 63 amp TPN MCB 4 Nos. | | | | |
| | | 40 amp TPN MCB 3 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - G (N) (GROUND FLOOR) as described above** | Set | 136,225.56 | 1 | 136,226 |
| | | | | | | |
| 113 | NDSR | **SDB - 1 (N) (FIRST FLOOR) Convention (C1) Bldg** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 Ka/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 No. | | | | |
| | | 63 amp TPN MCB 3 Nos. | | | | |
| | | 40 amp TPN MCB 3 Nos. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | For detail refer SLD. | | | | |
| | | **SDB - 1 (N) (FIRST FLOOR) as described above** | Set | 132,469.61 | 1 | 132,470 |
| | | | | | | |
| 114 | NDSR | **SDB - 2 (N) (SECOND FLOOR) Convention (C1) Bldg** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 No. | | | | |
| | | 63 amp TPN MCB 4 Nos. | | | | |
| | | 40 amp TPN MCB 5 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 2 (N) (SECOND FLOOR) as described above** | Set | 148,215.72 | 1 | 148,216 |
| | | | | | | |
| 115 | NDSR | **SDB - B1(E) (BASEMENT FLOOR) Convention (C1) Bldg** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | | | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 Ka/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 2 Nos. | | | | |
| | | 40 amp TPN MCB 3 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - B1 (E) (BASEMENT FLOOR) as described above** | Set | 128,858.11 | 1 | 128,858 |
| | | | | | | |
| 116 | NDSR | **SDB - G (E) (GROUND FLOOR) Convention (C1) Bldg** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | ON / OFF / TRIP indicating lights with control MCB's. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 Ka/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 2 Nos. | | | | |
| | | 40 amp TPN MCB 3 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - G (E) (GROUND FLOOR) as described above** | Set | 128,858.11 | 1 | 128,858 |
| | | | | | | |
| 117 | NDSR | **SDB - 1 (E) (FIRST FLOOR) Convention (C1) Bldg** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 2 Nos. | | | | |
| | | 40 amp TPN MCB 3 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 1 (E) (FIRST FLOOR) as described above** | Set | 128,858.11 | 1 | 128,858 |
| | | | | | | |
| 118 | NDSR | **SDB - 2 (E) (SECOND FLOOR) Convention (C1) Bldg** | | | | |
| | (i) | **Incoming** | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 100 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 1 Nos. | | | | |
| | | 63 amp TPN MCB 3 Nos. | | | | |
| | | 40 amp TPN MCB 4 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB - 2 (E) (SECOND FLOOR) CONVENTION BUILDING as described above** | Set | 136,225.56 | 1 | 136,226 |
| | | | | | | |
| 119 | NDSR | **MDB-UPS-1 Convention (C1) Bldg** | | | | |
| | (i) | **Incoming** | | | | |
| | | 2 nos. 160 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | Earth incomers to be interconnected. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-125 Amps digital electronic ammeter with selector switch with 3 nos. 125/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 100 amp TPN MCCB 2 No. | | | | |
| | | For detail refer SLD. | | | | |
| | | **MDB UPS- 1 as described above** | Set | 260,172.04 | 1 | 260,172 |
| | | | | | | |
| 120 | NDSR | **MDB UPS-2 Convention (C1) Bldg** | | | | |
| | (i) | **Incoming** | | | | |
| | | 2 nos. 100 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | (UPS to run in parallel mode) 2 No. | | | | |
| | | | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-125 Amps digital electronic ammeter with selector switch with 3 nos. 125/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA/sec) with coloured heat shrinkable insulation sleeve. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | (iii) | **Outgoing** | | | | |
| | | 100 amp TPN MCCB 2 Nos. | | | | |
| | | 40 amp TPN MCB 14 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **MDB UPS- 2 as described above** | Set | 336,157.88 | 1 | 336,158 |
| | | | | | | |
| 121 | NDSR | **SERVER DB-1 & SERVER DB-2 Convention (C1) Bldg** | | | | |
| | (i) | **Incoming** | | | | |
| | | 100 amps TPN MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-100 Amps digital electronic ammeter with selector switch with 3 nos. 100/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 32 amp ADP MCB 12 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SERVER DB-1 & SERVER DB-2 as described above** | Set | 108,200.37 | 1 | 108,200 |
| | | | | | | |
| 122 | NDSR | **Lift Panel Convention (C1) Bldg** | | | | |
| | (i) | **Incoming** | | | | |
| | | 200 amps 4P changeover switch (on load) | | | | |
| | | 200 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-160 Amps digital electronic ammeter with selector switch with 3 nos. 160/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (25 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB 8 Nos. | | | | |
| | | 40 amp DP MCB 3 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **Lift Panel as described above** | Set | 316,077.98 | 1 | 316,078 |
| | | | | | | |
| | | **UTILITY BUILDING (U1) BUILDING** | | | | |
| 123 | NDSR | **SDB - N Utility Bldg (U1)** | | | | |
| | **A** | **Incoming** | | | | |
| | (i) | 400 amps 4 pole MCCB (35KA) with built in microprocessor based release unit for short circuit, over current and earth fault protection with adjustable setting as per specification and with following accessories : | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | (iii) | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (iv) | Auxiliary contacts required for necessary interlocking of breakers.mechanical interlocking to be provided. | | | | |
| | | 1 Set | | | | |
| | (v) | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. & phase indicating lamps connected through 415 V √ 3 : 110 V √ 3 PT's, Primary and Secondary of PT's shall be protected by 2 amp TP MCB's | | | | |
| | | 1 Set | | | | |
| | (vi) | 0-400 Amps digital electronic ammeter with selector switch with 3 nos. 400/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | (vii) | ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | **B** | **Bus Bars** | | | | |
| | | 500 amps TPN aluminium bus bars (35 kA/sec) with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB(35KA) 1 Nos. | | | | |
| | | 63 amp TPN MCB(35KA) 1 Nos. | | | | |
| | | 100 amp TPN MCCB(35KA) 1 Nos. | | | | |
| | | 40 amp TPN MCCB(35KA) 6 Nos. | | | | |
| | | 160 amp TPN MCCB(35KA) 1 Nos. | | | | |
| | (iv) | **Bus Coupler** | | | | |
| | | 400 amps 4 pole indicating lamps with control MCB's. | | | | |
| | | | | | | |
| | | **SECTION-II (SDB - E)** | | | | |
| | (C ) | **Incoming** | | | | |
| | (i) | 400 amps 4 pole MCCB (35KA) with built in microprocessor based release unit for short circuit, over current and earth fault protection with adjustable setting as per specification and with following accessories : | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | (iii) | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (iv) | Auxiliary contacts required for necessary interlocking of breakers.mechanical interlocking to be provided. | | | | |
| | | 1 Set | | | | |
| | (v) | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. & phase indicating lamps connected through 415 V √ 3 : 110 V √ 3 PT's, Primary and Secondary of PT's shall be protected by 2 amp TP MCB's | | | | |
| | | 1 Set | | | | |
| | (vi) | 0-400 Amps digital electronic ammeter with selector switch with 3 nos. 400/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | (vii) | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 500 amps TPN aluminium bus bars (35 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 63 amp TPN MCCB(35KA) 1 Nos. | | | | |
| | | 63 amp TPN MCB(35KA) 1 Nos. | | | | |
| | | 32 amp TPN MCCB(35KA) 1 Nos. | | | | |
| | | 40 amp TPN MCCB(35KA) 2 Nos. | | | | |
| | | 40 amp DP MCB(35KA) 4 Nos. | | | | |
| | | 160 amp TPN MCCB(35KA) 2 Nos. | | | | |
| | | **SDB - N as described above** | Set | 845,667.49 | 1 | 845,667 |
| | | | | | | |
| 124 | NDSR | **SDB- UPS Utility Bldg (U1)** | | | | |
| | (i) | **Incoming** | | | | |
| | | 63 amps 4P MCCB (25KA) with in built earth fault protection & with following accessories: | | | | |
| | | 1 No. | | | | |
| | (ii) | Digital Multi-function meter with RS 485 communication port of accuracy class-0.5 to measure and display the following electrical quantities : | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 1 No. | | | | |
| | | Phase indicating lights | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 1 Set | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. protected by 2 amp TPN MCB's | | | | |
| | | 1 Set | | | | |
| | | 0-63 Amps digital electronic ammeter with selector switch with 3 nos. 63/5A, 15VA, CL-1.0 Current Transformer | | | | |
| | | 1 Set | | | | |
| | | Breaker ON / OFF / TRIP indicating lights with control MCB's. | | | | |
| | | 1 Set | | | | |
| | (ii) | **Bus Bars** | | | | |
| | | 100 amps TPN aluminium bus bars (25 kA/SEC) with coloured heat shrinkable insulation sleeve. | | | | |
| | (iii) | **Outgoing** | | | | |
| | | 40 amp TPN MCB 2 Nos. | | | | |
| | | 40 amp DP MCB 3 Nos. | | | | |
| | | For detail refer SLD. | | | | |
| | | **SDB-UPS as described above** | Set | 103,866.57 | 6 | 623,199 |
| | | | | | | |
| | | **TOTAL CARRIED TO SUMMARY** | | | | **47,745,399** |
| | | | | | | |
| O | | **POWER AND DISTRIBUTION TRANSFORMERS & COMPACT SUB STATION** | | | | |
| 1.0 | | Suppy , installation, testing & commissioning of 5 MVA(ONAN)/6.3 MVA(ONAF), 66/11 KV, 3-ph , 50Hz, **Class A** insulation, impedance 8.15%, ONAN cooled , copper wound ,oil filled transformer with OLTC for voltage variation from + 5% to - 15 % in steps of 1.25% each,winding temperature indicator ( WTI ) ,Oil temperature indicator ( OTI ) , Buchholz Relay with required potential free contacts & with RTCC Panel as per specification including 2 Nos. 350/5A CTs class 5 P20 & Class PS inside bushing chamber for REF & SEF relays. Maximum losses as per latest IS standards amended upto date. | Nos. | 9,288,485.00 | 2 | 18,576,970 |
| | | | | | | |
| 2.0 | | Suppy , installation, testing & commissioning of 2500 kVA, 11/0.433KV , 3-ph , 50Hz, **Class A** insulation, impedance 6.25%, ONAN cooled , copper wound ,oil filled transformer with OFF load tap changer for voltage variation from + 5% to - 7.5 % in steps of 2.25% each as per specification. | Nos. | 4,517,920.00 | 2 | 9,035,840 |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| 3.0 | | Supply, installation, testing and commissioning of Panel for 6.6 KV neutral grounding resistor (NGR)of 33 ohm and 315 Amps for 10 s. For 5/6.3 MVA transformer with 400 A single pole 11KV isolator.<br>The register element shall be made of un breakable corrosion proof. Punched stainless steel grid of Ferro chrome aluminum alloy. The resistor shall be suitable for the full load current on 30 sec. with temperature rise not carrying exceeding 375 deg C over ambient temperature. The resistance element shall be supported on suitable insulating base housed in 2 mm thick sheet steel self supporting, free standing cubical with louvers on sides. The unit shall be complete with connection, terminals glands plates etc. | No. | 250,000.00 | 2 | 500,000 |
| | | | | | | |
| 4.0 | | **RMU WITH TWO OUTGOING FEEDERS (ESS-1 UTILITY BLDG)** | | | | |
| | | Supply, testing & commissioning of GIS type RMU (Ring main unit). comprising 2 Nos. 11 KV , 630 A, 20 KA incoming isolators and 2 nos. 630 A VCB 20 KA as outgoings and earth switch bus bars, interlocking and earth bar complete with snap action mechanism for manual & motorized operation, F.PI(Fault position Indication), bushing for 630A, arc proof cable cover complete with interlocking FRTU (IEC 61850) for SCADA. | | | | |
| | | Each Load Break Switch shall be a 3-position switch, with integrated capability with to earth at full-making capacity, all motorized/manually operable through separate operating shafts/push-buttons, and shall be accompanied by a SCADA compatible FPI having SC+EF detection capability. | | | | |
| | | Each Fixed-Type VCB shall be associated with motorized/manual spring-charging drive, series tripping coil and associated self-powered relay with CTs, ON/OFF push buttons, suitably interlocked line-side series disconnector cum earthing switch, semaphore indications, Class 1.0 accurate ammeters and multifunction meters. | | | | |
| | | Each RMU shall be accompanied with Metering ready BusPT unit, comprising of Metering Class PTs, suitably isolated via HRC fuses and anti-condensation space heaters, providing bus-voltage signals to respective multifunction meters of respective VCBs. Shall also be provided with R-Y-B indications and associate voltmeter. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | RMU shall enclose all necessary accessories required for SCADA incl. FRTU (as per specification), all binary inputs providing potential free status of LBS/VCB/Earth-Switches, Gas-Pressure-Low etc. and necessary digital integration of multifunction meters with RTU over ModBus as reqd. | | | | |
| | | | | | | |
| | | **RMU WITH TWO OUTGOING FEEDERS (ESS-1 UTILITY BLDG) PANEL BOARD AS DESCRIBED ABOVE** | **Set** | 1,466,901.00 | 1 | 1,466,901 |
| | | | | | | |
| 5.0 | | **COMPACT SUB-STATION-2A & 2B (2000 KVA each )** | | | | |
| | | Design, manufacture, loading, unloading as directed by Project Manager, supply, installation, testing( and commissioning of Compact unitized Substation, outdoor type, comprising following components interconnected with one another, including required interconnection with cable/ busbar and internal earthing connections complete as required and as per specifications. | | | | |
| | | | | | | |
| | | 11KV Compact secondary substation outdoor type designed for natural cooling having type tested equipment comprising distribution transformer and 11 KV VCB switchgear enclosed in laser sealed/welded stainless steel tank,low voltage switchboard,interconnection between HT switchgear and transformer using cables and transformer to LT switchgear using Al busbars/cables,factory built ready for connection type,internal earthing factory completed and other associated equipment etc. complete as required conforming to detailed specifications. | | | | |
| | | | | | | |
| | | The enclosure shall have modular construction using G.I sheets and shall be painted with polyurethane paint from the exterior. The enclosure for HT & LT switchgear shall be provided with IP54 ingress protection.The transformer compartment will have IP34 ingress protection. The transformer used shall be specially designed for low losses. The combinations of Compact substation shall be as per details below: | | | | |
| | | | | | | |
| a | | **11 KV RING MAIN UNIT WITH VCB** | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Supply, testing & commissioning of GIS type RMU (Ring main unit). comprising 2 Nos. 11 KV , 630 A, 20 KA incoming isolators and 1 nos. 630 A VCB 20 KA as outgoings and earth switch bus bars, interlocking and earth bar complete with snap action mechanism for manual and motorized operation, F.PI (Fault position Indication), bushing for 630A, arc proof cable cover complete with interlocking FRTU (IEC 61850) for SCADA. | | | | |
| | | Each Load Break Switch shall be a 3-position switch, with integrated capability to earth at full-making capacity, all motorized/manually operable through separate operating shafts/push-buttons, and shall be accompanied by a SCADA compatible FPI having SC+EF detection capability. | | | | |
| | | Each Fixed-Type VCB shall be associated with motorized/manual spring-charging drive, series tripping coil and associated self-powered relay with CTs, ON/OFF push buttons, suitably interlocked line-side series disconnector cum earthing switch, semaphore indications, Class 1.0 accurate ammeters and multifunction meters. | | | | |
| | | Each RMU shall be accompanied with Metering ready BusPT unit, comprising of Metering Class PTs, suitably isolated via HRC fuses and anti-condensation space heaters, providing bus-voltage signals to respective multifunction meters of respective VCBs. Shall also be provided with R-Y-B indications and associate voltmeter. | | | | |
| | | RMU shall enclose all necessary accessories required for SCADA incl. FRTU (as per specification), all binary inputs providing potential free status of LBS/VCB/Earth-Switches, Gas-Pressure-Low etc. and necessary digital integration of multifunction meters with RTU over ModBus as reqd. | | | | |
| | | | | | | |
| b | | **TRANSFORMER (OIL TYPE with OFF load Tap Changer )** | | | | |
| | | 1No. 11KV / 415V, 2000 KVA three phase, 4 wire, 50Hz, DYn11, ONAN Cooled type transformer mounted inside compact substation enclosure, with Cu winding and standard fittings. | | | | |
| | | | | | | |
| c | | **LT PANEL(MOUNTED INSIDE COMPACT SUBSTATION ENCLOSURE)** | | | | |
| | | Incomer cum Outgoing-415V LT feeder panel having 3200 A four Pole EDO ACB with O/L,S/C and E/F protection output of ACB shall have the provision of Bus duct flanges on top or side. | | | | |
| | | | | | | |
| | | 2000 KVA Compact sub-station as described above and as per specifications. | Set | 6,161,754.00 | 2 | 12,323,508 |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| 6.0 | | **COMPACT SUB-STATION-3A & 3B (1600 KVA each)** | | | | |
| | | Design, manufacture, loading, unloading as directed by Project Manager, supply, installation, testing( and commissioning of Compact unitized Substation, outdoor type, comprising following components interconnected with one another, including required interconnection with cable/ busbar and internal earthing connections complete as required and as per specifications. | | | | |
| | | | | | | |
| | | 11KV Compact secondary substation outdoor type designed for natural cooling having type tested equipment comprising distribution transformer and 11 KV VCB switchgear enclosed in laser sealed/welded stainless steel tank,low voltage switchboard,interconnection between HT switchgear and transformer using cables and transformer to LT switchgear using Al busbars/cables,factory built ready for connection type,internal earthing factory completed and other associated equipment etc. complete as required conforming to detailed specifications. | | | | |
| | | | | | | |
| | | The enclosure shall have modular construction using G.I sheets and shall be painted with polyurethane paint from the exterior. The enclosure for HT & LT switchgear shall be provided with IP54 ingress protection.The transformer compartment will have IP34 ingress protection. The transformer used shall be specially designed for low losses. The combinations of Compact substation shall be as per details below: | | | | |
| | | | | | | |
| | | **a) 11 KV RING MAIN UNIT WITH VCB** | | | | |
| | | Supply, testing & commissioning of GIS type RMU (Ring main unit). comprising 2 Nos. 11 KV , 630 A, 20 KA incoming isolators and 1 nos. 630 A VCB 20 KA as outgoings and earth switch bus bars, interlocking and earth bar complete with snap action mechanism for manual and motorized operation, F.PI(Fault position Indication), bushing for 630A, arc proof cable cover complete with interlocking FRTU (IEC 61850) for SCADA. | | | | |
| | | Each Load Break Switch shall be a 3-position switch, with integrated capability to earth at full-making capacity, all motorized/manually operable through separate operating shafts/push-buttons, and shall be accompanied by a SCADA compatible FPI having SC+EF detection capability. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Each Fixed-Type VCB shall be associated with motorized/manual spring-charging drive, series tripping coil and associated self-powered relay with CTs, ON/OFF push buttons, suitably interlocked line-side series disconnector cum earthing switch, semaphore indications, Class 1.0 accurate ammeters and multifunction meters. | | | | |
| | | Each RMU shall be accompanied with Metering ready BusPT unit, comprising of Metering Class PTs, suitably isolated via HRC fuses and anti-condensation space heaters, providing bus-voltage signals to respective multifunction meters of respective VCBs. Shall also be provided with R-Y-B indications and associate voltmeter. | | | | |
| | | RMU shall enclose all necessary accessories required for SCADA incl. FRTU (as per specification), all binary inputs providing potential free status of LBS/VCB/Earth-Switches, Gas-Pressure-Low etc. and necessary digital integration of multifunction meters with RTU over ModBus as reqd. | | | | |
| | | | | | | |
| | | **b) TRANSFORMER (OIL TYPE with OFF load Tap Changer )** | | | | |
| | | 1No. 11KV / 415V, 1600 KVA three phase, 4 wire, 50Hz, DYn11, ONAN Cooled type transformer mounted inside compact substation enclosure, with Cu winding and standard fittings. | | | | |
| | | | | | | |
| | | **c) LT PANEL(MOUNTED INSIDE COMPACT SUBSTATION ENCLOSURE)** | | | | |
| | | Incomer cum Outgoing-415V LT feeder panel having 2500 A four Pole EDO ACB with O/L,S/C and E/F protection output of ACB shall have the provision of Bus duct flanges on top or side. | | | | |
| | | | | | | |
| | | 1600 KVA Compact sub-station as described above and as per specifications. | Set | 5,697,225.00 | 2 | 11,394,450 |
| | | | | | | |
| 7.0 | | **COMPACT SUB-STATION-4A & 4B (2000 KVA each)** | | | | |
| | | Design, manufacture, loading, unloading as directed by Project Manager, supply, installation, testing( and commissioning of Compact unitized Substation, outdoor type, comprising following components interconnected with one another, including required interconnection with cable/ busbar and internal earthing connections complete as required and as per specifications. | | | | |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 11KV Compact secondary substation outdoor type designed for natural cooling having type tested equipment comprising distribution transformer and 11 KV VCB switchgear enclosed in laser sealed/welded stainless steel tank,low voltage switchboard,interconnection between HT switchgear and transformer using cables and transformer to LT switchgear using Al busbars/cables,factory built ready for connection type,internal earthing factory completed and other associated equipment etc. complete as required conforming to detailed specifications. | | | | |
| | | | | | | |
| | | The enclosure shall have modular construction using G.I sheets and shall be painted with polyurethane paint from the exterior. The enclosure for HT & LT switchgear shall be provided with IP54 ingress protection.The transformer compartment will have IP34 ingress protection. The transformer used shall be specially designed for low losses. The combinations of Compact substation shall be as per details below: | | | | |
| | | | | | | |
| | | **a) 11 KV RING MAIN UNIT WITH VCB** | | | | |
| | | Supply, testing & commissioning of GIS type RMU (Ring main unit). comprising 2 Nos. 11 KV , 630 A, 20 KA incoming isolators and 1 nos. 630 A VCB 20 KA as outgoings and earth switch bus bars, interlocking and earth bar complete with snap action mechanism for manual and motorized operation, F.PI(Fault position Indication), bushing for 630A, arc proof cable cover complete with interlocking FRTU (IEC 61850) for SCADA. | | | | |
| | | Each Load Break Switch shall be a 3-position switch, with integrated capability to earth at full-making capacity, all motorized/manually operable through separate operating shafts/push-buttons, and shall be accompanied by a SCADA compatible FPI having SC+EF detection capability. | | | | |
| | | Each Fixed-Type VCB shall be associated with motorized/manual spring-charging drive, series tripping coil and associated self-powered relay with CTs, ON/OFF push buttons, suitably interlocked line-side series disconnector cum earthing switch, semaphore indications, Class 1.0 accurate ammeters and multifunction meters. | | | | |
| | | Each RMU shall be accompanied with Metering ready BusPT unit, comprising of Metering Class PTs, suitably isolated via HRC fuses and anti-condensation space heaters, providing bus-voltage signals to respective multifunction meters of respective VCBs. Shall also be provided with R-Y-B indications and associate voltmeter. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | RMU shall enclose all necessary accessories required for SCADA incl. FRTU (as per specification), all binary inputs providing potential free status of LBS/VCB/Earth-Switches, Gas-Pressure-Low etc. and necessary digital integration of multifunction meters with RTU over ModBus as reqd. | | | | |
| | | | | | | |
| | | **b) TRANSFORMER (OIL TYPE with OFF load Tap Changer )** | | | | |
| | | 1No. 11KV / 415V, 2000 KVA three phase, 4 wire, 50Hz, DYn11, ONAN Cooled type transformer mounted inside compact substation enclosure, with Cu winding and standard fittings. | | | | |
| | | | | | | |
| | | **c) LT PANEL(MOUNTED INSIDE COMPACT SUBSTATION ENCLOSURE)** | | | | |
| | | Incomer cum Outgoing-415V LT feeder panel having 3200 A four Pole EDO ACB with O/L,S/C and E/F protection output of ACB shall have the provision of Bus duct flanges on top or side. | | | | |
| | | | | | | |
| | | 2000 KVA Compact sub-station as described above and as per specifications. | Set | 6,161,754.00 | 2 | 12,323,508 |
| | | | | | | |
| | | **TOTAL CARRIED TO SUMMARY** | | | | 65,621,177 |
| | | | | | | |
| P | | **66 KV GIS SWITCHGEARS , 11 KV MAIN HT PANEL & DG SYNCH. PANEL** | | | | |
| | | | | | | |
| 1.0 | | Supply of of 60KV,10KA, Zinc oxide type, heavy duty, station class, lightning arrestor.1CX50 sqmm copper flexible cable to be provided for connection with LA surge counter including connector arrangement required for connection with PTR HV side busbar . | Set | 150,000.00 | 6 | 900,000 |
| 2.0 | | Supply of Outdoor type 72.5kV GIS to dry type Termination kit for 72.5kV XLPE Cables of 3CX1000 Sq.mm.with required accessories as per . specifications. | Set | 65,000.00 | 4 | 260,000 |
| 3.0 | | Supply of 72.5kV, 31.5 kA for 3 Secs, 1250A, indoor SF6 GIS switchgear Panel,metal enclosed,insulated with SF6 with high pressure in segreggated components in independent gas zones along with Local Control Cubicle. 66 KV Switchgear, Control and Relay GIS unit. The panel shall be of SF6 Gas Insulated with metal enclosed compartmentalized design with all the High voltage compartments viz. Circuit Breaker, Bus Bar, Current Transformers(5 Core-multiwinding-multiratio),isolator, earthing switch, bus disconnector switch , GIS cable termination and Voltage transformers separated by metallic partitions. | Set | 14,000,000.00 | 2 | 28,000,000 |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | The LCC and separate CR Panel shall be a part of the requirement with mandatory spares as mentioned in specificationsIt is to be extendible on both sides with Copper insulated busbars and complete with GIS Dry type cable termination kits including supply of adaptor if any , ,non-motorized PT link , line differential relays for all line panels,cable cleating arrangement, base frames etc, glands as per cable sizes specified elsewhere.<br><br>The equipment shall meet all the technical requirement as given in detailed specifications and must be provided with a separate CR Panel for protection, control and automation purposes and comply to the Protection & Automation (SCADA) requirements in totality as given in the various parts of technical specifications and shall be fully compatible with substation automation /SCADA as detailed out in the specifications. Compatible with IEC 61850 Protocol. Cost of control and relay panel (CRP) and 220V single phase AC to 220V V DC converter, 2kVA to be included in the item cost. | | | | |
| 4.0 | | Supply of 66 kv Line Differential Relay for Remote end:The relay shall meet the all the technical requirement as given in detailed Protection & Automation (SCADA) requirements in totality as given in the various parts of technical specifications and shall be fully compatible with substation automation /SCADA as detailed out in the detailed specifications. Compatible with IEC 61850 Protocol.with required accessories as per . specifications. | Set | 130,000.00 | 2 | 260,000 |
| 5.0 | | Supply of equipments for Providing and maintaining positive pressure of 0.5 kg/cmsq in GIS control room complete with equipments and measuring humidity level suitable for GIS equipment in line with relavent standard & practice with required accessories as per . specifications. | Set | 35,000.00 | 1 | 35,000 |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| 6.0 | | Installation, testing and commissioning of 72.5kV, 31.5 kA for 3 Secs, 1250A, indoor double busbar SF6 GIS switchgear Panel,metal enclosed,insulated with SF6 with high pressure in segreggated components in independent gas zones along with Local Control Cubicle. 66 KV Switchgear, Control and Relay GIS unit. The panel shall be of SF6 Gas Insulated with metal enclosed compartmentalized design with all the High voltage compartments viz. Circuit Breaker, Bus Bar, Current Transformers(5 Core-multiwinding multiratio),isolator, earthing switch, bus disconnector switch , GIS cable termination and Voltage transformers separated by metallic partitions. The LCC and separate CR Panel shall be a part of the requirement with mandatory spares as mentioned in specifications.It is to be extendible on both sides with | Set | 150,000.00 | 2 | 300,000 |
| | | Copper insulated busbars and complete with GIS Dry type cable termination kits including supply of adaptor if any , ,non-motorized PT link , line differential relays for all line panels,cable cleating arrangement, base frames etc, glands as per cable sizes specified elsewhere. The equipment shall meet all the technical requirement as given in detailed specifications and must be provided with a separate CR Panel for protection, control and automation purposes and comply to the Protection & Automation (SCADA) requirements in totality as given in the various parts of technical specifications and shall be fully compatible with substation automation /SCADA as detailed out in the specifications. Compatible with IEC 61850 Protocol. | | | | |
| 7.0 | | Installation, testing and commissioning of 66 kv Line Differential Relay for Remote end:The relay shall meet the all the technical requirement as given in detailed Protection & Automation (SCADA) requirements in totality as given in the various parts of technical specifications and shall be fully compatible with substation automation /SCADA as detailed out in the detailed specifications. Compatible with IEC 61850 Protocol. | Set | 15,000.00 | 2 | 30,000 |
| 8.0 | | Installation, testing and commissioning of equipments for Providing and maintaining positive pressure of 0.5 kg/cmsq in GIS control room complete with equipments and measuring humidity level suitable for GIS equipment in line with relavent standard & practice with required accessories as per . specifications. | Set | 10,000.00 | 1 | 10,000 |
| 9.0 | | Providing & Installtion of 66KV , cable interface unit complete in all respects. | Set | 5,000.00 | 6 | 30,000 |
| | | | | | | |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| 1.0 | | **Supply, Installation, Testing and Commissioning of 11KV,HT PANEL BOARD -** | | | | |
| | | **Incoming** | | | | |
| | | **Transformer Incoming** | | | | |
| | | Two (2) Nos. 11 KV 1250A VCB (500 MVA) 26.3 KA rupturing capacity at 11kV rated metal clad, floor mounting, horizontal isolation horizontal drawout type and as per specifications complete with the following with each breaker as shown in drawing. | | | | |
| | | | | | | |
| | | Manually & motor operated (230V AC), spring charged trip free type, VCB incorporating mechanical as well as electrical ON/OFF indication, spring charge/discharge mechanical indication"OFF" push button test/service position limit switches with 4NO/4NC breaker auxilary contacts in service position. | | | | |
| | | | | | | |
| | | Cast Resin CT with dual ratio double wound, 350-200/5A /5+5 & with metering and protection core. | | | | |
| | | | | | | |
| | | 15VA burden for protection ( Class 5P-20) | | | | |
| | | Set 3 | | | | |
| | | 15VA burden of metering ( accuracy class 0.5) | | | | |
| | | 15VA burden for REF(Class PS CTs) | | | | |
| | | Set 3 | | | | |
| | | 15VA burden, 350/5AClass PS CTs for differential protection | | | | |
| | | Set 3 | | | | |
| | | Voltage transformer with each , 3 limbs connected in star, dual class , 11kV/3/110V/3 with drawable type with automatic shutters 100 VA burden with primary & secondary fuses.( Confirming related IS specs.) (3 sets) | | | | |
| | | | | | | |
| | | **Protection** | | | | |
| | | Over current & short circuit 51,51N & one earth fault element with numerical IDMT relay with shunt trip on 24volts DC, (11 KV relay on 61850 protocol ) consisting 2 element over current relay with setting from 50 to 200% (step of 25%) and earth fault with setting from 20 to 80% (step of 10%) . | | | | |
| | | | | | | |
| | | Trip circuit supervision relay (95). | | | | |
| | | Antipumping relay | | | | |
| | | | | | | |
| | | All wiring necessary for the above including interconnections. The size of the conductor should not be less than 1.5sqmm copper wire where required. | | | | |
| | | | | | | |
| | | Test terminal block fuses, circuit lables , phase indication lamps etc. as per standard practice. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | | | | | |
| | | **Metering** | | | | |
| | | Voltmeter range 0-12KV with necessary voltmeter selector switch & suitable for 110V AC 96x96sqmm dial with shrouded terminal & protection fuses. | | | | |
| | | | | | | |
| | | Ammeter range (0- 350A) with necessary ammeter selector switch dual graduated scale, 96x96 sqmm dial with shrouded terminal . | | | | |
| | | Trivector Meter | | | | |
| | | Power Factor Meter | | | | |
| | | Frequency Meter | | | | |
| | | Necessary DC supply healthy LED type indication lamp & switch. | | | | |
| | | Control : T-N-C ( Trip , Neutral & Close) breaker control switch with indicating arrangement. | | | | |
| | | Danger plate (As per specification) | | | | |
| | | Set of circuit breaker ON/OFF/Autotrip / Spring charged/Trip circuit healthy indicating lamp(LED type) | | | | |
| | | Three pin socket + switch. | | | | |
| | | Anticondensation space heater / thermostat | | | | |
| | | | | | | |
| | | **DG Incoming** | | | | |
| | | Two (2) Nos. 11 KV, 800 A VCB (500 MVA) 26.3 KA rupturing capacity at 11kV rated metal clad, floor mounting, horizontal isolation horizontal drawout type and as per specifications complete with the following with each breaker as shown in drawing. | | | | |
| | | | | | | |
| | | Manually & motor operated (230V AC), spring charged trip free type, VCB incorporating mechanical as well as electrical ON/OFF indication, spring charge/discharge mechanical indication"OFF" push button test/service position limit switches with 4NO/4NC breaker auxilary contacts in service position. | | | | |
| | | | | | | |
| | | Cast Resin CT with dual ratio double wound, 600-300 /5+5 & with metering and protection core. | | | | |
| | | | | | | |
| | | 15VA burden for protection ( Class 5P-20) | | | | |
| | | Set 3 | | | | |
| | | 15VA burden of metering ( accuracy class 0.5) | | | | |
| | | 15VA burden for REF(Class PS CTs) | | | | |
| | | Set 3 | | | | |
| | | Voltage transformer with each , 3 limbs connected in star, dual class , 11kV/3/110V/3 with drawable type with automatic shutters 100 VA burden with primary & secondary fuses.( Confirming related IS specs.) (3 sets) | | | | |
| | | | | | | |
| | | **Protection** | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Over current & short circuit 51,51N & one earth fault element with numerical IDMT relay with shunt trip on 24volts DC, (11 KV relay on 61850 protocol ) consisting 2 element over current relay with setting from 50 to 200% (step of 25%) and earth fault with setting from 20 to 80% (step of 10%) . | | | | |
| | | | | | | |
| | | Trip circuit supervision relay (95). | | | | |
| | | Antipumping relay | | | | |
| | | | | | | |
| | | All wiring necessary for the above including interconnections. The size of the conductor should not be less than 1.5sqmm copper wire where required. | | | | |
| | | | | | | |
| | | Test terminal block fuses, circuit lables , phase indication lamps etc. as per standard practice. | | | | |
| | | | | | | |
| | | **Metering** | | | | |
| | | Voltmeter range 0-12KV with necessary voltmeter selector switch & suitable for 110V AC 96x96sqmm dial with shrouded terminal & protection fuses. | | | | |
| | | | | | | |
| | | Ammeter range (0- 600A) with necessary ammeter selector switch dual graduated scale, 96x96 sqmm dial with shrouded terminal . | | | | |
| | | Trivector Meter | | | | |
| | | Power Factor Meter | | | | |
| | | Frequency Meter | | | | |
| | | Necessary DC supply healthy LED type indication lamp & switch. | | | | |
| | | Control : T-N-C ( Trip , Neutral & Close) breaker control switch with indicating arrangement. | | | | |
| | | Danger plate (As per specification) | | | | |
| | | Set of circuit breaker ON/OFF/Autotrip / Spring charged/Trip circuit healthy indicating lamp(LED type) | | | | |
| | | Three pin socket + switch. | | | | |
| | | Anticondensation space heater / thermostat | | | | |
| | | **Bus Coupler :-** | | | | |
| | | 1 No. 1250 A 11 KV, Vacuume circuit breaker (500 MVA) 26.3KA rupturing capacity at 11kV rated metal clad, floor mounting, horizontal isolation horizontal drawout type complete as per SLD. | | | | |
| | | Note: Protection same as provided with incomer. | | | | |
| | | **Outgoings** | | | | |
| | | 8 Nos. 11 KV 800 A (500 MVA) 26.3 KA rupturing capacity at 11kV rated metal clad, floor mounting, horizontal isolation horizontal drawout type complete with the following: | | | | |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Manually & motor operated (230V AC), spring charged trip free type, VCB incorporating mechanical as well as electrical ON/OFF indication, spring charge/discharge mechanical indication"OFF" push button test/service position limit switches with 4NO/4NC breaker auxilary contacts in service position. | | | | |
| | | | | | | |
| | | Cast Resin CT with double wound, 300 /5+5 with metering and protection core. | | | | |
| | | | | | | |
| | | 15VA burden for protection ( Class 5P-10) | | | | |
| | | Set 3 | | | | |
| | | 15VA burden of metering ( accuracy class 1.0) | | | | |
| | | | | | | |
| | | **Protection** | | | | |
| | | Over current & short circuit 51,51N & one earth fault element with numerical relay with shunt trip on 24volts DC, (11 KV relay on 61850 protocol ) consisting 2 element over current relay with setting from 50 to 200% (step of 25%) and earth fault with setting from 20 to 80% (step of 10%) . | | | | |
| | | | | | | |
| | | Trip circuit supervision relay (95). | | | | |
| | | Antipumping relay | | | | |
| | | | | | | |
| | | **Metering :** | | | | |
| | | Ammeter range (0-250) with necessary ammeter selector switch dual graduated scale, 96x96 sqmm dial with shrouded terminal . | | | | |
| | | | | | | |
| | | Necessary DC supply healthy indication lamp & switch. | | | | |
| | | Control : T-N-C ( Trip , Neutral & Close) breaker control switch with indicating arrangement. | | | | |
| | | Danger plate (As per specification) | | | | |
| | | Set of circuit breaker ON/OFF/Autotrip / Spring charged/Trip circuit healthy indicating lamp(LED type) | | | | |
| | | Three pin socket + switch. | | | | |
| | | Anticondensation space heater / thermostat | | | | |
| | | 50x6mm, copper earth bus shall be provided for the full length of panel. | | | | |
| | | | | | | |
| | | Terminal boxes with single gland trifucating cable box suitable for 11KV aluminium XLPE (E) cable of size 3C x 300 sqmm for incoming & 300 Sq.mm for outgoings. | | | | |
| | | | | | | |
| | | All control wiring necessary for the above including interconnections. The size of the conductor should not be less than 1.5sqmm PVC insulated copper wire where required. | | | | |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Test terminal block fuses, circuit lables , phase indication lamps etc. as per standard practice. | | | | |
| | | | | | | |
| | | | | | | |
| | | **11KV,HT PANEL BOARD Described as above -** | **Set** | 9,974,930.00 | 1 | 9,974,930 |
| | | | | | | |
| 3.0 | | **11KV, SYNCHRONIZING PANEL (INDOOR TYPE) -supply , installation , testing and commissioning of following** | | | | |
| | | **Incoming** | | | | |
| | | Four (4) Nos. 11 KV, 630 A VCB 26.3 KA rupturing capacity at 11kV rated metal clad, floor mounting, horizontal isolation horizontal drawout type complete each with the following: | | | | |
| | | | | | | |
| | | Manually & motor operated (230V AC), spring charged trip free type, VCB incorporating mechanical as well as electrical ON/OFF indication, spring charge/discharge mechanical indication"OFF" push button test/service position limit switches with 4NO/4NC breaker auxilary contacts in service position. | | | | |
| | | | | | | |
| | | Cast Resin CT with double wound, 110/1+1 A protection core. | | | | |
| | | Protection Class - PS (110/1A) | | | | |
| | | Cast Resin CT with double wound, 110/1 A with metering core. | | | | |
| | | 15 VA burden of metering Class-1 | | | | |
| | | 24 V shunt trip coil | | | | |
| | | Set 3 | | | | |
| | | Voltage transformer with each , 3 limbs connected in star, dual class , 11kV/3/110V/3 with drawable type with automatic shutters 100 VA burden with primary & secondary fuses.( Confirming related IS specs.) | | | | |
| | | | | | | |
| | | All wiring necessary for the above including interconnections. The size of the conductor should not be less than 1.5sqmm copper wire where required. | | | | |
| | | | | | | |
| | | Test terminal block fuses, circuit lables , phase indication lamps etc. as per standard practice. | | | | |
| | | | | | | |
| | | **Metering** | | | | |
| | | Voltmeter range 0-12KV with necessary voltmeter selector switch & suitable for 110V AC 96x96sqmm dial with shrouded terminal & protection fuses. | | | | |
| | | Ammeter range (0-150A) with necessary ammeter selector switch dual graduated scale, 96x96 sqmm dial with shrouded terminal . | | | | |
| | | Trivector Meter | | | | |
| | | Power Factor Meter | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Frequency Meter | | | | |
| | | Necessary DC supply healthy LED type indication lamp & switch. | | | | |
| | | Control : T-N-C ( Trip , Neutral & Close) breaker control switch with indicating arrangement. | | | | |
| | | Danger plate (As per specification) | | | | |
| | | Set of circuit breaker ON/OFF/Autotrip / Spring charged/Trip circuit healthy indicating lamp(LED type) | | | | |
| | | Three pin socket + switch. | | | | |
| | | Anticondensation space heater / thermostat | | | | |
| | | **Protection** | | | | |
| | | Over current 50,50N Insutantaneous short circuit 51,51N & one earth fault element with numerical relay with shunt trip on 24volts DC, consisting 2 element over current relay with setting from 50 to 200% (step of 25%) and earth fault with setting from 20 to 80% (step of 10%) . | | | | |
| | | | | | | |
| | | Trip circuit supervision relay (95). | | | | |
| | | Antipumping relay & 49,27,59 relays. | | | | |
| | | | | | | |
| | | **Bus Coupler :-** | | | | |
| | | 1 No. 800 A 11 KV, Vacuume circuit breaker (500 MVA) 26.3KA rupturing capacity at 11kV rated metal clad, floor mounting, horizontal isolation horizontal drawout type complete as per SLD. | | | | |
| | | **Protection** | | | | |
| | | Over current 50,50N Insutantaneous short circuit 51,51N & one earth fault element with numerical relay with shunt trip on 24volts DC, consisting 2 element over current relay with setting from 50 to 200% (step of 25%) and earth fault with setting from 20 to 80% (step of 10%) . | | | | |
| | | | | | | |
| | | Trip circuit supervision relay (95). | | | | |
| | | Antipumping relay & 49,27,59 relays. | | | | |
| | | | | | | |
| | | **Outgoings** | | | | |
| | | Two (2) Nos. 11 KV, 800 A VCB 26.3 KA rupturing capacity at 11kV rated metal clad, floor mounting, horizontal isolation horizontal drawout type each with the followings:- | | | | |
| | | | | | | |
| | | Manually & motor operated (230V AC), spring charged trip free type, VCB incorporating mechanical as well as electrical ON/OFF indication, spring charge/discharge mechanical indication"OFF" push button test/service position limit switches with 4NO/4NC breaker auxilary contacts in service position. | | | | |
| | | | | | | |
| | | Cast Resin CT dual ratio with double wound, 400-200/1+1 with metering and protection core. | | | | |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 15 VA burden for protection ( Class 5P-10) | | | | |
| | | Set 3 | | | | |
| | | 15 VA burden of metering ( accuracy class 1.0) | | | | |
| | | | | | | |
| | | **Protection** | | | | |
| | | Over current 50,50N Insutantaneaus short circuit 51,51N & one earth fault element with numerical relay with shunt trip on 24volts DC, consisting 2 element over current relay with setting from 50 to 200% (step of 25%) and earth fault with setting from 20 to 80% (step of 10%) . | | | | |
| | | | | | | |
| | | Trip circuit supervision relay (95). | | | | |
| | | Antipumping relay | | | | |
| | | | | | | |
| | | **Metering :** | | | | |
| | | Ammeter range (0- 400 A) with necessary ammeter selector switch dual graduated scale, 96x96 sqmm dial with shrouded terminal . | | | | |
| | | Necessary DC supply healthy LED type indication lamp & switch. | | | | |
| | | Control : T-N-C ( Trip , Neutral & Close) breaker control switch with indicating arrangement. | | | | |
| | | Danger plate (As per specification) | | | | |
| | | Set of circuit breaker ON/OFF/Autotrip / Spring charged/Trip circuit healthy indicating lamp(LED type) | | | | |
| | | Three pin socket + switch. | | | | |
| | | Anticondensation space heater / thermostat | | | | |
| | | 50x6mm, copper earth bus shall be provided for the full length of panel. | | | | |
| | | Terminal boxes with single gland trifucating cable box suitable for 11KV aluminium XLPE (E) cable of size 3C x 185 sqmm for incoming & 3C x 300 sqmm for outgoing. | | | | |
| | | | | | | |
| | | All control wiring necessary for the above including interconnections. The size of the conductor should not be less than 1.5sqmm PVC insulated copper wire where required. | | | | |
| | | | | | | |
| | | Test terminal block fuses, circuit lables , phase indication lamps etc. as per standard practice. | | | | |
| | | Battery Charger 30A, 200 AH , 230V AC to 24V DC with sealed maintenance free batteries . | | | | |
| | | | | | | |
| | | **11kV Synchronozation panel described as above** | **Set** | 4,620,740.00 | 1 | 4,620,740 |
| | | | | | | |
| 4.0 | | **NIC & NGR Panel for DGs** | | | | |
| | | Supply, installation, Testing & Commissioning of NIC & NGR panel with following and including connectivity between DG set & NGR as well as between NGR and ground complete as required. | | | | |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Neutral Isolating Switch for 4 Nos. DG sets: | | | | |
| | | Each comprising of following : | | | | |
| | | 4 NoS. 200 amps single Pole 11 KV vacuum contactor for neutral isolation | | | | |
| | | One set of Alluminium bus bars with each contactors. | | | | |
| | | On/Off indicating lamps including all accessories | | | | |
| | | Auto / Manual Selector Switch | | | | |
| | | EARTH FAULT RELAY (51N) | | | | |
| | | Cast Resin CT with double wound, 110/1 with protection core. | | | | |
| | | 10 VA burden for protection ( Class 5P-10) | | | | |
| | | Set 1 | | | | |
| | | **NGR PANEL :** | | | | |
| | | Each comprising of the following : | | | | |
| | | The 33 Ohm, 200 amp, 10 seconds, register element shall be made of un breakable corrosion proof. Punched stainless steel grid of Ferro chrome aluminum alloy. The resistor shall be suitable for the full load current on 10 sec. with temperature rise not carrying exceeding 375o C over ambient temperature. The resistance element shall be supported on suitable insulating base housed in 2 mm thick sheet steel self supporting, free standing cubical with louvers on sides. The unit shall be complete with connection, terminals glands plates etc. | | | | |
| | | | | | | |
| | | **Neutral Isolating & NGR Panel described as above complete as per specification** | **Sets** | 3,056,775.00 | 1 | 3,056,775 |
| | | | | | | |
| 5.0 | | **Supply, installation, Testing & commissiong of Control and Relay panel ( indoor type) with following :** | | | | |
| | | 2 No. 1500 KVA 11 KV DG sets incoming each comprises the following : | | | | |
| | | PLC panel for 4 nos. DG sets with all components & accessories required for two 1500 KVA DG Sets synchronization. | | | | |
| | | Breaker Control Switch | | | | |
| | | Excitation Ammeter | | | | |
| | | Excitation voltmeter | | | | |
| | | Temperature scanner | | | | |
| | | Multifunction meter with RS-485 ports. | | | | |
| | | Multi function numeric relay with Mod bus RS-485 ports for the following: | | | | |
| | | | | | | |
| | | a) Voltage restrained over current protection (50/50N/51 /51N). | | | | |
| | | b) Machine Thermal Relay (49) | | | | |
| | | c) Current unbalance (46) | | | | |
| | | d) Loss of excitation (40) | | | | |
| | | e) Reverse Power (32) | | | | |
| | | f) Under Power (37) | | | | |
| | | g) Under / Over frequency (81) | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| Sl. No | DSR Item No. | Description of Items | Unit | Rate | Total QTY | AMOUNT (INR) |
| | | h) Breaker failure protection ( 52BF) | | | | |
| | | i) Volts/Hz (24) | | | | |
| | | j) Under / Over voltage (27 / 59) | | | | |
| | | Master trip relay (86) | | | | |
| | | Trip circuit supervision relay (95) | | | | |
| | | Engine cranking relay | | | | |
| | | Emergency Push Button. | | | | |
| | | k) Synchronising Relay (25k) | | | | |
| | | Numerical relay for generator protection with dual adjustable slop (87G) | | | | |
| | | Numeric restricted earth fault (64 R) | | | | |
| | | | | | | |
| | | Suitable rating battery charger with voltmeter range of 0-50 volt and Ammeter range of 0-50 amp for trickle and Boosting charging as per specifications | | | | |
| | | | | | | |
| | | Audio visual annunciation windows with accept, reset & test, push buttons. | | | | |
| | | a) High water temperature | | | | |
| | | b) Low lube pressure | | | | |
| | | c) Engine over speed | | | | |
| | | d) Over/under voltage | | | | |
| | | e) Over load / Earth fault | | | | |
| | | f) Differential | | | | |
| | | g) Reverse power | | | | |
| | | h) Under/over frequency | | | | |
| | | i) Winding temperature high | | | | |
| | | j) Bearing temperature high | | | | |
| | | k) Over Current | | | | |
| | | l) Earth Fault | | | | |
| | | m) 4 no. spares | | | | |
| | | | | | | |
| | | Microprocessor based DG controller and HMI (Human Machine Interference) shall also be part of relay panel.- | | | | |
| | | | | | | |
| | | PLC panels | | | | |
| | | Components for PLC Panels comprises following | | | | |
| | | | | | | |
| | | Main Processor 1 No. | | | | |
| | | 32 Channel digital I/P Module 10 No. | | | | |
| | | 32 Channel digital O/P Module 10 No. | | | | |
| | | 16 Slot I/o Rack 2 No. | | | | |
| | | Rack Power Supply 2 No. | | | | |
| | | 4 Channel Analog I/P Module 1 No. | | | | |
| | | EEPROM 1 No. | | | | |
| | | Power Monitor 12 No. | | | | |
| | | Advance Interface Convertor 1 No. | | | | |
| | | Communication Cable 1 No. | | | | |
| | | Communication Card 1 No. | | | | |
| | | Window base graphics software 1 No. | | | | |
| | | | | | | |
| | | 1 Set mimic | | | | |
| | | 1 set Aux. Relays | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 1 Set indicating lights / PB | | | | |
| | | 1 set control MCB's | | | | |
| | | 1 No. Auto/Manual/Test Switch | | | | |
| | | 1No. status indicator | | | | |
| | | | | | | |
| | | Manual Synchronizing - 1 set each comprising of the following | | | | |
| | | 1No. Double Voltmeter | | | | |
| | | 1No. Double Frequency meter | | | | |
| | | 1No. Synchroscope | | | | |
| | | 1No. Synchronizing Switch | | | | |
| | | 1No.set Selector Switch | | | | |
| | | 1No. Dark lamps | | | | |
| | | 1No. Bright lamps | | | | |
| | | 1No. Check Synchronizing Relay | | | | |
| | | | | | | |
| | | Control relay /PLC Panel described as above complete as per specification | Set | 3,220,000.00 | 2 | 6,440,000 |
| | | Note: control & relay panel for two future dg sets hall be considered in later stage. | | | | |
| | | **TOTAL CARRIED TO SUMMARY** | | | | 53,917,445 |
| | | | | | | |
| Q | | **ISOLATOR PANEL BOARDS (INDOOR & OUTDOOR TYPE)** | | | | |
| | | Supplying,Installation, testing and commissioning of cubical Type tested (TTA) Isolator cum Capacitor panel (IP52) suitable for 415V, 3 Phase,4 wire 50 Hz AC supply system fabricated in compartmentalized design from CRCA sheet steel of 2mm thick for frame work and covers, 3mm thick for gland plates i/c cleaning & finishing completed 7 tank process of powder coating in approved shade,having E-91 grade TPN Aluminium alloy bus bars of high conductivity,with short circuit withstand capacity for 1 sec, bottom base channel of MS section not less that 100 mm x 50mm x 5mm thick, fabrication shall be done | | | | |
| | | transportable sections,entire panel shall have a common copper earth bar of size 25mmx5mm at the rear with 2 no's earth stud,solid connections from main bus bar to switchgears with required size of alunimium bus bars and control wiring PVC insulated copper conductor S/C cable alleys,cable gland plates in two half,i/c providing following switch gears: (with all necessary hardware, accessories as required for complete installation as per specifications and single line digram).LT Panels should be as per IEC-61439-1 & 2. Ashed over all isolator panels shall also be provided ads shown in the drawing : | | | | |
| | | | | | | |
| 1(A) | | **ISOLATOR PANEL 1 & ISOLATOR PANEL 2 (ESS-1) INDOOR TYPE** | | | | |
| | | **Incoming** | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 1 Set RBYN , 4000 Amp 4 Pole Bus Bars with the Provision of Bus duct connectivity flange on top or side. | | | | |
| | | | | | | |
| | | 1 No. 4000 Amp FP electrically operated fully drawout type air circuit breaker with microprocessor based release unit for over load, short circuit, and earth fault protection with current unbalane , voltage unbalance reverse power and frequency & harmonics measurement as per specification and each with following accessories : | | | | |
| | | | | | | |
| | | Electronic energy meter of accuracy class-0.5S, with 3 Nos. 4000/5 A 15VA CTs to measure and display the following electrical Parameters : | | | | |
| | | | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | | | | | |
| | | Phase indicating light through 415 V / √ 3 : 110 V/ √ 3PT, Primary / Secondary of PT's shall be protected by 2 A MCB's. | | | | |
| | | | | | | |
| | | Breaker ON / OFF / TRIP LED type indicating lights with control MCB's. | | | | |
| | | Spring charge / trip circuit healthy indication | | | | |
| | | Under voltage release | | | | |
| | | 24 V DC Shunt trip coil. | | | | |
| | | Under voltage relay with timer (27) | | | | |
| | | Over voltage relay with timer (59) | | | | |
| | | Breaker control switch | | | | |
| | | 1 No. 96 x 96 sq.mm 0-4000A/1600A digital ammeter with selector switch and 3 Nos. 4000 / 5 A ,15 VA CL:0.5 CT's | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. through 415 V / √ 3 : 110 V/ √ 3 PT's, Primary and Secondary of PT's shall be protected by 2 A TP MCB's | | | | |
| | | Auxiliary contacts required for necessary interlocking of breakers. | | | | |
| | | Separate set of class 5P20, 15VA CT of suitable capacity for protection | | | | |
| | | | | | | |
| | | **Bus Bars** | | | | |
| | | 5000 A TPN aluminium bus bars (65 KA) with coloured heat shrinkable insulation sleeves | | | | |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | **Outgoings** | | | | |
| | | 1 Nos. 3200 A 4P electrically operated fully draw out type aircircuit breaker with micorprocessor based release unit for short circuit ,over load, earth fault protection & energy parameters as per specifications. | | | | |
| | | 1 Nos. 1600 A TPN electrically operated fully draw out type aircircuit breaker with micorprocessor based release unit for short circuit ,over load, earth fault protection & energy parameters as per specifications. | | | | |
| | | 1 Nos. 1600 A 4P electrically operated fully draw out type aircircuit breaker with micorprocessor based release unit for short circuit ,over load, earth fault protection & energy parameters as per specifications. | | | | |
| | | 2 Nos. 1000 A 4P electrically operated fully draw out type aircircuit breaker with micorprocessor based release unit for short circuit ,over load, earth fault protection & energy parameters as per specifications. | | | | |
| | | **Isolator Panel as described above** | **Sets** | 3,576,824.00 | 2 | 7,153,648 |
| | | | | | | |
| 1 (B) | | **IGBT based Hybrid Power Factor Correction Panel (750 KVAR) Indoor Type** | | | | |
| | | Design, supply, installation, testing & commissioning of cubicle type compartementalized floor mounted free standing type with separation system as per IS:8623 part-1 for 415V, 50HZ, 3 phase 4 wire supply, moisture, dust and vermin proof IP-52 with cooling intrinsic design of voltage sourced IGBT based intelligent Hybrid PFC panel with Programmable Microprocessor controller to maintain Power Factor, Harmonics & Unbalancing duly housed in epoxy powder coated 2mm thick CRCA sheet steel compatmentalised enclosure free standing type with all supports, accessories, switch gears, control gears, protections, wiring, interconnections, control MCBs etc. as required complete in all respects & having its main components as bellow along with all other standard components ,circuitry & specifications as required: | | | | |
| | | | | | | |
| | | Hybrid PFC Panel shall have a rating of 750kvar @ 415V. It shall comprise at least 470kvar of IGBT based active filter (for reactive, harmonics and unbalance compensation) and remainder capacity (280kvar) of detuned capacitor banks (for reactive compensation). The detuned capacitor banks shall be controlled through the microprocessor used in the active filter. | | | | |
| | | | | | | |
| | | **Incomer** | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | In coming ACB 1600A-TP-65kA-415Volts - 01 Nos. | | | | |
| | | Neutral Link 500A-SP-65kA - 01 Nos. | | | | |
| | | **Metering & Indications** | | | | |
| | | Display meter with compatible RS 485 ports - 01 Nos. | | | | |
| | | Phase Indicating & ON-OFF LED Lights 230 V - 03 Nos | | | | |
| | | Ammeter - digital 3 Phase - 2 Nos. | | | | |
| | | MCB 6A-SP-10kA-C-Curve - 3 Nos. | | | | |
| | | **Active Filter** | | | | |
| | | a) Required IGBTs | | | | |
| | | b) IGBT base active technology | | | | |
| | | c) Gate driver, Interfacing and other control cards | | | | |
| | | d) Heat Sinks | | | | |
| | | e) Heavy duty cooling blowers/ fans with protection | | | | |
| | | f) Voltage Sensing Cards & circuitry | | | | |
| | | g) Current Transducers | | | | |
| | | h) SMPS | | | | |
| | | i) SSR | | | | |
| | | j) MCCB with ROM 630A-TP-65kA-T/M - 2 Nos. | | | | |
| | | k) MCB 10A-FP-10KA- C curve - 02 Nos. | | | | |
| | | l) Contactor 225A-TP-AC3 Duty - 4 Nos. | | | | |
| | | m) Protections | | | | |
| | | p) Choke coil for interfacing IGBT with grid | | | | |
| | | n) High Frequency & D C bus capacitors | | | | |
| | | o) Interconnection with UNIVININ copper stranded wires, Copper Bus-bars, earth bus, danger notice boards, inscription plates, terminals for incoming & outgoing cable connections | | | | |
| | | p) Remote sensing resin cast CTs shall be provided in main panel on common Bus by Main Panel Manufacturer | | | | |
| | | q) All required hardware's, softwares, protections, cards, inscription plates, Danger notice board etc., as required to be provided to complete the system | | | | |
| | | r) MCCB, contactor and fuses of applicable rating and protections shall be provided for the active filter | | | | |
| | | | | | | |
| | | **Programmable Microprocessor controller** | | | | |
| | | i) Instantaneous corrections of leading & lagging power factor & to keep the power factor nearer to unity | | | | |
| | | ii) Instantaneous corrections in current THD levels & maintain las per IEEE 519-92 | | | | |
| | | iii) Three phase (non-neutral) unbalance compensation | | | | |
| | | iv) Reduction in voltage distortions as a result of reduction in ITHD | | | | |
| | | v) Reduction in surges caused by switching of Heavy Load reduce tripping effect on electronic devices | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | | | | | |
| | | **Detuned Capacitor Banks** | | | | |
| | | a) Switched Capacitors - Heavy duty (MPP) type AC three phase capacitors 16 KVAR - 08 Nos 525V grade with discharge resistor, control gears capacitor duty contactors suitable for 35KVAR & switch gears MCCBs-80A-TP-65 kA - 08 Nos of required ratings with overload & short circuit protections for each capacitor banks, LED ON indication light, auto manual switch & Auxiliary contactors, ON-OFF push buttons , timers, ammeters, control MCBs, interconnection & control wiring with copper conductor wire, Main copper bus bars etc as required | | | | |
| | | b) Control Circuits with 1.5SQmm copper conductor FRLS wires | | | | |
| | | c) 7% Detuned aluminium series reactors with minim 180% linearity with each capacitor bank | | | | |
| | | | | | | |
| | | All MCCB/ACB's shall be suitable for 65 KA (ICS) breaking capacity. | | | | |
| | | **HPFC Panel as described above** | **Set** | 4,171,275.84 | 2 | 8,342,552 |
| | | | | | | |
| 2.0 | | **MAIN NORMAL PANEL - ESS 1** | | | | |
| | | **SECTION I** | | | | |
| | | **Incoming** | | | | |
| | | | | | | |
| | | 1000 A 4P electrically operated fully draw out type air circuit breaker (65 kA)with micorprocessor based release unit for short circuit ,over load, earth fault protection & energy parameters as per specifications. | | | | |
| | | | | | | |
| | | Electronic energy meter of accuracy class-0.5S, with 3 Nos. 1000 /5 A 15VA CTs to measure and display the following electrical Parameters : | | | | |
| | | | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | | | | | |
| | | Phase indicating light through 415 V / √ 3 : 110 V/ √ 3PT, Primary / Secondary of PT's shall be protected by 2 A MCB's. | | | | |
| | | | | | | |
| | | Breaker ON / OFF / TRIP LED type indicating lights with control MCB's. | | | | |
| | | | | | | |
| | | Spring charge / trip circuit healthy indication | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Under voltage release | | | | |
| | | 24 V DC Shunt trip coil. | | | | |
| | | Under voltage relay with timer (27) | | | | |
| | | Over voltage relay with timer (59) | | | | |
| | | Breaker control switch | | | | |
| | | 1 No. 96 x 96 sq.mm 0-100A digital ammeter with selector switch and 3 Nos. 1000 / 5 A ,15 VA CL:0.5 CT's. | | | | |
| | | | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. through 415 V /√ 3 : 110 V/ √ 3 PT's, Primary and Secondary of PT's shall be protected by 2 A TP MCB's. | | | | |
| | | | | | | |
| | | Auxiliary contacts required for necessary interlocking of breakers. | | | | |
| | | | | | | |
| | | Separate set of class 5P10, 15VA CT of suitable capacity for protection. | | | | |
| | | | | | | |
| | | **Bus Bars** | | | | |
| | | 1200 A TPN aluminium bus bars (65 KA) with coloured heat shrinkable insulation sleeves | | | | |
| | | | | | | |
| | | **Outgoings** | | | | |
| | | 1 No, 800 amps TPN electrically operated fully drawout type air circuit breaker with ON / OFF / TRIP indicating lamps with control MCB's, shunt trip, 415V under voltage release, 1 No. 230 V AC closing coil breaker control switch etc. | | | | |
| | | 400 A FP MCCB (65 kA) 5 Nos. | | | | |
| | | 250 A FP MCCB (65 kA) 1 No. | | | | |
| | | | | | | |
| | | All outgoings shall haveMultifunction meter. | | | | |
| | | | | | | |
| | | **Bus Coupler-: Breaker `B'** | | | | |
| | | 1000 amps 4 pole electrically operated fully drawout type air circuit breaker with ON / OFF / TRIP indicating lamps with control MCB's, shunt trip, 415V under voltage release, 1 No. 230 V AC closing coil breaker control switch etc. | | | | |
| | | 1 Set | | | | |
| | | **SECTION - II** | | | | |
| | | **Incoming** | | | | |
| | | 1000 A 4P electrically operated fully draw out type air circuit breaker with micorprocessor based release unit for short circuit ,over load, earth fault protection & energy parameters as per specifications. | | | | |
| | | | | | | |
| | | Multifunctional meter of accuracy class-0.5S, with 1 No.1000/5 A 15VA CTs to measure and display the following electrical Parameters : | | | | |
| | | | | | | |
| | | Real Time | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | 3 Nos. Phase indicating light through 415 V / √ 3 : 110 V/ √ 3 PT. | | | | |
| | | Breaker ON / OFF / TRIP LED type indicating lights with control MCB's. | | | | |
| | | Spring charge / trip circuit healthy indication | | | | |
| | | | | | | |
| | | 1 No. 96 x 96 sq.mm 0-1000A digital ammeter with selector switch and 3 Nos. 1000 / 5 A ,15 VA CL:0.5 CT's | | | | |
| | | | | | | |
| | | 96 x 96 mm sq. 0-500 Volt digital voltmeter with selector switch through 415 V / √ 3 : 110 V/ √ 3 PT's, Primary and Secondary of PT's shall be protected by 2 A TP MCB's | | | | |
| | | | | | | |
| | | Breaker control switch | | | | |
| | | | | | | |
| | | Auxiliary contacts required for necessary interlocking of breakers. | | | | |
| | | | | | | |
| | | **Bus Bars** | | | | |
| | | 1200 A TPN aluminium bus bars (65 KA) with coloured heat shrinkable insulation sleeves | | | | |
| | | | | | | |
| | | **Outgoings** | | | | |
| | | 2 Nos. 630 A 4P electrically operated fully draw out type air circuit breaker with micorprocessor based release unit for short circuit ,over load, earth fault protection & energy parameters as per specifications. | | | | |
| | | 630 A 4P MCCB (65 kA) 1 Nos. | | | | |
| | | 400 A 4P MCCB (65 kA) 2 Nos. | | | | |
| | | 250 A 4P MCCB (65 kA) 2 Nos. | | | | |
| | | | | | | |
| | | All outgoings shall haveMultifunction meter. | | | | |
| | | All MCCB/ACB's shall be suitable for 65 KA (ICS) breaking capacity. | | | | |
| | | 415 / 110 V suitable rating control transformer shall be provided for aux. Control supply. | | | | |
| | | Wiring with space heater, thermostat and control MCB's shall be provided all vertical sections of main LT panel. | | | | |
| | | All outgoing MCCB's feeders shall be provided with short circuit & earth fault relay module. | | | | |
| | | All incoming as well as outgoing feeders shall have pad locking facility. | | | | |
| | | Suitable danger board shall be provided. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | All bus bar section / backside panels shall have pad locking facility and hinged type door. | | | | |
| | | 4 pole surge arrestor with each incoming feeder | | | | |
| | | | | | | |
| | | All incoming as well as outgoing air circuit breaker shall be compatible with BAS system (Bacnet) | | | | |
| | | **Main Normal Panel at ESS-1 as described above** | **Set** | 3,846,819.19 | 1 | 3,846,819 |
| | | | | | | |
| 3.0 | | **MAIN EMERGENCY PANEL - ESS 1** | | | | |
| | | **SECTION I** | | | | |
| | | **Incoming** | | | | |
| | | 1 No. 1000 A 4P electrically operated fully draw out type air circuit breaker with micorprocessor based release unit for short circuit ,over load, earth fault protection & energy parameters as per specifications. | | | | |
| | | | | | | |
| | | Electronic energy meter of accuracy class-0.5S, with 3 Nos. 1000/5 A 15VA CTs to measure and display the following electrical Parameters : | | | | |
| | | | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | | | | | |
| | | Phase indicating light through 415 V /√ 3 : 110 V/ √ 3PT, Primary / Secondary of PT's shall be protected by 2 A MCB's. | | | | |
| | | | | | | |
| | | Breaker ON / OFF / TRIP LED type indicating lights with control MCB's. | | | | |
| | | Spring charge / trip circuit healthy indication | | | | |
| | | Under voltage release | | | | |
| | | 24 V DC Shunt trip coil. | | | | |
| | | Under voltage relay with timer (27) | | | | |
| | | Over voltage relay with timer (59) | | | | |
| | | Breaker control switch | | | | |
| | | | | | | |
| | | 1 No. 96 x 96 sq.mm 0-100A digital ammeter with selector switch and 3 Nos. 1000 / 5 A ,15 VA CL:0.5 CT's | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. through 415 V /√ 3 : 110 V/ √ 3 PT's, Primary and Secondary of PT's shall be protected by 2 A TP MCB's | | | | |
| | | Auxiliary contacts required for necessary interlocking of breakers. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Separate set of class 5P10, 15VA CT of suitable capacity for protection | | | | |
| | | | | | | |
| | | **Bus Bars** | | | | |
| | | 1200 A TPN aluminium bus bars (65 KA) with coloured heat shrinkable insulation sleeves | | | | |
| | | | | | | |
| | | **Outgoings** | | | | |
| | | 400A FP MCCB (65KA) 3 No. | | | | |
| | | 315 A FP MCCB (65KA) 1 Nos. | | | | |
| | | 250 A FP MCCB(65KA) 1 Nos. | | | | |
| | | | | | | |
| | | All outgoings shall haveMultifunction meter. | | | | |
| | | | | | | |
| | | **Bus Coupler-: Breaker `B'** | | | | |
| | | 1000 amps 4 pole electrically operated fully drawout type air circuit breaker with ON / OFF / TRIP indicating lamps with control MCB's, shunt trip, 415V under voltage release, 1 No. 230 V AC closing coil breaker control switch etc. | | | | |
| | | 1 Set | | | | |
| | | **SECTION - II** | | | | |
| | | **Incoming** | | | | |
| | | 1000 A 4P electrically operated fully draw out type air circuit breaker with micorprocessor based release unit for short circuit ,over load, earth fault protection & energy parameters as per specifications. | | | | |
| | | | | | | |
| | | Multifunctional meter of accuracy class-0.5S, with 1 No. 1000/5 A 15VA CTs to measure and display the following electrical Parameters : | | | | |
| | | | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | | | | | |
| | | 3 Nos. Phase indicating light through 415 V / √ 3 : 110 V/ √ 3 PT. | | | | |
| | | | | | | |
| | | Breaker ON / OFF / TRIP LED type indicating lights with control MCB's. | | | | |
| | | | | | | |
| | | Spring charge / trip circuit healthy indication | | | | |
| | | | | | | |
| | | 1 No. 96 x 96 sq.mm 0-1000A digital ammeter with selector switch and 3 Nos. 1000 / 5 A ,15 VA CL:0.5 CT's | | | | |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 96 x 96 mm sq. 0-500 Volt digital voltmeter with selector switch through 415 V /√ 3 : 110 V/ √ 3 PT's, Primary and Secondary of PT's shall be protected by 2 A TP MCB's | | | | |
| | | | | | | |
| | | Breaker control switch | | | | |
| | | | | | | |
| | | Auxiliary contacts required for necessary interlocking of breakers. | | | | |
| | | | | | | |
| | | **Bus Bars** | | | | |
| | | 1200 A TPN aluminium bus bars (65 KA) with coloured heat shrinkable insulation sleeves | | | | |
| | | | | | | |
| | | **Outgoings** | | | | |
| | | 630A 4P MCCB(65KA) 1 Nos. | | | | |
| | | 400 A 4P MCCB(65KA) 3 No. | | | | |
| | | 250 A 4P MCCB(65KA) 2 No. | | | | |
| | | **Main Emergency Panel at ESS-1 as described above** | **Set** | 3,829,339.56 | 1 | 3,829,340 |
| | | | | | | |
| | | All outgoings shall haveMultifunction meter. | | | | |
| | | | | | | |
| | | All MCCB/ACB's shall be suitable for 65 KA (ICS) breaking capacity. | | | | |
| | | 415 / 110 V suitable rating control transformer shall be provided for aux. Control supply. | | | | |
| | | Wiring with space heater, thermostat and control MCB's shall be provided all vertical sections of main LT panel. | | | | |
| | | All outgoing MCCB's feeders shall be provided with short circuit & earth fault relay module. | | | | |
| | | All incoming as well as outgoing feeders shall have pad locking facility. | | | | |
| | | Suitable danger board shall be provided. | | | | |
| | | All bus bar section / backside panels shall have pad locking facility and hinged type door. | | | | |
| | | 4 pole surge arrestor with each incoming feeder | | | | |
| | | All incoming as well as outgoing air circuit breaker shall be compatible with BAS system (Bacnet) | | | | |
| | | | | | | |
| 4.0 | | **ISOLATOR CUM HPFC PANEL BOARDS - CSS 2A** | | | | |
| | | 1 Set RBYN , 3600 Amp 4 Pole Bus Bars with the Provision of Bus duct connectivity flange on top or side. | | | | |
| | | **Incoming** | | | | |
| | | 1 No. 2000 Amp & 1 No. 1600 Amp FP electrically operated fully drawout type air circuit breaker with microprocessor based release unit for over load, short circuit, and earth fault protection with current unbalane , voltage unbalance reverse power and frequency & harmonics measurement as per specification and each with following accessories : | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | | | | | |
| | | Electronic energy meter of accuracy class-0.5S, with 3 Nos. 2000/5 A & 3 Nos. 1600/5A, 15VA CTs to measure and display the following electrical Parameters : | | | | |
| | | | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | | | | | |
| | | Phase indicating light through 415 V /√ 3 : 110 V/ √ 3PT, Primary / Secondary of PT's shall be protected by 2 A MCB's. | | | | |
| | | | | | | |
| | | Breaker ON / OFF / TRIP LED type indicating lights with control MCB's. | | | | |
| | | Spring charge / trip circuit healthy indication | | | | |
| | | Under voltage release | | | | |
| | | 24 V DC Shunt trip coil. | | | | |
| | | Under voltage relay with timer (27) | | | | |
| | | Over voltage relay with timer (59) | | | | |
| | | Breaker control switch | | | | |
| | | | | | | |
| | | 1 No. 96 x 96 sq.mm 0-2000A & 1600A digital ammeter with selector switch and 3 Nos. 2000 / 5 A / 1600A/5A ,15 VA CL:0.5 CT's | | | | |
| | | | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. through 415 V /√ 3 : 110 V/ √ 3 PT's, Primary and Secondary of PT's shall be protected by 2 A TP MCB's | | | | |
| | | | | | | |
| | | Auxiliary contacts required for necessary interlocking of breakers. | | | | |
| | | | | | | |
| | | Separate set of class 5P10, 15VA CT of suitable capacity for protection | | | | |
| | | | | | | |
| | | **Bus Bars** | | | | |
| | | 2200A & 1800 A TPN aluminium bus bars (50 KA) with coloured heat shrinkable insulation sleeves (2 Sets) as per SLD | | | | |
| | | | | | | |
| | | **Outgoings** | | | | |
| | | 4 Nos. 800 A TPN electrically operated fully draw out type aircircuit breaker with micorprocessor based release unit for short circuit ,over load, earth fault protection & energy parameters as per specifications. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 4 Nos. 630 A TPN electrically operated fully draw out type aircircuit breaker with micorprocessor based release unit for short circuit ,over load, earth fault protection & energy parameters as per specifications. | | | | |
| | | 250 A 4P MCCB(65KA) 1 No. | | | | |
| | | 100 A 4P MCCB(65KA) 1 No. | | | | |
| | | | | | | |
| | | **IGBT based Hybrid Power Factor Correction Panel (650 KVAR)** | | | | |
| | | Design, supply, installation, testing & commissioning of cubicle type compartementalized floor mounted free standing type with separation system as per IS:8623 part-1 for 415V, 50HZ, 3 phase 4 wire supply, moisture, dust and vermin proof IP-41 with cooling intrinsic design of voltage sourced IGBT based intelligent Hybrid PFC panel with Programmable Microprocessor controller to maintain Power Factor, Harmonics & Unbalancing duly housed in epoxy powder coated 2mm thick CRCA sheet steel compatmentalised enclosure free standing type with all supports, accessories, switch gears, control gears, protections, wiring, interconnections, control MCBs etc. as required complete in all respects & having its main components as bellow along with all other standard components ,circuitry & specifications as required: | | | | |
| | | | | | | |
| | | Hybrid PFC Panel shall have a rating of 650kvar @ 415V. It shall comprise at least 410kvar of IGBT based active filter (for reactive, harmonics and unbalance compensation) and remainder capacity (240kvar) of detuned capacitor banks (for reactive compensation). The detuned capacitor banks shall be controlled through the microprocessor used in the active filter. | | | | |
| | | | | | | |
| | | **Incomer** | | | | |
| | | In coming ACB 1600A-TP-50kA-415Volts - 01 Nos. | | | | |
| | | Neutral Link 400A-SP-50kA - 01 Nos. | | | | |
| | | **Metering & Indications** | | | | |
| | | Display meter with compatible RS 485 ports - 01 Nos. | | | | |
| | | Phase Indicating & ON-OFF LED Lights 230 V - 03 Nos | | | | |
| | | Ammeter - digital 3 Phase | | | | |
| | | MCB 6A-SP-10kA-C-Curve - 3 Nos. | | | | |
| | | **Active Filter** | | | | |
| | | a) Required IGBTs | | | | |
| | | b) IGBT base active technology | | | | |
| | | c) Gate driver, Interfacing and other control cards | | | | |
| | | d) Heat Sinks | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | e) Heavy duty cooling blowers/ fans with protection | | | | |
| | | f) Voltage Sensing Cards & circuitry | | | | |
| | | g) Current Transducers | | | | |
| | | h) SMPS | | | | |
| | | i) SSR | | | | |
| | | j) MCCB with ROM 400A-FP-36kA-T/M - 1 Nos. | | | | |
| | | k) MCCB with ROM 400A-TP-36kA-T/M - 2 Nos. | | | | |
| | | l) MCB 10A-FP-10KA- C curve - 04 Nos. | | | | |
| | | m) Contactor 400A-FP-AC1 Duty - 1 Nos. | | | | |
| | | n) Contactor 325A-TP-AC3 Duty - 2 Nos. | | | | |
| | | o) Protections | | | | |
| | | p) Choke coil for interfacing IGBT with grid | | | | |
| | | q) High Frequency & D C bus capacitors | | | | |
| | | r) Interconnection with UNIVININ copper stranded wires, Copper Bus-bars, earth bus, danger notice boards, inscription plates, terminals for incoming & outgoing cable connections | | | | |
| | | s) Remote sensing resin cast CTs shall be provided in main panel on common Bus by Main Panel Manufacturer | | | | |
| | | t) All required hardware's, softwares, protections, cards, inscription plates, Danger notice board etc., as required to be provided to complete the system | | | | |
| | | u) MCCB, contactor and fuses of applicable rating and protections shall be provided for the active filter | | | | |
| | | | | | | |
| | | **Programmable Microprocessor controller** | | | | |
| | | i) Instantaneous corrections of leading & lagging power factor & to keep the power factor nearer to unity | | | | |
| | | ii) Instantaneous corrections in current THD levels & maintain las per IEEE 519-92 | | | | |
| | | iii) Three phase (non-neutral) unbalance compensation | | | | |
| | | iv) Reduction in voltage distortions as a result of reduction in ITHD | | | | |
| | | v) Reduction in surges caused by switching of Heavy Load reduce tripping effect on electronic devices | | | | |
| | | | | | | |
| | | **Detuned Capacitor Banks** | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | a) Switched Capacitors - Heavy duty (MPP) type AC three phase capacitors 25 KVAR - 08 Nos 525V grade with discharge resistor, control gears capacitor duty contactors suitable for 35KVAR & switch gears MCCBs-80A-TP-25 kA - 04 Nos of required ratings with overload & short circuit protections for each capacitor banks, LED ON indication light, auto manual switch & Auxiliary contactors, ON-OFF push buttons , timers, ammeters, control MCBs, interconnection & control wiring with copper conductor wire, Main copper bus bars etc as required | | | | |
| | | b) Control Circuits with 1.5SQmm copper conductor FRLS wires | | | | |
| | | c) 7% Detuned aluminium series reactors with minim 180% linearity with each capacitor bank | | | | |
| | | | | | | |
| | | | | | | |
| | | All MCCB/ACB's shall be suitable for 50 KA (ICS) breaking capacity. | | | | |
| | | **Isolator Cum HPFC Panel at CSS 2A as described above** | **Set** | 7,701,873.00 | 1 | 7,701,873 |
| | | | | | | |
| 5.0 | | **ISOLATOR CUM HPFC PANEL BOARDS - CSS 2B** | | | | |
| | | 1 Set RBYN , 3600 Amp 4 Pole Bus Bars with the Provision of Bus duct connectivity flange on top or side as per SLD. | | | | |
| | | **Incoming** | | | | |
| | | 1 No. 2000 Amp & 1 No. 1600 Amp FP electrically operated fully drawout type air circuit breaker with microprocessor based release unit for over load, short circuit, and earth fault protection with current unbalane , voltage unbalance reverse power and frequency & harmonics measurement as per specification and each with following accessories : | | | | |
| | | | | | | |
| | | Electronic energy meter of accuracy class-0.5S, with 3 Nos. 2000/5 A & 3 Nos. 1600/5 A 15VA CTs to measure and display the following electrical Parameters : | | | | |
| | | | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Phase indicating light through 415 V / √ 3 : 110 V/ √ 3PT, Primary / Secondary of PT's shall be protected by 2 A MCB's. | | | | |
| | | | | | | |
| | | Breaker ON / OFF / TRIP LED type indicating lights with control MCB's. | | | | |
| | | Spring charge / trip circuit healthy indication | | | | |
| | | Under voltage release | | | | |
| | | 24 V DC Shunt trip coil. | | | | |
| | | Under voltage relay with timer (27) | | | | |
| | | Over voltage relay with timer (59) | | | | |
| | | Breaker control switch | | | | |
| | | | | | | |
| | | 1 No. 96 x 96 sq.mm 0-2000A & 1600A digital ammeter with selector switch and 3 Nos. 2000 / 5 A & 1600A/5A ,15 VA CL:0.5 CT's | | | | |
| | | | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. through 415 V / √ 3 : 110 V/ √ 3 PT's, Primary and Secondary of PT's shall be protected by 2 A TP MCB's | | | | |
| | | | | | | |
| | | Auxiliary contacts required for necessary interlocking of breakers. | | | | |
| | | | | | | |
| | | Separate set of class 5P10, 15VA CT of suitable capacity for protection | | | | |
| | | | | | | |
| | | **Bus Bars** | | | | |
| | | 2200 & 1800 A TPN aluminium bus bars (50 KA) with coloured heat shrinkable insulation sleeves (2 Sets) | | | | |
| | | | | | | |
| | | **Outgoings (For Section I & II )** | | | | |
| | | 4 Nos. 400 A TPN MCCB(50kA) | | | | |
| | | 5 Nos. 630 A TPN electrically operated fully draw out type aircircuit breaker with micorprocessor based release unit for short circuit ,over load, earth fault protection & energy parameters as per specifications. | | | | |
| | | | | | | |
| | | **IGBT based Hybrid Power Factor Correction Panel (650 KVAR)** | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Design, supply, installation, testing & commissioning of cubicle type compartementalized floor mounted free standing type with separation system as per IS:8623 part-1 for 415V, 50HZ, 3 phase 4 wire supply, moisture, dust and vermin proof IP-41 with cooling intrinsic design of voltage sourced IGBT based intelligent Hybrid PFC panel with Programmable Microprocessor controller to maintain Power Factor, Harmonics & Unbalancing duly housed in epoxy powder coated 2mm thick CRCA sheet steel compatmentalised enclosure free standing type with all supports, accessories, switch gears, control gears, protections, wiring, interconnections, control MCBs etc. as required complete in all respects & having its main components as bellow along with all other standard components ,circuitry & specifications as required: | | | | |
| | | | | | | |
| | | Hybrid PFC Panel shall have a rating of 650kvar @ 415V. It shall comprise at least 410kvar of IGBT based active filter (for reactive, harmonics and unbalance compensation) and remainder capacity (240kvar) of detuned capacitor banks (for reactive compensation). The detuned capacitor banks shall be controlled through the microprocessor used in the active filter. | | | | |
| | | | | | | |
| | | **Incomer** | | | | |
| | | In coming ACB 1250A-TP-50kA-415Volts - 01 Nos. | | | | |
| | | Neutral Link 400A-SP-50kA - 01 Nos. | | | | |
| | | **Metering & Indications** | | | | |
| | | Display meter with compatible RS 485 ports - 01 Nos. | | | | |
| | | Phase Indicating & ON-OFF LED Lights 230 V - 03 Nos | | | | |
| | | Ammeter - digital 3 Phase | | | | |
| | | MCB 6A-SP-10kA-C-Curve - 3 Nos. | | | | |
| | | **Active Filter** | | | | |
| | | a) Required IGBTs | | | | |
| | | b) IGBT base active technology | | | | |
| | | c) Gate driver, Interfacing and other control cards | | | | |
| | | d) Heat Sinks | | | | |
| | | e) Heavy duty cooling blowers/ fans with protection | | | | |
| | | f) Voltage Sensing Cards & circuitry | | | | |
| | | g) Current Transducers | | | | |
| | | h) SMPS | | | | |
| | | i) SSR | | | | |
| | | j) MCCB with ROM 400A-FP-36kA-T/M - 1 Nos. | | | | |
| | | k) MCCB with ROM 400A-TP-36kA-T/M - 2 Nos. | | | | |
| | | l) MCB 10A-FP-10KA- C curve - 04 Nos. | | | | |
| | | m) Contactor 400A-FP-AC1 Duty - 1 Nos. | | | | |
| | | n) Contactor 325A-TP-AC3 Duty - 2 Nos. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | o) Protections | | | | |
| | | p) Choke coil for interfacing IGBT with grid | | | | |
| | | q) High Frequency & D C bus capacitors | | | | |
| | | r) Interconnection with UNIVININ copper stranded wires, Copper Bus-bars, earth bus, danger notice boards, inscription plates, terminals for incoming & outgoing cable connections | | | | |
| | | s) Remote sensing resin cast CTs shall be provided in main panel on common Bus by Main Panel Manufacturer | | | | |
| | | t) All required hardware's, softwares, protections, cards, inscription plates, Danger notice board etc., as required to be provided to complete the system | | | | |
| | | u) MCCB, contactor and fuses of applicable rating and protections shall be provided for the active filter | | | | |
| | | | | | | |
| | | **Programmable Microprocessor controller** | | | | |
| | | i) Instantaneous corrections of leading & lagging power factor & to keep the power factor nearer to unity | | | | |
| | | ii) Instantaneous corrections in current THD levels & maintain las per IEEE 519-92 | | | | |
| | | iii) Three phase (non-neutral) unbalance compensation | | | | |
| | | iv) Reduction in voltage distortions as a result of reduction in ITHD | | | | |
| | | v) Reduction in surges caused by switching of Heavy Load reduce tripping effect on electronic devices | | | | |
| | | | | | | |
| | | **Detuned Capacitor Banks** | | | | |
| | | a) Switched Capacitors - Heavy duty (MPP) type AC three phase capacitors 25 KVAR - 08 Nos 525V grade with discharge resistor, control gears capacitor duty contactors suitable for 35KVAR & switch gears MCCBs-80A-TP-25 kA - 04 Nos of required ratings with overload & short circuit protections for each capacitor banks, LED ON indication light, auto manual switch & Auxiliary contactors, ON-OFF push buttons , timers, ammeters, control MCBs, interconnection & control wiring with copper conductor wire, Main copper bus bars etc as required | | | | |
| | | b) Control Circuits with 1.5SQmm copper conductor FRLS wires | | | | |
| | | c) 7% Detuned aluminium series reactors with minim 180% linearity with each capacitor bank | | | | |
| | | | | | | |
| | | All MCCB/ACB's shall be suitable for 50 KA (ICS) breaking capacity. | | | | |
| | | **Isolator Cum HPFC Panel at CSS 2B as described above** | **Set** | 7,007,021.00 | 1 | 7,007,021 |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| 6.0 | | **ISOLATOR CUM HPFC PANEL BOARDS - CSS 3A (OUTDOOR TYPE)** | | | | |
| | | 1 Set RBYN , 2800 Amp 4 Pole Bus Bars with the Provision of Bus duct connectivity flange on top or side as per SLD. | | | | |
| | | | | | | |
| | | **Incoming** | | | | |
| | | 2 Nos. 1600A FP electrically operated fully drawout type air circuit breaker each with microprocessor based release unit for over load, short circuit, and earth fault protection with current unbalane , voltage unbalance reversr power and frequency & harmonics measurement as per specification and each with following accessories : | | | | |
| | | | | | | |
| | | Electronic energy meter of accuracy class-0.5S, with 3 Nos. 1600/5 A 15VA CTs (2sets) to measure and display the following electrical Parameters : | | | | |
| | | | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | | | | | |
| | | Phase indicating light through 415 V / √ 3 : 110 V/ √ 3PT, Primary / Secondary of PT's shall be protected by 2 A MCB's. | | | | |
| | | | | | | |
| | | Breaker ON / OFF / TRIP LED type indicating lights with control MCB's. | | | | |
| | | | | | | |
| | | Spring charge / trip circuit healthy indication | | | | |
| | | Under voltage release | | | | |
| | | 24 V DC Shunt trip coil. | | | | |
| | | Under voltage relay with timer (27) | | | | |
| | | Over voltage relay with timer (59) | | | | |
| | | Breaker control switch | | | | |
| | | | | | | |
| | | 1 No. 96 x 96 sq.mm 0-1600A digital ammeter with selector switch and 3 Nos. 1600 / 5 A ,15 VA CL:0.5 CT's | | | | |
| | | | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. through 415 V / √ 3 : 110 V/ √ 3 PT's, Primary and Secondary of PT's shall be protected by 2 A TP MCB's | | | | |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Auxiliary contacts required for necessary interlocking of breakers. | | | | |
| | | | | | | |
| | | Separate set of class 5P10, 15VA CT of suitable capacity for protection | | | | |
| | | | | | | |
| | | **Bus Bars** | | | | |
| | | 1800 A TPN aluminium bus bars (50 KA) with coloured heat shrinkable insulation sleeves (2 Sets) | | | | |
| | | | | | | |
| | | **Outgoings (For Section I & II)** | | | | |
| | | 1 Nos. 630 A 4P electrically operated fully draw out type aircircuit breaker with micorprocessor based release unit for short circuit ,over load, earth fault protection & energy parameters as per specifications. | | | | |
| | | 630 A FP MCCB (50 KA) 2 No. | | | | |
| | | 400 A FP MCCB (50 KA) 5 Nos. | | | | |
| | | 315 A FP MCCB (50 KA) 1 No. | | | | |
| | | 250 A FP MCCB (50 KA) 1 No. | | | | |
| | | | | | | |
| | | **IGBT based Hybrid Power Factor Correction Panel (550 KVAR)** | | | | |
| | | Design, supply, installation, testing & commissioning of cubicle type compartementalized floor mounted free standing type with separation system as per IS:8623 part-1 for 415V, 50HZ, 3 phase 4 wire supply, moisture, dust and vermin proof IP-41 with cooling intrinsic design of voltage sourced IGBT based intelligent Hybrid PFC panel with Programmable Microprocessor controller to maintain Power Factor, Harmonics & Unbalancing duly housed in epoxy powder coated 2mm thick CRCA sheet steel compatmentalised enclosure free standing type with all supports, accessories, switch gears, control gears, protections, wiring, interconnections, control MCBs etc. as required complete in all respects & having its main components as bellow along with all other standard components ,circuitry & specifications as required: | | | | |
| | | | | | | |
| | | Hybrid PFC Panel shall have a rating of 550kvar @ 415V. It shall comprise at least 410kvar of IGBT based active filter (for reactive, harmonics and unbalance compensation) and remainder capacity (140kvar) of detuned capacitor banks (for reactive compensation). The detuned capacitor banks shall be controlled through the microprocessor used in the active filter. | | | | |
| | | | | | | |
| | | **Incomer** | | | | |
| | | In coming ACB 1250A-TP-50kA-415Volts - 01 Nos. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| Sl. No | DSR Item No. | Description of Items | Unit | Rate | Total QTY | AMOUNT (INR) |
| | | Neutral Link 400A-SP-50kA - 01 Nos. | | | | |
| | | **Metering & Indications** | | | | |
| | | Display meter with compatible RS 485 ports - 01 Nos. | | | | |
| | | Phase Indicating & ON-OFF LED Lights 230 V - 03 Nos | | | | |
| | | Ammeter - digital 3 Phase | | | | |
| | | MCB 6A-SP-10kA-C-Curve - 3 Nos. | | | | |
| | | **Active Filter** | | | | |
| | | a) Required IGBTs | | | | |
| | | b) IGBT base active technology | | | | |
| | | c) Gate driver, Interfacing and other control cards | | | | |
| | | d) Heat Sinks | | | | |
| | | e) Heavy duty cooling blowers/ fans with protection | | | | |
| | | f) Voltage Sensing Cards & circuitry | | | | |
| | | g) Current Transducers | | | | |
| | | h) SMPS | | | | |
| | | i) SSR | | | | |
| | | j) MCCB with ROM 320A-FP-50kA-T/M - 1 Nos. | | | | |
| | | k) MCCB with ROM 320A-TP-36kA-T/M - 2 Nos. | | | | |
| | | l) MCB 10A-FP-10kA- C curve - 04 Nos. | | | | |
| | | m) Contactor 350A-FP-AC1 Duty - 1 Nos. | | | | |
| | | n) Contactor 265A-TP-AC3 Duty - 2 Nos. | | | | |
| | | o) Protections | | | | |
| | | p) Choke coil for interfacing IGBT with grid | | | | |
| | | q) High Frequency & D C bus capacitors | | | | |
| | | r) Interconnection with UNIVININ copper stranded wires, Copper Bus-bars, earth bus, danger notice boards, inscription plates, terminals for incoming & outgoing cable connections | | | | |
| | | s) Remote sensing resin cast CTs shall be provided in main panel on common Bus by Main Panel Manufacturer | | | | |
| | | t) All required hardware's, softwares, protections, cards, inscription plates, Danger notice board etc., as required to be provided to complete the system | | | | |
| | | u) MCCB, contactor and fuses of applicable rating and protections shall be provided for the active filter | | | | |
| | | | | | | |
| | | **Programmable Microprocessor controller** | | | | |
| | | i) Instantaneous corrections of leading & lagging power factor & to keep the power factor nearer to unity | | | | |
| | | ii) Instantaneous corrections in current THD levels & maintain las per IEEE 519-92 | | | | |
| | | iii) Three phase (non-neutral) unbalance compensation | | | | |
| | | iv) Reduction in voltage distortions as a result of reduction in ITHD | | | | |
| | | v) Reduction in surges caused by switching of Heavy Load reduce tripping effect on electronic devices | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | | | | | |
| | | **Detuned Capacitor Banks** | | | | |
| | | a) Switched Capacitors - Heavy duty (MPP) type AC three phase capacitors 25kvar - 04 Nos & 20kvar - 04 Nos 525V grade with discharge resistor, control gears capacitor duty contactors suitable for 33.3kvar & switch gears MCCBs-80A-TP-25 kA - 04 Nos of required ratings with overload & short circuit protections for each capacitor banks, LED ON indication light, auto manual switch & Auxiliary contactors, ON-OFF push buttons , timers, ammeters, control MCBs, interconnection & control wiring with copper conductor wire, Main copper bus bars etc as required | | | | |
| | | b) Control Circuits with 1.5SQmm copper conductor FRLS wires | | | | |
| | | c) 7% Detuned aluminium series reactors with minim 180% linearity with each capacitor bank | | | | |
| | | | | | | |
| | | All MCCB/ACB's shall be suitable for 50 KA (ICS) breaking capacity. | | | | |
| | | **Isolator Cum HPFC Panel at CSS3A as described above** | **Set** | 5,847,009.00 | 1 | 5,847,009 |
| | | | | | | |
| 7.0 | | **ISOLATOR CUM HPFC PANEL BOARDS - CSS 3B (OUTDOOR TYPE)** | | | | |
| | | 1 Set RBYN , 2800 Amp 4 Pole Bus Bars with the Provision of Bus duct connectivity flange on top or side as per SLD. | | | | |
| | | **Incoming** | | | | |
| | | 2 Nos, 1600A FP electrically operated fully drawout type air circuit breaker each microprocessor based release unit for over load, short circuit, and earth fault protection with current unbalane , voltage unbalance reversr power and frequency & harmonics measurement as per specification and each with following accessories : | | | | |
| | | | | | | |
| | | Electronic energy meter of accuracy class-0.5S, with 3 Nos. 1600/5 A (2 sets) 15VA CTs to measure and display the following electrical Parameters : | | | | |
| | | | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Phase indicating light through 415 V / √ 3 : 110 V/ √ 3PT, Primary / Secondary of PT's shall be protected by 2 A MCB's. | | | | |
| | | | | | | |
| | | Breaker ON / OFF / TRIP LED type indicating lights with control MCB's. | | | | |
| | | | | | | |
| | | Spring charge / trip circuit healthy indication | | | | |
| | | Under voltage release | | | | |
| | | 24 V DC Shunt trip coil. | | | | |
| | | Under voltage relay with timer (27) | | | | |
| | | Over voltage relay with timer (59) | | | | |
| | | Breaker control switch | | | | |
| | | | | | | |
| | | 1 No. 96 x 96 sq.mm 0-1600A digital ammeter with selector switch and 3 Nos. 1600 / 5 A ,15 VA CL:0.5 CT's | | | | |
| | | | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. through 415 V / √ 3 : 110 V/ √ 3 PT's, Primary and Secondary of PT's shall be protected by 2 A TP MCB's | | | | |
| | | | | | | |
| | | Auxiliary contacts required for necessary interlocking of breakers. | | | | |
| | | | | | | |
| | | Separate set of class 5P10, 15VA CT of suitable capacity for protection | | | | |
| | | | | | | |
| | | **Bus Bars** | | | | |
| | | 1800 A TPN aluminium bus bars (50 KA) with coloured heat shrinkable insulation sleeves (2 Sets) | | | | |
| | | | | | | |
| | | **Outgoings (For Section I & II)** | | | | |
| | | 2 Nos. 630 A 4P electrically operated fully draw out type aircircuit breaker with micorprocessor based release unit for short circuit ,over load, earth fault protection & energy parameters as per specifications. | | | | |
| | | 400 A FP MCCB (35 KA) 5 No. | | | | |
| | | 315 A FP MCCB (35 KA) 1 No. | | | | |
| | | | | | | |
| | | **IGBT based Hybrid Power Factor Correction Panel (550 KVAR)** | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Design, supply, installation, testing & commissioning of cubicle type compartementalized floor mounted free standing type with separation system as per IS:8623 part-1 for 415V, 50HZ, 3 phase 4 wire supply, moisture, dust and vermin proof IP-41 with cooling intrinsic design of voltage sourced IGBT based intelligent Hybrid PFC panel with Programmable Microprocessor controller to maintain Power Factor, Harmonics & Unbalancing duly housed in epoxy powder coated 2mm thick CRCA sheet steel compatmentalised enclosure free standing type with all supports, accessories, switch gears, control gears, protections, wiring, interconnections, control MCBs etc. as required complete in all respects & having its main components as bellow along with all other standard components ,circuitry & specifications as required: | | | | |
| | | | | | | |
| | | Hybrid PFC Panel shall have a rating of 550kvar @ 415V. It shall comprise at least 410kvar of IGBT based active filter (for reactive, harmonics and unbalance compensation) and remainder capacity (140kvar) of detuned capacitor banks (for reactive compensation). The detuned capacitor banks shall be controlled through the microprocessor used in the active filter. | | | | |
| | | | | | | |
| | | **Incomer** | | | | |
| | | In coming ACB 1250A-TP-50kA-415Volts - 01 Nos. | | | | |
| | | Neutral Link 400A-SP-50kA - 01 Nos. | | | | |
| | | **Metering & Indications** | | | | |
| | | Display meter with compatible RS 485 ports - 01 Nos. | | | | |
| | | Phase Indicating & ON-OFF LED Lights 230 V - 03 Nos | | | | |
| | | Ammeter - digital 3 Phase - 2 Nos. | | | | |
| | | MCB 6A-SP-10kA-C-Curve - 3 Nos. | | | | |
| | | **Active Filter** | | | | |
| | | a) Required IGBTs | | | | |
| | | b) IGBT base active technology | | | | |
| | | c) Gate driver, Interfacing and other control cards | | | | |
| | | d) Heat Sinks | | | | |
| | | e) Heavy duty cooling blowers/ fans with protection | | | | |
| | | f) Voltage Sensing Cards & circuitry | | | | |
| | | g) Current Transducers | | | | |
| | | h) SMPS | | | | |
| | | i) SSR | | | | |
| | | j) MCCB with ROM 320A-FP-50kA-T/M - 1 Nos. | | | | |
| | | k) MCCB with ROM 320A-TP-36kA-T/M - 2 Nos. | | | | |
| | | l) MCB 10A-FP-10kA- C curve - 04 Nos. | | | | |
| | | m) Contactor 350A-FP-AC1 Duty - 1 Nos. | | | | |
| | | n) Contactor 265A-TP-AC3 Duty - 2 Nos. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | o) Protections | | | | |
| | | p) Choke coil for interfacing IGBT with grid | | | | |
| | | q) High Frequency & D C bus capacitors | | | | |
| | | r) Interconnection with UNIVININ copper stranded wires, Copper Bus-bars, earth bus, danger notice boards, inscription plates, terminals for incoming & outgoing cable connections | | | | |
| | | s) Remote sensing resin cast CTs shall be provided in main panel on common Bus by Main Panel Manufacturer | | | | |
| | | t) All required hardware's, softwares, protections, cards, inscription plates, Danger notice board etc., as required to be provided to complete the system | | | | |
| | | u) MCCB, contactor and fuses of applicable rating and protections shall be provided for the active filter | | | | |
| | | | | | | |
| | | **Programmable Microprocessor controller** | | | | |
| | | i) Instantaneous corrections of leading & lagging power factor & to keep the power factor nearer to unity | | | | |
| | | ii) Instantaneous corrections in current THD levels & maintain las per IEEE 519-92 | | | | |
| | | iii) Three phase (non-neutral) unbalance compensation | | | | |
| | | iv) Reduction in voltage distortions as a result of reduction in ITHD | | | | |
| | | v) Reduction in surges caused by switching of Heavy Load reduce tripping effect on electronic devices | | | | |
| | | | | | | |
| | | **Detuned Capacitor Banks** | | | | |
| | | a) Switched Capacitors - Heavy duty (MPP) type AC three phase capacitors 25kvar - 04 Nos & 20kvar - 04 Nos 525V grade with discharge resistor, control gears capacitor duty contactors suitable for 33.3kvar & switch gears MCCBs-80A-TP-25 kA - 04 Nos of required ratings with overload & short circuit protections for each capacitor banks, LED ON indication light, auto manual switch & Auxiliary contactors, ON-OFF push buttons , timers, ammeters, control MCBs, interconnection & control wiring with copper conductor wire, Main copper bus bars etc as required | | | | |
| | | b) Control Circuits with 1.5SQmm copper conductor FRLS wires | | | | |
| | | c) 7% Detuned aluminium series reactors with minim 180% linearity with each capacitor bank | | | | |
| | | | | | | |
| | | All MCCB/ACB's shall be suitable for 50 KA (ICS) breaking capacity. | | | | |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | **Isolator Cum HPFC Panel at CSS 3B as described above** | **Set** | 6,588,088.00 | 1 | 6,588,088 |
| | | | | | | |
| 8.0 | | **ISOLATOR CUM HPFC PANEL BOARDS - CSS 4A (OUTDOOR TYPE)** | | | | |
| | | 1 Set RBYN , 4000 Amp 4 Pole Bus Bars with the Provision of Bus duct connectivity flange on top or side as per SLD. | | | | |
| | | **Incoming** | | | | |
| | | 1 No. 2500 Amp & 1 No. 1250 Amp FP electrically operated fully drawout type air circuit breaker each with microprocessor based release unit for over load, short circuit, and earth fault protection with current unbalane , voltage unbalance reverse power and frequency & harmonics measurement as per specification and each with following accessories : | | | | |
| | | | | | | |
| | | Electronic energy meter of accuracy class-0.5S, with 3 Nos.2500/5 A & 1250/5A , 15VA CTs to measure and display the following electrical Parameters : | | | | |
| | | | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |
| | | Frequency / Harmonics | | | | |
| | | | | | | |
| | | Phase indicating light through 415 V /√ 3 : 110 V/ √ 3PT, Primary / Secondary of PT's shall be protected by 2 A MCB's. | | | | |
| | | | | | | |
| | | Breaker ON / OFF / TRIP LED type indicating lights with control MCB's. | | | | |
| | | | | | | |
| | | Spring charge / trip circuit healthy indication | | | | |
| | | Under voltage release | | | | |
| | | 24 V DC Shunt trip coil. | | | | |
| | | Under voltage relay with timer (27) | | | | |
| | | Over voltage relay with timer (59) | | | | |
| | | Breaker control switch | | | | |
| | | | | | | |
| | | 1 No. 96 x 96 sq.mm 0-2500A & 0-1250A digital ammeter with selector switch and 3 Nos. 2500 / 5 A & 1250/5A ,15 VA CL:0.5 CT's | | | | |
| | | | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. through 415 V /√ 3 : 110 V/ √ 3 PT's, Primary and Secondary of PT's shall be protected by 2 A TP MCB's | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | | | | | |
| | | Auxiliary contacts required for necessary interlocking of breakers. | | | | |
| | | | | | | |
| | | Separate set of class 5P10, 15VA CT of suitable capacity for protection | | | | |
| | | | | | | |
| | | **Bus Bars** | | | | |
| | | 2800A & 1400 A TPN aluminium bus bars (50 KA) with coloured heat shrinkable insulation sleeves (2 Sets) | | | | |
| | | | | | | |
| | | **Outgoings (For Section I & II)** | | | | |
| | | 5 Nos. 630 A 4P electrically operated fully draw out type aircircuit breaker with micorprocessor based release unit for short circuit ,over load, earth fault protection & energy parameters as per specifications. | | | | |
| | | 400 A FP MCCB (35 KA) 1 No. | | | | |
| | | 315A FP MCCB (35 KA) 1 No. | | | | |
| | | 250A FP MCCB (35 KA) 6 Nos. | | | | |
| | | 160A FP MCCB (35 KA) 1 No. | | | | |
| | | | | | | |
| | | **IGBT based Hybrid Power Factor Correction Panel (650 KVAR)** | | | | |
| | | Design, supply, installation, testing & commissioning of cubicle type compartementalized floor mounted free standing type with separation system as per IS:8623 part-1 for 415V, 50HZ, 3 phase 4 wire supply, moisture, dust and vermin proof IP-41 with cooling intrinsic design of voltage sourced IGBT based intelligent Hybrid PFC panel with Programmable Microprocessor controller to maintain Power Factor, Harmonics & Unbalancing duly housed in epoxy powder coated 2mm thick CRCA sheet steel compatmentalised enclosure free standing type with all supports, accessories, switch gears, control gears, protections, wiring, interconnections, control MCBs etc. as required complete in all respects & having its main components as bellow along with all other standard components ,circuitry & specifications as required: | | | | |
| | | | | | | |
| | | Hybrid PFC Panel shall have a rating of 650kvar @ 415V. It shall comprise at least 410kvar of IGBT based active filter (for reactive, harmonics and unbalance compensation) and remainder capacity (240kvar) of detuned capacitor banks (for reactive compensation). The detuned capacitor banks shall be controlled through the microprocessor used in the active filter. | | | | |
| | | | | | | |
| | | **Incomer** | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | In coming ACB 1600A-TP-50kA-415Volts - 01 Nos. | | | | |
| | | Neutral Link 400A-SP-50kA - 01 Nos. | | | | |
| | | **Metering & Indications** | | | | |
| | | Display meter with compatible RS 485 ports - 01 Nos. | | | | |
| | | Phase Indicating & ON-OFF LED Lights 230 V - 03 Nos | | | | |
| | | Ammeter - digital 3 Phase | | | | |
| | | MCB 6A-SP-10kA-C-Curve - 3 Nos. | | | | |
| | | **Active Filter** | | | | |
| | | a) Required IGBTs | | | | |
| | | b) IGBT base active technology | | | | |
| | | c) Gate driver, Interfacing and other control cards | | | | |
| | | d) Heat Sinks | | | | |
| | | e) Heavy duty cooling blowers/ fans with protection | | | | |
| | | f) Voltage Sensing Cards & circuitry | | | | |
| | | g) Current Transducers | | | | |
| | | h) SMPS | | | | |
| | | i) SSR | | | | |
| | | j) MCCB with ROM 400A-FP-36kA-T/M - 1 Nos. | | | | |
| | | k) MCCB with ROM 400A-TP-36kA-T/M - 2 Nos. | | | | |
| | | l) MCB 10A-FP-10KA- C curve - 04 Nos. | | | | |
| | | m) Contactor 400A-FP-AC1 Duty - 1 Nos. | | | | |
| | | n) Contactor 325A-TP-AC3 Duty - 2 Nos. | | | | |
| | | o) Protections | | | | |
| | | p) Choke coil for interfacing IGBT with grid | | | | |
| | | q) High Frequency & D C bus capacitors | | | | |
| | | r) Interconnection with UNIVININ copper stranded wires, Copper Bus-bars, earth bus, danger notice boards, inscription plates, terminals for incoming & outgoing cable connections | | | | |
| | | s) Remote sensing resin cast CTs shall be provided in main panel on common Bus by Main Panel Manufacturer | | | | |
| | | t) All required hardware's, softwares, protections, cards, inscription plates, Danger notice board etc., as required to be provided to complete the system | | | | |
| | | u) MCCB, contactor and fuses of applicable rating and protections shall be provided for the active filter | | | | |
| | | | | | | |
| | | **Programmable Microprocessor controller** | | | | |
| | | i) Instantaneous corrections of leading & lagging power factor & to keep the power factor nearer to unity | | | | |
| | | ii) Instantaneous corrections in current THD levels & maintain las per IEEE 519-92 | | | | |
| | | iii) Three phase (non-neutral) unbalance compensation | | | | |
| | | iv) Reduction in voltage distortions as a result of reduction in ITHD | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | v) Reduction in surges caused by switching of Heavy Load reduce tripping effect on electronic devices | | | | |
| | | | | | | |
| | | **Detuned Capacitor Banks** | | | | |
| | | a) Switched Capacitors - Heavy duty (MPP) type AC three phase capacitors 25 KVAR - 08 Nos 525V grade with discharge resistor, control gears capacitor duty contactors suitable for 35KVAR & switch gears MCCBs-80A-TP-25 kA - 04 Nos of required ratings with overload & short circuit protections for each capacitor banks, LED ON indication light, auto manual switch & Auxiliary contactors, ON-OFF push buttons , timers, ammeters, control MCBs, interconnection & control wiring with copper conductor wire, Main copper bus bars etc as required | | | | |
| | | b) Control Circuits with 1.5SQmm copper conductor FRLS wires | | | | |
| | | c) 7% Detuned aluminium series reactors with minim 180% linearity with each capacitor bank | | | | |
| | | | | | | |
| | | All MCCB/ACB's shall be suitable for 50 KA (ICS) breaking capacity. | | | | |
| | | **Isolator Cum Capacitor Panel at CSS4A as described above** | **Set** | 8,372,166.00 | 1 | 8,372,166 |
| | | | | | | |
| 9.0 | | **ISOLATOR CUM CAPACITOR PANEL BOARDS - CSS 4B** | | | | |
| | | 1 Set RBYN , 4000 Amp 4 Pole Bus Bars with the Provision of Bus duct connectivity flange on top or side as per SLD. | | | | |
| | | **Incoming** | | | | |
| | | 1 No. 2500 Amp & 1 No. 1250 Amp FP electrically operated fully drawout type air circuit breaker each with microprocessor based release unit for over load, short circuit, and earth fault protection with current unbalane , voltage unbalance reverse power and frequency & harmonics measurement as per specification and each with following accessories : | | | | |
| | | | | | | |
| | | Electronic energy meter of accuracy class-0.5S, with 3 Nos. 2500/5 A & 1250/5A 15VA CTs to measure and display the following electrical Parameters : | | | | |
| | | | | | | |
| | | Real Time | | | | |
| | | Total active energy (KWH/MWH) | | | | |
| | | Maximum demand (KVA/MVA) (KW/MW) | | | | |
| | | Maximum demand reset count. | | | | |
| | | Instantaneous power factor | | | | |
| | | Logging of active energy eight time of a day. | | | | |
| | | Current | | | | |
| | | Voltage | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Frequency / Harmonics | | | | |
| | | | | | | |
| | | Phase indicating light through 415 V / √ 3 : 110 V/ √ 3PT, Primary / Secondary of PT's shall be protected by 2 A MCB's. | | | | |
| | | | | | | |
| | | Breaker ON / OFF / TRIP LED type indicating lights with control MCB's. | | | | |
| | | | | | | |
| | | Spring charge / trip circuit healthy indication | | | | |
| | | Under voltage release | | | | |
| | | 24 V DC Shunt trip coil. | | | | |
| | | Under voltage relay with timer (27) | | | | |
| | | Over voltage relay with timer (59) | | | | |
| | | Breaker control switch | | | | |
| | | 1 No. 96 x 96 sq.mm 0-2000A & 1250 Adigital ammeter with selector switch and 3 Nos. 2000 / 5 A & 1250/5A ,15 VA CL:0.5 CT's | | | | |
| | | | | | | |
| | | 0-500 Volt digital voltmeter with selector switch 96 x 96 mm sq. through 415 V / √ 3 : 110 V/ √ 3 PT's, Primary and Secondary of PT's shall be protected by 2 A TP MCB's | | | | |
| | | | | | | |
| | | Auxiliary contacts required for necessary interlocking of breakers. | | | | |
| | | | | | | |
| | | Separate set of class 5P10, 15VA CT of suitable capacity for protection | | | | |
| | | | | | | |
| | | **Bus Bars** | | | | |
| | | 2800A & 1400 A TPN aluminium bus bars (50 KA) with coloured heat shrinkable insulation sleeves (2 Sets) | | | | |
| | | | | | | |
| | | **Outgoings (For Section I & II)** | | | | |
| | | 1 Nos. 1600 A TPN electrically operated fully draw out type aircircuit breaker with micorprocessor based release unit for short circuit ,over load, earth fault protection & energy parameters as per specifications. | | | | |
| | | 4 Nos. 630 A TPN electrically operated fully draw out type aircircuit breaker with micorprocessor based release unit for short circuit ,over load, earth fault protection & energy parameters as per specifications. | | | | |
| | | 400 A FP MCCB (35 KA) 2 No. | | | | |
| | | 315 A FP MCCB (35 KA) 1 No. | | | | |
| | | 250 A FP MCCB (35 KA) 5 Nos. | | | | |
| | | 160 A FP MCCB (35 KA) 1 No. | | | | |
| | | | | | | |
| | | **IGBT based Hybrid Power Factor Correction Panel (650 KVAR)** | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Design, supply, installation, testing & commissioning of cubicle type compartementalized floor mounted free standing type with separation system as per IS:8623 part-1 for 415V, 50HZ, 3 phase 4 wire supply, moisture, dust and vermin proof IP-41 with cooling intrinsic design of voltage sourced IGBT based intelligent Hybrid PFC panel with Programmable Microprocessor controller to maintain Power Factor, Harmonics & Unbalancing duly housed in epoxy powder coated 2mm thick CRCA sheet steel compatmentalised enclosure free standing type with all supports, accessories, switch gears, control gears, protections, wiring, interconnections, control MCBs etc. as required complete in all respects & having its main components as bellow along with all other standard components ,circuitry & specifications as required: | | | | |
| | | | | | | |
| | | Hybrid PFC Panel shall have a rating of 650kvar @ 415V. It shall comprise at least 410kvar of IGBT based active filter (for reactive, harmonics and unbalance compensation) and remainder capacity (240kvar) of detuned capacitor banks (for reactive compensation). The detuned capacitor banks shall be controlled through the microprocessor used in the active filter. | | | | |
| | | | | | | |
| | | **Incomer** | | | | |
| | | In coming ACB 1250A-TP-50kA-415Volts - 01 Nos. | | | | |
| | | Neutral Link 400A-SP-50kA - 01 Nos. | | | | |
| | | **Metering & Indications** | | | | |
| | | Display meter with compatible RS 485 ports - 01 Nos. | | | | |
| | | Phase Indicating & ON-OFF LED Lights 230 V - 03 Nos | | | | |
| | | Ammeter - digital 3 Phase | | | | |
| | | MCB 6A-SP-10kA-C-Curve - 3 Nos. | | | | |
| | | **Active Filter** | | | | |
| | | a) Required IGBTs | | | | |
| | | b) IGBT base active technology | | | | |
| | | c) Gate driver, Interfacing and other control cards | | | | |
| | | d) Heat Sinks | | | | |
| | | e) Heavy duty cooling blowers/ fans with protection | | | | |
| | | f) Voltage Sensing Cards & circuitry | | | | |
| | | g) Current Transducers | | | | |
| | | h) SMPS | | | | |
| | | i) SSR | | | | |
| | | j) MCCB with ROM 400A-FP-36kA-T/M - 1 Nos. | | | | |
| | | k) MCCB with ROM 400A-TP-36kA-T/M - 2 Nos. | | | | |
| | | l) MCB 10A-FP-10KA- C curve - 04 Nos. | | | | |
| | | m) Contactor 400A-FP-AC1 Duty - 1 Nos. | | | | |
| | | n) Contactor 325A-TP-AC3 Duty - 2 Nos. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | o) Protections | | | | |
| | | p) Choke coil for interfacing IGBT with grid | | | | |
| | | q) High Frequency & D C bus capacitors | | | | |
| | | r) Interconnection with UNIVININ copper stranded wires, Copper Bus-bars, earth bus, danger notice boards, inscription plates, terminals for incoming & outgoing cable connections | | | | |
| | | s) Remote sensing resin cast CTs shall be provided in main panel on common Bus by Main Panel Manufacturer | | | | |
| | | t) All required hardware's, softwares, protections, cards, inscription plates, Danger notice board etc., as required to be provided to complete the system | | | | |
| | | u) MCCB, contactor and fuses of applicable rating and protections shall be provided for the active filter | | | | |
| | | | | | | |
| | | **Programmable Microprocessor controller** | | | | |
| | | i) Instantaneous corrections of leading & lagging power factor & to keep the power factor nearer to unity | | | | |
| | | ii) Instantaneous corrections in current THD levels & maintain las per IEEE 519-92 | | | | |
| | | iii) Three phase (non-neutral) unbalance compensation | | | | |
| | | iv) Reduction in voltage distortions as a result of reduction in ITHD | | | | |
| | | v) Reduction in surges caused by switching of Heavy Load reduce tripping effect on electronic devices | | | | |
| | | | | | | |
| | | **Detuned Capacitor Banks** | | | | |
| | | a) Switched Capacitors - Heavy duty (MPP) type AC three phase capacitors 25 KVAR - 08 Nos 525V grade with discharge resistor, control gears capacitor duty contactors suitable for 35KVAR & switch gears MCCBs-80A-TP-25 kA - 04 Nos of required ratings with overload & short circuit protections for each capacitor banks, LED ON indication light, auto manual switch & Auxiliary contactors, ON-OFF push buttons , timers, ammeters, control MCBs, interconnection & control wiring with copper conductor wire, Main copper bus bars etc as required | | | | |
| | | b) Control Circuits with 1.5SQmm copper conductor FRLS wires | | | | |
| | | c) 7% Detuned aluminium series reactors with minim 180% linearity with each capacitor bank | | | | |
| | | | | | | |
| | | All MCCB/ACB's shall be suitable for 50 KA (ICS) breaking capacity. | | | | |
| | | **Isolator Cum Capacitor Panel at CSS4B as described above** | **Set** | 8,240,708.00 | 1 | 8,240,708 |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Note : All Isolator Panels described above shall be considered with th efollowings :- | | | | |
| i | | 415 / 110 V suitable rating control transformer shall be provided for aux. Control supply. | | | | |
| ii | | Wiring with space heater, thermostat and control MCB's shall be provided all vertical sections of main LT panel. | | | | |
| iii | | All outgoing MCCB's feeders shall be provided with built-in short circuit & earth fault relay module. | | | | |
| iv | | All incoming as well as outgoing feeders shall have pad locking facility. | | | | |
| v | | Suitable danger board shall be provided. | | | | |
| vi | | All bus bar section / backside panels shall have pad locking facility and hinged type door. | | | | |
| vii | | 4 pole surge arrestor with each incoming feeder | | | | |
| viii | | All incoming as well as outgoing air circuit breaker shall be compatible with BAS system (Bacnet) | | | | |
| ix | | Both incoming breakers (for Normal & emergency supply) shall be operated through SCADA. Normal supply breaker shall be tripped down when DG Sets are in operation & to be ON when grid supply restore. | | | | |
| | | | | | | |
| | | | | | | |
| 10.0 | | **FEEDER PILLAR - 1 (Typical)** | | | | |
| | | Feeder Pillars shall be fabricated with 2mm thick CRCA sheet, power coated, outdoor type (IP-65), double door type, inside door with 1.6 mm sheet, cable gland sheet at bottom , as per the drawing & with the following:- | | | | |
| | | | | | | |
| | | **Incoming :** | | | | |
| | | 1 No. 63 Amps 4P MCCB | | | | |
| | | 3 No. Auto / manual selector switch | | | | |
| | | Astronomical Timers (for each phase) as required | | | | |
| | | 1 Job control flexible cabling between Astronomical Timers | | | | |
| | | 3 Nos 63 A double pole RCCBs (30 mA) | | | | |
| | | 3 Nos 63 A double pole MCBs | | | | |
| | | 3 No. 70 A DP contactor with necessary NO& NC auxilliary contacts | | | | |
| | | | | | | |
| | | **Bus Bars** | | | | |
| | | 100 amps TPN aluminium bus bars with heat shrinkable insulation sleeve | | | | |
| | | | | | | |
| | | **Outgoing** | | | | |
| | | 15 amps SP MCBs 15 Nos | | | | |
| | | | | | | |
| | | Feeder Pillar as described above | Sets | 95,198.99 | 5 | 475,995 |
| | | | | | | |
| 11.0 | | **MDB - 1 & MDB-2 (External Lighting)** | | | | |
| | | **Incoming** | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 160A FP MCCB (35kA) with following accessories: | | | | |
| | | | | | | |
| | | 0-500 volts digital electronic volt meter with selector switch through 415 V /√ 3 : 110 V /√ 3 PT, primary and secondary of PT shall be protected by 2 amps TP MCB's. | | | | |
| | | 1 Set | | | | |
| | | 0-160 Amps digital electronic ammeter with selector switch and 160/5 amps 15 VA, CL 1 CTs . | | | | |
| | | 1 Set | | | | |
| | | Phase indicating light with ON/OFF/TRIP indication through 415 / 110 V PT, primary & secondary of PT shall be protected by 2 amps SP MCB's. | | | | |
| | | 3 Sets | | | | |
| | | **Bus Bars** | | | | |
| | | 200 amps TPN aluminium bus bars (35 kA) with coloured heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | | **Outgoing** | | | | |
| | | 5 Nos. 63A TPN MCCB (35 KA) | | | | |
| | | | | | | |
| | | All MCCBs shall be of 35 kA (Ics) breaking capacity | | | | |
| | | | | | | |
| | | **MDB -1 & MDB- 2 for External lighting as described above** | Set | 162,661.70 | 2 | 325,323 |
| | | | | | | |
| 12.0 | | **DG Auxiliary Panel - 1** | | | | |
| | | **Incoming** | | | | |
| | | 1 No. 400A ON load changeover switch | | | | |
| | | 4 Nos. 160 amps TPN MCCBs & 1 No. 400 A 4 Pole MCCB | | | | |
| | | 0-500 volt digital electronic voltmeter with selector switch and shall be protected by 2 amps MCB's. | | | | |
| | | 1 set | | | | |
| | | 0-400 amps digital electronic ammeter with selector switch and 400/5 amps 15 VA, CL 1 CTs | | | | |
| | | 1 set | | | | |
| | | Phase indicating light shall be protected by 2 amps MCB's. | | | | |
| | | 3 set | | | | |
| | | ON/OFF /Trip indicating lamps. | | | | |
| | | | | | | |
| | | **Bus Bars** | | | | |
| | | 500 amps TPN aluminium bus bars with heat shrinkable insulation sleeve. | | | | |
| | | | | | | |
| | | **Outgoings :** | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | 160 AMP TP MCCB with 40 HP Soft starter and outgoing feeder to DG radiator fan motor. Each compartment shall contain CT operated digital electronic ammeters of 0-30 amps range with selector switch, CT's, auto/manual selector switch and three indicating lamps with MCB's and Push button for ON/OFF status of motor. | | | | |
| | | 4 Sets | | | | |
| | | 32 Amp TP MPCB with 3 HP direct online starter with outgoing feeders to HSD overflow pump (including 1 No. standby). Each compartment shall contain CT operated digital ammeter of 0-10 amps range with selector switch, CT's, auto / manual selector switch and three indicating lamps with MCB's and Push buttons for ON/OFF status of motors. | | | | |
| | | 2 Sets | | | | |
| | | 4 No. suitable rating MPCB, contactor with timer shall be provided for DG priming pump. | | | | |
| | | | | | | |
| | | Spare MCB's of the following capacity. | | | | |
| | | 40 amps TPN MCB<br>4 No. | | | | |
| | | | | | | |
| | | **Notes :** | | | | |
| i | | Necessary cable alleys, internal wiring, control wiring, interlocking for DG auxiliary equipments shall also be included in the cost of panel. | | | | |
| ii | | All MCCBs shall be of 35 KA breaking capacity. | | | | |
| iii | | Potential free contact shall be provided to remote starting facilities of each starter through BAS. | | | | |
| iv | | Interlocking shall be provided between respective DG primary pump and DG Breaker when DG set ON & primary pump OFF. | | | | |
| | | | | | | |
| | | **DG Auxiliary Panel-1 as described above.** | Set | 1,199,016.08 | 1 | 1,199,016 |
| | | | | | | |
| 13.0 | | **S/F 160 A TPN MCCB Isolator : Supplying and fixing 160 Amps, 415 Volts, TPN, MCCB, isolator in 1.6mm thick CRCA sheet steel enclosure of approved make design and painted with approved paint shade complete with connections, testing and commissioning etc. as required.** | Each | 26,869.52 | 24 | 644,868 |
| | | | | | | |
| 14.0 | | **S/F 250 A TPN MCCB Isolator : Supplying and fixing 200 Amps, 415 Volts, TPN, MCCB, isolator in 1.6mm thick CRCA sheet steel enclosure of approved make design and painted with approved paint shade complete with connections, testing and commissioning etc. as required.** | Each | 36,692.78 | 15 | 550,392 |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| 15.0 | | **S/F 100 A TPN MCCB Isolator : Supplying and fixing 200 Amps, 415 Volts, TPN, MCCB, isolator in 1.6mm thick CRCA sheet steel enclosure of approved make design and painted with approved paint shade complete with connections, testing and commissioning etc. as required.** | Each | 16,757.33 | 19 | 318,389 |
| | | | | | | |
| 15.0 | | **S/F 63 A TPN MCCB Isolator : Supplying and fixing 200 Amps, 415 Volts, TPN, MCCB, isolator in 1.6mm thick CRCA sheet steel enclosure of approved make design and painted with approved paint shade complete with connections, testing and commissioning etc. as required.** | Each | 16,757.33 | 51 | 854,624 |
| | | **TOTAL CARRIED TO SUMMARY** | | | | 71,297,831 |
| | | | | | | |
| R | | **DG SETS AND EXHAUST PIPING SYSTEM** | | | | |
| 1.0 | | Supply, installation, testing and commissioning of radiator cooled 1500 KVA ,11 KV, 50 Hz- 3 phase prime (actual) rating diesel generating set (11000 Volts Alternator with PCCM or equivalent) along with CT Adaptor Box, AVM Pads including cable termination box with all associated equipment / work as per specifications. Alternator shall have class F insulation 11000 Volts and rated for 1200 KW output at 0.8 p.f. at site. Engine shall not be derated upto 50 deg.C ambient and suitable for bearing the starting current after changeover. | Set | 18,221,175.00 | 2 | 36,442,350 |
| | | | | | | |
| 2.0 | | Supply, installation, testing and commissioning of powder coated acoustic enclosure suitable for 1500 KVA DG set for outdoor application as per specification complete with all accessories as required including ventilation system. No deration in DG set capacity shall be accepted on this account. | Set | 1,463,306.00 | 2 | 2,926,612 |
| | | | | | | |
| 3.0 | | **Exhaust Piping** | | | | |
| | | Supply, erection, testing and commissioning of exhaust piping Min. 5.2mm Thick of following sizes with welding joint including bends, MS pipe supports, clamps, dash fastener, nuts, bolts etc.,with first layer of insulation 25mm thick ceramic fiber wool (48Kg/Cub. Mtr.) & second layer minimum 75mm thick rockwooll (96Kg/Cub. Mtr.) covered with 26 SWG aluminium sheet claddings etc. complete as required and as per specifications. | | | | |
| a | | 400 mm dia. NB | Mtrs. | 15,479.00 | 192 | 2,971,968 |
| b | | 250 mm dia. NB | Mtrs. | 8,510.00 | 24 | 204,240 |
| | | | | | | |
| 4.0 | | **Expansion Bellows** | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Providing and fixing following sizes (internal dia) externally pressurized expansion bellows rated for the pressure as required by the piping system and -20deg C to 550 deg C temperature. Bellows shall be made of SS 321 and flanges shall be amd eof mild steel as per ASA# 150lbs. The expansion bellows shall be provided with control rodes/ guids and integrated lining to reduce turbuance and ensure proper internal alignment. | | | | |
| i | | 400 mm dia NB | Nos. | 22,000.00 | 6 | 132,000 |
| ii | | 250 mm dia NB | Nos. | 17,000.00 | 2 | 34,000 |
| | | | | | | |
| 6.0 | | **Supporting MS Structure** | | | | |
| | | Supplying all the material for fabrication 30 mtr High lattice tower for supporting 4 Nos. Chimmnes for 1500 KVA DG Sets complete with suitable size M.S channel, M.S angle, M.S flat, dash fastners, nut, bolt etc. complete including 1 coat of redoxide & 2 coat of enamel paint and other Accessories as required at the site of work. Lightning arrestor & 40 x 6 mm GI strip including 2 Nos. earthing stations with GI plate, also to be included in the item. (The item shall be in the scope of DG vendor.) | Kgs. | 138.00 | 15000 | 2,070,000 |
| | | | | | | |
| 7.0 | | **Aviation Light** | | | | |
| i | | Lightening Arrstor Non seamer type | Nos. | 22,988.50 | 1 | 22,989 |
| ii | | Aviation light | Nos. | 17,859.50 | 1 | 17,860 |
| iii | | 25x3 mm GI strip | Mtrs. | 172.50 | 40 | 6,900 |
| iv | | Isolator switch | Nos. | 8,510.00 | 1 | 8,510 |
| v | | Insualtors | Nos. | 138.00 | 60 | 8,280 |
| vi | | Chemical earthing | Nos. | 41,699.00 | 2 | 83,398 |
| vii | | 50x6 mm GI mstrip | Mtrs. | 448.50 | 50 | 22,425 |
| | | | | | | |
| 5.0 | | Supply, erection, testing and commissioning of motorized fuel transfer pumps as required. | Nos. | 34,500.00 | 2 | 69,000 |
| | | | | | | |
| | | **TOTAL CARRIED TO SUMMARY** | | | | 45,020,531 |
| | | | | | | |
| S | | **HSD STORAGE AND SUPPLY SYSTEM** | | | | |
| 1.0 | | Supplying, installing, testing and commissioning of underground Horizontal cylindrical HSD storage tank (6mm thick shell and 8 mm thick plain ends) installation including the following : | | | | |
| a | | Inlet and outlet connections. | | | | |
| b | | Vent pipe with flame arrester. | | | | |
| c | | Dip pipe assembly with calibration chart, complete with cap with locking arrangement with dip stick engraving in it. | | | | |
| d | | 550 mm internal dia manhole with cover. | | | | |
| e | | Cleats for anchoring (4 Nos.) | | | | |
| f | | Lifting lugs :- | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | (The design, fabrication, pressure testing, corrosion protection, anchoring, earthing etc. will be done strictly as per IS:10987-1992 and duly approved by 'CCOE' suitable for underground installation.) | | | | |
| | | | | | | |
| g | | 15 KL capacity HSD tank size (approx.) 1950 mm dia (shell outside diameter) & 5500 mm long (overall length). | Set | 858,785.50 | 1 | 858,786 |
| | | | | | | |
| 2.0 | | Supply, installation, testing & commissioning of flame proof electrical driven rotary gear pumps suitable for pumping of HSD consisting of following & as per IS 2148. (Pump shall be suitable for automatic/manual operation as required) Self priming gear pump with weather protection cover for motor. [Location : HSD Yard ]. | | | | |
| | | | | | | |
| | | Horizontally mounted single stage capable of delivering 35 LPM at 30 Mtr. Head while running at required 1440 RPM, complete with proper connection to suction and delivery line, bypass arrangement against over pressure. | | | | |
| | | Flame proof motor suitable for 415 + 10% V, 3 phase, 50 Hz AC supply and of suitable HP for the above pumps. | | | | |
| | | Flame proof on-off push button station of required rating suitable for the above motor without no volt coil including connection, interconnection in switch board. | | | | |
| | | Common base plate of required strength manufactured out of cast iron. | | | | |
| | | Suitable RCC foundation and anti vibration damping arrangement with cushy foot or similar mounting arrangement. | | | | |
| | | Coupling and coupling guard for direct coupling of pump and motor. | | | | |
| | | Pressure gauge with valve on the delivery side. | | | | |
| | | Strainer at inlet - 32 mm dia | | | | |
| | | The pump set as described above (1w + 1 standby) | Set | 131,468.00 | 2 | 262,936 |
| | | | | | | |
| 3.0 | | Providing, fixing, testing & commissioning of M.S. class `C' (heavy duty) exposed pipes conforming to IS : 1239 and fittings like tees, elbows, junctions, unions, bends, plugs, flanges etc. clamps, structural supports as required/ directed at site including cutting & making good the walls, floors, RCC work etc. cutting chases & filling the same with cement concrete 1:3:6 (1 cement :3 coarse sand :6 graded stone aggregate 20 mm nominal size) or cement mortar 1:4 (1 cement :4 coarse sand) as required including painting the pipes with desired shade of enamel paint over a coat of primer. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | **Location : Inside Plant Room** | | | | |
| a | | 25 mm dia | RM | 402.50 | 50 | 20,125 |
| b | | 32 mm dia | RM | 506.00 | 40 | 20,240 |
| c | | 40 mm dia | RM | 621.00 | 40 | 24,840 |
| d | | 50 mm dia | RM | 851.00 | 40 | 34,040 |
| e | | 65 mm dia | RM | 1,115.50 | 10 | 11,155 |
| | | | | | | |
| 4.0 | | Supply, installation, testing and commissioning of MS class C (heavy duty) pipe in trenches including fittings like tees, elbows, unions, bends plugs etc. for fuel oil piping including provision of supports etc. Provision of 6 mm Pypcoat anticrossive treatment to the pipe | | | | |
| a | | 40 mm dia | RM | 874.00 | 15 | 13,110 |
| b | | 50 mm dia | RM | 1,173.00 | 20 | 23,460 |
| | | | | | | |
| 5.0 | | Supply, installation, testing & commissioning of CI plug valve of the following sizes suitable for pressure of 10 Kg / Sqcm complete with all necessary fittings (Audco) | | | | |
| a | | 25 mm dia | Nos. | 4,462.00 | 6 | 26,772 |
| | | | | | | |
| 6.0 | | Supply, installation, testing & commissioning of GM non-return valves of the following sizes G.M. suitable for pressure of 10 Kg / Sqcm complete with all necessary fittings. (Audco). | | | | |
| a | | 40 mm dia | Nos. | 3,887.00 | 3 | 11,661 |
| | | | | | | |
| 7.0 | | Supply, installation, testing & commissioning of gun metal float valve with copper float ball and brass rod of required length suitable for pressure of 10 Kg / sqcm complete as required. | | | | |
| a | | 32 mm dia | Nos. | 4,266.50 | 2 | 8,533 |
| | | | | | | |
| 8.0 | | Providing and fixing level controller for day oil storage tanks, including wiring, cabling, probes, solenoid valve suitable for HSD fuel and with all other accessories ready for automatic operation of fuel oil pump complete as required. | Sets | 36,133.00 | 2 | 72,266 |
| | | | | | | |
| 9.0 | | Providing and fixing Y strainer for oil supply line | | | | |
| a | | 40 mm dia | Nos. | 11,914.00 | 2 | 23,828 |
| b | | 50 mm dia | Nos. | 11,914.00 | 1 | 11,914 |
| c | | 65 mm dia | Nos. | 17,859.50 | 2 | 35,719 |
| | | | | | | |
| 10.0 | | Supply, installation, testing and commissioning of 990 litres capacity day oil storage tank fabricated from 4 mm thick MS plates. Cost of Tank shall include provision of 450 mm ID Manhole cover, level indicator & flanged connection for inlet, outlet, overflow, vent, drain, boiler return and provision for installing probes of level controller Tank shall be mounted on 2m high steel structure support with access ladder (painted with 2 coats of Red Oxide Primer). | Set | 82,478.00 | 2 | 164,956 |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | | | | | |
| 11.0 | | On 80 mm dia Fuel line [For unloading] with 50 mm dia Oil flow meter, 3 Nos. 80 mm dia valve, 1 No. basket strainer (suitable for 15000 Ltr. Per Hr. flow). | Set | 207,138.00 | 1 | 207,138 |
| | | | | | | |
| 12.0 | | Providing and fixing rubber hose suitable for HSD service at unloading point 3 Mtr. Length with coupling joints. | | | | |
| a | | 65 mm dia | Nos. | 9,188.50 | 1 | 9,189 |
| | | | | | | |
| | | **Tank Anchorage & Earthing Work :** | | | | |
| | | Underground H.S.D. tank anchorage by means of steel flats of round bars having adequate cross section to resist the uplift at a stress level of 137.00 Mpa (1400 Kgf/cm2). | | | | |
| | | | | | | |
| 13.0 | | HSD tank earthing as per clause/para 11.5.4 of IS : 10987-1992 and fuel pipe line earthing as per IPR-1972. | LS | 18,400.00 | 1 | 18,400 |
| | | | | | | |
| 14.0 | | Supply, installation, testing & commissioning of automatic level controller with low level & high level cut off and alarm indication including all fitting, control cabling and accessories. | | | | |
| a | | HSD Buffer tank | Set | 37,409.50 | 1 | 37,410 |
| b | | HSD Over flow tank | Set | 37,409.50 | 1 | 37,410 |
| | | | | | | |
| 15.0 | | Providing, fixing, testing & commissioning of approved quality GM float with copper ball float and brass rod required length of following sizes :- | | | | |
| a | | 40 mm dia | Each | 5,117.50 | 2 | 10,235 |
| | | | | | | |
| | | **BUFFER TANK :** | | | | |
| 16.0 | | Supply, installation testing & commissioning 990 Ltr. Cap. Buffer Tank for HSD to be installed in DG room & Boiler Room. The tank shall be fabricated from 5 mm thick MS plates. Tank shall be provided with all necessary nozzles for inlet, out let, vent, drain, overflow and 450 mm dia manhole for easy access for cleaning & maintenance. Tank shall be provided with float & Board type level Indicator. | | | | |
| | | HSD Buffer Tank 990 Ltrs. capacity (1000x1000x1000 mm deep) with all accessories. | Set | 95,220.00 | 1 | 95,220 |
| | | | | | | |
| | | **OVER FLOW TANK:** | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| 17.0 | | Supply, installation, testing & commissioning of 990 Ltrs. Capacity overflow tank for HSD overflowing from day oil tanks installed in the DG room & Boiler Room. The tank shall be fabricated from 5 mm thick M.S. plates. Tank shall be having necessary nozzles for inlet, outlet, vent, drain, overflow and a manhole of 550mm dia for easy access to all equipments/instruments inside the tank and shall also include float operated level indicator. Tank shall be placed at 450 mm below finished floor level inside plant room. All equipments/instruments inside or near this tank to be of flameproof construction. | | | | |
| | | HSD overflow tank 990 litres capacity (1000 x 1000 x 1000 mm deep) with all accessories as above. | Set | 95,220.00 | 1 | 95,220 |
| | | | | | | |
| 18.0 | | Structural Steel platform for Buffer tank fabricated from beams, Channels, angles, plates, chequrered plates etc. of suitbales heights to be erected in DG room. | Kg. | 138.00 | 2000 | 276,000 |
| | | | | | | |
| 19.0 | | Providing, Installing, testing & commissioning of ultrasonic level transmitter in undergrounding HSD storage tanks. The level indicator shall be provided in electrical control panel. Cost of electrical cabling from level transmitter to level indicater to be included in this item. | Set | 136,206.00 | 1 | 136,206 |
| | | | | | | |
| | | Starts/stop, level indication shall be interface with BMS. necessary potential free contacts shall be provided in local control station, panels. | | | | |
| | | | | | | |
| 20.0 | | Providing, Fixing testing & commissioning of CI Foot valve including all fitting & accessories. | | | | |
| a | | 50 mm dia | Each | 2,208.00 | 1 | 2,208 |
| | | | | | | |
| | | **TOTAL CARRIED TO SUMMARY** | | 1,812,365.50 | | 2,548,975 |
| | | | | | | |
| T | | **EXTERNAL LIGHTING FIXTURES:** | | | | |
| 1.0 | | **Supply,Installation,Testing & commissing of following light fittings & poles :-** | | | 0 | |
| a | | 7m high octagenal pole ( as per specification) with 60 W LED light similar to BENP 60 w LED of Bajaj or equivalent | Nos | 27,500.00 | 150 | 4,125,000 |
| b | | Post top light with 3.5 m high 80 mm dia of pipe ( medium grade ) with 25W LED similar to BLPTSP of bajaj or equivalent | Nos | 10,000.00 | 25 | 250,000 |
| c | | Tall bollard light with 12 W LED similar to NL-534-1201 p LED in 600 mm height of NOVA or equivalent | Nos. | 11,500.00 | 380 | 4,370,000 |
| d | | Small stone Bollard with 7W LED similar to NL-534-701 P LED in 450 mm height of Nova or equivalent | Nos. | 7,000.00 | 425 | 2,975,000 |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| e | | Movable light of Trilux make as approved by TRILUX or equivalent | Nos. | 6,000.00 | 60 | 360,000 |
| f | | Projector light / Narrow beam light of NOVA as approved by architect | Nos. | 11,000.00 | 50 | 550,000 |
| g | | Narrow beam light (floor mounting) of NOVA as approved by architect | Nos. | 6,500.00 | 15 | 97,500 |
| h | | Pedestal lights of Trilux make as approved by architect | Nos. | 8,000.00 | 70 | 560,000 |
| i | | Under water light similar to NL-7546-609-P LED of NOVA with ip 65 outdoor enclosure or equivalent or equivalent | Nos. | 8,500.00 | 30 | 255,000 |
| j | | Down light fitting of NOVA as approved by architect. | Nos. | 3,500.00 | 10 | 35,000 |
| k | | 26 w empor 80-RB6L-/2600-730 6GIS ETDD of Trilux or equivalent | Nos. | 7,000.00 | 10 | 70,000 |
| l | | 49 W Publisca P1 - RB6L/4200-730 6GIS ETDD of Trilux or equivalent | Nos. | 8,000.00 | 60 | 480,000 |
| m | | Gate light fitting with 45W led similar to BRIL 45W LED 111713 of Bajaj or equivalent | Nos. | 9,500.00 | 11 | 104,500 |
| n | | 7m high octagenal pole ( as per specification) with 45 W led light similar to BENP 45 w LED of Bajaj or equivalent | Nos. | 20,000.00 | 75 | 1,500,000 |
| | | | | | | |
| 2.0 | | **High Mast Light** | | | | |
| i | | Supply , installation, testing & commissioning of 16 mtr high mast complete in respects including lighting fixtues, lamps, wiring / cabling upto terminal box. The mast shall have the following specifications:- | | | | |
| a | | Structure - Material of constructions - Hot rolled MS Plate | | | | |
| | | No. of Sections - (3) , Base section - 5mm thick, middle section - 4 mm thick & upper section - 4 mm | | | | |
| | | Length of each section - 7.115 mtr | | | | |
| | | Top - Face to face inside - 200 mm | | | | |
| | | Bottom - Face to face inside - 450 mm | | | | |
| | | Circular Base plate - 725 x 32 mm | | | | |
| | | No. of foundation bolts - 8 Nos. | | | | |
| b | | Dynamic loading - Max. design wind speed - 180 KM / Hr | | | | |
| c | | Lantern Carriage - Ring - Inside dia - 800 mm | | | | |
| | | Capacity - 750 Kg | | | | |
| d | | Double drum winch - Capacity - 75 Kg | | | | |
| | | Operation - Motorized | | | | |
| | | Gear ration - 53:1 | | | | |
| e | | Stainless steel wire rope , No. of rope - 2 for winch & 3 for lantern. | | | | |
| | | Dia - 6 mm | | | | |
| | | construction - 7/19 with central core ss | | | | |
| | | Breaking load - 2300 Kg. | | | | |
| f | | Power load - 3 Phase , 415 V | | | | |
| | | wattage - 1.1 KW | | | | |
| | | reversible - Yes | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| g | | Lighting fixtures - 8 Nos. 100W LED lighting fixtures similar to BENP 20 FL 100 W LED of bajaj or equivalent of Wipro. | | | | |
| h | | 2 Nos. GI earth plate (Earthing stations) - As per CPWD specifications) with 25 x 6 mm GI earth strips connecting to highmast. | | | | |
| I | | Aviation obstruction light | | | | |
| J | | Lightning arrestor | | | | |
| | | | | | | |
| | | **High mast as described above** | Set | 550,000.00 | 5 | 2,750,000 |
| | | | | | | |
| ii | | same as above 2 (ii) but for 20 mtr. | Set | 650,000.00 | 5 | 3,250,000 |
| | | | | | | |
| 3.0 | | Supply, installation and fixing of Weather proof IP65 type cast iron junction box with 2 Nos. earthing terminal to receive 2 x 10sq.mm Aluminum Armoured cable (2 Nos.) .The scope also includes supply and pulling of 3Nos. 2.5 sq.mm stranded copper flexible cables from Junction box to Lighting luminaries with supply ,fixing of 10Amp SP -C-CL,10k.A.MCB , elmex terminals etc (Minimum size of Junction box is 215 mm x 125 mm x88 mm). | No. | 4,000.00 | 200 | 800,000 |
| 4.0 | | Supply, installation, testing & commissioning of Exhaust fan of 300 mm dia. 900rpm single phase heavy duty complete with all accessories. | Nos | 2,500.00 | 2 | 5,000 |
| 5.0 | | Supplying and embedding following dia G.I. pipe (medium class) in pole collar/ foundation (during casting) for cable entry including bending the pipe to the required shape complete as required. | | | | |
| a | | 32 mm dia | metre | 259.00 | 800 | 207,200 |
| b | | 40 mm dia | metre | 292.00 | 1000 | 292,000 |
| | | | | | | |
| | | **TOTAL CARRIED TO SUMMARY** | | | | 23,036,200 |
| | | | | | | |
| U | | **SAFETY AND FIRE PROTECTION EQUIPMENTS** | | | | |
| 1.0 | | Providing and fixing M.V. danger notice plate of 200 mm X 150 mm, made of mild steel,atleast 2mm thick,and vitreous enamelled white on both sides,and with inscription in single red colour on front side as required. | Each | 133.00 | 20 | 2,660 |
| 2.0 | | Providing and fixing HT danger notice plate of 250 mm X 200 mm, made of mild steel,atleast 2mm thick,and vitreous enamelled white on both sides,and with inscription in single red colour on front side as required. | Each | 146.00 | 20 | 2,920 |
| 3.0 | | Supply and fixing wooden framed covered with glass shock treatment chart printed on cloth in English ,Hindi & Local language. | Job | 1,230.00 | 8 | 9,840 |
| 4.0 | | Supply and fixing suitable size wooden framed covered with glass for Main Panel SLD in electrical room as per IE rules fixed to wall as required. | Job | 2,050.00 | 8 | 16,400 |

| ELECTRICAL WORKS - NON DSR | | | | | | |
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| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| 5.0 | | Supply and providing ISI marked electrical 1.1 kV grade 3 mm thick anti-skid rubber mat as per IS:15652-2006 with up to date ammendment. | Sqm | 3,280.00 | 150 | 492,000 |
| 6.0 | | Supply, installation, testing and commissioning of Standard First aid box complete with all accessories as required. | Each | 1,430.00 | 15 | 21,450 |
| 7.0 | | Floor mounted bucket stand with GI buckets to hand 4 nos. of 13 ltrs buckets sand filled. The stand shall be 5'(L) x 3'(H) x 2"(W) made out of 30 x 300 x4mm MS angle frame duly coated with 2 coats of red oxide primer & 2 coats of red finish paint | Each | 2,465.00 | 8 | 19,720 |
| 8.0 | | Supply and fixing in position 1000 mm wide rubber matting of 11 KV grade as per electricity rules. Thickness of rubber mat shall be as per latest IS Code. | RM | 3,080.00 | 150 | 462,000 |
| 9.0 | | Supply and fixing in position 1000 mm wide rubber matting of 66 KV grade as per electricity rules. Thickness of rubber mat shall be as per IS Code. | RM | 5,390.00 | 30 | 161,700 |
| 10.0 | | Portable 5 kg. dry type fire extinguisher suitable for electrical fire and as recommended by the tariff advisory committee. | Each | 4,520.00 | 8 | 36,160 |
| 11.0 | | Supply and fixing of in-position the fire extinguishers dry chemical power (ABC) 5 kg capacity. | No. | 8,470.00 | 8 | 67,760 |
| 12.0 | | Supply and fixing of in position the fire extinguishers dry chemical power (ABC) 2 kg capacity. | No. | 6,160.00 | 12 | 73,920 |
| 13.0 | | Supply and fixing of tool kit with all standard tools such as screw driver , spaner etc as required. | Each | 4,100.00 | 2 | 8,200 |
| 14.0 | | Supply of 11kV pair of hand gloves | Set | 820.00 | 12 | 9,840 |
| 15.0 | | Supply of 66kV pair of hand gloves | Set | 1,440.00 | 2 | 2,880 |
| 16.0 | | Supply and fixing of cable/ busbar 11kV earthing truck/ trolley. | No. | 116,100.00 | 2 | 232,200 |
| 17.0 | | Providing & fixing of Fire Buckets (6 nos.) with stand having capacity of 9 liters conforming to relevant BIS specifications. | Each | 3,080.00 | 4 | 12,320 |
| 18.0 | | Providing & fixing Fire Extinguishers mechanical foam type having capacity of 9 liters (for fighting oil fires) in accordance with OISD standard - 117 | Each | 410.00 | 2 | 820 |
| 19.0 | | Providing & fixing of 'No Smoking' and 'No Unauthorized Entry' signboards in English and Hindi, as per IPR- 1970. | Each | 410.00 | 2 | 820 |
| 20.0 | | Supply,installation,testing and commissing of 200 AH Capacity 24 volts DC hermetically sealed maintenance free lead acid batteries duly charged | Each | 410.00 | 2 | 820 |
| 21.0 | | Supply,installation,testing and commissing of battery charger unit with provisions of boost & float charging, suitable for 240 v single phase AC 10% AC, 50 HZ, Power supply as per specifactions | Each | 40,000.00 | 6 | 240,000 |
| | | | | | | |
| | | **TOTAL CARRIED OVER TO SUMMARY** | | | | 1,874,430 |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | | | | | |
| V | | **HT CABLES AND TERMINATIONS** | | | | |
| | | | | | | |
| | | The rates under this section shall also include the following: | | | | |
| | | Providing and fixing approved cable supports and grouting the same as required. | | | | |
| | | Effecting proper connections at terminations. | | | | |
| | | Ensuring that provision is left in buildings and trenches as the work proceeds, for incorporating of cable supports at a later date. | | | | |
| | | Providing all, fixing accessories such as clamping devices, nuts and bolts etc. | | | | |
| | | Clamping to supports where laid in trenches. | | | | |
| | | Providing proper supports for cable terminals as called for. | | | | |
| | | Wherever cables cross walls provide proper sleeves at the time of civil work. | | | | |
| | | | | | | |
| 1.0 | | Supplying of following size 66 KV grade sheathed Un-earthed (UE) aluminium conductor, XLPE, corrugated Aluminium sheathed armoured cables. | | | | |
| a | | 3 C x 300 sq.mm 66 KV Sheathed cable | RM | 5,450.00 | 110 | 599,500 |
| | | | | | | |
| 2.0 | | Laying of 66 kV grade, aluminium conductor, XLPE, corrugated Aluminium sheathed, UE (Un-earthed) aluminum conductor cable of following size direct in existing RCC trench direct on sand cushion in one tier formation as required. | | | | |
| a | | 3 C x 300 sq.mm 66 KV Sheathed cable | RM | 550.00 | 110 | 60,500 |
| | | | | | | |
| 3.0 | | Supply and making outdoor cable end termination with heat shrinkable jointing kit complete with all accessories including lugs suitable for following size of 3 core , Sheathed aluminium conductor cable of 66 KV grade as required. | | | | |
| a | | 3 C x 300 Sq.mm | Each | 65,000.00 | 8 | 520,000 |
| | | | | | | |
| | | **HT Cables (UE) & Terminations** | | | | |
| 4.0 | | Supplying of following size 11 KV grade XLPE, FRLS (outersheath) aluminium conductor (UE) armoured cables. | | | | |
| a | | Single Core 1000 Sqmm | RM | 5,000.00 | 650 | 3,250,000 |
| b | | 3 C x 400 Sq.mm | RM | 2,207.00 | 135 | 297,945 |
| c | | 3 C x 300 Sq.mm | RM | 1,877.00 | 4500 | 8,446,500 |
| d | | 3 C x 240 Sq.mm | RM | 1,631.00 | 105 | 171,255 |
| e | | 1 C x 300 Sq.mm | RM | 705.00 | 40 | 28,200 |
| f | | 1 C x 185 Sq.mm | RM | 545.00 | 340 | 185,300 |
| | | | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| 5.0 | | Supply and making indoor cable end termination with heat shrinkable jointing kit complete with all accessories including lugs suitable for following size of 3 core , XLPE aluminium conductor cable of 11 KV grade as required. | | | | |
| a | | Single Core 1000 Sqmm | Each | 35,000.00 | 12 | 420,000 |
| b | | 3 C x 400 Sq.mm | Each | 9,360.00 | 2 | 18,720 |
| c | | 3 C x 300 Sq.mm | Each | 7,628.40 | 2 | 15,257 |
| d | | 3 C x 240 Sq.mm | Each | 7,628.40 | 2 | 15,257 |
| e | | 1 C x 185 Sq.mm | Each | 3,500.00 | 2 | 7,000 |
| | | | | | | |
| 6.0 | | Supply and making outdoor cable end termination with heat shrinkable jointing kit complete with all accessories including lugs suitable for following size of 3 core , XLPE aluminium conductor cable of 11 KV grade as required. | | | | |
| a | | Single Core 1000 Sqmm | Each | 50,000.00 | 12 | 600,000 |
| b | | 3 C x 400 Sq.mm | Each | 12,500.00 | 4 | 50,000 |
| c | | 3 C x 300 Sq.mm | Each | 11,236.80 | 20 | 224,736 |
| d | | 3 C x 240 Sq.mm | Each | 11,236.80 | 4 | 44,947 |
| e | | 1 C x 185 Sq.mm | Each | 6,000.00 | 16 | 96,000 |
| | | **TOTAL CARRIED TO SUMMARY** | | | | **15,051,117** |
| | | | | | | |
| W | | **SCADA SYSTEM** | | | | |
| 1 | | Supply, Erection, Testing and Commissioning of Electrical SCADA equipments and materials as per respective technical specifications and relevant special conditions and suitable for monitoring and control of 66kV and 11kV HT Panels in the MRS, and RMUs and Main Distribution Panel boards of secondary substations (ESS-1, ESS-2, ESS-3 & ESS-4) via Optical Fibre Communication using OFC cable and including interfacing LIUs. LIUs shall be the part of scada and fibre optical cable shall be provided by client seperately. The SCADA system shall comply all the requirements of communication interface using IEC-61850 protocol between itself and other devices like RTU, RMU, protection relays as required. | | | | |
| | | The control & monitoring system shall be structure at station leve with main operator station having 21" monitor connected with system processor hardware which should be of industrial grade and tested for all relevant EMC / CE / IEC tests. | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Communication system consisting as per below:<br>Intelligent Data Concentrator -- 01 No.<br>Commercial Grade Computer with OS Software/Keyboard / Optical Mouse and Backup Inverter (atleast 20min backup) -- 01 No<br>21" inch LCD Monitor -- 01 No<br>Operator Workstation Console with ergonomic table-chair arrangement (Mounting of Server PCs /Monitors) -- 02 Nos.<br>Engineering workstation - 1No.<br>Patch cords (CAT6/FO) for Relay Networking/ and other passive network components as listed below-Lump-sum (100 mts.) | | | | |
| | | Shielded Twisted pair Cable(STP) (supplied as loose) , Software/Programming Tool for Relays/DataConcentractor incl. Engineering Software for Relay Settings/DR/Fault Analysis (01No.) and Software for Gateway applications (01 No)<br>The engineering shall include implementation of HMI level single-line-diagrams of all HT Panels (66kV, 11kV), RMUs, and Incomer/BusCoupler feeders of Main LT Panels, with capability to monitor and control. All reporting, event capturing, disturbance recording tools shall be provided as part of package and in line with SCADA architecture proposed. | | | | |
| | | The scope shall be complete including implementation of SCADA scheme and handing over the same to end-customer after commissioning, with guaranteed provision of free-of-charge on-site training to end-client in three separate visits not less than 02-man-days each spread over 06-months subsequent to date of commissioning. | Lot | 7,000,000.00 | 1 | 7,000,000 |
| | | | | | | |
| 2 | | Supply,laying ,testing & commisioning of 12 Core Single mode, OM3 grade, armoured optical fiber cable complete including 600mm deep excavation works with refilling sand and brick protection | RM | 350.00 | 4000 | 1,400,000 |
| | | | | | | |
| | | **TOTAL CARRIED TO SUMMARY** | | | | 8,400,000 |
| | | | | | | |
| X | | **NITROGEN INJECTION FIRE PREVENTION AND EXTINGUISHING SYSTEM** | | | | |

| ELECTRICAL WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **Sl. No** | **DSR Item No.** | **Description of Items** | **Unit** | **Rate** | **Total QTY** | **AMOUNT (INR)** |
| | | Supply, installation, supervision, testing & commisioning of Nitrogen injection fire prevention system for 5/6.3 MVA 66/11 KV Power transformer, complete including 100 mm dia class 'C' pipe between transformer and F.E cubicle and oil pit, 12 core X 1.5 sqmm FRLS armoured cable with all accessories for connections between transformer - circuit breaker - F.E cubicle , 1.5 sqmm X 4 core FRLS copper armoured cable for connection between relay panel to control box , DG source & without civil work ( foundation required for fire extinguishing cubicle & oil pit .) | | | | |
| | | **TOTAL CARRIED TO SUMMARY** | **Set** | 1,100,000.00 | **2** | **2,200,000** |
| | | | | | | |
| Y | | **ENERGY MANAGEMENT SYSTEM** | | | | |
| 1.0 | | Supply, Installation, testing & Commissioning of software for Energy Management system suitable for 400 meters having capability of Server Client Architecture and with reparts capability complying ISO 50000-1 as per specifications having atleast 2 web client. | Set | 2,270,531.00 | 1 | 2,270,531 |
| | | | | | | |
| 2.0 | | Supply, Installation, testing & commissioning of Server grade workstation for EMS System as per specification | Set | 497,770.00 | 1 | 497,770 |
| | | | | | | |
| 3.0 | | Integration gateway for Energy meters & other communication devices over modbus IP with inbuilt web server, complete in all respects including power supply. | Lot | 720,457.00 | 1 | 720,457 |
| | | | | | | |
| 4.0 | | Ethernet managed switch - 12 ports supporting RSTP protocol | Set | 45,496.00 | 1 | 45,496 |
| | | | | | | |
| 5.0 | | Supply, Installation, testing & Commissioning of 2 Core 1.5 Sqmm sheilded Copper Cable in MS conduit | RM | 51.00 | 2500 | 127,500 |
| | | | | | | |
| 6.0 | | 2 KVA online UPS with 60min. Battery backup | No. | 110,033.00 | 1 | 110,033 |
| | | | | | | |
| | | **TOTAL CARRIED TO SUMMARY** | | | | **3,771,787** |
| | | | | | | |
| Z | | **MISCELLANEOUS ITEMS** | | | | |
| | | | | | | |
| | | **GI SLEEVES** | | | | |
| 1.0 | | Providing and fixing of the following size medium class GI pipe sleeves | | | | |
| a | | 100 mm. dia. | Metre | 1,838.00 | 192 | 352,896 |
| b | | 150 mm. dia. | Metre | 699.00 | 292 | 204,108 |
| c | | 200 mm. dia. | Metre | 4,068.00 | 58 | 235,944 |
| d | | 300 mm. dia. | Metre | 5,915.00 | 38 | 224,770 |
| | | | | | | |
| | | **TOTAL CARRIED OVER TO SUMMARY** | | | | **1,017,718** |
| **TOTAL ELECTRICAL NDSR** | | | | | | **870303798** |

**SUMMARY - HVAC WORKS**

| S.No. | Description of Work | DSR Amount (Rs.) | NDSR Amount (Rs.) |
|---|---|---|---|
| A | HIGH SIDE EQUIPMENT | 1,114,410 | 209,224,164 |
| B | AIR CONDITIONING EQUIPMENTS: | - | **109,775,215** |
| C | VENTILATION SYSTEM: | - | 24,943,699 |
| D | AIR DISTRIBUTION SYSTEM: | 67,441,383 | 53,012,612 |
| E | PIPING & ACCESSORIES | 22,391,532 | **39,534,032** |
| F | ELECTRICAL WORKS | 5,267,072 | **43,339,318** |
| G | OPERATION | - | - |
| H | MAINTENANCE | - | - |
| | | | |
| | **TOTAL** | **96214397** | **479829041** |
| **TOTAL DSR AND NDSR** | | **576043438** | |

| HVAC WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Total Qty** | **Total Amount** |
| | | | | | | |
| **A)** | | **HIGH SIDE EQUIPMENT** | | | | |
| | | | | | | |
| **1.0** | | **HUME PIPE**<br>Supply , installation , testing and commissioning of RCC Hume pipe for carying buried pipe as per specification & the sizes will be as per drawings and schedules : | | | | |
| **1.1** | **1733** | 2000 MM DIA | Metre | 9,450.00 | 80 | 756,000 |
| **1.2** | **1736** | 900 mm dia | Metre | 4,595.00 | 78 | 358,410 |
| | | | | | | |
| | | **TOTAL OF SUB SECTION (A) CARRIED OVER TO SUMMARY** | | | | **1,114,410** |
| | | | | | | |
| **D)** | | **AIR DISTRIBUTION SYSTEM** | | | | |
| | | | | | | |
| **1.0** | 16.12.1 | **Factory fabricated Sheet Metal Duct:**<br>Supply, installation, balancing and commissioning of factory fabricated GSS sheet metal rectangular/round ducting complete with neoprene rubber gaskets, elbows, splitter dampers, vanes, hangers, supports etc. as per approved drawings and specifications of following sheet thickness complete as required. | | | | |
| 1.1 | 16.12.1.1 | 0.63mm thick | SQMT | 725.00 | 22781 | 16,516,225 |
| 1.2 | 16.12.1.2 | 0.80mm thick | SQMT | 890.00 | 20354 | 18,115,060 |
| 1.3 | 16.12.1.3 | 1.00mm thick | SQMT | 1,004.00 | 4290 | 4,307,160 |
| 1.4 | 16.12.1.4 | 1.25mm thick | SQMT | 1,257.00 | 3297 | 4,144,329 |
| | | | | | | |
| **2.0** | 16.12.2 | **Site fabricated Sheet Metal Duct:**<br>Supply, installation, balancing and commissioning of site fabricated GSS sheet metal rectangular/round ducting complete with neoprene rubber gaskets, elbows, splitter dampers, vanes, hangers, supports etc. as per approved drawings and specifications of following sheet thickness complete as required. | | | | |
| 2.1 | 16.12.2.1 | 0.63mm thick | SQMT | 605.00 | 3857 | 2,333,485 |
| 2.2 | 16.12.2.2 | 0.80mm thick | SQMT | 728.00 | 3439 | 2,503,592 |
| 2.3 | 16.12.2.3 | 1.00mm thick | SQMT | 949.00 | 731 | 694,099 |
| 2.4 | 16.12.2.4 | 1.25mm thick | SQMT | 1,072.00 | 563 | 603,536 |
| | | | | | | |
| **3.0** | 16.13 | **Volume Control Damper**<br>Supply, installation, testing and commissioning of G.I volume control duct damper complete with neoprene rubber gaskets, nuts, bolts, screws, linkages, flanges etc, as per specifications | SQMT | 5,413.00 | 212 | 1,147,989 |
| | | | | | | |
| **4.0** | 16.14 | **Motorised ON/OFF Volume Control Damper**<br>Supply, installation, testing and commissioning of motorised(ON-OFF Type)duct mounted G.I volume control damper with enthalpy sensor and necessary control wiring (minimum 1.5 mm ) for integeration within AHU room.The unit shall be capable to communicate with BMS system | | | | |
| | 16.14.1 | Damper | SQMT | 6,168.00 | 31 | 189,728 |

| HVAC WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Total Qty** | **Total Amount** |
| | 16.14.2 | Actuator | NO. | 5,342.00 | 135 | 721,170 |
| | | | | | | |
| **5.0** | 16.21 | **Duct Acoustic Lining**<br>Supply and fixing of acoustic lining of supply air duct and plenum with 25 mm thick resin bonded glass wool having density of 32 kg/m³, with 25 mm X 25 mm GI section of 1.25 mm thick, at 600 mm centre to centre covered with inforced Plastic tissue paper and 0.5 mm thick perforated aluminum sheet fixed to inside surface of ducts with admium plated nuts, bolts, stick pins, CPRX compound etc. complete as required and as per specifications. | | | | |
| | | 25 mm thick | SQMT | 543.00 | 7667 | 4,163,181 |
| | | | | | | |
| 6.0 | 16.22 | **AHU Room Acoustic Lining**<br>Supplying,fixing acoustic lining on wall and ceiling of AHU rooms with 50 mm thick,density 32 kg/cu.m resin bonded glass fibre insulation friction fixed in 610 mm X 610 mm frame work made of 25X 50 X 50 X50 X 25 mm made out of 0.6 mm thick GI Sheet U Shaped channel and covered with reinforced fibre glass tissue and finished with 0.80 mm perforated aluminium sheet etc.complete as per drawings and as per specification | SQMT | 864.00 | 8228 | 7,108,992 |
| | | 50 mm thick | | | | |
| | | | | | | |
| **7.0** | 16.19 | **Thermal Insulated Flexible Duct**<br>Supply, installation, testing & commissioning of thermal insulated flexible duct of sizes shown per drawings and duly supported at regular interval as per site requirement, shop drawings etc. complete as required as per specifications. | | | | |
| 7.1 | 16.19.1 | 200mm dia | SQMT | 376.00 | 5615 | 2,111,240 |
| | | | | | | |
| **8.0** | 16.20 | **Fire Damper**<br>Supplying, Fixing,testing and commissioning of fire damper in supply air duct/main branch and return air path as and where required of required sizes i/c control wiring, the damper shall be motorized and spring return so as to close the damper in the event of power failure automatically and open the same in case of power being restored. The spring return action shall be inbuilt mechanism and not externally mounted. the damper shall also be closed in the event of fire signal complete as required adn as per specifications. | | | | |
| **8.1** | 16.20.1 | Fire damper | SQMT | 7,053.00 | 130 | 914,563 |
| **8.2** | 16.20.2 | Actuator | Nos. | 6,551.00 | 285 | 1,867,035 |
| | | | | | | |
| | | **TOTAL OF SUB SECTION (D) CARRIED OVER TO SUMMARY** | | | | **67,441,383** |
| | | | | | | |
| **E)** | | **PIPING AND ACCESSORIES** | | | | |

| HVAC WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Total Qty** | **Total Amount** |
| | | | | | | |
| **1.0** | 16.3 | **Chilled Water Piping: Inside Building**<br>Supplying, laying/ fixing, testing and commissioning of following nominal size of chilled water piping inside the building (with necessary clamps, vibration isolators and fittings but excluding valves, strainers, gauges etc.) duly insulated with fire retardant quality expanded polystyrene moulded pipe section of density 20 Kg/cu.m after a thick coat of cold setting adhesive (CPRX Compound) wrapping with 500 gm polythene faced hessain and finally applying .63 mm aluminium sheet cladding complete with type 3, grade 1 roofing felt strip (as per IS: 1322 as amended upto date) at the joints repairing of damage to building etc as per specifications and as required.<br>Note:- The pipes of sizes 150 mm and below shall be M.S 'C' class as per IS:1239 and pipes size above 150 mm shall be welded black steel pipe heavy class as per IS: 3589, from minimum 6.35 mm thick M.S. Sheet for pipes upto 350 mm dia and from minimum 7mm thick MS sheet for Pipes of 400 mm Dia and above. | | | | |
| 1.1 | 16.3.1 | 400 mm dia MS pipes (75 mm insulation) | RMT | 9,425.00 | 20 | 188,500 |
| 1.2 | 16.3.2 | 350 mm dia MS pipes (75 mm insulation) | RMT | 6,302.00 | 20 | 126,040 |
| 1.3 | 16.3.3 | 300 mm dia MS pipes (75 mm insulation) | RMT | 5,737.00 | 40 | 229,480 |
| 1.4 | 16.3.4 | 250 mm dia MS pipes (75 mm insulation) | RMT | 4,866.00 | 854 | 4,155,564 |
| 1.5 | 16.3.5 | 200 mm dia MS pipes (75 mm insulation) | RMT | 4,060.00 | 690 | 2,801,400 |
| 1.6 | 16.3.6 | 150mm dia MS pipes (75 mm insulation) | RMT | 2,725.00 | 1150 | 3,133,750 |
| 1.7 | 16.3.7 | 125 mm dia MS pipes (50 mm insulation) | RMT | 2,283.00 | 638 | 1,456,554 |
| 1.8 | 16.3.8 | 100 mm dia MS pipes (50 mm insulation) | RMT | 1,936.00 | 541 | 1,047,376 |
| 1.9 | 16.3.9 | 80 mm dia MS pipes (50 mm insulation) | RMT | 1,512.00 | 644 | 973,728 |
| 1.10 | 16.3.10 | 65 mm dia MS pipes (50 mm insulation) | RMT | 1,306.00 | 744 | 971,664 |
| 1.11 | 16.3.11 | 50 mm dia MS pipes (50 mm insulation) | RMT | 1,077.00 | 1401 | 1,508,877 |
| 1.12 | 16.3.12 | 40 mm dia MS pipes (50 mm insulation) | RMT | 911.00 | 166 | 151,135 |
| 1.13 | 16.3.13 | 32 mm dia MS pipes (50 mm insulation) | RMT | 807.00 | 1268 | 1,023,276 |
| 1.14 | 16.3.14 | 25 mm dia MS pipes (50 mm insulation) | RMT | 722.00 | 99 | 71,478 |
| | | | | | | |
| **2.0** | 16.10 | **Condensor water Piping**<br>Supplying, fixing, testing and commissioning of condensor water pipe of following size of MS "C" class along with necessary clamps,vibration isolator nad fittings such as bends,tees etc.but excluding valves, strainers, gauges etc.adequately supported on rigid supports duly painted as per specification and as required complete in all respect.<br>Note:- The pipes sizes 150 mm and below shall be M.S 'C' class as per IS:1239 and pipes size above 150 mm shall be welded black steel pipe heavy class as per IS: 3589, from minimum 6.35 mm thick M.S. Sheet for pipes upto 350 mm dia and from minimum 7 mm thick MS sheet for Pipes of 400 mm Dia and above. | | | | |
| 2.1 | 16.10.1.1 | 300 mm dia | Rmt | 4,140.00 | 133 | 550,620 |

| HVAC WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Total Qty** | **Total Amount** |
| 2.2 | 16.10.1.2 | 250 mm dia | Rmt | 3,485.00 | 60 | 209,100 |
| 2.3 | 16.10.1.3 | 200 mm dia | Rmt | 2,875.00 | 66 | 189,750 |
| 2.4 | 16.10.1.6 | 100 mm dia | Rmt | 1,399.00 | 130 | 181,870 |
| | | | | | | |
| **3.0** | 16.7 | Supplying , fixing, testing and commissioning of following valves, strainers, gauges in the chilled water plumbing duly insulated to the same specification as the connected piping and adequately supported as per specification. | | | | |
| | 16.7.1 | Butterfly Valve (Manual) with C.I body SS disc nitrile sheet & O- ring & PN-16 pressure rating for chilled water/hot water circulation as specified. | | | | |
| 3.1 | 16.7.1.1 | 200 mm dia | Nos. | 10,982.00 | 23 | 252,586 |
| 3.2 | 16.7.1.2 | 150 mm dia | Nos. | 6,499.00 | 20 | 129,980 |
| 3.3 | 16.7.1.3 | 125 mm dia | Nos. | 5,654.00 | 31 | 175,274 |
| 3.4 | 16.7.1.4 | 100 mm dia | Nos. | 5,205.00 | 72 | 374,760 |
| 3.5 | 16.7.1.5 | 80 mm dia | Nos. | 3,638.00 | 53 | 192,814 |
| 3.6 | 16.7.1.6 | 65 mm dia | Nos. | 3,269.00 | 177 | 578,613 |
| 3.7 | 16.7.1.7 | 50 mm dia | Nos. | 2,978.00 | 216 | 643,248 |
| 3.8 | 16.7.1.8 | 40 mm dia (Ball Valve) | Nos. | 2,629.00 | 4 | 10,516 |
| | | | | | | |
| | 16.7.2 | BALANCING VALVE WITH BUILT IN MEASURING FACILITY with C I body flanged construction with EPDM coated disc with long pitch with protected out pipe insulation & PN 16 pressure rating for chilled / hot water circulation as specified. | | | | |
| 3.9 | 16.7.2.1 | 200 mm dia | Nos. | 48,655.00 | 4 | 194,620 |
| 3.10 | 16.7.2.3 | 125 mm dia | Nos. | 18,608.00 | 2 | 37,216 |
| | | | | | | |
| | 16.7.3 | Non Return Valve with dual plate of CI body SS plates vulcanized NBR seal flanged end & PN-16 pressure rating for chilled / hot water circulation including insulation as specified. | | | | |
| 3.11 | 16.7.3.1 | 200 mm dia | Nos | 9,530.00 | 4 | 38,120 |
| 3.12 | 16.7.3.2 | 150 mm dia | Nos | 6,354.00 | 2 | 12,708 |
| | | | | | | |
| | 16.7.4 | Y Strainer of Ductile CI Body flanged ends with stainless steel strainer for chilled / hot water circulation including insulation as specified. | | | | |
| 3.14 | 16.7.4.1 | 200 mm dia | Nos. | 20,741.00 | 2 | 41,482 |
| 3.15 | 16.7.4.2 | 150 mm dia | Nos. | 10,418.00 | 2 | 20,836 |
| 3.16 | 16.7.4.4 | 100 mm dia | Nos. | 6,806.00 | 12 | 81,672 |
| 3.17 | 16.7.4.5 | 80 mm dia | Nos. | 4,948.00 | 9 | 44,532 |
| 3.18 | 16.7.4.6 | 65 mm dia | Nos. | 4,746.00 | 35 | 166,110 |
| 3.19 | 16.7.4.7 | 50 mm dia | Nos. | 3,446.00 | 50 | 172,300 |
| 3.20 | 16.7.4.8 | 40 mm dia | Nos. | 2,423.00 | 10 | 24,230 |
| | | | | | | |
| **4.0** | 16.8 | **Pressure Gauges:** Providing and fixing in position the industrial type pressure gauges with gun metal/ brass valves complete as required | Nos. | 958.00 | 116 | 111,128 |
| | | | | | | |
| **5.0** | 16.9 | **Temperature Gauges:** Providing and fixing in position the mercury in glass industrial type thermometers | Nos. | 688.00 | 116 | 79,808 |

| HVAC WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Total Qty** | **Total Amount** |
| | | | | | | |
| **6.0** | 16.11 | Supplying, fixing, testing & commissioning of following valves, guages and strainers for condenser water circulation as per specificatons. | | | | |
| | 16.11.1 | Butterfly Valve (Manual) with C.I body SS disc nitrile sheet & O- ring & PN-16 pressure rating as specified. | | | | |
| 6.1 | 16.11.1.3 | 125 mm dia | Nos. | 5,068.00 | 3 | 15,204 |
| 6.2 | 16.11.1.4 | 100 mm dia | Nos. | 4,615.00 | 3 | 13,845 |
| 6.3 | 16.11.1.5 | 80 mm dia | Nos. | 3,256.00 | 3 | 9,768 |
| | | | | | | |
| | | **TOTAL OF SUB SECTION (E) CARRIED OVER TO SUMMARY** | | | | **22,391,532** |
| | | | | | | |
| **F)** | | **ELECTRICAL WORKS** | | | | |
| **1.0** | **4.1** | **Cable Tray**<br>Supply, and installing following size of perforated pre-painted M.S. cable trays with perforation not more than 17.5%, inconvenient section s, joined with connectors, suspended from the ceiling with with M.S. suspenders, including bolts & nuts, painting suspenders etc as required. | | | | |
| 1.1 | 4.1.1 | 100 mm width x 50 mm depth x 1.6mm thickness | RMT | 461.00 | 4465 | 2,058,365 |
| 1.2 | 4.1.2 | 150 mm width x 50 mm depth x 1.6mm thickness | RMT | 520.00 | 2990 | 1,554,800 |
| | | | | | | |
| | | | | | | |
| **2.0** | | **G.I. Earthing Strip/Wire:** | | | | |
| 2.1 | 5.7 | Supplying and laying 6 SWG GI wire at 0.50 metre below ground level for conductor earth electrode including connections / termination with GI thimble etc. as required. | RMT | 27.00 | 2990 | 80,730 |
| 2.2 | 5.9 | Supplying and laying 25mm x 5mm GI strip at at 0.50 metre below ground as strip earth electrode including connections / terminating with GI nut, bolts, spring, washer etc.as required (Jointing shall be done by overlapping and with 2 set of G.I nut bolt and spring washer spaced at 50mm). | Each | 109.00 | 4100 | 446,900 |
| | | | | | | |
| | | | | | | |
| **3.0** | 2.7 | **Distribution Board**<br>Supplying and fixing following way, single pole and neutral, sheet steel, MCB distribution board, 240 Volts, on surface / recess complete with tinned copper bus bar, neutral bus bar, earth bar, din bar, interconnections, powder painted including earthing etc.as required . (But without MCB/RCCB/Isolator) | | | | |
| 3.1.1 | 2.7.4 | 2 + 4 way / 6 way , Double door | Each | 2,508.00 | 3 | 7,524 |
| 3.1.2 | 2.7.5 | 2 + 6 way / 8 way , Double door | Each | 2,995.00 | 6 | 17,970 |

| HVAC WORKS - DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Total Qty** | **Total Amount** |
| | 2.8 | Supplying and fixing following way prewired TP&N MCB distribution board of steel sheet for 415 volts on surface/ recess complete with loose wire box, terminal connectors for all incoming and outgoing circuits, duly prewired with suitable size FRLS PVC insulated copper conductor up to terminal blocks, tinned copper bus bar, neutral link, earth bar, din bar, detachable gland plate, interconnections, powder painted including earthing etc.as required . (But without MCB/RCCB/Isolator) | | | | |
| 3.1.3 | 2.8.5 | 4 way (4 + 12), Double door | Each | 7,357.00 | 18 | 132,426 |
| 3.1.4 | 2.8.6 | 6 way (4 + 18), Double door | Each | 9,496.00 | 6 | 56,976 |
| 3.1.5 | 2.8.7 | 8 way (4 + 24), Double door | Each | 10,405.00 | 15 | 156,075 |
| 3.1.6 | 2.8.8 | 10 way (4 + 36), Double door | Each | 12,782.00 | 2 | 25,564 |
| | | Supplying and fixing 5amps to 32 amps rating 240/415 volts, "C" curve, miniature circuit breaker suitable for inductive load of following poles in existing MCB DB complete with connections, testing and commissioning etc. as required. | | | | |
| 3.1.5 | 2.10.5 | Triple Pole neutral | Each | 887.00 | 2 | 1,774 |
| | | | | | | |
| **4.0** | 7.8 | **Cabling**<br>Laying and fixing of one no. PVC insulated and PVC sheathed / XLPE power cable of 1.1 kV grade of following sizes on cable tray as required. | | | | |
| 4.1.1 | 7.8.1 | Upto 35 sq. mm. (Clamped with 1mm thick saddle) | RMT | 20.00 | 28986 | 579,720 |
| 4.1.2 | 7.8.2 | Above 35 sq. mm. and upto 95 sq mm. (Clamped with 25x3mm MS flat clamp) | RMT | 48.00 | 427 | 20,496 |
| 4.1.3 | 7.8.3 | Above 95 sq. mm. and upto 185 sq mm. (Clamped with 25/40x3mm MS flat clamp) | RMT | 59.00 | 444 | 26,196 |
| 4.1.4 | 7.8.4 | Above 185 sq. mm. and upto 400 sq mm. ((Clamped with 40x3mm MS flat clamp) | RMT | 91.00 | 1116 | 101,556 |
| | | | | | | |
| | | **TOTAL OF SUB SECTION (F) CARRIED OVER TO SUMMARY** | | | | **5,267,072** |
| | | | | | | |
| | | **GRAND TOTAL OF SUB SECTIONS (D+E+F)** | | | | **96,214,397** |
| | | | | | | |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| **A.** | | **HIGH SIDE EQUIPMENT** | | | | |
| **1** | | **CHILLER** | | | | |
| 1.0 | **NDSR** | Supplying , installation, testing and commissioning of CENTRIFUGAL WATER CHILLING UNIT with | Nos | 24,238,014.54 | 4 | **96,952,058** |
| | | based control panel with graphics and all mounted on a steel frame complete as per specifications. Motor shall be suitable for 415±10% 50 cycles 3 phase AC supply and motor cable terminal box shall be suitable to connect Electrical Cabling. Chiller electrical isolator shall be provided. One incomer upto incoming of VFD starter will be provided . Electrical Cabling from VFD starter to various compressors and elements in chiller shall be included. Cost of piping for VFD cooling shall be included as required. Refrigerant used shall be Ozone friendly HFC-134a as detailed in specifications.Chiller to be with acoustic jacket. Noise level shall be maintained 84 dbA @1 meter distance. Chiller construction shall be as per ASME / GB standard. | | | | |
| | | The machine shall be able to a unload unload minimum 25% even at constant condenser water entering temperature without surging and without hot gas by pass. The Unit shall be complete in all respect and shall be factory tested with reports submitted and it should meet the specification, Drawing & Schedule.<br>The chilling machine shall be ECBC/ ASHRAE 90.1-2013 Compliant for performance.<br>Chiller shall be with Refrigerant isolation valves, Vendor to provide part load efficiency details (at actual conditions) in matrix form along with the computer selection (i.e. NPLV / IPLV etc). | | | | |
| | | Location : New Delhi, Design Ambient: 110 $^{0}$F | | | | |
| | | Net Capacity : 1000 TR (actual) | | | | |
| | | Refrigerant : R-134a | | | | |
| | **a** | <u>Chiller</u> | | | | |
| | | Chilled Water IN 56°F | | | | |
| | | Chilled Water OUT 44°F | | | | |
| | | Chilled Water Flow 2000 USGPM | | | | |
| | | Fouling factor 0.0002 FPS | | | | |
| | | <u>Condenser</u> | | | | |
| | | Condenser Water IN 88.0 °F | | | | |
| | | Condenser Water Out 98.0 °F | | | | |
| | | Condenser Water Flow 3000 GPM | | | | |
| | | Fouling factor 0.0005 FPS | | | | |
| | | Maximum Power Consumed at above conditions : Less than 0.6 kW/TR (including VFD losses)- | | | | |
| | | Min COP at AHRI conditions : 6.3 | | | | |
| | | Minimum IPLV (AHRI 550/590)- 0.35 | | | | |
| | | Source of VFD for chiller : OEM / Vendor approved | | | | |
| | | Maximum NPLV : Less than 0.35 kW/TR | | | | |
| | | Maximum Pressure Drop In Condenser:8 m | | | | |
| | | Maximum Pressure Drop In Evaporator: 6 m | | | | |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| | **b** | 1 No.-Suitable capacity squirrel cage induction motor with class 'F' Insulation & efficiency class IE3 suitable for operation on 415+10% volts, 50 HZ, A.C. Supply. | | | | |
| | **c** | 1 No. variable frequency drive along with standard harmonic filters suitable for compressor motor complete with ammeter with CTs, overload protection, under voltage protection, protection against phase reversal & independent single phase preventers etc as required. (Active Harmonic filters are required primarily for Airports/Hospital where there is interference between electromagnetic waves possible. It comes default in magnetic bearing chillers, NOT required in our case) | | | | |
| | **d** | Necessary drive arrangement | | | | |
| | **e** | 1 Set- lubrication device consisting of automatic electric oil pump, oil cooler, head tank, oil strainer, automatic pressure regulating mechanism, oil heater, thermal switch etc. as per specifications. | | | | |
| | **f** | 1 No - Matching shell and tube water cooled condenser of M.S. shell and integrally fined copper tubes. Condenser shell should be ASME certified(U-stamped) or GB Complied. | | | | |
| | **g** | 1 No. -Matching shell and tube flooded type chiller for centrifugal type units of M.S.shell and integrally finned copper tubes. Chiller shell should be ASME certified(U-stamped) or GB Complied. | | | | |
| | **h** | 1 Lot- Refrigerant piping fittings, valves and accessories to inter c connect compressor, condenser, chillers and expansion valve. | | | | |
| | **i** | 1 Set - Microprocessor based control panel complete with accessories as per specifications. | | | | |
| | **j** | Lot - Refrigerant line accessories comprising of safety valves, angle valves, liquid line indications, liquid level control etc. | | | | |
| | **k** | Lot- DP switches at inlet and outlet of condenser and chiller, water drain and air purge valves wherever required | | | | |
| | **l** | Lot- Suction line and chiller insulation with minimum 19 mm thick polyvinyl nitrile rubber insulation finished with 24G Aluminium Cladding as required. | | | | |
| | **m** | Lot - Frame work for mounting the above condenser, chiller compressor and motor with base plate complete with antivibration ads/springs. | | | | |
| | **n** | Lot-Initial/first charge of refrigerant gas and compressor oil duly charged at factory. | | | | |
| | **o** | Witness of performance testing of 1 # chiller at 4 points (100% ,75% , 50% & 25%) @ reducing condenser temperature at AHRI certified test bed at works. | | | | |
| | | | | | | |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| | | Submittal:<br>1. Computerised sheet @ duty conditions to verify Ikw/TR @ duty conditions & NPLV as per AHRI relief<br>2. Computerised sheet @ AHRI conditions to verify COP @ AHRI<br>3. Computerised sheet with partload ranging 100%-25% at reducing entering condenser water temp to verify smooth operation / surge free operation<br>4. Tech data in tender format | | | | |
| | | | | | | |
| **2** | **NDSR** | **ELECTRIC RESISTANCE HOT WATER GENERTAOR**<br>Supplying , Installation , Testing and Commissioning of Electric resistance immersion type Hot Water Generator made of 10 mm thick MS sheet, complete with all accessories and components, copper tube chrome plated , internally factory wired complete with electrical panel with 50 mm thick resin bonded fiber glass wool cladded with 0.6 mm Aluminium sheet on MS frame welded to generator body as per specifications and drawings. The Unit shall be complete in all respect and shall be factory tested with reports submitted and it should meet the specification, Drawing & Schedule. The unit shall be BMS compatible.<br>Hot Water IN 45°C<br>Hot water OUT 50°C<br>Chilled Water Flow 756 GPM<br>Working PSI 230 PSI<br>Test Pressure 300 PSI | | | | |
| 2.1 | | 1000 KW, 3 Nos | Nos. | 2,072,439.04 | 3 | **6,217,317** |
| | | | | | | |
| **3.0** | **NDSR** | **PRIMARY WATER PUMP**<br>Supplying , installation, testing and commissioning of mentioned capacity & head given below water circuit. The pumps shall be close coupled , single stage , centrifugal , end suction with backpull out design. Hence , the rotating unit can be removed and serviced without disconnecting the suction and discharge piping. The pump and base frame shall be factory assembled at the pump manufacturer's facility. Installation instructions shall be included with pump at time of shipment. The pump manufacturer shall have complete unit responsibility. The pump shall be balanced statically and dynamically. The pump are constant speed. | | | | |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| | | The noise level shall not exceed 75 dbA at 2 m from the source. The pump shall be required to meet specification mentioned and per drawings and schedules. The Pumps shall be BMS compatible.<br>The scope of work shall include Lifting, shifting & positioning of pump at location shown on drawing. | | | | |
| | | End suction/ Radial Split casing type pump. | | | | |
| | | Suitable HP , TEFC squirrel cage induction motor with class 'F' insulations & efficiency class IE-3 , 1450 rpm synchronous speed , operating on 415 +/- 10% volts ,3 phase , 50 Hz A.C.supply. | | | | |
| | | Lot-Expanded polystyrene (T.F.Quality) insulations of not less than 75mm thick duly cladded between aluminium sheets of 0.5mm thickness and properly clamped to pump in two semicircular section as per specifications. | | | | |
| | | Min. pump efficiency at duty conditions shall be 75% (Minimum ECBC standards or ASHRAE - 90.1 standards): | | | | |
| | | The Pump shall be capable to communicate effectively with BMS. | | | | |
| | | Mounting frame with Anti vibration pads. | | | | |
| | | Note - Total Head Loss given is minimum requirement for the system. Actual Head shall be calculated & confirmed by the vender at time of Bidding. | | | | |
| | | | | | | |
| 3.1 | | 2000 USGPM , 18 meter head | Nos | 719,897.91 | 4 | **2,879,592** |
| | | | | | | |
| **4.0** | **NDSR** | **SECONDARY WATER PUMP** | | | | |
| | | Supplying , installation, testing and commissioning of mentioned capacity & head secondary water circuit with VFD. The pumps shall be close coupled , single stage , centrifugal , end suction with back-pull out design with Dedicated microprocessor based pump controller with parallel pumping software duly downloaded, suitable to run on variable frequency drives as required and multiple differential pressure sensor / transmitters as necessary and as described in the specifications. Hence , the rotating unit can be removed and serviced without disconnecting the suction and discharge piping. | | | | |
| | | The pump and base frame shall be factory assembled at the pump manufacturer's facility. Installation instructions shall be included with pump at time of shipment. The pump manufacturer shall have complete unit responsibility. The Unit shall be complete in all respect and it should meet the specification, Drawing & Schedule. The scope of work shall include Lifting, shifting & positioning of pump at location shown on drawing. | | | | |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| | | 1 No. End suction/vertical split casing type pump. | | | | |
| | | 1 NO- Suitable HP, TEFC squirrel cage induction motor with class 'F' insulations & efficiency class IE-3, 1450 rpm synchronous speed , operating on 415 +10% volts ,3 phase , 50 Hz A.C.supply. | | | | |
| | | The total sound intensity with all pumps in operation should not exceed 75 dB at a distance of 2 meters. The Pumps to be capable of providing 10% higher flow rate. All rotating parts are to be covered with an encasing. The duty point of the pump shall be defined in the pump curve. | | | | |
| | | Variable secondary Panel should have One dedicated multi pump processor based pump controller with parallel pumping software duly installed. The pump selected for variable speed drive shall be capable of performing satisfactorily over a wide range of speed, allowing a speed variation from 20 % to 100 %.The pump logic controller assembly shall be listed and approved by Underwriter's Laboratory, Inc. (UL). The controller shall be specifically designed for variable speed pumping applications. | | | | |
| | | Microprocessor based control panel shall have suitable hardware & software so that it can be integrated directly to IBMS with standard communication open protocol using backnet / Modbus as well as open IP. | | | | |
| | | (All the Pump set will have their control panel with respect to the motor rating). | | | | |
| | | All pumps to be provided with separate IP 54 rated variable frequency drives with integrated input disconnect switch. Control panel should also consist of cooling fan. | | | | |
| | | VFD - The variable frequency drive(s) shall be pulse width modulation (PWM) type, microprocessor controlled design. VFD shall be capable of operating in voltage ranges of 240V or 415 V +/- 10% AC, three phase; at frequencies of 48 to 63 Hz. VFD shall be factory fitted and unit mounted. | | | | |
| | | Min. pump efficiency at duty conditions shall be 75% (Minimum ECBC standards or ASHRAE - 90.1 standards): | | | | |
| | | Lot-Expanded polystyrene (T.F.Quality) insulations of not less than 75mm thick duly cladded between aluminium sheets of 0.5mm thickness and properly clamped to pump in two semicircular section as per specifications. | | | | |
| | | Lot- Mounting frame work with anti vibration pads. | | | | |
| | | Note- Total Head Loss given is minimum requirement for the system. Actual Head shall be calculated & confirmed by the vender at time of Bidding. | | | | |
| | | | | | | |
| 4.1 | | 2000 USGPM , 50 meter head | Nos | 2,319,168.87 | 4 | **9,276,675** |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| | | | | | | |
| **5.0** | **NDSR** | **CONDENSOR WATER PUMP** | | | | |
| | | Supplying , installation, testing and commissioning of mentioned capacity & head condenser water circuit. The pumps shall be close coupled , single stage , centrifugal , end suction with backpull out design. Hence , the rotating unit can be removed and serviced without disconnecting the suction and discharge piping. The pump and base frame shall be factory assembled at the pump manufacturer's facility. Installation instructions shall be included with pump at time of shipment. The pump manufacturer shall have complete unit responsibility. The pump shall be balanced statically and dynamically. | | | | |
| | | The pump are constant speed. The noise level shall not exceed 75 dbA at 2 m from the source. The pump shall be required to meet specification mentioned and per drawings and schedules. The Pump Shall be BMS Compatible. | | | | |
| | | End suction Radial split casing type pump. | | | | |
| | | Suitable HP , TEFC squirrel cage induction motor with class 'F' insulations & efficiency class IE-3 , 1450 rpm synchronous speed , operating on 415 +/- 10% volts ,3 phase , 50 Hz A.C.supply. | | | | |
| | | Min. pump efficiency at duty conditions shall be 75% (Minimum ECBC standards or ASHRAE - 90.1 standards): | | | | |
| | | The Pump shall be capablele to communicate effectively with BMS. | | | | |
| | | Mounting frame with Anti vibration pads. | | | | |
| | | Note- Total Head Loss given is minimum requirement for the system. Actual Head shall be calculated & confirmed by the vender at time of Bidding. | | | | |
| | | | | | | |
| 5.1 | | 3000 USGPM , 22 meter head | Nos | 957,173.68 | 4 | **3,828,695** |
| | | | | | | |
| **6.0** | **NDSR** | **Tertiary Pumps:** | | | | |
| | | Supplying , installation, testing and commissioning of water pump set capable of delivering following USGPM of chilled/hot water against given head each comprising with Dedicated microprocessor based pump controller with parallel pumping software duly downloaded, Suitable to run on variable frequency drives as required and multiple differential pressure sensor / transmitters as necessary and as described in the specifications. The pump shall be complete in all respects and shall be factory tested with reports submitted. These shall be as shown in the drawings. | | | | |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| | | Suitable HP , TEFC squirrel cage induction motor with class 'F' insulations & efficiency class IE-3 , 1450 rpm synchronous speed , operating on 415 +/- 10% volts ,3 phase , 50 Hz A.C.supply. | | | | |
| | | Min. pump efficiency at duty conditions shall be 75% (Minimum ECBC standards or ASHRAE - 90.1 standards) | | | | |
| | | The total noise level with all pumps in operation should not exceed 75 dB at a distance of 2 meters. The Pumps to be capable of providing 10% higher flow rate. All rotating parts are to be covered with an encasing. The duty point of the pump shall be defined in the pump curve. | | | | |
| | | The pump selected for variable speed drive shall be capable of performing satisfactorily over a wide range of speed, allowing a speed variation from 20 % to 100 %.The pump logic controller assembly shall be listed and approved by Underwriter's Laboratory, Inc. (UL). The controller shall be specifically designed for variable speed pumping applications. | | | | |
| | | VFD - The variable frequency drive(s) shall be pulse width modulation (PWM) type, microprocessor controlled design. VFD shall be capable of operating in voltage ranges of 240V or 415 V +/- 10% AC, three phase; at frequencies of 48 to 63 Hz. VFD shall be factory fitted and unit mounted. | | | | |
| | | **Note- Total Head Loss given is minimum requirement for the system. Actual Head shall be calculated & confirmed by the vender at time of Bidding.** | | | | |
| 6.1 | | 1224 USGPM ,20 mtr head (1 W + 1 S) | Nos. | 1,291,296.70 | 2 | **2,582,593** |
| 6.2 | | 678 USGPM ,20 mtr head(1 W + 1 S) | Nos. | 1,051,551.68 | 2 | **2,103,103** |
| 6.3 | | 444 USGPM ,18 mtr head(1 W + 1 S) | Nos. | 665,750.60 | 2 | **1,331,501** |
| 6.4 | | 978 USGPM ,20 mtr head(1 W + 1 S) | Nos. | 935,950.64 | 2 | **1,871,901** |
| 6.5 | | 1585 USGPM,20 mtr head(1 W + 1 S) | Nos. | 1,195,008.40 | 2 | **2,390,017** |
| 6.6 | | 1512 USGPM,22 mtr head(1 W+ 1 S) | Nos. | 1,195,008.40 | 2 | **2,390,017** |
| | | | | | | |
| **7.0** | **NDSR** | **COOLING TOWER** | | | | |
| | | Supplying , installation, testing and commissioning of Induced Draft counter flow Fibre glass-reinforced plastic Cooling Towers CTI Certified in accordance with the technical specification, Drawings and Schedule of Quantities. Tower shall be vertical , Induced Draft counter flow type in fibre-glass reinforcement plastic construction , complete with statically and dynamically balanced axial flow type fan, TEFC induction motor with efficiency class IE3, surface and spray section , eliminators , steel supports. The tower shall be CTI certified and meet energy efficiency per ASHRAE 90.1 - 2013 standards. | | | | |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| | | The tower shall be complete in all respects inlcuding but not limited to base frame, mounting, Isolating devices, tanks, drift eleminator, make-up quick fill arrangement, overflow and drain connections with necessary valves and suitable inspection ladder, access arrangement for cooling tower interior, steel/ masonary supporting structure, anti-vibration mountings etc and other accessories as mentioned in the specifications. The Unit shall be complete in all respect and shall be factory tested with reports submitted and it should meet the specification, Drawing & Schedule. The scope of work shall include Lifting, shifting & positioning of cooling tower at location shown on drawing. | | | | |
| | | VFD - The variable frequency drive(s) shall be pulse width modulation (PWM) type, microprocessor controlled design. VFD shall be capable of operating in voltage ranges of 240V or 415 V +/- 10% AC, three phase; at frequencies of 48 to 63 Hz. VFD shall be factory fitted and unit mounted. | | | | |
| | | The Cooling tower shall be capable to communicate effectively with BMS. | | | | |
| | | CDW In- 98 0 F | | | | |
| | | CDW Out- 88 0 F | | | | |
| | | Range of CT: 10 $^0$F | | | | |
| | | Wet bulb approach: 5 $^0$F | | | | |
| | | Ambient WBT- 83 0 F | | | | |
| | | Drift loss < 0.005% | | | | |
| | | | | | | |
| 7.1 | | CHILLED WATER FLOW: 6000 USGPM (for four cells) | Nos | 6,845,941.48 | 2 | **13,691,883** |
| | | HEAT REJECTION : 7037100 Kcal/hr (for four cells) | | | | |
| 7.2 | | CHILLED WATER FLOW: 3000 USGPM (for two cells) | Nos | 3,259,784.89 | 1 | **3,259,785** |
| | | HEAT REJECTION : 3518550 Kcal/hr (for two cells) | | | | |
| | | | | | | |
| 8.0 | **NDSR** | **CLOSED EXPANSION TANK WITH PRESSURISATION PUMP** | | | | |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| | | Supply, installation, testing, balancing and commissioning of PRESSURISED CHILLED WATER EXPANSION TANK with full acceptance factor and shall be ASME rated/ European standard code no. 97/23/ECalong with necessary accessories such as air vents, Safety Valves, Pressurization pumps and its panel , with required Support & Foundation etc. in order to keep chilled water/hot water system under pressure and to prevent entrapment of air in the system. The tank shall be precharged steel expansion tank with replaceable heavy duty butyl rubber bladder. The tank shall have 50 MM system connection and 20 mm drain and charging valve connection to facilitate the onsite charging of the tank to meet system requirement. The tank shall be fitted with lifting rings and a floor mounting skirt for vertical installation. | | | | |
| | | The tank and air separator must be constructed in accordance with section VIII of the ASME Boiler and pressure vessel code and stamped 125 PSI working pressure. The complete system shall be sourced from single manufacturer and supplied and installed with all accessories and safety fixtures required for proper functioning of the complete hydronic system. Install Expansion tank in accordance with manufacturer's written instructions. The drawing, schedules and specification shall be referred. | | | | |
| | | The tank shall be designed to absorb the expansion forces of heating/cooling system water while maintaining proper system pressurization under varying operating conditions. The heavy duty bladder should contain system water thereby eliminating tank corrosion and water logging problems. The system should include PRV and Airvent also. And complete as per technical specification. Tank shall be selected for 125 psi | | | | |
| | | Supply, Installing, Testing and commissioning of Pressurizing unit consisting of Inline vertical multistage, centrifugal clear water pumps (1W+1S) with S.S. 304 casing, S.S. 304 impeller and S.S. 316 shaft, CI Base,TEFC motor (with mechanical seal) with control panel and Set of accessories such as pressure switches, suction and discharge pipe manifolds, pressure gauges, valves etc. conforming to the specifications.<br>This Shall Include Control panel, Set of accessories such as pressure switches, suction and discharge pipe manifolds, pressure gauges, valves etc. | | | | |
| | | PRESSURIZATION UNIT set | | | | |
| 8.1 | | 4000 liters | Nos | 3,111,867.15 | 2 | **6,223,734** |
| | | | | | | |
| 9.0 | | **Air separator** | | | | |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| | | Supply, installation, testing, balancing and commissioning of centrifugal type air separator with required Support & Foundation for design water flow rate with a maximum pressure loss of 1 feet water gauge. The unit shall have Flanged or Grooved inlet and outlet connections tangential to the vessel shell. Vessel shell diameter to be three times the nominal inlet/outlet pipe diameter. The unit shall have an internal stainless steel air collector tube with 5/32" diameter perforations and 63% open area designed to direct accumulated air to the compression tank via an NPT connection at top of unit. Manufacturer to furnish data sheet specifying air collection efficiency and pressure drop at rated flow. The air separator(s) must be designed, constructed, and stamped for 125 psig @ 350oF in accordance with Section VIII, Division I of | | | | |
| | | the ASME Boiler and Pressure Vessel Code, and registered with the National Board of Boiler and Pressure Vessel Inspectors. The air separator(s) shall be painted with one shop coat of light gray air dry enamel. A Manufacturers' Data Report for Pressure Vessels, Form U-1 as required by the provisions of the ASME Boiler and Pressure Vessel Code shall be furnished for each air separator upon request. Install Air separator in accordance with manufacturer's written instructions.<br>(The Air Separator Size is to be Calculated & validated by the contractor before ordering.) | | | | |
| 9.1 | | 600 NB | Nos | 5,194,790.75 | 1 | **5,194,791** |
| | | | | | | |
| 10.0 | | **DESCALING of Condensor Loop** | | | | |
| | | Supply, Installation, testing and Commissioning of de-scaling product on the condensor loop to avoid de-scaling of the equipment. The unit shall be installed per drawings and the specifications. The material of construction shall be SS. The component shall be able to achieve following water parameters: | | | | |
| | | Ph - 7.0 to 8.5 | | | | |
| | | Total Hardness Upto 10000 ppm | | | | |
| | | TDS upto 50000 ppm | | | | |
| 10.1 | | 300 NB | Nos. | 935,696.71 | 4 | **3,742,787** |
| | | | | | | |
| **11.0** | **NDSR** | **PRECISION AIR CONDITIONING DUAL FLUID TYPE** | | | | |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item | Description of Work | Unit | Rate | Total Quanti | Total Amount |
| | | Supply , Installation , Testing & Commissioning & Handing over of Microprocessor based Dual Fluid (Refrigerant R410a & chilled water) Type High Precision air conditioning unit with R 410 A refrigerant with Bottom discharge consisting of inlet filter section with Eu-4 filters , EC fan motor, fan motor assembly to deliver below mentioned air quantity , chilled water cooling coil & Dx Coiling Coil , condensate drain pan , Microprocessor panel , digital display , programmable control & recording unit complete with intelligent 16 digit 2 line alpha numeric display , function keys , cursor keys , free programmable keys ,LEDS , inscription filelds with integrated battery backup supply at 24 V AC 50 Hz. The unit shall be suitable for operation on 415 V 50 Hz AC supply. | | | | |
| | | The Display panel shall display date , time , actual & set values , operating conditions , signal faults , collective faults limiting values. Units Should be with Floor discharge type & Body should be with metal panels with insulation. Heater banks & Humidifier to maintain humidity inside the space. The Unit shall be complete in all respect and shall be factory tested with reports submitted and it should meet the specification,Drawing & Schedule. The scope of work shall include Lifting, shifting & positioning of Precision air conditioning dual fluid at location shown on drawing. | | | | |
| | | Quoted price shall include cost of first charge of refrigerant for complete refrigeration circuit, suitable size, epoxy coated MS stand for indoor and outdoor unit, vibration isolators, power cabling, control cabling and earthing. The unit shall have water leak detector which should be able to generate alarm in case of water leakage. | | | | |
| | | Direct Drive motor suitable for 415 +/- 15% V , 50 Hzs , 3P , TEFC squirrel cage induction motor and BHP rating 15% higher than the peak capacity. Fan Arrangement shall be With BACKWARD CURVED for partial load efficiencies. | | | | |
| | | System should be capable of working through chilled water at a entering temperature of 7.0 deg C / 13 deg C. Necessary 2-way valves for each module should be part of supply. | | | | |
| | | Units Should be supplied with 2 way Modulating valve | | | | |
| | | All listed accessories should be part of scope. Necessary BMS integration software & Hardware should be included under the scope of supply. Every two modules together should have one power panel. | | | | |
| | | Insulated Refrigerant piping between indoor & outdoor unit would be in the scope of PAC Vendor. | | | | |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| | | MS stanad for housing indoor unit on the false flooring shall be scope of supply. Height available below false floor shall be clear 600 mm. | | | | |
| | | The BMS shall accept all necessary inputs and outputs including remote start / stop , safety shutdown input , drive trip output etc. , The Display panel shall display date, time , actual & set values , operating conditions , signal faults , collective faults limiting values , relay module for tripping of the unit in case of fire . Equipment should also be equipped with RS 485 Card for BMS integration. The BMS integration card should be compatible with third party BMS system through Open/Modbus protocol. No controlling required from BMS , only monitoring of the parameters/alarms. | | | | |
| | | SS Drain pan Should Be provided with insulation per specification or manufacturer recommendation. | | | | |
| | | All listed accessories including all accessories should be part of scope. Necessary BMS integration software & Hardware should be included under the scope of supply. Every two modules together should have one power panel. | | | | |
| | | It Shall Include commissioning filter and unit shall be charged with R410 Refrigerant after installation of unit. | | | | |
| | | Each unit shall have inbuilt sequential controller for operating N+1 configuration. Microprocessor should have inbuilt feature of Team Mode & cascade mode incase required. The controls shall have sepaerate indication of operating modes(cooling, heating, humidifying & dehumidifying), alarm conditions(temperature high, loss of sensor, compressor HP & LP, no air flow and low humidifier water). | | | | |
| | | The unit shall have a provision for auto restart in the event of power disruption. | | | | |
| | | 2 sets of potential free contacts for all drives. | | | | |
| | | The capacity of PAC should be mentioned as below With out any deviation | | | | |
| 11.1 | | 25.0 TR , 15,000 Cfm/ Module Air quantity from each unit at a external static of 15 mm of wg PAC Unit with all listed accessories as specified in all the section ( 5 W + 1S) | No. | 1,391,650.61 | 6 | **8,349,904** |
| | | | | | | |
| **12** | | **POT STRAINER** | | | | |
| | | Supply , installation , testing and commissioning of MS POT Strainer as per specification & the sizes will be as per drawings and schedules : | | | | |
| 12.1 | | 600 NB | Nos. | 364,691.70 | 1 | **364,692** |
| | | | | | | |
| **13** | **NDSR** | **Pre insulated MS C class Pipe with HDPE (High density polyethylene) - CHILLED WATER PIPING OUT-SIDE THE BUILDING** | | | | |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| 13.1 | | Supply , Installation , testing and commissioning of non corrosive pre insulated jacketed buried pipe which shall be MS ERW heavy duty class to specified following dia NB and with thickness as per technical specification. The outer protective insulation jacket material shall be HDPE as per Specs. Field joints shall be made in straight sections of pipes only and the same is not allowed at elbows to tees. All the field joint insulation and casing materials for the field joint shall be supplied by pre-insulated pipe manufacturer. The insulation shall be Superfoam rigid cellular polyurethane foam, injected between the core pipe and the outer casing/jacket, having a density of 40 kg/m3 (2.5 lbs/ft3) nominal and thermal conductivity coefficient of 0.021W/m°K maximum at a mean temperature of 24°C (75°F) | | | | |
| | | and Insulation thickness shall be 65 mm for 150 dia, 75 mm thick upto 200 mm dia. and above as per specifications. The insulation shall meet IS 12436 specifications with typical operating temperature between -30°C to 100°C. Insulation thickness shall be as per technical specification. The pipe shall be suitable to convey the water having water temperature range of 5 C to 80 C without any distortion. The pipe shall be tested at site at a test pressure of 230 PSI for continue 7 days or 160 hours. The pipe shall be suitable for buried i.e. underground application. The pipes shall be complete with flanges at 500 mtr. distance at suitable locations. The pipe shall be complete in all respect including but not limited to bends, elbows, fittings, valves required, gauges, jointing etc. The drawing shall be referred for the complete routing of the pipe. | | | | |
| | | Base pipe shall be MS IS-1239 part-I / IS-3589, depending upon size.<br>The outer casing/jacket shall be made of extruded high-density Polyethylene (HDPE) pipe having a density of 900 to 960 kg/m3. HDPE wall thickness shall be 4mm thick for 60.3 mm dia and above. | | | | |
| | | All ends of straight pipes and fittings shall be sealed with polyolefin end seal, applied to the exposed ends of the insulation for protection against moisture ingress. | | | | |
| 13.1.1 | | 600 mm dia MS pipes with 8mm thk | Rmt | 23,210.74 | **501** | **11,628,581** |
| 13.1.2 | | 550 mm dia MS pipes with 8mm thk | Rmt | 21,093.71 | 218 | **4,598,429** |
| 13.1.3 | | 500 mm dia MS pipes with 8mm thk | Rmt | 18,673.05 | 202 | **3,771,956** |
| 13.1.4 | | 450 mm dia MS pipes with 8mm thk | Rmt | 16,888.89 | 472 | **7,971,558** |
| 13.1.5 | | 400 mm dia MS pipes with 8mm thk | Rmt | 14,756.54 | 215 | **3,172,657** |
| 13.1.6 | | 350 mm dia MS pipes with 8mm thk | Rmt | 11,420.83 | 23 | **262,679** |
| 13.1.7 | | 300 mm dia MS pipes with 6.4mm thk | Rmt | 9,477.89 | 304 | **2,881,279** |
| 13.1.8 | | 250 mm dia MS pipes with 6.4mm thk | Rmt | 8,654.76 | 230 | **1,990,594** |
| 13.1.9 | | 200 mm dia MS pipes with 6.4mm thk | Rmt | 7,016.84 | 23 | **161,387** |
| 13.1.10 | | 150 mm dia MS pipes Class C | Rmt | 5,826.01 | 23 | **133,998** |
| | | | | | | |
| | | | | | | |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| | | **TOTAL OF SUB SECTION (A) CARRIED OVER TO SUMMARY** | | | | **209,224,164** |
| | | | | | | |
| **B)** | | **AIR CONDITIONING EQUIPMENTS:** | | | | |
| | | | | | | |
| **1.0** | **NDSR** | **AIR HANDLING UNITS** | | | | |
| 1.1 | | Supply , Installation , testing and commissioning of factory built floor mounted Double Skinned Chilled/hot water Air-handling unit Horizontal / Vertical type fabricated out of extruded aluminium section with 0.8 mm pre-plasticized / pre-coated Galvanized steel sheet outside & 0.8 mm plain Galvanised steel sheet inside with blower , blower section with AMCA certified blower (Suitable static pressure as required , minimum 2 bend GSS/ PVC eliminators ) and blower motor TEFC type with IE-3 Class rating suitable for operation on 415 volts ± 10% , 50 Hz ± 5% AC supply , 4/6/8 Row cooling coil and 2 row deep heating coil made of | | | | |
| | | Aluminium finned Copper tube( Tube thickness not less than 0.5 mm) with coil section , thermostat , pre-filter section with non woven synthetic media of 10 micron particle size with an efficiency of 90% , polished stainless steel drain pan made out of 18 G sheet duly insulated complete with motor and belt drive package. The AHU shall be complete in all respect and drain piping as per the specification to be provided to the closest floor drain. | | | | |
| | | The cost should include 150 mm dia dial type pressure gauges ( 2 nos.) and industrial type thermometer ( 2 nos.) at the inlet and outlet of each type of coil , auto purge valve wherever required, Mixing chamber with return air and fresh air damper , necessary vibration isolation arrangement etc. complete as per specification and drawings. | | | | |
| | | The AHU panels shall be insulated with 46±2 mm thick & 40 Kg/m³ density PU foam. The motor & blower assembly shall be mounted on Aluminium extruded section only. The complete AHU shall confirm to standard specification. The face velocity across cooling coil shall be limited to 400 FPM maximum. The capacity of Air-handlers shall be as follows: | | | | |
| | | All AHU shall be with variable frequency drive (VFD) of suitable rating as per specifications and configuration of AHUs , Pre-Filter and Merv-13 bag filter. | | | | |
| | | AHU shall be selected considering 1ºF Chilled temperature rise in piping distribution | | | | |
| | | Total Static pressure given below minimum required for the system. Actual static pressure shall be calculated & confirmed by the vendor at time of Bidding. | | | | |
| 1.1.1 | | 2800 CFM and 9.9 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 233,387.02 | 1 | **233,387** |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item | Description of Work | Unit | Rate | Total Quanti | Total Amount |
| 1.1.2 | | 2900 CFM and 10 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 235,502.31 | 1 | **235,502** |
| 1.1.3 | | 5350 CFM and 15.9 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 327,023.87 | 1 | **327,024** |
| 1.1.4 | | 3700 CFM and 18 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 267,654.72 | 1 | **267,655** |
| 1.1.5 | | 3900 CFM and 16 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 277,949.14 | 1 | **277,949** |
| 1.1.6 | | 4150 CFM and 13.5 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 284,012.97 | 1 | **284,013** |
| 1.1.7 | | 4050 CFM and 12 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 282,038.70 | 1 | **282,039** |
| 1.1.8 | | 3900 CFM and 12 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 281,051.56 | 1 | **281,052** |
| 1.1.9 | | 6100 CFM and 18.9 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 365,945.21 | 1 | **365,945** |
| 1.1.10 | | 5300 CFM and 16 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 326,036.73 | 1 | **326,037** |
| 1.1.11 | | 5500 CFM and 14.70 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 335,485.03 | 1 | **335,485** |
| 1.1.12 | | 5550 CFM and 19 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 336,613.18 | 1 | **336,613** |
| 1.1.13 | | 6650 CFM and 20.3 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 398,379.66 | 1 | **398,380** |
| 1.1.14 | | 4400 CFM and 16.2 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 306,294.02 | 1 | **306,294** |
| 1.1.15 | | 4700 CFM and 16 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 312,357.86 | 1 | **312,358** |
| 1.1.16 | | 8450 CFM and 23.4 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 459,864.09 | 1 | **459,864** |
| 1.1.17 | | 5900 CFM and 16.4 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 361,996.67 | 1 | **361,997** |
| 1.1.18 | | 5600 CFM and 15.2 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 355,932.84 | 1 | **355,933** |
| 1.1.19 | | 5750 CFM and 17.5 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 358,894.24 | 1 | **358,894** |
| 1.1.20 | | 5350 CFM and 16.7 TR capacity 6 R.D Cooling Coil , 2 R.D Heating coil , 65 mm WG | Nos. | 335,485.03 | 1 | **335,485** |
| 1.1.21 | | 3600 CFM and 14.9 TR capacity 6 R.D Cooling Coil ,2 R.D Heating coil , 65 mm WG | Nos. | 319,972.90 | 1 | **319,973** |
| 1.1.22 | | 1800 CFM and 8.8 TR capacity 6 R.D Cooling Coil ,2 R.D Heating coil , 50 mm WG | Nos. | 227,746.25 | 1 | **227,746** |
| 1.1.23 | | 6220 CFM and 24.85 TR capacity 6 R.D Cooling Coil,2 R.D Heating coil , SP 65 mm WG | Nos. | 334,920.95 | 1 | **334,921** |
| 1.1.24 | | 7250 CFM and 22.9 TR capacity 6 R.D Cooling Coil,2 R.D Heating coil , SP 65 mm WG | Nos. | 439,275.27 | 1 | **439,275** |
| 1.1.25 | | 6150 CFM and 24.25 TR capacity 6 R.D Cooling Coil,2 R.D Heating coil , SP 65 mm WG | Nos. | 335,485.03 | 1 | **335,485** |
| 1.1.26 | | 6750 CFM and 25.5 TR capacity 6 R.D Cooling Coil,2 R.D Heating coil , SP 65 mm WG (with UL certified UV section including UV emitters) | Nos. | 626,972.02 | 1 | **626,972** |
| 1.1.27 | | 7450 CFM and 21 TR capacity 6 R.D Cooling Coil,2 R.D Heating coil , SP 75 mm WG | Nos. | 449,287.64 | 1 | **449,288** |
| 1.1.28 | | 5000 CFM and 20.8 TR capacity 6 R.D Cooling Coil,2 R.D Heating coil , SP 65 mm WG | Nos. | 363,829.92 | 2 | **727,660** |
| 1.1.28 | | 5920 CFM and 25.7 TR capacity 6 R.D Cooling Coil,2 R.D Heating coil , SP 65 mm WG | Nos. | 334,920.95 | 1 | **334,921** |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item | Description of Work | Unit | Rate | Total Quanti | Total Amount |
| 1.1.29 | | 5900 CFM and 18.5 TR capacity 6 R.D Cooling Coil,2 R.D Heating coil , SP 65 mm WG (with UL certified UV section including UV emitters) | Nos. | 448,441.53 | 1 | **448,442** |
| 1.1.30 | | 6875 CFM and 25.5 TR capacity 6 R.D Cooling Coil,2 R.D Heating coil , SP 65 mm WG | Nos. | 439,275.27 | 1 | **439,275** |
| 1.1.31 | | 4620 CFM and 21.5 TR capacity 6 R.D Cooling Coil,2 R.D Heating coil , SP 65 mm WG | Nos. | 363,970.94 | 1 | **363,971** |
| 1.1.32 | | 8250 CFM and 26.5 TR capacity 6 R.D Cooling Coil,2 R.D Heating coil , SP 65 mm WG | Nos. | 471,709.72 | 1 | **471,710** |
| 1.1.33 | | 7800 CFM and 26.2 TR capacity 6 R.D Cooling Coil,2 R.D Heating coil , SP 65 mm WG | Nos. | 471,709.72 | 1 | **471,710** |
| 1.1.33 | | 3350 CFM and 17.6 TR capacity 6 R.D Cooling Coil,2 R.D Heating coil , SP 65 mm WG | Nos. | 267,654.72 | 1 | **267,655** |
| 1.1.34 | | 4875 CFM and 18.5 TR capacity 6 R.D Cooling Coil,2 R.D Heating coil , SP 65 mm WG | Nos. | 363,829.92 | 1 | **363,830** |
| 1.1.35 | | 6150 CFM and 20 TR capacity 6 R.D Cooling Coil,2 R.D Heating coil , SP 75 mm WG | Nos. | 366,932.34 | 1 | **366,932** |
| 1.1.36 | | 4400 CFM and 12 TR capacity 6 R.D Cooling Coil,2 R.D Heating coil , SP 75 mm WG | Nos. | 269,346.96 | 1 | **269,347** |
| 1.1.37 | | 6150 CFM and 17 TR capacity 6 R.D Cooling Coil,2 R.D Heating coil , SP 75 mm WG | Nos. | 366,932.34 | 1 | **366,932** |
| 1.1.38 | | 4150 CFM and 12 TR capacity 6 R.D Cooling Coil,2 R.D Heating coil , SP 75 mm WG | Nos. | 281,192.58 | 1 | **281,193** |
| 1.1.39 | | 5500 CFM and 19 TR capacity 6 R.D Cooling Coil,2 R.D Heating coil , SP 75 mm WG | Nos. | 278,513.21 | 1 | **278,513** |
| 1.1.40 | | 6150 CFM and 23 TR capacity 6 R.D Cooling Coil,2 R.D Heating coil , SP 75 mm WG | Nos. | 366,932.34 | 1 | **366,932** |
| 1.1.41 | | 4150 CFM and 14 TR capacity 6 R.D Cooling Coil,2 R.D Heating coil , SP 75 mm WG | Nos. | 281,192.58 | 1 | **281,193** |
| 1.1.42 | | 4150 CFM and 22.5 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG (with UL certified UV section including UV emitters) | Nos. | 408,109.99 | 1 | **408,110** |
| 1.1.43 | | 3300 CFM and 14.1 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 50 mm WG | Nos. | 248,617.11 | 1 | **248,617** |
| 1.1.44 | | 12800 CFM and 57.5 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 536,014.54 | 2 | **1,072,029** |
| 1.1.45 | | 14500 CFM and 56.5 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 616,254.55 | 2 | **1,232,509** |
| 1.1.46 | | 6650 CFM and 30.5 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 398,379.66 | 1 | **398,380** |
| 1.1.47 | | 7000 CFM and 23.5 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 429,403.92 | 1 | **429,404** |
| 1.1.48 | | 6000 CFM and 28.80 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 363,970.94 | 1 | **363,971** |
| 1.1.49 | | 16500 CFM and 61.5 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 743,030.95 | 1 | **743,031** |
| 1.1.50 | | 14000 CFM and 47 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 439,275.27 | 1 | **439,275** |
| 1.1.51 | | 7200 CFM and 30.5 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 432,929.40 | 1 | **432,929** |
| 1.1.52 | | 14150 CFM and 56.9 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 616,395.57 | 1 | **616,396** |
| 1.1.53 | | 9500 CFM and 36.5 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 482,286.17 | 1 | **482,286** |
| 1.1.55 | | 8000 CFM and 27 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 125 mm WG | Nos. | 471,709.72 | 2 | **943,419** |
| 1.1.56 | | 3000 CFM and 12 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 229,720.52 | 1 | **229,721** |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item | Description of Work | Unit | Rate | Total Quanti | Total Amount |
| 1.1.57 | | 12500 CFM and 46.5 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 528,540.52 | 1 | **528,541** |
| 1.1.58 | | 7000 CFM and 21.9 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG (with UL certified UV section including UV emitters) | Nos. | 389,128.79 | 1 | **389,129** |
| 1.1.59 | | 14000 CFM and 52 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 615,267.42 | 1 | **615,267** |
| 1.1.60 | | 11000 CFM and 56.5 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 517,258.97 | 1 | **517,259** |
| 1.1.61 | | 7250 CFM and 23.5 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 425,173.34 | 1 | **425,173** |
| 1.1.62 | | 6500 CFM and 20.5 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 376,662.68 | 1 | **376,663** |
| 1.1.63 | | 14000 CFM and 50 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 615,690.47 | 1 | **615,690** |
| 1.1.64 | | 13500 CFM and 66.5 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 553,218.90 | 1 | **553,219** |
| 1.1.65 | | 7000 CFM and 27 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 429,403.92 | 1 | **429,404** |
| 1.1.66 | | 16000 CFM and 57.5 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 727,518.82 | 1 | **727,519** |
| 1.1.67 | | 14000 CFM and 64 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 616,395.57 | 1 | **616,396** |
| 1.1.68 | | 6000 CFM and 29.5 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 363,970.94 | 1 | **363,971** |
| 1.1.69 | | 16000 CFM and 56.5 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 728,646.97 | 1 | **728,647** |
| 1.1.70 | | 16500 CFM and 67.5 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 743,454.00 | 1 | **743,454** |
| 1.1.71 | | 6000 CFM and 29.5 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 363,970.94 | 1 | **363,971** |
| 1.1.72 | | 8000 CFM and 29.7 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 471,709.72 | 1 | **471,710** |
| 1.1.73 | | 4500 CFM and 21.5 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG (with UL certified UV section including UV emitters) | Nos. | 430,109.01 | 1 | **430,109** |
| 1.1.74 | | 7500 CFM and 32.5 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 449,287.64 | 1 | **449,288** |
| 1.1.75 | | 6000 CFM and 21.9 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 363,970.94 | 1 | **363,971** |
| 1.1.76 | | 9000 CFM and 35.5 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 439,275.27 | 1 | **439,275** |
| 1.1.77 | | 4500 CFM and 14.5 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 376,521.66 | 1 | **376,522** |
| 1.1.78 | | 7000 CFM and 20.5 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 429,403.92 | 1 | **429,404** |
| 1.1.79 | | 9500 CFM and 36 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 482,286.17 | 1 | **482,286** |
| 1.1.80 | | 10000 CFM and 32 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 517,258.97 | 1 | **517,259** |
| 1.1.81 | | 9350CFM and 38.5 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 482,286.17 | 1 | **482,286** |
| 1.1.82 | | 8200 CFM and 28.6 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 471,709.72 | 1 | **471,710** |
| 1.1.83 | | 8200 CFM and 26.5 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 471,709.72 | 1 | **471,710** |
| 1.1.84 | | 7000 CFM and 36.5 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 65 mm WG (with UL certified UV section including UV emitters) | Nos. | 640,932.94 | 2 | **1,281,866** |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| 1.1.85 | | 9000 CFM and 31 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 482,286.17 | 1 | **482,286** |
| 1.1.86 | | 12200 CFM and 41.2 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 528,540.52 | 1 | **528,541** |
| 1.1.87 | | 10850 CFM and 38.8 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG (with UL certified UV section including UV emitters) | Nos. | 725,967.61 | 1 | **725,968** |
| 1.1.88 | | 9850 CFM and 34.6 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 482,286.17 | 1 | **482,286** |
| 1.1.89 | | 6450 CFM and 20.8 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 376,662.68 | 1 | **376,663** |
| 1.1.90 | | 4350 CFM and 16.7 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 269,346.96 | 2 | **538,694** |
| 1.1.91 | | 3500 CFM and 16.5 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 65 mm WG (with UL certified UV section including UV emitters) | Nos. | 389,128.79 | 2 | **778,258** |
| 1.1.92 | | 8375 CFM and 25 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 439,275.27 | 1 | **439,275** |
| 1.1.93 | | 8500 CFM and 25.9 TR capacity 6 R.D Cooling Coil, 2 R.D. Heating Coil, SP 75 mm WG | Nos. | 439,275.27 | 1 | **439,275** |
| | | | | | | |
| **2.0** | **NDSR** | **CEILING SUSPENDED AIR HANDLING UNITS** | | | | |
| 2.1 | | Supply , Installation , testing and commissioning of factory built Double Skinned Chilled/hot water Air-handling unit Ceiling suspended type fabricated out of extruded aluminium section with 0.8 mm pre-plasticized / pre-coated Galvanised steel sheet outside & 0.8 mm plain Galvanised steel sheet inside with blower with AMCA certified blower , blower section(Suitable static pressure as required , minimum 2 bend GSS/ PVC eliminators ) and blower motor TEFC type with IE-3 Class rating suitable for operation on 415 volts ± 10% , 50 Hz ± 5% AC supply , 4/6 Row cooling coil and 2 row deep heating coil made of | | | | |
| | | Aluminium finned Copper tube( Tube thickness not less than 0.5 mm) with coil section , thermostat , pre-filter section with non woven synthetic media of 10 micron particle size with an efficiency of 90% , polished stainless steel drain pan made out of 18 G sheet duly insulated complete with motor and belt drive package. The AHU shall be complete in all respect and drain piping as per the specification to be provided to the closest floor drain. | | | | |
| | | The cost should include 150 mm dia dial type pressure gauges ( 2 nos.) and industrial type thermometer ( 2 nos.) at the inlet and outlet of each type of coil , auto purge valve wherever required, Mixing chamber with return air and fresh air damper , necessary vibration isolation arrangement etc. complete as per specification and drawings. | | | | |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| | | The AHU panels shall be insulated with 25±2 mm thick & 40 Kg/m³ density PU foam. The motor& blower assembly shall be mounted on Aluminium extruded section only. The complete AHU shall confirm to standard specification. The face velocity across cooling coil shall be limited to 400 FPM maximum. The capacity of Air-handlers shall be as follows:<br>AHU shall be selected considering 1ºF Chilled temperature rise in piping distribution<br>Total Static pressure given below minimum required for the system. Actual static pressure shall be calculated & confirmed by the vendor at time of Bidding. | | | | |
| 2.1.1 | | 1512 CFM AND 5.3 TR capacity ,4 R.D cooling coil, 2 R.D Heating coil ceiling suspended AHU with 25 mm WG | Nos. | 93,480.16 | 1 | **93,480** |
| 2.1.2 | | 1200 CFM and 4 TR capacity 4 R.D Cooling Coil, 2 R. D, Heat coil, Ceiling Suspended AHU with 25 mm WG | Nos. | 94,373.28 | 1 | **94,373** |
| 2.1.3 | | 2500 CFM AND 10 TR capacity 4 R.D cooling coil, 2 R.D Heating coil ,CS AHU with 40 mmwg | Nos. | 96,903.80 | 1 | **96,904** |
| 2.1.4 | | 1200 CFM AND 3 TR capacity 4 R.D cooling coil, 2 R.D Heating coil,CS AHU with 30 mmwg | Nos. | 78,148.22 | 1 | **78,148** |
| 2.1.5 | | 750 CFM AND 3 TR capacity 4 R.D cooling coil, 2 R.D Heating coil ,CS AHU with 25 mmwg | Nos. | 66,984.19 | 1 | **66,984** |
| 2.1.6 | | 850 CFM AND 3.5 TR capacity 4 R.D cooling coil, 2 R.D Heating coil,CS AHU with 25 mmwg | Nos. | 68,621.58 | 1 | **68,622** |
| 2.1.7 | | 1150 CFM AND 3 TR cooling capacity 4 R.D cooling coil, 2 R.D Heating coil ,CS AHU with 35mmwg | Nos. | 77,106.25 | 2 | **154,212** |
| 2.1.8 | | 1000 CFM AND 2.5 TR cooling capacity 4 R.D cooling coil, 2 R.D Heating coil ,CS AHU with 35mmwg | Nos. | 71,152.10 | 2 | **142,304** |
| 2.1.9 | | 2000 CFM AND 9.5 TR cooling capacity 4 R.D cooling coil, 2 R.D Heating coil ,CS AHU with 40 mmwg | Nos. | 95,564.11 | 1 | **95,564** |
| 2.1.10 | | 3460 CFM AND 6.5 TR cooling capacity 4 R.D cooling coil, 2 R.D Heating coil ,CS AHU with 40 mmwg | Nos. | 180,113.05 | 2 | **360,226** |
| 2.1.11 | | 3000 CFM AND 10.5 TR cooling capacity 4 R.D cooling coil, 2 R.D Heating coil ,CS AHU with 40 mmwg | Nos. | 138,285.14 | 1 | **138,285** |
| 2.1.12 | | 2200 CFM AND 7.7 TR cooling capacity 4 R.D cooling coil, 2 R.D Heating coil ,CS AHU with 40 mmwg | Nos. | 96,903.80 | 1 | **96,904** |
| 2.1.13 | | 2150 CFM AND 8.6 TR cooling capacity 4 R.D cooling coil, 2 R.D Heating coil ,CS AHU with 40 mmwg | Nos. | 96,903.80 | 1 | **96,904** |
| | | | | | | |
| **3.0** | **NDSR** | **Heat Recovery Unit** | | | | |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| 3.1 | | Supplying, installation, testing and commissioning of factory built Floor mounted double skin type heat recovery wheel units made of 43±2 mm thick panels of pre plasticized G.I. casing of thickness 0.8 mm outside layer and plane GI of 0.6mm inside layer with polyurethene foam (PUF) insulation of density 38 kg/m3 factory injected between them by injection moulding machine, complete with supply & exhaust air blower section with DIDW backward curved centrifugal supply air blower & DIDW forward curved centrifugal exhaust air blower, Heat recovery wheel section with wheel efficiency not less than 75%, filter sections with washable synthetic type pre filter having efficiency 90% down to 10 micron in supply & exhaust air stream, filter sections with fine filter having efficiency 95% down to 5 micron & , belt drive package with | | | | |
| | | TEFC drive motor suitable for 415 ± 10% volts, 50 Hz, 3 phase, A.C supply, complete, drain connections with drain valve, stainless steel drain pan, thermometers and pressure gauge at the inlet and outlet of cooling coil,Y strainer at inlet and canvass connection, necessary vibration isolation arrangement, canopy for weather protection if unit will be installed at outdoor etc. The entire framework shall be mounted on an aluminium alloy or galvanized steel (depending on size) channel base as per manufacturer's recommendation.<br>The unit shall be complete in all respect ,factory tested and report to be submitted and it should match specifications, Drawings & Schedule of following capacities: | | | | |
| | | All the heat recovery units shall be provided with thermal break profile. Penetrations through the casing made for cabling, controls and other ancillary equipment shall be airtight and weather tight and purpose made during manufacture. Units shall be with limit switch and with control wiring.<br>Openings for cable entry, gauges and devices, pressure testing probe and any Accessories entry shall be factory done and no penetration of casing at site shall be allowed for all types of HRW. | | | | |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| | | The supply air section comprise of Damper Section and Filter Section. Damper section shall contain a built in damper of aluminum profile with leakage class III. The damper blades shall be connected with plastic gear wheels with a gasket of silicon rubber to produce tightness between the blades. The supply air filter section shall include the 1st bank of filter of class G3 or MERV-06 before the Heat Recovery Wheel (HRW), The filter section shall be normally cleanable type. The filter elements shall be mounted on rails and shall be easily pulled out for replacement. The rails shall be provided with efficient gaskets to minimize the risk of leakage.<br>All filters shall conform to ASHRAE 52.1 or EN-779 standard. | | | | |
| | | **HRW unit shall be backward curve DIDW fan with inbuilt factory fitted VFD at supply air side and forward curve DIDW fan without VFD at exhaust air side**. Motor shall be designed for quiet operation. The fan motor shall be suitable for VFD operation. The sound level of the fan in its operating connected arrangement shall not exceed 85 DBA at 1 m from the equipment casing. Marine light with power electrical cabling shall be provided in the fan section. Viewing glass shall be provided for all fan sections. | | | | |
| | | The return air section shall comprise of above sections except the fine filters. | | | | |
| | | The heat recovery section comprise of Wheel, Casing, Seal, Hub & Spokes, Drive etc. The wheels shall be tested in accordance with ASHRAE S4-78 method of testing air to air heat exchangers. Development and manufacturers shall meet all quality assurance criteria specified in BSEN ISO 9001. The heat recovery wheel shall have flame spread index classification of 0 as per NFPA 90A. The minimum sensible and latent heat recovery efficiencies shall be 75%. A computerized selection shall be enclosed along with offer. Heat wheels shall be complete with a purging sector with carry-over certified to be a maximum of 0.05% of the intake air volume with directionally orientated media. The drive system shall be complete with mounting bracket, motor, gearbox and controls and shall be suitable for single speed or variable speed operation. | | | | |
| | | The face velocity across the wheel should not exceed 700 fpm (3.5 m/s). | | | | |
| | | The unit shall be capable to communicate effectively with BMS. | | | | |
| 3.1.1 | | 2300 CFM,SP 60 mm WG | Nos. | 439,118.58 | 1 | **439,119** |
| 3.1.2 | | 1600 CFM,SP 60 mm WG | Nos. | 406,966.17 | 1 | **406,966** |
| 3.1.3 | | 2400 CFM,SP 60 mm WG | Nos. | 450,729.17 | 1 | **450,729** |
| 3.1.4 | | 2950 CFM,SP 60 mm WG | Nos. | 522,774.39 | 1 | **522,774** |
| 3.1.5 | | 6000 CFM, SP 60 mm WG | Nos. | 802,470.60 | 3 | **2,407,412** |
| 3.1.6 | | 6000 CFM ,SP 60 mm WG | Nos. | 800,833.21 | 1 | **800,833** |
| 3.1.7 | | 15000 CFM,SP 75 mm WG | Nos. | 791,901.99 | 1 | **791,902** |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| 3.1.8 | | 4200 CFM,SP 60 mm WG | Nos. | 629,651.39 | 1 | **629,651** |
| 3.1.9 | | 7000 CFM,SP 60 mm WG | Nos. | 974,545.54 | 1 | **974,546** |
| 3.1.10 | | 15600 CFM,SP 75 mm WG | Nos. | 1,906,221.21 | 1 | **1,906,221** |
| 3.1.11 | | 17600 CFM,SP 75 mm WG | Nos. | 2,242,630.70 | 1 | **2,242,631** |
| 3.1.12 | | 9000 CFM,SP 65 mm WG | Nos. | 1,173,265.31 | 1 | **1,173,265** |
| 3.1.13 | | 17600 CFM,SP 75 mm WG | Nos. | 2,242,630.70 | 1 | **2,242,631** |
| 3.1.14 | | 9000 CFM,SP 65 mm WG | Nos. | 1,173,265.31 | 1 | **1,173,265** |
| 3.1.15 | | 8050 CFM,SP 65 mm WG | Nos. | 1,027,388.63 | 1 | **1,027,389** |
| 3.1.16 | | 10555 CFM,SP 65 mm WG | Nos. | 1,271,508.79 | 1 | **1,271,509** |
| 3.1.17 | | 6450 CFM,SP 65 mm WG | Nos. | 869,305.94 | 1 | **869,306** |
| | | | | | | |
| **4.0** | | **FAN COIL UNITS** | | | | |
| 4.1 | | Supply , Installation , testing and commissioning of factory fabricated Fan coil unit with 12 mm static pressure each complete with copper pipe connections with brass fittings , wiring with 3 pin socket plug , U-trap in drain pipe connection near FCU , 3 speed switch , fire retardant double canvas connections , 4 row deep chilled water coil , three speed motor , washable filters , Stainless steel drain pan insulated with 13 mm aluminium faced nitrile rubber. Fan coil unit shall be suitable for 220 ± 10 volts , 50 Hz cycle single phase power supply , maximum RPM of motor shall be 960. | | | | |
| 4.1.1 | | 1 TR cooling Capacity/400 CFM, 3 row deep cooling coil and 1 row deep heating coil. | Nos. | 14,693.02 | 1 | **14,693** |
| 4.1.2 | | 1.5 TR cooling Capacity/500 CFM, 3 row deep cooling coil and 1 row deep heating coil. | Nos. | 16,247.09 | 1 | **16,247** |
| 4.1.3 | | 2.5 TR cooling capacity, 4 row deep cooling coil and 1 row deep heating coil. | Nos. | 22,322.09 | 12 | **267,865** |
| 4.1.4 | | 3.0 TR Cooling Capacity/1200, 4 row deep cooling coil and 1 row deep heating coil. | Nos. | 24,582.56 | 2 | **49,165** |
| 4.1.5 | | 2.5 TR Cooling Capacity/500, 4 row deep cooling coil and 1 row deep heating coil. | Nos. | 22,322.09 | 1 | **22,322** |
| 4.1.6 | | 3 TR Cooling Capacity/1200, 4 row deep cooling coil and 1 row deep heating coil. | Nos. | 24,582.56 | 1 | **24,583** |
| 4.1.7 | | 4 TR Cooling Capacity/1200, 4 row deep cooling coil and 1 row deep heating coil. | Nos. | 31,646.51 | 2 | **63,293** |
| | | | | | | |
| **5.0** | **NDSR** | **AIR WASHER** | | | | |
| 5.1 | | Supplying, installation, testing and commissioning of double skin construction Air Washer Unit consisting of following DIDW backward curved class-I centrifugal fan having AMCA certified Blower (Efficiency >75%), TEFC weather proof motor of IP55 protection having efficiency class IE3 at 415±10% volts, 3 phase, 50 cycles power , belt drive, multisheave pulley mounted on motor and fan shaft, belt guard, motor and fan mounted on common base with metallistik vibration isolators. Fan capacity shall be based on outlet velocity not exceeding 600 M/minute. | | | | |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| | | Cellulose fill air washer, giving 90% efficiency at 500 FPM air velocity across pads, factory assembled and complete with wet section & tank in 18G SS, Cellulose fill, water distribution header, PVC piping, ball valves (for quick fill, isolation of tank and pumps) brass Y strainers and necessary fittings. The quoted price shall also include drift eliminators.<br>2 No. (1W+1SB) horizontal monobloc pumps (of suitable rating) of factory mounted on GI channel base with electric motor for circulation of water. Pumps shall be aligned and suitable for 230±10% volts, 50 cycle's, 1 phase power supply. One No. 3 phase isolator switch in weather proof enclosure shall be provided near motor. | | | | |
| 5.1.1 | | 8000 CFM/50 mm WG | Nos. | 226,571.09 | 1 | **226,571** |
| | | | | | | |
| **6.0** | | **DRY SCRUBBER** | | | | |
| 6.1 | | Supply, Installation, Testing and Commissioning of DRY Scrubber each comprising of electrostatic precipitation technology, dry type air cleaner to remove oil, smoke and fumes from exhaust air, as per the Specifications and as follows:<br>Electrostatic section shall be made of 16 gauge galvanised sheet, high bake epoxy powder coated, washable type aluminium mesh filters, stainless steel spiked ionizers to create high voltage DC field, aluminum collector plates which should be alternatively charged positive and negative with large collecting area with 14" deep cell, to work as magnet for charged smoke and oil particles. Average efficiency of 90-95% in single pass as per ASHRAE test method. Electrostatic Precipitator should be able to charge particles from 0.01 micron to 10 microns through solid state power supply. Collector cell should be of permanent type and incorporate slide out facility for easy removal for cleaning.<br>Power supplies shall be 100% solid state UL Listed, Module of capacity above 3000 CFM shall be equipped with Pulse width modulating (PWM)The system should be fitted with interlock switch for safety . The system should allow connection to a fan section to achieve 500 FPM velocity across the air cleaner.<br>The unit shall have DIDW backward curved fan for kitchen having AMCA certified blower including all necessary accessories to complete the installation. | | | | |
| 6.1.1 | | 10000 CFM/75 mm WG | Nos. | 1,148,054.18 | 1 | **1,148,054** |
| **7.0** | | **Split type Air-conditioners** | | | | |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| **7.1** | | Supplying , installation, testing and commissioning of (nominal capacity) Air-cooled split AC unit , inverter type along with indoor/ outdoor units , controls , copper piping , PVC condensate drain piping , valves and insulation suitable to operate on 230 Volts 50 Hz AC supply etc. Complete as required including voltage stabiliser of suitable rating to give constant output of 230V for input range of 180 V to 260 V with time delay , high/low cut off , meter to read input and output voltages , ON/OFF switches etc. as required. Quoted price shall include cost of wireless remote controller , cooling thermostat , wiring , control cooling and earthing. Unit shall be provided with auto timer setting , complete as per technical specifications and tender drawings. Quoted price shall also include wireless remote. | | | | |
| | | **Hi Wall Split Unit for IT/Server Room and Fire Control Room** | | | | |
| 7.1.1 | | 2.0 TR | Nos. | 90,879.14 | 29 | **2,635,495** |
| 7.1.2 | | 1.5 TR | Nos. | 73,643.44 | 56 | **4,124,032** |
| 7.1.3 | | 1.0 TR | Nos. | 65,809.03 | 10 | **658,090** |
| 7.1.4 | | 8.5 TR (DX Type Ductable Unit) | Nos. | 250,074.31 | 2 | **500,149** |
| | | | | | | |
| **8.0** | | **Refrigerant Piping** | | | | |
| 8.1 | | Supply , fabrication , installation , testing of Interconnecting refrigerant copper pipe work with closed cell cross linked polyethylene (XLPE) tubular insulation between each set of indoor & outdoor units as per specifications , all piping inside the room shall be copper and properly supported with MS hanger. | | | | |
| 8.1.1 | | 34.9 mm O.D(insulation : 19 mm) | RMT | 2,177.44 | 20 | **43,549** |
| 8.1.2 | | 28.6 mm O.D(insulation : 19 mm) | RMT | 1,866.38 | 20 | **37,328** |
| 8.1.3 | | 22.2 mm O.D(insulation : 19 mm) | RMT | 1,633.08 | 609 | **994,545** |
| 8.1.4 | | 19.1 mm O.D(insulation : 19 mm) | RMT | 1,516.43 | 20 | **30,329** |
| 8.1.5 | | 15.8 mm O.D(insulation : 19 mm) | RMT | 1,399.78 | 777 | **1,087,631** |
| 8.1.6 | | 12.7 mm O.D.(insulation : 13 mm) | RMT | 1,283.13 | 892 | **1,144,555** |
| 8.1.7 | | 9.5 mm O.D.(insulation : 13 mm) | RMT | 1,244.25 | 415 | **516,364** |
| 8.1.8 | | 6.4 mm O.D.(insulation : 13 mm) | RMT | 1,166.48 | 1117 | **1,302,964** |
| | | | | | | |
| **9.0** | | **Drain Piping for Split Air Conditioner** | | | | |
| 9.1 | | Supply ,installation , testing and commissioning of Rigid heavy class PVC piping complete with fittings , supports as per specifications and duly insulated with 6 mm thick closed cell crosslinked polyethylene (XLPE) tubular insulation. | | | | |
| 9.1.1 | | 25 mm dia | RMT | 136.32 | 1361 | **185,530** |
| 9.1.2 | | 32 mm dia | RMT | 156.69 | 1072 | **167,970** |
| 9.1.3 | | 40 mm dia | RMT | 235.03 | 125 | **29,379** |
| | | | | | | |
| **10.0** | | **Thermal Insulation** | | | | |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| 10.1 | | Supply,Installation,Testing and commissioning of Thermal insulation material for Duct insulation shall be anti-microbial closed cell cross linked polyethylene foam. Thermal conductivity of the insulation material shall not exceed 0.032 W/moK at an average temperature of 25oC. Density of the material shall be 25-30 Kg/m3. The product shall have temperature range of –40 oC to 105oC. The insulation material shall be fire rated for Class 1 as per BS 476 Part 7, 1987 for surface spread of flame test. Water vapour permeability as per DIN 52615 shall not exceed 0.15ng/Pa.Sec.m. | | | | |
| | | Thermal conductivity of the material shall not be affected by ageing, as per DIN 52616. The material must be tested for ageing effect in an accredited laboratory for a minimum period of five years to satisfy the ageing criteria. | | | | |
| | | The smoke density of the material as per AS-1530.3 shall not exceed 1. There shall be no toxicity in the emitted smoke, both under flaming and non-flaming conditions, as per AITM 3.000 (1993). | | | | |
| 10.1.1 | | 19 mm | Sqmt | 604.04 | **50492** | **30,499,046** |
| | | 32 mm | Sqmt | 1,018.04 | 50 | **50,902** |
| | | | | | | |
| 11.0 | | **Hepa Filter** | | | | |
| | | Supply, installation, testing and commissioning of epoxy sealed DOP tested HEPA filters of efficiency 99.97% down to 0.3 micron particle size in aluminium frame as per given drawings, specification and schedules. | | | | |
| | | The cost shall include the cost and installation of HEPA filter in extruded MS housing. | | | | |
| | | | | | | |
| 11.1 | | 610x610x305 | Nos. | 15,794.17 | 16 | **252,707** |
| | | | | | | |
| | | **TOTAL OF SUB SECTION (B) CARRIED OVER TO SUMMARY** | | | | **109,775,215** |
| | | | | | | |
| **C)** | | **VENTILATION SYSTEM:** | | | | |
| | | | | | | |
| **1.0** | | **Fire Rated Tube Axial Flow Fans** | | | | |
| **1.1** | | Supply , installation , testing and commissioning of Fire Rated Tube Axial flow fans complete with tube casing , impeller , bird screen , gravity louvers , necessary nut bolts , Necessary transition piece and canvas connection for proper installation, silencers on inlet and outlet and directly coupled TEFC Sq.cage IP-55, Class-H and IE-3 High efficiency induction motor mounted on vibration isolators suitable for 415V±10% , 50 Hz. 3 phase electric supply complete as per the technical specifications enclosed. The fans shall be AMCA certified. The fan shall be rated for a minimum of 250 Deg C for a minimum of 2 hours application. The fan shall be complete in all respect and should match the specification ,Drawings and Schedule. The unit shall be capable to communicate with BMS system. | | | | |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item | Description of Work | Unit | Rate | Total Quanti | Total Amount |
| | | For dia upto 1120 fan RPM should be 1450 and above 1120 dia 950 RPM<br>Note:Noise level should be selected for 3 meter distance from fan at room condition.<br>For normal case - 80db(A)@3m<br>For Emergency case - 90db(A)@3m<br>All fan should be factory tested in presence of PMC /consultant/Client representative | | | | |
| 1.1.1 | | 30000 CFM (40 mm Static Pressure, Ceiling Mounted) for Basement Exhaust | Nos. | 305,412.18 | 1 | **305,412** |
| 1.1.2 | | 30000 CFM (40 mm Static Pressure, Ceiling Mounted) for Basement Exhaust | Nos. | 305,412.18 | 1 | **305,412** |
| 1.1.3 | | 36000 CFM (40 mm Static Pressure, Ceiling Mounted) for Basement Fresh | Nos. | 420,046.50 | 1 | **420,046** |
| 1.1.4 | | 25000 CFM (25 mm Static Pressure , Ceiling Mounted) for Basement Exhaust | Nos. | 198,348.21 | 1 | **198,348** |
| 1.1.5 | | 25000 CFM (40 mm Static Pressure , Ceiling Mounted) for Basement Exhaust (Normal) | Nos. | 245,351.98 | 1 | **245,352** |
| 1.1.6 | | 23500 CFM (40 mm Static Pressure , Floor Mounted) for Atrium Fresh Air | Nos. | 245,351.98 | 1 | **245,352** |
| 1.1.7 | | 23500 CFM (40 mm Static Pressure , Floor Mounted) for Atrium Exhaust | Nos. | 245,351.98 | 1 | **245,352** |
| 1.1.8 | | 11500 CFM (40 mm Static Pressure , Floor Mounted) for Atrium Fresh Air | Nos. | 118,840.73 | 1 | **118,841** |
| 1.1.9 | | 11500 CFM (40 mm Static Pressure , Floor Mounted) for Atrium Exhaust | Nos. | 118,840.73 | 1 | **118,841** |
| 1.1.10 | | 13700 CFM (30 mm Static Pressure , Ceiling Mounted) for Basement Exhaust | Nos. | 141,653.44 | 1 | **141,653** |
| 1.1.11 | | 13700 CFM (30 mm Static Pressure , Ceiling Mounted) for Basement Exhaust | Nos. | 141,653.44 | 1 | **141,653** |
| 1.1.12 | | 16500 CFM (30 mm Static Pressure , Ceiling Mounted) for Basement Fresh Air | Nos. | 141,653.44 | 1 | **141,653** |
| 1.1.13 | | 3000 CFM (30 mm Static Pressure , Ceiling Mounted) for UPS , Store & Electrical Room Exhaust | Nos. | 60,832.88 | 1 | **60,833** |
| 1.1.14 | | 26500CFM (25 mm Static Pressure, Ceiling Mounted) for Basement Exhaust | Nos. | 232,175.62 | 2 | **464,351** |
| 1.1.15 | | 24500 CFM (25 mm Static Pressure, Ceiling Mounted) for Basement Exhaust | Nos. | 198,348.21 | 2 | **396,696** |
| 1.1.16 | | 26500 CFM (40 mm Static Pressure, Ceiling Mounted) for Basement Fresh | Nos. | 277,618.87 | 1 | **277,619** |
| 1.1.17 | | 24500 CFM (40 mm Static Pressure, Ceiling Mounted) for Basement Fresh | Nos. | 245,351.98 | 1 | **245,352** |
| 1.1.18 | | 28000 CFM (25 mm Static Pressure, Ceiling Mounted) for Basement Exhaust | Nos. | 277,618.87 | 2 | **555,238** |
| 1.1.19 | | 29750 CFM (25 mm Static Pressure, Ceiling Mounted) for Basement Exhaust | Nos. | 305,412.18 | 2 | **610,824** |
| 1.1.20 | | 28000 CFM (40 mm Static Pressure, Ceiling Mounted) for Basement Fresh | Nos. | 277,618.87 | 1 | **277,619** |
| 1.1.21 | | 29000CFM (40 mm Static Pressure, Ceiling Mounted) for Basement Fresh | Nos. | 305,412.18 | 1 | **305,412** |
| 1.1.22 | | 7000 CFM, (25 mm Static pressure ,ceiling mounted) for utility block | Nos. | 83,814.08 | 6 | **502,884** |
| 1.1.23 | | 7800 CFM, (25 mm Static pressure ,ceiling mounted) for utility block | Nos. | 94,042.46 | 2 | **188,085** |
| 1.1.24 | | 15000 CFM,(40 mm Static pressure ,ceiling mounted) for utility block | Nos. | 141,653.44 | 1 | **141,653** |
| 1.1.25 | | 23000 CFM, (40 mm Static pressure ,ceiling mounted) for utility block | Nos. | 245,351.98 | 1 | **245,352** |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| 1.1.26 | | 24000 CFM, (40 mm Static pressure ,ceiling mounted) for utility block | Nos. | 245,351.98 | 1 | **245,352** |
| 1.1.27 | | 27000 CFM, (40 mm Static pressure ,ceiling mounted) for utility block | Nos. | 277,618.87 | 1 | **277,619** |
| 1.1.28 | | 36100 CFM (35 mm Static Pressure, Ceiling Mounted) for Basement Exhaust | Nos. | 420,046.50 | 2 | **840,093** |
| 1.1.29 | | 33000 CFM (35 mm Static Pressure, Ceiling Mounted) for Basement Exhaust | Nos. | 420,046.50 | 2 | **840,093** |
| 1.1.30 | | 36100 CFM (40 mm Static Pressure, Ceiling Mounted) for Basement Fresh | Nos. | 420,046.50 | 1 | **420,046** |
| 1.1.31 | | 36100 CFM (35 mm Static Pressure, Ceiling Mounted) for Basement Fresh | Nos. | 420,046.50 | 3 | **1,260,139** |
| 1.1.32 | | 31600 CFM (30 mm Static Pressure, Ceiling Mounted) for Basement Exhaust | Nos. | 305,412.18 | 4 | **1,221,649** |
| | | | | | | |
| **2.0** | | **Fire Rated Tube Axial Flow Fans Fan Pressurisation** | | | | |
| **2.1** | | Supply , installation , testing and commissioning of Fire Rated Tube Axial flow fans complete with tube casing , impeller , bird screen , gravity louvers , necessary nut bolts , Necessary transition piece and canvas connection for proper installation, silencers on inlet and outlet and directly coupled TEFC Sq.cage IP-55 , Class-H, IE 1 efficiency induction motor mounted on vibration isolators suitable for 415V±10% , 50 Hz. 3 phase electric supply complete as per the technical specifications enclosed. The fans shall be AMCA certified. The fan shall be rated for a minimum of 250 Deg C for a minimum of 2 hours application. The fan shall be complete in all respect and should match the specification ,Drawings and Schedule.The unit shall be capable to communicate with BMS system. | | | | |
| | | For dia upto 1120 fan RPM should be 1450 and above 1120 dia 950 RPM | | | | |
| | | Note:Noise level should be selected for 3 meter distance from fan at room condition.<br>For normal case - 80db(A)@3m<br>For Emergency case - 90db(A)@3m | | | | |
| | | All fan should be factory tested in presence of PMC /consultant/Client representative | | | | |
| | | | | | | |
| 2.1.1 | | 7500 CFM (25 mm Static Pressure, Floor Mounted) for Staircase Pressurization at Ground Floor | Nos. | 86,170.04 | 3 | **258,510** |
| 2.1.2 | | 7000 CFM (25 mm Static Pressure, Floor Mounted) for Lift lobby Pressurization at Terrace | Nos. | 98,180.56 | 1 | **98,181** |
| 2.1.3 | | 8000 CFM (25 mm Static Pressure, Floor Mounted) for Liftwell Pressurization at Terrace | Nos. | 98,180.56 | 1 | **98,181** |
| 2.1.4 | | 14500 CFM (35 mm Static Pressure, Floor Mounted) for Liftwell Pressurization at Terrace | Nos. | 134,755.58 | 1 | **134,756** |
| 2.1.5 | | 10000 CFM (35 mm Static Pressure, Floor Mounted) for Liftwell Pressurization at Terrace | Nos. | 114,062.02 | 1 | **114,062** |
| 2.1.6 | | 7500 CFM (25 mm Static Pressure , Floor Mounted) for Staircase Pressurization | Nos. | 86,170.04 | 4 | **344,680** |
| 2.1.7 | | 15000 CFM (40 mm Static Pressure , Floor Mounted) for Liftlobby Pressurization at Terrace | Nos. | 134,755.58 | 1 | **134,756** |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| 2.1.8 | | 7000 CFM (30 mm Static Pressure , Floor Mounted) for Liftwell Pressurization at Terrace | Nos. | 98,180.56 | 1 | **98,181** |
| 2.1.9 | | 3000 CFM (30 mm Static Pressure , Floor Mounted) for Liftwell Pressurization at Terrace | Nos. | 58,882.23 | 1 | **58,882** |
| 2.1.10 | | 8000 CFM (30 mm Static Pressure , Floor Mounted) for Staircase Pressurization at Ground Floor | Nos. | 98,180.56 | 4 | **392,722** |
| 2.1.11 | | 16000 CFM (30 mm Static Pressure , Floor Mounted) for Lift lobby Pressurization at Terrace | Nos. | 134,755.58 | 1 | **134,756** |
| 2.1.12 | | 5100 CFM (30 mm Static Pressure , Floor Mounted) for Liftwell Pressurization at Terrace | Nos. | 85,260.75 | 1 | **85,261** |
| 2.1.13 | | 7500 CFM (20 mm Static Pressure, Floor Mounted) for Staircase Pressurization at Ground Floor | Nos. | 80,113.17 | 7 | **560,792** |
| 2.1.14 | | 18000 CFM (30 mm Static Pressure, Floor Mounted) for Lift lobby Pressurization at Terrace | Nos. | 141,686.83 | 2 | **283,374** |
| 2.1.15 | | 9000 CFM (20 mm Static Pressure, Floor Mounted) for Liftwell Pressurization at Terrace | Nos. | 104,909.92 | 2 | **209,820** |
| 2.1.16 | | 7500 CFM (20 mm Static Pressure, Floor Mounted) for Staircase Pressurization at Ground Floor | Nos. | 80,113.17 | 7 | **560,792** |
| 2.1.17 | | 17600 CFM (30 mm Static Pressure, Floor Mounted) for Lift lobby Pressurization at Terrace | Nos. | 141,686.83 | 2 | **283,374** |
| 2.1.18 | | 9000 CFM (30 mm Static Pressure, Floor Mounted) for Liftwell Pressurization at Terrace | Nos. | 104,909.92 | 2 | **209,820** |
| 2.1.19 | | 4900 CFM (30 mm Static Pressure, Floor Mounted) for Liftwell Pressurization at Terrace | Nos. | 85,260.75 | 2 | **170,521** |
| 2.1.20 | | 5300 CFM (30 mm Static Pressure, Floor Mounted) for Liftwell Pressurization at Terrace | Nos. | 85,260.75 | 1 | **85,261** |
| 2.1.21 | | 6700 CFM (30 mm Static Pressure, Floor Mounted) for staircase Pressurization | Nos. | 98,180.56 | 1 | **98,181** |
| 2.1.22 | | 7200 CFM (30 mm Static Pressure, Floor Mounted) for Staircase Pressurization | Nos. | 98,180.56 | 3 | **294,542** |
| 2.1.23 | | 7700 CFM (30 mm Static Pressure, Floor Mounted) for Liftlobby Pressurization | Nos. | 98,180.56 | 2 | **196,361** |
| 2.1.24 | | 6850 CFM (30 mm Static Pressure, Floor Mounted) for Liftlobby Pressurization | Nos. | 98,180.56 | 1 | **98,181** |
| 2.1.25 | | 7750 CFM (30 mm Static Pressure, Floor Mounted) for Liftlobby Pressurization | Nos. | 98,180.56 | 1 | **98,181** |
| 2.1.26 | | 8550 CFM (30 mm Static Pressure, Floor Mounted) for Staircase Pressurization | Nos. | 104,909.92 | 4 | **419,640** |
| 2.1.27 | | 9150 CFM (30 mm Static Pressure, Floor Mounted) for Liftlobby Pressurization | Nos. | 104,909.92 | 1 | **104,910** |
| 2.1.28 | | 9820 CFM (30 mm Static Pressure, Floor Mounted) for Liftwell Pressurization | Nos. | 114,062.02 | 1 | **114,062** |
| 2.1.29 | | 14500 CFM (30 mm Static Pressure, Floor Mounted) for Liftwell Pressurization | Nos. | 134,755.58 | 2 | **269,511** |
| 2.1.30 | | 12850 CFM (30 mm Static Pressure, Floor Mounted) for Staircase Pressurization | Nos. | 125,266.48 | 1 | **125,266** |
| | | | | | | |
| **3.0** | | **Propeller Fans** | | | | |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| **3.1** | | Supply , installation , testing and commissioning of propeller type fan with Aluminium/SS blades and complete with induction Motor suitable for operation with 230 V single phase 50 Hz with suitable frame etc. as per IS:2312-1967 with gravity dampers for exhaust complete as per specifications and drawings. for fan upto 100 CFM, wall/Ceiling mounted propeller type exhaust fans shall be of slim line Axial Flow type. Fan casing and impeller are manufactured from tough injection moulded poly propylene . Front grill shall be high quality ABS and neon indicators from polycarbonate. Motor shall be of single phase, shaded pole, 230 V, 50 Hz . Noise level should not exceed 45dB(A) @3m.The fan shall be complete in all respect and should match the specification ,Drawings and Schedule.The unit shall be capacble to communicate with BMS system. | | | | |
| | | | | | | |
| 3.1.1 | | 200 CFM | Nos. | 8,353.07 | 2 | **16,706** |
| 3.1.2 | | 300 CFM | Nos. | 9,643.38 | 1 | **9,643** |
| 3.1.3 | | 750 CFM | Nos. | 13,174.76 | 6 | **79,049** |
| 3.1.4 | | 1200 CFM | Nos. | 18,403.92 | 1 | **18,404** |
| 3.1.5 | | 2600 CFM | Nos. | 27,843.56 | 1 | **27,844** |
| 3.1.6 | | 600 CFM | Nos. | 13,174.76 | 8 | **105,398** |
| 3.1.7 | | 1500 CFM | Nos. | 21,731.56 | 1 | **21,732** |
| 3.1.8 | | 750 CFM | Nos. | 13,174.76 | 1 | **13,175** |
| 3.1.9 | | 400 CFM | Nos. | 9,643.38 | 5 | **48,217** |
| 3.1.10 | | 100 CFM | Nos. | 3,327.65 | 30 | **99,829** |
| 3.1.11 | | 150 CFM | Nos. | 8,353.07 | 9 | **75,178** |
| 3.1.12 | | 1100 CFM | Nos. | 18,403.92 | 16 | **294,463** |
| 3.1.13 | | 1150 CFM | Nos. | 18,403.92 | 2 | **36,808** |
| 3.1.14 | | 1050 CFM | Nos. | 18,403.92 | 6 | **110,424** |
| 3.1.15 | | 1250 CFM | Nos. | 18,403.92 | 4 | **73,616** |
| 3.1.16 | | 1300 CFM | Nos. | 18,403.92 | 1 | **18,404** |
| 3.1.17 | | 1000 CFM | Nos. | 18,403.92 | 1 | **18,404** |
| 3.1.18 | | 115 CFM | Nos. | 3,327.65 | 2 | **6,655** |
| 3.1.19 | | 250 CFM | Nos. | 9,643.38 | 1 | **9,643** |
| 3.1.20 | | 325 CFM | Nos. | 9,643.38 | 1 | **9,643** |
| 3.1.21 | | 450 CFM | Nos. | 9,643.38 | 1 | **9,643** |
| 3.1.22 | | 500 CFM | Nos. | 13,174.76 | 2 | **26,350** |
| 3.1.23 | | 675 CFM | Nos. | 13,174.76 | 1 | **13,175** |
| 3.1.24 | | 700 CFM | Nos. | 13,174.76 | 1 | **13,175** |
| 3.1.25 | | 800 CFM | Nos. | 13,174.76 | 1 | **13,175** |
| 3.1.26 | | 1400 CFM | Nos. | 21,731.56 | 1 | **21,732** |
| 3.1.27 | | 1500 CFM | Nos. | 21,731.56 | 1 | **21,732** |
| 3.1.28 | | 1950 CFM | Nos. | 21,731.56 | 1 | **21,732** |
| 3.1.29 | | 2200 CFM | Nos. | 27,843.56 | 1 | **27,844** |
| | | | | | | |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| **4.0** | | **Cabinet Fan** | | | | |
| 4.1 | | Supply , installation , testing and commissioning of factory fabricated Single Skinned cabinet type fan section made out of extruded aluminium section with 1.0mm pre-plasticized /pre-coated Galvanised steel sheet with DIDW blower , blower section and blower motor TEFC type suitable for operation on 415 volts ± 10% , 50 Hz ± 5% AC supply with motor and belt drive package. The fan Motor shall be of efficiency class IE-3 or Eff-1 whichever is higher. The cabinet as well as blower assembly shall be AMCA Certified and shall be selected for maximum efficiency.The fan shall be complete in all respect and should match the specification ,Drawings and Schedule.<br><br>The motor & blower assembly shall be mounted on Aluminium extruded section/GSS. The complete fan section shall conform to standard specification. The fan outlet velocity shall be limited to 9.5 MPS maximum.The unit shall be capable to communicate with BMS system. | | | | |
| | | | | | | |
| 4.1.1 | | 1900 CFM (15mm Static Pressure, Ceiling Mounted) | Nos. | 95,196.47 | 1 | **95,196** |
| 4.1.2 | | 4250 CFM (20 mm Static Pressure, Floor Mounted) | Nos. | 130,947.60 | 1 | **130,948** |
| 4.1.3 | | 4300 CFM (20 mm Static Pressure, Floor Mounted) | Nos. | 130,947.60 | 1 | **130,948** |
| 4.1.4 | | 4800 CFM (40 mm Static Pressure,Ceiling mounted) | Nos. | 155,335.85 | 1 | **155,336** |
| 4.1.5 | | 5600 CFM (30 mm static pressure , floor mounted) | Nos. | 164,533.73 | 1 | **164,534** |
| 4.1.6 | | 1550 CFM(20 mm static pressure , floor mounted) | Nos. | 86,518.78 | 1 | **86,519** |
| 4.1.7 | | 16500 CFM (30mm Static Pressure, Floor Mounted) | Nos. | 344,188.56 | 2 | **688,377** |
| 4.1.8 | | 4300 CFM (15 mm Static Pressure, Floor Mounted) | Nos. | 130,041.67 | 1 | **130,042** |
| 4.1.9 | | 3300 CFM (30 mm Static Pressure, Floor Mounted) | Nos. | 119,674.36 | 2 | **239,349** |
| 4.1.10 | | 3200 CFM (30 mm Static Pressure, Floor Mounted) | Nos. | 119,674.36 | 2 | **239,349** |
| 4.1.11 | | 3500 CFM (30mm Static Pressure, Floor Mounted) | Nos. | 130,947.60 | 2 | **261,895** |
| 4.1.12 | | 4800 CFM (15 mm Static Pressure, Floor Mounted) | Nos. | 149,600.08 | 1 | **149,600** |
| 4.1.13 | | 3350 CFM (40 mm Static Pressure, Floor Mounted) | Nos. | 121,560.93 | 1 | **121,561** |
| 4.1.14 | | 3000 CFM (30 mm Static Pressure, Floor Mounted) | Nos. | 117,214.62 | 1 | **117,215** |
| 4.1.15 | | 4500 CFM(15 mm Static Pressure, Ceiling Mounted) | Nos. | 150,506.01 | 1 | **150,506** |
| 4.1.16 | | 8700 CFM(20 mm Static Pressure, Ceiling Mounted) | Nos. | 221,661.94 | 1 | **221,662** |
| 4.1.17 | | 4000 CFM(20 mm Static Pressure, Ceiling Mounted) | Nos. | 130,947.60 | 1 | **130,948** |
| 4.1.18 | | 6000 CFM(20 mm Static Pressure, Ceiling Mounted) | Nos. | 164,533.73 | 1 | **164,534** |
| 4.1.19 | | 1500 CFM(20 mm Static Pressure, Ceiling Mounted) | Nos. | 86,518.78 | 1 | **86,519** |
| 4.1.20 | | 2500 CFM(5 mm Static Pressure, Ceiling Mounted) | Nos. | 117,214.62 | 1 | **117,215** |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| 4.1.21 | | 4250 CFM(15 mm Static Pressure, Ceiling Mounted) | Nos. | 130,947.60 | 1 | **130,948** |
| 4.1.22 | | 3000 CFM(15 mm Static Pressure, Ceiling Mounted) | Nos. | 117,214.62 | 1 | **117,215** |
| 4.1.23 | | 5150 CFM(15 mm Static Pressure, Ceiling Mounted) | Nos. | 155,335.85 | 1 | **155,336** |
| 4.1.24 | | 2150 CFM(20 mm Static Pressure, Ceiling Mounted) | Nos. | 95,196.47 | 1 | **95,196** |
| 4.1.25 | | 3400 CFM(20 mm Static Pressure, Ceiling Mounted) | Nos. | 121,560.93 | 1 | **121,561** |
| | | | | | | |
| **5.0** | | **Inline Fans** | | | | |
| 5.1 | | Supply , installation , testing and commissioning , of duct mounted inline fans complete with direct driven centrifugal fan, **with 230 V single phase 50 Hz motor, shall be with efficiency of EFF2 or IE1, direct drive arrangement**, heavy gauge sheet metal casing , rubber isolator mounts and other accessories.The fan shall be complete in all respect and should match the specification ,Drawings and Schedule. Inline fans shall be of following capacities. | | | | |
| 5.1.1 | | 700 CFM (15 mm Static Pressure) | Nos. | 25,466.67 | 2 | **50,933** |
| 5.1.2 | | 400 CFM (15 mm Static Pressure) | Nos. | 20,509.16 | 1 | **20,509** |
| 5.1.3 | | 300 CFM (15 mm Static Pressure) | Nos. | 17,249.43 | 1 | **17,249** |
| | | | | | | |
| **6.0** | | Supply, Installation , testing and commissioning of CO sensor as per specifications and in the spaces marked in drawings. | Nos. | 44,656.13 | 28 | **1,250,372** |
| | | | | | | |
| | | **TOTAL OF SUB SECTION (C) CARRIED OVER TO SUMMARY** | | | | **24,943,699** |
| | | | | | | |
| **D)** | | **AIR DISTRIBUTION SYSTEM:** | | | | |
| | | | | | | |
| **1.0** | | **Diffusers** | | | | |
| | | Supply , installation , testing and commissioning of Powder coated Aluminium extruded Diffuser as per specification & the sizes will be as per drawings and schedules : | | | | |
| 1.1 | | Supply Air Diffuser | SQMT | 20,052.95 | 853 | **17,105,167** |
| 1.2 | | Return Air Diffuser | SQMT | 15,465.12 | 838 | **12,959,772** |
| | | | | | | |
| **2.0** | | **Round Diffuser** | | | | |
| | | Supply , installation , testing and commissioning of Powder coated Aluminium extruded round Diffuser as per specification & the sizes will be as per drawings and schedules : | | | | |
| 2.1 | | 150 mm dia | Nos. | 7,740.40 | 630 | **4,876,449** |
| | | | | | | |
| **3.0** | | **Slot Type Diffuser** | | | | |
| 3.1 | | Supply , installation , testing and commissioning of Powder coated Aluminium extruded multislots ceiling linear air terminals with hit and miss type volume control dampers. | RMT. | 2,481.94 | 213 | **528,653** |
| | | | | | | |
| **4.0** | | **Exhaust Air Grilles:** | | | | |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| 4.1 | | Supplying , Installing, testing , balancing & fixing of powder coated extruded aluminium Exhaust Air Grills of various sizes and as per specifications and approved drawings and schedules | SQMT | 7,912.75 | 109 | **864,073** |
| | | | | | | |
| **5.0** | | **Supply/Return Grills** | | | | |
| | | Supplying , installation, testing ,balancing & fixing of powder coated extruded aluminium Grills of various sizes and as per specifications and approved drawings and schedules. | | | | |
| 5.1 | | Supply Air Grills | SQMT | 14,728.69 | 149 | **2,190,156** |
| 5.2 | | Return Air Grills | SQMT | 7,912.75 | 23 | **179,619** |
| | | | | | | |
| **6.0** | | **Exhaust Air Louvers** | | | | |
| 6.1 | | Supplying , Installing, testing and commissioning of powder coated extruded aluminium exhaust air louvers with min.60 % free area , with metallic frame work & fixing accessories , to be fixed on external wall to exhaust air from basement area to ambient , it shall be suitable for exhausting required air in CFM . Louvers need to be suitable in order avoid rain water entry in to basement @ 15 degree deflection with bird screen complete as per specification approved drawings and schedules. | SQMT | 9,119.25 | 107 | **973,936** |
| | | | | | | |
| **7.0** | | **Fresh Air Louvers** | | | | |
| 7.1 | | Supplying, installation, testing and commissioning of GI construction fresh air louvers with min. 60 % free area , bird screen and fresh air filters and painted in baked enamel shade with metallic frame work complete as per specification approved drawings and schedules. | SQMT | 9,119.25 | 150 | **1,363,328** |
| | | | | | | |
| **8.0** | | **Back Draft Dampers** | | | | |
| 8.1 | | Supplying, fixing , testing & commissioning of Back Draft damper having 18 gauge G.I. frame and 20 gauge louvers at exhaust/supply air fans. | SQMT | 8,617.85 | 27 | **232,682** |
| | | | | | | |
| **9.0** | | **Antistatic Floor Standing Grille** | | | | |
| | | Supply, installation, testing and commissioning of Antistatic floor grilles with opposed blade dampers to take live load as required for supporting server racks. Pressure loss with dampers shall not exceed 20Pa for designed air flow and throw of 2.2 Meters. To be installed on level with false floor top .Finish and colour to match the false floor and to be approve by the architect. | | | | |
| 9.1 | | High CFM Grilles- 1050 CFM Per Grilles - 600mm x 600mm | Nos. | 9,675.49 | 144 | **1,393,271** |
| | | | | | | |
| | | | | | | |
| **10.0** | | **VAV BOXES WITH CONTROLS** | | | | |
| **10.1** | | Supply, Installation , Testing & Commissioning of VAV boxes of following capacities as per Specifications , schedules provided and includes all following:- | | | | |
| | | VAVs shall be pressure independent type & low velocity type | | | | |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item | Description of Work | Unit | Rate | Total Quanti | Total Amount |
| | | VAV Boxes shall be slow reacting type capable of delivering variable air volume type by the action of opposed blade volume control damper | | | | |
| | | VAV boxes shall be supplied with end flanges for attachment to flanged duct ends and shall be complete with all internal Acoustic treatment. | | | | |
| | | The casing shall be double skin type of Galvanized sheet steel construction with a completely sealed , easily removable. The access shall be provided in the top side only. | | | | |
| | | VAV shall be electronically controlled networkable controller type complete with low leakage damper, actuator , Microprocessor unit , wall/ ceiling mounted temperature sensor with ON/OFF Switch , control transformer , unit hander brackets etc. | | | | |
| | | VAV Boxes shall also be able to reset any air flow between zero and the maximum air quantity that the boxes can handle without changing orifices or other parts, but the boxes shall be factory set at 10% of the maximum flow as minimum flow. | | | | |
| | | The noise level from the VAV boxes shall not exceed 35 dbA | | | | |
| | | The quoted price shall be inclusive of the temperature sensor for each VAV unit & associated cable required for the functioning of the VAV system | | | | |
| | | The temperature sensor and the entire control mechanism shall be fully compatible with BMS System. Datas like temperatures, set points , damper position shall be monitored through BMS system | | | | |
| | | Integrators for the below VAVs to connect with the BMS system to read and modify the parameters. Integrator should release open protocol BACnet / MODBUS to integrate with third party BMS System. | | | | |
| | | Power wiring from the Socket (Socket Provided by Electrical CONTRACTOR near (within 2 meter) the VAVs) to VAVs | | | | |
| | | Fixing of thermostat above the false floor/ Partition with necessary control wiring and conduiting. | | | | |
| | | The capacities of the units with the above specification are as follows:- | | | | |
| | | | | | | |
| 10.1.1 | | 900 CFM | Nos. | 38,605.98 | 1 | **38,606** |
| 10.1.2 | | 1920 CFM | Nos. | 39,908.01 | 1 | **39,908** |
| 10.1.3 | | 3350 CFM | Nos. | 43,885.10 | 1 | **43,885** |
| 10.1.4 | | 300 CFM | Nos. | 38,399.46 | 1 | **38,399** |
| 10.1.5 | | 710 CFM | Nos. | 38,605.98 | 1 | **38,606** |
| 10.1.6 | | 450 CFM | Nos. | 38,331.70 | 1 | **38,332** |
| 10.1.7 | | 1020 CFM | Nos. | 39,017.40 | 1 | **39,017** |
| 10.1.8 | | 1400 CFM | Nos. | 39,181.97 | 1 | **39,182** |
| 10.1.9 | | 1925 CFM | Nos. | 39,908.01 | 1 | **39,908** |
| 10.1.10 | | 815 CFM | Nos. | 38,605.98 | 1 | **38,606** |
| 10.1.11 | | 940 CFM | Nos. | 39,017.40 | 1 | **39,017** |
| 10.1.12 | | 1020 CFM | Nos. | 39,017.40 | 1 | **39,017** |
| 10.1.13 | | 1880 CFM | Nos. | 39,908.01 | 1 | **39,908** |
| 10.1.14 | | 2035 CFM | Nos. | 41,416.56 | 1 | **41,417** |
| 10.1.15 | | 900 CFM | Nos. | 38,605.98 | 1 | **38,606** |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item | Description of Work | Unit | Rate | Total Quanti | Total Amount |
| 10.1.16 | | 1455 CFM | Nos. | 39,908.01 | 1 | **39,908** |
| 10.1.17 | | 1275 CFM | Nos. | 39,181.97 | 1 | **39,182** |
| 10.1.18 | | 780 CFM | Nos. | 38,605.98 | 1 | **38,606** |
| 10.1.19 | | 1275 CFM | Nos. | 39,181.97 | 1 | **39,182** |
| 10.1.20 | | 2390 CFM | Nos. | 41,416.56 | 1 | **41,417** |
| 10.1.21 | | 3840 CFM | Nos. | 43,885.10 | 1 | **43,885** |
| 10.1.22 | | 1000 CFM | Nos. | 39,017.40 | 1 | **39,017** |
| 10.1.23 | | 1450 CFM | Nos. | 39,908.01 | 1 | **39,908** |
| 10.1.24 | | 1000 CFM | Nos. | 39,017.40 | 1 | **39,017** |
| 10.1.25 | | 840 CFM | Nos. | 38,605.98 | 1 | **38,606** |
| 10.1.26 | | 1300 CFM | Nos. | 39,181.97 | 1 | **39,182** |
| 10.1.27 | | 875 CFM | Nos. | 38,605.98 | 1 | **38,606** |
| 10.1.28 | | 1060 CFM | Nos. | 39,181.97 | 1 | **39,182** |
| 10.1.29 | | 1200 CFM | Nos. | 39,181.97 | 1 | **39,182** |
| 10.1.30 | | 960 CFM | Nos. | 39,017.40 | 1 | **39,017** |
| 10.1.31 | | 1000 CFM | Nos. | 39,017.40 | 2 | **78,035** |
| 10.1.32 | | 1050 CFM | Nos. | 39,017.40 | 1 | **39,017** |
| 10.1.33 | | 1150 CFM | Nos. | 39,181.97 | 1 | **39,182** |
| 10.1.34 | | 1200 CFM | Nos. | 39,181.97 | 1 | **39,182** |
| 10.1.35 | | 1300 CFM | Nos. | 39,181.97 | 1 | **39,182** |
| 10.1.36 | | 1650 CFM | Nos. | 39,908.01 | 1 | **39,908** |
| 10.1.37 | | 1700 CFM | Nos. | 39,908.01 | 1 | **39,908** |
| 10.1.38 | | 1720 CFM | Nos. | 39,908.01 | 1 | **39,908** |
| 10.1.39 | | 1900 CFM | Nos. | 39,908.01 | 1 | **39,908** |
| 10.1.40 | | 2000 CFM | Nos. | 39,908.01 | 1 | **39,908** |
| 10.1.41 | | 2200 CFM | Nos. | 41,416.56 | 1 | **41,417** |
| 10.1.42 | | 2500 CFM | Nos. | 41,416.56 | 2 | **82,833** |
| 10.1.43 | | 2750 CFM | Nos. | 41,416.56 | 1 | **41,417** |
| 10.1.44 | | 3250 CFM | Nos. | 43,885.10 | 2 | **87,770** |
| 10.1.45 | | 3400 CFM | Nos. | 43,885.10 | 1 | **43,885** |
| 10.1.45 | | 3800 CFM | Nos. | 43,885.10 | 2 | **87,770** |
| 10.1.46 | | 1600 CFM | Nos. | 39,908.01 | 2 | **79,816** |
| 10.1.47 | | 1300 CFM | Nos. | 39,181.97 | 1 | **39,182** |
| 10.1.48 | | 1100 CFM | Nos. | 39,181.97 | 2 | **78,364** |
| 10.1.49 | | 1500 CFM | Nos. | 39,908.01 | 1 | **39,908** |
| 10.1.50 | | 580 CFM | Nos. | 38,468.84 | 1 | **38,469** |
| 10.1.51 | | 1400 CFM | Nos. | 39,181.97 | 1 | **39,182** |
| 10.1.52 | | 2350 CFM | Nos. | 41,416.56 | 1 | **41,417** |
| 10.1.53 | | 2000 CFM | Nos. | 39,908.01 | 2 | **79,816** |
| 10.1.54 | | 2150 CFM | Nos. | 41,416.56 | 1 | **41,417** |
| 10.1.55 | | 2550 CFM | Nos. | 41,416.56 | 1 | **41,417** |
| 10.1.56 | | 900 CFM | Nos. | 38,605.98 | 1 | **38,606** |
| 10.1.57 | | 1920 CFM | Nos. | 39,908.01 | 1 | **39,908** |
| 10.1.58 | | 3350 CFM | Nos. | 43,885.10 | 1 | **43,885** |
| 10.1.59 | | 300 CFM | Nos. | 38,399.46 | 1 | **38,399** |
| 10.1.60 | | 710 CFM | Nos. | 38,605.98 | 1 | **38,606** |
| 10.1.61 | | 450 CFM | Nos. | 38,331.70 | 1 | **38,332** |
| 10.1.62 | | 1020 CFM | Nos. | 39,017.40 | 1 | **39,017** |
| 10.1.63 | | 1400 CFM | Nos. | 39,181.97 | 1 | **39,182** |
| 10.1.64 | | 1925 CFM | Nos. | 39,908.01 | 1 | **39,908** |
| 10.1.65 | | 815 CFM | Nos. | 39,017.40 | 1 | **39,017** |
| 10.1.66 | | 940 CFM | Nos. | 39,017.40 | 1 | **39,017** |
| 10.1.67 | | 1020 CFM | Nos. | 39,017.40 | 1 | **39,017** |
| 10.1.68 | | 1880 CFM | Nos. | 39,908.01 | 1 | **39,908** |
| 10.1.69 | | 2035 CFM | Nos. | 41,416.56 | 1 | **41,417** |
| 10.1.70 | | 900 CFM | Nos. | 39,017.40 | 1 | **39,017** |
| 10.1.71 | | 1455 CFM | Nos. | 39,908.01 | 1 | **39,908** |
| 10.1.72 | | 1275 CFM | Nos. | 39,181.97 | 1 | **39,182** |
| 10.1.73 | | 780 CFM | Nos. | 39,017.40 | 1 | **39,017** |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item | Description of Work | Unit | Rate | Total Quanti | Total Amount |
| 10.1.74 | | 1275 CFM | Nos. | 39,181.97 | 1 | **39,182** |
| 10.1.75 | | 2390 CFM | Nos. | 41,416.56 | 1 | **41,417** |
| 10.1.76 | | 3840 CFM | Nos. | 43,885.10 | 1 | **43,885** |
| 10.1.77 | | 1000 CFM | Nos. | 39,017.40 | 1 | **39,017** |
| 10.1.78 | | 1450 CFM | Nos. | 39,908.01 | 1 | **39,908** |
| 10.1.79 | | 1000 CFM | Nos. | 39,017.40 | 1 | **39,017** |
| 10.1.80 | | 840 CFM | Nos. | 38,605.98 | 1 | **38,606** |
| 10.1.81 | | 1300 CFM | Nos. | 39,181.97 | 1 | **39,182** |
| 10.1.82 | | 875 CFM | Nos. | 38,605.98 | 1 | **38,606** |
| 10.1.83 | | 1060 CFM | Nos. | 39,017.40 | 1 | **39,017** |
| 10.1.84 | | 1200 CFM | Nos. | 39,181.97 | 1 | **39,182** |
| 10.1.85 | | 1020 CFM | Nos. | 39,017.40 | 4 | **156,070** |
| 10.1.86 | | 1380 CFM | Nos. | 39,181.97 | 1 | **39,182** |
| 10.1.87 | | 2270 CFM | Nos. | 41,416.56 | 1 | **41,417** |
| 10.1.88 | | 1580 CFM | Nos. | 39,908.01 | 2 | **79,816** |
| 10.1.89 | | 1650 CFM | Nos. | 39,908.01 | 1 | **39,908** |
| 10.1.90 | | 2100 CFM | Nos. | 41,416.56 | 2 | **82,833** |
| 10.1.91 | | 1700 CFM | Nos. | 39,908.01 | 2 | **79,816** |
| 10.1.92 | | 1380 CFM | Nos. | 39,181.97 | 1 | **39,182** |
| 10.1.93 | | 1690 CFM | Nos. | 39,908.01 | 1 | **39,908** |
| 10.1.94 | | 1810 CFM | Nos. | 39,908.01 | 1 | **39,908** |
| 10.1.95 | | 1690 CFM | Nos. | 39,908.01 | 1 | **39,908** |
| 10.1.96 | | 990 CFM | Nos. | 38,605.98 | 1 | **38,606** |
| 10.1.97 | | 990 CFM | Nos. | 38,605.98 | 1 | **38,606** |
| 10.1.98 | | 990 CFM | Nos. | 38,605.98 | 1 | **38,606** |
| 10.1.99 | | 990 CFM | Nos. | 39,017.40 | 1 | **39,017** |
| 10.1.100 | | 1560 CFM | Nos. | 39,908.01 | 1 | **39,908** |
| 10.1.101 | | 1340 CFM | Nos. | 39,181.97 | 1 | **39,182** |
| 10.1.102 | | 1050 CFM | Nos. | 39,017.40 | 1 | **39,017** |
| 10.1.103 | | 1170 CFM | Nos. | 38,605.98 | 2 | **77,212** |
| 10.1.104 | | 1000 CFM | Nos. | 39,017.40 | 4 | **156,070** |
| 10.1.105 | | 1800 CFM | Nos. | 39,908.01 | 1 | **39,908** |
| 10.1.106 | | 975 CFM | Nos. | 38,605.98 | 1 | **38,606** |
| 10.1.107 | | 1420 CFM | Nos. | 39,908.01 | 2 | **79,816** |
| 10.1.108 | | 2816 CFM | Nos. | 41,416.56 | 1 | **41,417** |
| 10.1.109 | | 800 CFM | Nos. | 38,605.98 | 2 | **77,212** |
| 10.1.110 | | 1470 CFM | Nos. | 39,908.01 | 2 | **79,816** |
| 10.1.111 | | 640 CFM | Nos. | 38,605.98 | 1 | **38,606** |
| 10.1.112 | | 1470 CFM | Nos. | 39,908.01 | 1 | **39,908** |
| 10.1.113 | | 820 CFM | Nos. | 38,605.98 | 2 | **77,212** |
| 10.1.114 | | 680 CFM | Nos. | 38,605.98 | 2 | **77,212** |
| 10.1.115 | | 1210 CFM | Nos. | 39,181.97 | 2 | **78,364** |
| 10.1.116 | | 2600 CFM | Nos. | 41,416.56 | 1 | **41,417** |
| 10.1.117 | | 1230 CFM | Nos. | 39,181.97 | 3 | **117,546** |
| 10.1.118 | | 3300 CFM | Nos. | 43,885.10 | 2 | **87,770** |
| 10.1.119 | | 2300 CFM | Nos. | 41,416.56 | 4 | **165,666** |
| 10.1.120 | | 3300 CFM | Nos. | 43,885.10 | 1 | **43,885** |
| 10.1.121 | | 1930 CFM | Nos. | 39,908.01 | 1 | **39,908** |
| 10.1.122 | | 1475 CFM | Nos. | 39,908.01 | 1 | **39,908** |
| 10.1.123 | | 1475 CFM | Nos. | 39,908.01 | 1 | **39,908** |
| 10.1.124 | | 1300 CFM | Nos. | 39,181.97 | 1 | **39,182** |
| 10.1.125 | | 1300 CFM | Nos. | 39,181.97 | 1 | **39,182** |
| 10.1.126 | | 2800 CFM | Nos. | 41,416.56 | 1 | **41,417** |
| 10.1.127 | | 825 CFM | Nos. | 38,605.98 | 1 | **38,606** |
| 10.1.128 | | 1100 CFM | Nos. | 39,181.97 | 1 | **39,182** |
| 10.1.129 | | 1000 CFM | Nos. | 39,017.40 | 1 | **39,017** |
| 10.1.130 | | 560 CFM | Nos. | 38,468.84 | 1 | **38,469** |
| 10.1.131 | | 1000 CFM | Nos. | 39,017.40 | 1 | **39,017** |
| 10.1.132 | | 820 CFM | Nos. | 38,605.98 | 2 | **77,212** |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item | Description of Work | Unit | Rate | Total Quanti | Total Amount |
| 10.1.133 | | 680 CFM | Nos. | 38,605.98 | 2 | **77,212** |
| 10.1.134 | | 1210 CFM | Nos. | 39,181.97 | 2 | **78,364** |
| 10.1.135 | | 1210 CFM | Nos. | 39,181.97 | 1 | **39,182** |
| 10.1.136 | | 2600 CFM | Nos. | 41,416.56 | 1 | **41,417** |
| 10.1.137 | | 1230 CFM | Nos. | 39,181.97 | 3 | **117,546** |
| 10.1.138 | | 3300 CFM | Nos. | 43,885.10 | 1 | **43,885** |
| 10.1.139 | | 2300 CFM | Nos. | 41,416.56 | 2 | **82,833** |
| 10.1.140 | | 4000 CFM | Nos. | 43,885.10 | 1 | **43,885** |
| 10.1.141 | | 2600 CFM | Nos. | 41,416.56 | 2 | **82,833** |
| 10.1.142 | | 2200 CFM | Nos. | 41,416.56 | 1 | **41,417** |
| 10.1.143 | | 2000 CFM | Nos. | 39,908.01 | 2 | **79,816** |
| 10.1.144 | | 1600 CFM | Nos. | 39,908.01 | 2 | **79,816** |
| 10.1.145 | | 3500 CFM | Nos. | 43,885.10 | 1 | **43,885** |
| 10.1.146 | | 1025 CFM | Nos. | 39,017.40 | 1 | **39,017** |
| 10.1.147 | | 1620 CFM | Nos. | 39,908.01 | 2 | **79,816** |
| 10.1.148 | | 820 CFM | Nos. | 38,605.98 | 1 | **38,606** |
| 10.1.149 | | 1620 CFM | Nos. | 39,908.01 | 1 | **39,908** |
| 10.1.150 | | 960 CFM | Nos. | 39,017.40 | 4 | **156,070** |
| 10.1.151 | | 1540 CFM | Nos. | 39,908.01 | 1 | **39,908** |
| 10.1.152 | | 1540 CFM | Nos. | 39,908.01 | 1 | **39,908** |
| 10.1.153 | | 3200 CFM | Nos. | 43,885.10 | 1 | **43,885** |
| 10.1.154 | | 1630 CFM | Nos. | 39,908.01 | 3 | **119,724** |
| 10.1.155 | | 1500 CFM | Nos. | 39,908.01 | 8 | **319,264** |
| 10.1.156 | | 420 CFM | Nos. | 38,331.70 | 1 | **38,332** |
| 10.1.157 | | 500 CFM | Nos. | 38,468.84 | 1 | **38,469** |
| 10.1.158 | | 570 CFM | Nos. | 38,468.84 | 1 | **38,469** |
| 10.1.159 | | 675 CFM | Nos. | 38,605.98 | 1 | **38,606** |
| 10.1.160 | | 710 CFM | Nos. | 38,605.98 | 1 | **38,606** |
| 10.1.161 | | 800 CFM | Nos. | 38,605.98 | 1 | **38,606** |
| 10.1.162 | | 1000 CFM | Nos. | 39,017.40 | 1 | **39,017** |
| 10.1.163 | | 1100 CFM | Nos. | 39,181.97 | 1 | **39,182** |
| 10.1.164 | | 1150 CFM | Nos. | 39,181.97 | 1 | **39,182** |
| 10.1.165 | | 1170 CFM | Nos. | 39,181.97 | 1 | **39,182** |
| 10.1.166 | | 1250 CFM | Nos. | 39,181.97 | 3 | **117,546** |
| 10.1.167 | | 1260 CFM | Nos. | 39,181.97 | 1 | **39,182** |
| 10.1.168 | | 1300 CFM | Nos. | 39,181.97 | 1 | **39,182** |
| 10.1.169 | | 1325 CFM | Nos. | 39,181.97 | 1 | **39,182** |
| 10.1.170 | | 1350 CFM | Nos. | 39,181.97 | 1 | **39,182** |
| 10.1.171 | | 1400 CFM | Nos. | 39,181.97 | 2 | **78,364** |
| 10.1.172 | | 1410 CFM | Nos. | 39,181.97 | 1 | **39,182** |
| 10.1.173 | | 1415 CFM | Nos. | 39,181.97 | 1 | **39,182** |
| 10.1.174 | | 1450 CFM | Nos. | 39,908.01 | 1 | **39,908** |
| 10.1.175 | | 1475 CFM | Nos. | 39,908.01 | 1 | **39,908** |
| 10.1.176 | | 1515 CFM | Nos. | 39,908.01 | 1 | **39,908** |
| 10.1.177 | | 1560 CFM | Nos. | 39,908.01 | 1 | **39,908** |
| 10.1.178 | | 1590 CFM | Nos. | 39,908.01 | 2 | **79,816** |
| 10.1.179 | | 1600 CFM | Nos. | 39,908.01 | 1 | **39,908** |
| 10.1.180 | | 1630 CFM | Nos. | 39,908.01 | 1 | **39,908** |
| 10.1.181 | | 1650 CFM | Nos. | 39,908.01 | 2 | **79,816** |
| 10.1.182 | | 1700 CFM | Nos. | 39,908.01 | 1 | **39,908** |
| 10.1.183 | | 1730 CFM | Nos. | 39,908.01 | 1 | **39,908** |
| 10.1.184 | | 1780 CFM | Nos. | 39,908.01 | 1 | **39,908** |
| 10.1.185 | | 1820 CFM | Nos. | 39,908.01 | 1 | **39,908** |
| 10.1.186 | | 1970 CFM | Nos. | 39,908.01 | 1 | **39,908** |
| 10.1.187 | | 2240 CFM | Nos. | 41,416.56 | 1 | **41,417** |
| 10.1.188 | | 2280 CFM | Nos. | 41,416.56 | 1 | **41,417** |
| 10.1.189 | | 2300 CFM | Nos. | 41,416.56 | 1 | **41,417** |
| 10.1.190 | | 2340 CFM | Nos. | 41,416.56 | 1 | **41,417** |
| 10.1.191 | | 2650 CFM | Nos. | 41,416.56 | 3 | **124,250** |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item | Description of Work | Unit | Rate | Total Quanti | Total Amount |
| 10.1.192 | | 2710 CFM | Nos. | 41,416.56 | 1 | **41,417** |
| 10.1.193 | | 2800 CFM | Nos. | 41,416.56 | 3 | **124,250** |
| 10.1.194 | | 2810 CFM | Nos. | 41,416.56 | 2 | **82,833** |
| 10.1.195 | | 3025 CFM | Nos. | 41,416.56 | 1 | **41,417** |
| 10.1.196 | | 3770 CFM | Nos. | 43,885.10 | 1 | **43,885** |
| 10.1.197 | | 4120 CFM | Nos. | 43,885.10 | 1 | **43,885** |
| | | | | | | |
| | | **TOTAL OF SUB SECTION (D) CARRIED OVER TO SUMMARY** | | | | **53,012,612** |
| | | | | | | |
| **E)** | | **PIPING & ACCESSORIES** | | | | |
| **1.0** | | **Chilled Water Piping: For Plant room** | | | | |
| | | Supplying, laying/ fixing, testing and commissioning of following nominal size of chilled water pipe inside the building (with necessary clamps, vibration isolators and fittings but excluding valves, strainers, gauges etc.) duly insulated with closed cell nitrile rubber with class "O" insulation and finally applying .63 mm aluminium sheet cladding complete with type 3, grade 1 roofing felt strip (as per IS: 1322 as amended upto date) at the joints repairing of damage to building etc as per specifications and as required. | | | | |
| | | Note:- The pipes of sizes 150 mm and below shall be M.S 'C' class as per IS:1239 and pipes size above 150 mm shall be welded black steel pipe heavy class as per IS: 3589, from minimum 6.35 mm thick M.S. Sheet for pipes upto 350 mm dia and from minimum 7 mm thick MS sheet for Pipes of 400 mm Dia and above. | | | | |
| 1.1 | | 600 mm dia(75 mm insulation) | Rmt | 11,986.64 | 240 | **2,876,795** |
| | | | | | | |
| **2.0** | | **Condenser water Piping** | | | | |
| | | Supplying, laying/ fixing, testing and commissioning of following nominal size of condenser water pipe of following size inside the plant room (with necessary clamps, vibration isolators and fittings but excluding valves, strainers, gauges etc.) | | | | |
| | | Note:- The pipes of sizes 150 mm and below shall be M.S 'C' class as per IS:1239 and pipes size above 150 mm shall be welded black steel pipe heavy class as per IS: 3589, from minimum 6.35 mm thick M.S. Sheet for pipes upto 350 mm diaand from minimum 7mm thick MS sheet for Pipes of 400 mm Dia and above. | | | | |
| 2.1 | | 800 mm dia | Rmt | 11,281.55 | 490 | **5,527,958** |
| 2.2 | | 600 mm dia | Rmt | 9,194.46 | 74 | **680,390** |
| 2.3 | | 350 mm dia | Rmt | 5,922.81 | 35 | **207,298** |
| | | | | | | |
| **3.0** | | **BUTTERFLY VALVE** | | | | |
| | | Supplying, fixing, testing & commissioning of Butterfly Valve (Gear operated for dia greater than 350 mm), for chilled water circulation, with C.I body SS disc nitrile sheet & O- ring & PN-16 pressure rating as specified. All valve shall be insulated with the same material as of pipe insulation material. | | | | |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| S.No | DSR Item | Description of Work | Unit | Rate | Total Quanti | Total Amount |
| 3.1 | | 600 mm dia | Nos. | 248,194.05 | 6 | **1,489,164** |
| 3.2 | | 500 mm dia | Nos. | 141,743.60 | 1 | **141,744** |
| 3.3 | | 450 mm dia | Nos. | 114,166.48 | 3 | **342,499** |
| 3.4 | | 400 mm dia | Nos. | 86,770.42 | 3 | **260,311** |
| 3.5 | | 350 mm dia | Nos. | 68,023.56 | 3 | **204,071** |
| 3.6 | | 300 mm dia | Nos. | 44,485.51 | 11 | **489,341** |
| 3.7 | | 250 mm dia | Nos. | 34,931.01 | 40 | **1,397,241** |
| 3.8 | | 32 mm dia ball valve | Nos. | 1,093.34 | 106 | **115,894** |
| | | | | | | |
| **4.0** | | **MOTORISED BUTTERFLY VALVE** Supplying, fixing, testing & commissioning of Motorized Butterfly Valve , for chilled water circulation, with C.I body SS disc nitrile sheet & O-ring & PN-16 pressure rating as specified. All valve shall be insulated with the same material as of pipe insulation material. | | | | |
| 4.1 | | 600 mm dia | Nos. | 640,680.50 | 2 | **1,281,361** |
| 4.2 | | 250 mm dia | Nos. | 89,855.44 | 9 | **808,699** |
| 4.3 | | 300 mm dia | Nos. | 126,854.74 | 4 | **507,419** |
| | | | | | | |
| **5.0** | | **BALANCING VALVE** BALANCING VALVE WITH BUILT IN MEASURING FACILITY with C I body flanged construction with EPDM coated disc with long pitch with protected out pipe insulation & PN 16 pressure rating for chilled / hot water circulation including insulation as specified.All valve shall be insulated with the same material as of pipe insulation material. | | | | |
| 5.1 | | 250 mm dia | Nos. | 83,427.74 | 8 | **667,422** |
| | | | | | | |
| **6.0** | | **Y-STRAINER** Supplying, fixing, testing & commissioning of Y Strainer of Ductile CI Body flanged ends with stainless steel strainer for chilled water circulation as specified | | | | |
| 6.1 | | 250 mm dia | Nos. | 28,039.52 | 8 | **224,316** |
| | | | | | | |
| **7.0** | | **NON RETURN VALVE** Supplying , fixing, testing & commissioning Non Return Valve with dual plate of CI body SS plates vulcanized NBR seal flanged end & PN-16 pressure rating for chilled / hot water circulation including insulation as specified.All valve shall be insulated with the same material as of pipe insulation material. | | | | |
| 7.1 | | 250 mm dia | Nos. | 18,802.58 | 10 | **188,026** |
| | | | | | | |
| **8.0** | | **BUTTERFLY VALVE** Supplying, fixing, testing & commissioning of Butterfly Valve (Gear operated for dia greater than 350 mm), for condensor water circulation, with C.I body SS disc nitrile sheet & O- ring & PN-16 pressure rating as specified. | | | | |
| 8.1 | | 600 mm dia | Nos. | 198,555.24 | 7 | **1,389,887** |
| 8.2 | | 300 mm dia | Nos. | 35,588.41 | 10 | **355,884** |
| 8.3 | | 350 mm dia | Nos. | 54,418.84 | 2 | **108,838** |
| 8.4 | | 250 mm dia | Nos. | 27,944.81 | 20 | **558,896** |
| | | | | | | |
| **9.0** | | **Y-STRAINER** | | | | |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| | | Supplying, fixing, testing & commissioning of Y Strainer of Ductile CI Body flanged ends with stainless steel strainer for condenser water circulation as specified | | | | |
| 9.1 | | 300 mm dia | Nos. | 42,179.06 | 5 | **210,895** |
| | | | | | | |
| **10.0** | | **NON RETURN VALVE** | | | | |
| | | Supply,installation ,testing and commissioning of Non Return Valve with dual plate of CI body SS plates vulcanized NBR seal flanged end & PN-16 pressure rating for condenser water circulation as specified. | | | | |
| **10.1** | | 300 mm dia | Nos. | 26,184.33 | 5 | **130,922** |
| | | | | | | |
| **11.0** | | **BALANCING VALVE** | | | | |
| | | BALANCING VALVE WITH BUILT IN MEASURING FACILITY with C I body flanged construction with EPDM coated disc with long pitch with protected out pipe insulation & PN 16 pressure rating for condensor water .All valve shall be insulated with the same material as of pipe insulation material. | | | | |
| 11.1 | | 300 mm dia | Nos. | 100,451.04 | 4 | **401,804** |
| | | | | | | |
| **12.0** | | **EXPANSION BELOW** | | | | |
| | | Supplying , fixing, testing & commissioning of expansion below of PN-16 pressure rating for chilled / hot water across pump and chillers for resisting the unit vibration to the main pipe Line. | | | | |
| 12.1 | | 300 mm dia | Nos. | 22,866.91 | 20 | **457,338** |
| 12.2 | | 250 mm dia | Nos. | 21,216.13 | 38 | **806,213** |
| 12.3 | | 200 mm dia | Nos. | 20,133.96 | 20 | **402,679** |
| 12.4 | | 150 mm dia | Nos. | 18,707.94 | 4 | **74,832** |
| | | | | | | |
| **13.0** | | **Auto Air Vent** | | | | |
| 13.1 | | Supply , Installation , Testing, & Commissioning of Auto air vent with ball valves **(Material of Construction Gun metel)** as required in the drawings and as per specifications. | Nos. | | | |
| | | **25 mm Dia** | | **3,220.47** | **130** | **418,661** |
| | | **40 mm Dia** | | **4,002.71** | **73** | **292,197** |
| | | | | | | |
| **14.0** | | **2-Way PICV Valves** | | | | |
| 14.1 | | Supply, Installation , Testing & Commissioning of Two way Modulating type Pressure Independent Balancing Cum Flow Control Valves | | | | |
| | | Supply , Installation, testing and commissioning of Pressure independent type 2 way Balancing and modulating Control valves in a single Unit of Valve. PN16 Rating. It should be diaphragm type & pressure balancing should be done with Delta P controller only (not cartridge). Pressure Drop across the valve must not exceed 20 kpa up to DN 32 (for FCUs) and 30 Kpa in bigger Sizes (for AHUs). | | | | |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| | | DN 15 to DN 32 Brass Body Ext. Threaded DN 40 & DN 50 Cast Iron Body2 , Ext. Threaded AND DN 65 to DN 100 Cast Iron body, Flanged Ends Connection | | | | |
| | | Duly mounted with Modulating actuator IP42/54 Accordingly type suitable for 24V AC. Actuator should be Gear type only (not thermal/wax) & should have the self-calibrating feature.Valve & Actuator combination should be able to give logarithmic control characteristics to achieve linear control. | | | | |
| | | The Valve should be selected to enable lowest possible pressure drop to have benefits of lower recurring Pumping Energy.All Valve shall be capable to communicate with BMS System. | | | | |
| | | As per specifications of following sizes with maximum Flow rate & Min. Pressure Drop : | | | | |
| 14.1.1 | | DN 32mm dia | Nos. | 27,409.98 | 23 | **630,430** |
| 14.1.2 | | DN 40 mm dia | Nos. | 48,468.87 | 6 | **290,813** |
| 14.1.3 | | DN 50 mm dia | Nos. | 58,831.18 | 57 | **3,353,377** |
| 14.1.4 | | DN 65 mm dia | Nos. | 80,112.92 | 35 | **2,803,952** |
| 14.1.5 | | DN 80 mm dia | Nos. | 106,520.10 | 14 | **1,491,281** |
| 14.1.6 | | DN 100 mm dia | Nos. | 135,824.27 | 13 | **1,765,715** |
| | | | | | | |
| **15.0** | | Supply, Installation , testing and commissioning of Proportional type cooling / heating type digital display type thermostat at locations specified in the drawings. The thermostat shall have provision of setting of space temperature as per requirement. Unit controller shall be installed in the spaces marked in drawings. | Nos. | 35,004.14 | 154 | **5,390,637** |
| | | | | | | |
| **16.0** | | **Drain Valve** | | | | |
| 16.1 | | Supply, Installation, Testing , & Commissioning of Ball Valve of 25 mm diameter (Drain) in dirt legs complete with nipples etc. as required as per specifications. | Nos. | 3,635.17 | 217 | **788,831** |
| | | | | | | |
| | | **TOTAL OF SUB SECTION (E) CARRIED OVER TO SUMMARY** | | | | **39,534,032** |
| **F)** | | **ELECTRICAL WORKS** | | | | |
| | | | | | | |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| | | Design , Fabrication ,Supply , Installation , Testing and Commissioning of following Wall mounted / Floor mounted(including base stand) , 415V2 ,3PH , 50Hz extensible and fully compartmentalized panels complying to IS 8623/93. The indoor panels shall be IP 42 and outdoor panels shall be IP 54 type. The Panel shall have proper space with required clearance for cables, incoming / outgoing switchgear, CTs , PTs , ammeter , Voltmeter, selector switches , Insulated and properly supported compartmentalized bus bars with heat shrinkable sleeves along with the other control circuit accessories within the panel and any other electrical component mentioned in the Panel SLD.The panel shall be fabricated out of CRCA not less than 2.0 mm thick for load bearing members and 1.6mm for the doors of LT panel. | | | | |
| | | The Panel shall have seven tank pre treatment process comprising of degreasing , rinsing , de-rusting , rinsing , phosphatising , rinsing and passivation followed by powder coat painting having a paint thickness of 60 microns or as specified. The Panel shall be Dust/Vermin poof. | | | | |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| **1.0** | | **Starter Panels** | | | | |
| 1.1 | | Supply, installation testing and commissioning of Direct online starters suitable for motors of air handling units/ Heat recovery wheel/Ventilation fans of below mentioned capacities. The starter shall comprise of all necessary power and control equipments including, Auto / manual selector switch, start / stop push button, LED indication, line contactor, Overload relays, Potential free NO/NC contact for control wiring, 415V actuated relay coil, necessary control wirings properly connected in fully usable state. Minimum utilization category for all contactors shall be AC3 and contactor shall be capable to withstand the steady state (full load) and starting inrush current. The starter shall have necessary protection device (MPCB +EOCR) whose settings and ratings shall be as per the type-2 co-ordination chart.<br><br>The starter shall have inbuilt protection against overcurrent, short circuit and single phasing. All below mentioned starters shall be BMS compatible and additional contacts and wiring required for BMS integration shall be provided. | | | | |
| 1.1.1 | | 0.55kW Direct online starter , 1.6A circuit breaker with OLR range 1.1-1.6A, 9A delta contactor. | Each | 25,858.40 | 1 | **25,858** |
| 1.1.2 | | 0.75 kW DOL starter ,2 A circuit breaker with OLR range 1.4-2 A , 9A delta contactor. | Each | 25,989.70 | 14 | **363,856** |
| 1.1.3 | | 1.1 kW DOL starter ,3.2 A circuit breaker with OLR range 2.2-3.2 A , 12A delta contactor. | Each | 25,989.70 | 9 | **233,907** |
| 1.1.4 | | 1.5 kW DOL starter ,4 A circuit breaker with OLR range 2.8-4 A , 16A delta contactor. | Each | 26,121.00 | 8 | **208,968** |
| **1.2** | | Supply, installation testing and commissioning of Star-delta starters suitable for motors of air handling units/ Tertiary pumps of below mentioned capacities. The starter shall comprise of all necessary power and control equipments including Auto / Manual selector switch, Start/stop push buttons, LED indications, Star contactor , delta contactor , timer relay contactor, electronic timer, potential free NO/NC contacts and necessary control wirings properly connected in fully usable state. Minimum utilization category for all contactors shall be AC3 and contactor shall be capable to withstand the steady state (full load) and starting inrush current. The starter shall have necessary protection device (MPCB +EOCR) whose settings and ratings shall be as per the type-2 co-ordination chart.<br><br>The starter shall have inbuilt protection against overcurrent, short circuit and single phasing. All these starters shall be equipped with discharge resistors suitable for making the starter run under the closed transition state. All below mentioned starters shall be BMS compatible and additional contacts and wiring required for BMS integration shall be provided. | | | | |
| 1.2.1 | | 2.2kW star delta starter , 5A circuit breaker with OLR range 2-3.2A , 16A delta contactor and 9A star contactor. | Each | 33,241.70 | 18 | **598,351** |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| 1.2.2 | | 3.7kW star delta starter , 8A circuit breaker with OLR range 3.2-5A , 16A delta contactor and 9A star contactor. | Each | 33,241.70 | 32 | **1,063,734** |
| 1.2.3 | | 5.5kW star delta starter , 12.5A circuit breaker with OLR range 5-8A , 32A delta contactor and 9A star contactor. | Each | 36,655.50 | 22 | **806,421** |
| 1.2.4 | | 7.5kW star delta starter , 16A circuit breaker with OLR range 6.3-10A , 32A delta contactor and 9A star contactor. | Each | 37,837.20 | 17 | **643,232** |
| 1.2.5 | | 11 kW star delta starter , 22A circuit breaker with OLR range 8-12.5A , 32A delta contactor and 9A star contactor. | Each | 38,099.80 | 33 | **1,257,293** |
| 1.2.6 | | 15kW star delta starter , 32A circuit breaker with OLR range 12.5-20A, 38A delta contactor and 16A star contactor. | Each | 43,061.40 | 7 | **301,430** |
| 1.2.7 | | 30kW star delta starter , 63A circuit breaker with OLR range 16-25A, 75A delta contactor and 32A star contactor. | Each | 63,752.50 | 4 | **255,010** |
| 1.2.8 | | 37kW star delta starter , 75A circuit breaker with OLR range 32-40A, 110A delta contactor and 32A star contactor. | Each | 76,226.00 | 6 | **457,356** |
| 1.2.10 | | 55kW star delta starter , 100A circuit breaker with OLR range 40-57A, 170A delta contactor and 32A star contactor. | Each | 111,020.50 | 6 | **666,123** |
| | | | | | | |
| **1.3** | | **VFD Panel** | | | | |
| | | | | | | |
| 1.3.1 | | 2.2kW VFD starter , 5A circuit breaker with OLR range 2-3.2A , 16A delta contactor and 9A star contactor. | Each | 41,304.10 | 13 | **536,953** |
| 1.3.2 | | 3.7kW VFD starter , 8A circuit breaker with OLR range 3.2-5A , 16A delta contactor and 9A star contactor. | Each | 41,304.10 | **45** | **1,858,685** |
| 1.3.3 | | 5.5 kW VFD starter , 12.5 A circuit breaker with OLR range 5-8A , 32A delta contactor and 9A star contactor. | Each | 48,131.70 | **27** | **1,299,556** |
| 1.3.4 | | 7.5kW VFD starter , 16A circuit breaker with OLR range 6.3-10A , 32A delta contactor and 9A star contactor. | Each | 49,313.40 | 29 | **1,430,089** |
| 1.3.5 | | 11kW star delta starter , 22A circuit breaker with OLR range 8-12.5A, 32A delta contactor and 9A star contactor. | Each | 49,576.00 | 6 | **297,456** |
| | | | | | | |
| **2.0** | | Electrical Panels | | | | |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| 2.1 | | **DEFINATION :**<br>1. Items under this section covers panels inside the building. This section however does not covers metering panel / metering side bus bars as the same is assumed to be the scope of supply company.<br>2. Loading / unloading / transportation of the panels shall also be considered in the rates.<br>3. All tools and accessories required to complete the job in full respect and as per engineer in charge shall be included.<br>4. Capacitor bank shall not be considered to be provided in any panel unless specified specifically.<br>5. Spare out going shall be provided with switchgear but shall not be provided with any meter. | | | | |
| | | Design , fabrication, wiring, Supply, Installation, Testing and Commissioning of following Wall mounted / Floor mounted(including base stand), 415V,3PH, 50Hz extensible and fully compartmentalized panels complying to IS 8623/93. The indoor panels shall be IP 42 and outdoor panels shall be IP 54 type. The Panel shall have proper space with required clearance for cables, incoming / outgoing switchgear, CTs, PTs, Ammeter, Voltmeter, selector switches, Insulated and properly supported compartmentalized bus bars with heat shrinkable sleeves along with the other control circuit accessories within the panel and any other electrical component mentioned in the Panel SLD. | | | | |
| | | The panel shall be fabricated out of CRCA not less than 2.0 mm thick for load bearing members and 1.6mm for the doors of LT panel. The Panel shall have seven tank pre treatment process comprising of degreasing, rinsing, de-rusting, rinsing, phosphatising, rinsing and passivation followed by powder coat painting having a paint thickness of 60 microns or as specified. The Panel shall be Dust/Vermin poof with earth studs as per the SLD and specifications. | | | | |
| 2.1.1 | | Pump Panel inclusive of :<br>Incomer : 1 Nos. x 100 A, Four pole , MCCB, 16kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB.<br>Incomer 1 :1 Nos. x CT 100/5A, CL:1, 10VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-100A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,150 A, Four pole , 16kA CU. busbar<br>Outgoing : 2 Nos. x 63A, TPN , MCCB, 16kA | Each | 74,415.10 | 1 | **74,415** |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| 2.1.2 | | Basement Floor Fire Panel inclusive of :<br>Incomer : 1 Nos. x 125 A, Four pole , MCCB, 16kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB.<br>Incomer 1 :1 Nos. x CT 150/5A, CL:1, 10VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-150A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,200 A, Four pole , 16kA CU. busbar<br>Outgoing : 8 Nos. x 32A, TPN , MCCB, 16kA<br>Outgoing : 2 Nos. x 16 A, TPN , MCCB, 16kA | Each | 171,300.30 | 1 | **171,300** |
| 2.1.3 | | Ground Floor HVAC Panel inclusive of :<br>Incomer : 1 Nos. x 40 A, TPN , MCCB, 16kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB.<br>Incomer 1 :1 Nos. x CT 40/5A, CL:1, 10VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-40A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,100 A, Four pole , 16kA CU. busbar<br>Outgoing : 1 Nos. x 32A, TPN , MCCB, 16kA<br>Outgoing : 5 Nos. x 16 A, TPN , MCCB, 16kA | Each | 121,537.60 | 1 | **121,538** |
| 2.1.4 | | 1ST,2ND & 4TH FLOOR HVAC Panel inclusive of :<br>Incomer : 1 Nos. x 63 A, Four pole , MCCB, 16kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB.<br>Incomer 1 :1 Nos. x CT 60/5A, CL:1, 10VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-60A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,100 A, Four pole , 16kA CU. busbar<br>Outgoing : 4 Nos. x 32A, TPN , MCCB, 16kA<br>Outgoing : 1 Nos. x 16 A, TPN , MCCB, 16kA | Each | 111,296.20 | 3 | **333,889** |
| 2.1.5 | | Fifth Floor HVAC Panel inclusive of :<br>Incomer : 1 Nos. x 63 A, Four pole , MCCB, 16kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB.<br>Incomer 1 :1 Nos. x CT 60/5A, CL:1, 10VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-60A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,100 A, Four pole , 16kA CU. busbar<br>Outgoing : 1 Nos. x 32A, TPN , MCCB, 16kA<br>Outgoing : 3 Nos. x 16 A, TPN , MCCB, 16kA | Each | 94,095.90 | 1 | **94,096** |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| 2.1.6 | | Terrace HVAC Panel inclusive of :<br>Incomer : 1 Nos. x 63 A, Four pole , MCCB, 16kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB.<br>Incomer 1 :1 Nos. x CT 60/5A, CL:1, 10VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-60A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,100 A, Four pole , 16kA CU. busbar<br>Outgoing : 10 Nos. x 16 A, TPN , MCCB, 16kA | Each | 157,382.50 | 1 | **157,383** |
| 2.1.7 | | 3RD Floor HVAC Pane-1 inclusive of :<br>Incomer : 1 Nos. x 630 A, Four pole , MCCB, 25kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB.<br>Incomer 1 :1 Nos. x CT 600/5A, CL:1, 15VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-600A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,800 A, Four pole , 16kA CU. busbar<br>Outgoing : 6 Nos. x 100A, TPN , MCCB, 16kA | Each | 184,566.90 | 1 | **184,567** |
| 2.1.8 | | 3RD Floor HVAC Pane-2 inclusive of :<br>Incomer : 1 Nos. x 630 A, Four pole , MCCB, 25kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB.<br>Incomer 1 :1 Nos. x CT 600/5A, CL:1, 15VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-600A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,800 A, Four pole , 16kA CU. busbar<br>Outgoing : 6 Nos. x 100A, TPN , MCCB, 16kA<br>Outgoing : 1 Nos. x 25 A, DP , MCB, 10kA | Each | 211,220.80 | 1 | **211,221** |
| 2.1.9 | | Pump Panel inclusive of :<br>Incomer : 1 Nos. x 100 A, Four pole , MCB, 10kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB.<br>Incomer 1 :1 Nos. x CT 100/5A, CL:1, 10VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-100A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,150 A, Four pole , 16kA CU. busbar<br>Outgoing : 2 Nos. x 63A, TPN , MCCB, 16kA<br>Outgoing : 1 Nos. x 63A, DP , MCB, 10kA | Each | 71,657.80 | 1 | **71,658** |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| 2.1.10 | | Basement Floor Fire Panel inclusive of :<br>Incomer : 1 Nos. x 160 A, Four pole , MCCB, 16kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB.<br>Incomer 1 :1 Nos. x CT 160/5A, CL:1, 10VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-160A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,200 A, Four pole , 16kA CU. busbar<br>Outgoing : 10 Nos. x 32A, TPN , MCCB, 16kA<br>Outgoing : 1 Nos. x 16 A, TPN , MCCB, 16kA | Each | 180,885.20 | 1 | **180,885** |
| 2.1.11 | | Ground, First, Second & Fourth Floor HVAC Panel inclusive of :<br>Incomer : 1 Nos. x 63 A, TPN , MCCB, 16kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB.<br>Incomer 1 :1 Nos. x CT 60/5A, CL:1, 10VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-60A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,100 A, Four pole , 16kA CU. busbar<br>Outgoing : 2 Nos. x 32A, TPN , MCCB, 16kA<br>Outgoing : 1 Nos. x 16 A, TPN , MCCB, 16kA<br>Outgoing : 1 Nos. x 25 A, TPN , MCB, 10kA | Each | 88,056.10 | 4 | **352,224** |
| 2.1.12 | | Third FLOOR HVAC Panel inclusive of :<br>Incomer : 1 Nos. x 63 A, Four pole , MCCB, 16kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB.<br>Incomer 1 :1 Nos. x CT 60/5A, CL:1, 10VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-60A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,100 A, Four pole , 16kA CU. busbar<br>Outgoing : 3 Nos. x 32A, TPN , MCCB, 16kA<br>Outgoing : 1 Nos. x 32 A, TPN , MCB, 10kA | Each | 89,369.10 | 1 | **89,369** |
| 2.1.13 | | Fifth Floor HVAC Panel inclusive of :<br>Incomer : 1 Nos. x 63 A, Four pole , MCCB, 16kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB.<br>Incomer 1 :1 Nos. x CT 60/5A, CL:1, 10VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-60A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,100 A, Four pole , 16kA CU. busbar<br>Outgoing : 1 Nos. x 32A, TPN , MCCB, 16kA<br>Outgoing : 2 Nos. x 16 A, TPN , MCCB, 16kA<br>Outgoing : 1 Nos. x 32 A, TPN , MCB, 10kA | Each | 89,369.10 | 1 | **89,369** |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| 2.1.14 | | Terrace HVAC Panel inclusive of :<br>Incomer : 1 Nos. x 63 A, Four pole , MCCB, 16kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB.<br>Incomer 1 :1 Nos. x CT 60/5A, CL:1, 10VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-60A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,100 A, Four pole , 16kA CU. busbar<br>Outgoing : 6 Nos. x 16 A, TPN , MCCB, 16kA | Each | 121,668.90 | 1 | **121,669** |
| 2.1.15 | | Pump Panel inclusive of :<br>Incomer : 1 Nos. x 63 A, Four pole , MCB, 16kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB.<br>Incomer 1 :1 Nos. x CT 60/5A, CL:1, 10VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-60A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,100 A, Four pole , 16kA CU. busbar<br>Outgoing : 2 Nos. x 32A, TPN , MCCB, 16kA<br>Outgoing : 1 Nos. x 16A, TPN , MCCB, 16kA | Each | 79,273.20 | 1 | **79,273** |
| 2.1.16 | | Basement Floor Fire Panel inclusive of :<br>Incomer : 1 Nos. x 63 A, Four pole , MCCB, 16kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB.<br>Incomer 1 :1 Nos. x CT 60/5A, CL:1, 10VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-160A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,100 A, Four pole , 16kA CU. busbar<br>Outgoing : 4 Nos. x 32A, TPN , MCCB, 16kA<br>Outgoing : 1 Nos. x 16 A, TPN , MCCB, 16kA | Each | 111,296.20 | 1 | **111,296** |
| 2.1.17 | | Ground HVAC Panel inclusive of :<br>Incomer : 1 Nos. x 100 A, TPN , MCCB, 10kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB.<br>Incomer 1 :1 Nos. x CT 100/5A, CL:1, 10VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-60A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,100 A, Four pole , 16kA CU. busbar<br>Outgoing : 4 Nos. x 32A, TPN , MCCB, 16kA<br>Outgoing : 1 Nos. x 63 A, TPN , MCB, 10kA | Each | 110,902.30 | 3 | **332,707** |

| HVAC WORKS - NON DSR | | | | | | |
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| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| 2.1.18 | | First, Second & Third FLOOR HVAC Panel inclusive of :<br>Incomer : 1 Nos. x 40 A, Four pole , MCCB, 16kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB.<br>Incomer 1 :1 Nos. x CT 40/5A, CL:1, 10VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-40A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,100 A, Four pole , 16kA CU. busbar<br>Outgoing : 2 Nos. x 32A, TPN , MCCB, 16kA<br>Outgoing : 1 Nos. x 25 A, TPN , MCB, 10kA | Each | 74,415.10 | 1 | **74,415** |
| 2.1.19 | | Fourth FLOOR HVAC Panel inclusive of :<br>Incomer : 1 Nos. x 40 A, Four pole , MCCB, 16kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB.<br>Incomer 1 :1 Nos. x CT 40/5A, CL:1, 10VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-40A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,100 A, Four pole , 16kA CU. busbar<br>Outgoing : 1 Nos. x 32A, TPN , MCCB, 16kA<br>Outgoing : 1 Nos. x 25 A, TPN , MCB, 10kA | Each | 64,436.30 | 1 | **64,436** |
| 2.1.20 | | Terrace HVAC Panel inclusive of :<br>Incomer : 1 Nos. x 40 A, Four pole , MCCB, 16kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB.<br>Incomer 1 :1 Nos. x CT 40/5A, CL:1, 10VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-40A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,100 A, Four pole , 16kA CU. busbar<br>Outgoing : 3 Nos. x 16 A, TPN , MCCB, 16kA | Each | 79,141.90 | 1 | **79,142** |
| 2.1.21 | | Pump Panel inclusive of :<br>Incomer : 1 Nos. x 200 A, Four pole , MCB, 10kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB.<br>Incomer 1 :1 Nos. x CT 200/5A, CL:1, 10VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-200A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,150 A, Four pole , 16kA CU. busbar<br>Outgoing : 2 Nos. x 63A, TPN , MCCB, 16kA<br>Outgoing : 8 Nos. x 32A, TPN , MCCB, 16kA<br>Outgoing : 1 Nos. x 63A, DP , MCB, 10kA | Each | 176,960.40 | 1 | **176,960** |

| HVAC WORKS - NON DSR | | | | | | |
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| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| 2.1.22 | | Ground Floor Fire Panel inclusive of :<br>Incomer : 1 Nos. x 160 A, Four pole , MCCB, 16kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB.<br>Incomer 1 :1 Nos. x CT 160/5A, CL:1, 10VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-160A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,200 A, Four pole , 16kA CU. busbar<br>Outgoing : 11 Nos. x 32A, TPN , MCCB, 16kA<br>Outgoing : 4 Nos. x 16 A, TPN , MCCB, 16kA<br>Outgoing : 1 Nos. x 25A, TPN , MCB, 10kA | Each | 222,244.70 | 1 | **222,245** |
| 2.1.23 | | First Floor HVAC Panel inclusive of :<br>Incomer : 1 Nos. x 63 A, TPN , MCCB, 16kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB.<br>Incomer 1 :1 Nos. x CT 60/5A, CL:1, 10VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-60A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,100 A, Four pole , 16kA CU. busbar<br>Outgoing : 4 Nos. x 32A, TPN , MCCB, 16kA<br>Outgoing : 1 Nos. x 25 A, TPN , MCB, 10kA | Each | 105,387.70 | 1 | **105,388** |
| 2.1.24 | | Second FLOOR HVAC Panel inclusive of :<br>Incomer : 1 Nos. x 63 A, Four pole , MCCB, 16kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB.<br>Incomer 1 :1 Nos. x CT 60/5A, CL:1, 10VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-60A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,100 A, Four pole , 16kA CU. busbar<br>Outgoing : 5 Nos. x 32A, TPN , MCCB, 16kA<br>Outgoing : 3 Nos. x 16 A, TPN , MCCB, 10kA<br>Outgoing : 1 Nos. x 25A, TPN , MCB, 10kA | Each | 140,182.20 | 1 | **140,182** |
| 2.1.25 | | Third Floor HVAC Panel inclusive of :<br>Incomer : 1 Nos. x 63 A, Four pole , MCCB, 16kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB.<br>Incomer 1 :1 Nos. x CT 60/5A, CL:1, 10VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-60A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,100 A, Four pole , 16kA CU. busbar<br>Outgoing : 3 Nos. x 32A, TPN , MCCB, 16kA<br>Outgoing : 2 Nos. x 16 A, TPN , MCCB, 16kA<br>Outgoing : 1 Nos. x 32 A, TPN , MCB, 10kA | Each | 113,134.40 | 1 | **113,134** |

| HVAC WORKS - NON DSR | | | | | | |
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| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| 2.1.26 | | Terrace HVAC Panel inclusive of :<br>Incomer : 1 Nos. x 125 A, Four pole , MCCB, 16kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB.<br>Incomer 1 :1 Nos. x CT 130/5A, CL:1, 10VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-130A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,100 A, Four pole , 16kA CU. busbar<br>Outgoing : 3 Nos. x 32A, TPN , MCCB, 16kA<br>Outgoing : 8 Nos. x 16 A, TPN , MCCB, 16kA | Each | 177,734.00 | 1 | **177,734** |
| 2.1.27 | | Pump Panel inclusive of :<br>Incomer : 1 Nos. x 100 A, Four pole , MCB, 16kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB.<br>Incomer 1 :1 Nos. x CT 100/5A, CL:1, 10VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-100A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,150 A, Four pole , 16kA CU. busbar<br>Outgoing : 2 Nos. x 63A, TPN , MCCB, 16kA<br>Outgoing : 2 Nos. x 32A, TPN , MCCB, 16kA<br>Outgoing : 1 Nos. x 25A, TPN , MCB, 10kA | Each | 109,983.20 | 2 | **219,966** |
| 2.1.28 | | Basement Floor Fire Panel 1 & 2 inclusive of :<br>Incomer : 1 Nos. x 125 A, Four pole , MCCB, 16kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB.<br>Incomer 1 :1 Nos. x CT 150/5A, CL:1, 15VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-150A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,200 A, Four pole , 16kA CU. busbar<br>Outgoing : 5 Nos. x 32A, TPN , MCCB, 16kA<br>Outgoing : 5 Nos. x 16 A, TPN , MCCB, 16kA | Each | 166,850.30 | 4 | **667,401** |
| 2.1.29 | | Ground Floor HVAC Panel inclusive of :<br>Incomer : 1 Nos. x 40 A, TPN , MCCB, 16kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB. Incomer 1 :1 Nos. x CT 40/5A, CL:1, 15VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-40A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,100 A, Four pole , 16kA CU. busbar<br>Outgoing : 1 Nos. x 32A, TPN , MCCB, 16kA<br>Outgoing : 5 Nos. x 16 A, TPN , MCCB, 16kA | Each | 115,774.60 | 2 | **231,549** |

| HVAC WORKS - NON DSR | | | | | | |
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| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| 2.1.30 | | GROUND FLOOR HVAC Panel-1 inclusive of :<br>Incomer : 1 Nos. x 63 A, Four pole , MCCB, 16kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB.<br>Incomer 1 :1 Nos. x CT 60/5A, CL:1, 15VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-60A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,100 A, Four pole , 16kA CU. busbar<br>Outgoing : 1 Nos. x 32A, TPN , MCCB, 16kA<br>Outgoing : 1 Nos. x 16 A, TPN , MCCB, 16kA<br>Outgoing : 1 Nos. x 25 A, TPN , MCB, 10kA | Each | 74,546.40 | 2 | **149,093** |
| 2.1.31 | | GROUND FLOOR HVAC Panel-2 inclusive of :<br>Incomer : 1 Nos. x 63 A, Four pole , MCCB, 16kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB. Incomer 1 :1 Nos. x CT 60/5A, CL:1, 15VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-60A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,100 A, Four pole , 16kA CU. busbar<br>Outgoing : 2 Nos. x 32A, TPN , MCCB, 16kA<br>Outgoing : 1 Nos. x 25 A, TPN , MCB, 10kA | Each | 74,546.40 | 2 | **149,093** |
| 2.1.32 | | FIRST FLOOR HVAC Panel-1 inclusive of :<br>Incomer : 1 Nos. x 63 A, Four pole , MCCB, 16kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB. Incomer 1 :1 Nos. x CT 60/5A, CL:1, 15VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-60A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,100 A, Four pole , 16kA CU. busbar<br>Outgoing : 2 Nos. x 32A, TPN , MCCB, 16kA<br>Outgoing : 1 Nos. x 32 A, TPN , MCB, 10kA | Each | 74,546.40 | 2 | **149,093** |
| 2.1.33 | | FIRST FLOOR HVAC Panel-2 inclusive of :<br>Incomer : 1 Nos. x 63 A, Four pole , MCCB, 16kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB.<br>Incomer 1 :1 Nos. x CT 60/5A, CL:1, 15VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-60A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,100 A, Four pole , 16kA CU. busbar<br>Outgoing : 1 Nos. x 32A, TPN , MCCB, 16kA<br>Outgoing : 1 Nos. x 32 A, TPN , MCB, 10kA | Each | 64,567.60 | 2 | **129,135** |

| HVAC WORKS - NON DSR | | | | | | |
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| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| 2.1.34 | | SECOND FLOOR HVAC Panel-1 & 2 inclusive of :<br>Incomer : 1 Nos. x 63 A, Four pole , MCCB, 16kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB.<br>Incomer 1 :1 Nos. x CT 60/5A, CL:1, 15VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-60A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,100 A, Four pole , 16kA CU. busbar<br>Outgoing : 2 Nos. x 32A, TPN , MCCB, 16kA<br>Outgoing : 1 Nos. x 16A, TPN , MCCB, 16kA<br>Outgoing : 1 Nos. x 40 A, TPN , MCB, 10kA | Each | 85,444.30 | 2 | **170,889** |
| 2.1.35 | | SECOND FLOOR HVAC Panel-2 inclusive of :<br>Incomer : 1 Nos. x 63 A, Four pole , MCCB, 16kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB.<br>Incomer 1 :1 Nos. x CT 60/5A, CL:1, 15VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-60A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,100 A, Four pole , 16kA CU. busbar<br>Outgoing : 2 Nos. x 32A, TPN , MCCB, 16kA<br>Outgoing : 1 Nos. x 16A, TPN , MCCB, 16kA<br>Outgoing : 1 Nos. x 63 A, TPN , MCB, 10kA | Each | 90,025.60 | 4 | **360,102** |
| 2.1.36 | | THIRD FLOOR HVAC Panel-1 & 2 inclusive of :<br>Incomer : 1 Nos. x 40 A, Four pole , MCCB, 16kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB.<br>Incomer 1 :1 Nos. x CT 40/5A, CL:1, 15VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-40A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,100 A, Four pole , 16kA CU. busbar<br>Outgoing : 2 Nos. x 32A, TPN , MCCB, 16kA<br>Outgoing : 1 Nos. x 16A, TPN , MCCB, 16kA<br>Outgoing : 1 Nos. x 25 A, TPN , MCB, 10kA | Each | 89,106.50 | 4 | **356,426** |
| 2.1.37 | | FOURTH FLOOR HVAC Panel-1 inclusive of :<br>Incomer : 1 Nos. x 63 A, Four pole , MCCB, 16kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB.<br>Incomer 1 :1 Nos. x CT 60/5A, CL:1, 15VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-60A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,100 A, Four pole , 16kA CU. busbar<br>Outgoing : 3 Nos. x 32A, TPN , MCCB, 16kA<br>Outgoing : 1 Nos. x 25 A, TPN , MCB, 10kA | Each | 84,919.10 | 4 | **339,676** |

| HVAC WORKS - NON DSR | | | | | | |
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| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| 2.1.38 | | TERRACE HVAC Panel-1 & 2 inclusive of :<br>Incomer : 1 Nos. x 32 A, Four pole , MCCB, 16kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB. Incomer 1 :1 Nos. x CT 30/5A, CL:1, 15VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-30A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,100 A, Four pole , 16kA CU. busbar<br>Outgoing : 2 Nos. x 32A, TPN , MCCB, 16kA | Each | 69,031.80 | 2 | **138,064** |
| 2.1.39 | | Chiller Panel-1,2 & 3<br>Incomer 1 : 1 Nos. x 4kVp, 75kA, Surge arrestor<br>Incomer 1 : 3 set. x R,Y,B indication lamp with 2A control MCB<br>Incomer 1 : 1 Nos. x 2000 A, Four pole , ACB, 25kA, Ics-Icu=36 kA EDO Type<br>Incomer 1 : 3 Nos. x CT 2000/5A, CL:1, 15VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multifunction meter, 0-2000A, with inbuilt selector switch.<br>Bus bar : 1 set. x 415V, 50HZ, 2500 A, Four pole , 25kA aluminium busbar<br>Outgoing : 2 Nos. x 1000 A, Four pole , ACB, 25kA with LSIG protections,<br>Outgoing :2 Nos. x CT 1000/5A, CL:1, 15VA Ring type<br>Outgoing : 2 sets R,G,A indication lamps with 2A MCB<br>Outgoing : 2 sets R,Y,B indication lamps with 2A MCB<br>Outgoing : 2 Nos. Digital multifunction meter | Each | 881,818.30 | 2 | **1,763,637** |
| 2.1.40 | | Primary Pumps Panel inclusive of :<br>Incomer : 1 Nos. x 630 A, Four pole , MCCB, 25kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB.<br>Incomer 1 :1 Nos. x CT 600/5A, CL:1, 10VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-600A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,800 A, Four pole , 16kA CU. busbar<br>Outgoing : 6 Nos. x 100A, TPN , MCCB, 16kA | Each | 202,155.80 | 1 | **202,156** |

| HVAC WORKS - NON DSR | | | | | | |
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| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| 2.1.41 | | Condensor Water Pumps Panel inclusive of :<br>Incomer : 1 Nos. x 630 A, Four pole , MCCB, 25kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB. Incomer 1 :1 Nos. x CT 600/5A, CL:1, 10VA, Ring type<br>Incomer 1: 1 Nos. x Digital MultiMate, 0-600A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,800 A, Four pole , 16kA CU. busbar<br>Outgoing : 6 Nos. x 200A, TPN , MCCB, 16kA | Each | 272,795.20 | 1 | **272,795** |
| 2.1.42 | | Cooling Tower Panel-1,2 & 3 inclusive of :<br>Incomer : 1 Nos. x 125 A, Four pole , MCCB, 16kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB.<br>Incomer 1 :1 Nos. x CT 100/5A, CL:1, 10VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-150A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,150 A, Four pole , 16kA CU. busbar<br>Outgoing : 8 Nos. x 32A, TPN , MCCB, 16kA | Each | 145,302.90 | 3 | **435,909** |
| 2.1.43 | | Cooling Tower Panel-4 inclusive of :<br>Incomer : 1 Nos. x 63 A, Four pole , MCCB, 16kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB.<br>Incomer 1 :1 Nos. x CT 100/5A, CL:1, 10VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-150A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,150 A, Four pole , 16kA CU. busbar<br>Outgoing : 4 Nos. x 32A, TPN , MCCB, 16kA | Each | 95,802.80 | 1 | **95,803** |
| 2.1.44 | | Hot Water Generator Panel-1,2<br>Incomer 1 : 1 Nos. x 4kVp, 75kA, Surge arrestor<br>Incomer 1 : 3 set. x R,Y,B indication lamp with 2A control MCB<br>Incomer 1 : 1 Nos. x 2000 A, Four pole , ACB, 25kA, Ics-Icu=36 kA EDO Type<br>Incomer 1 : 3 Nos. x CT 2000/5A, CL:1, 15VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multifunction meter, 0-2000A, with inbuilt selector switch.<br>Bus bar : 1 set. x 415V, 50HZ, 2500 A, Four pole , 25kA aluminium busbar<br>Outgoing : 2 Nos. x 1000 A, Four pole , ACB, 25kA with LSIG protections, | Each | 881,818.30 | 2 | **1,763,637** |

| HVAC WORKS - NON DSR | | | | | | |
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| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| | | Outgoing :2 Nos. x CT 1000/5A, CL:1, 15VA Ring type<br>Outgoing : 2 sets R,G,A indication lamps with 2A MCB<br>Outgoing : 2 sets R,Y,B indication lamps with 2A MCB<br>Outgoing : 2 Nos. Digital multifunction meter | | | | |
| 2.1.45 | | Hot Water Generator Panel-3<br>Incomer 1 : 1 Nos. x 4kVp, 75kA, Surge arrestor<br>Incomer 1 : 3 set. x R,Y,B indication lamp with 2A control MCB<br>Incomer 1 : 1 Nos. x 1000 A, Four pole , ACB, 25kA, Ics-Icu=36 kA EDO Type<br>Incomer 1 : 3 Nos. x CT 2000/5A, CL:1, 15VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multifunction meter, 0-2000A, with inbuilt selector switch.<br>Bus bar : 1 set. x 415V, 50HZ, 1000 A, Four pole , 25kA aluminium busbar<br>Outgoing : 2 Nos. x 630 A, Four pole , ACB, 25kA with LSIG protections,<br>Outgoing :2 Nos. x CT 600/5A, CL:1, 15VA Ring type<br>Outgoing : 2 sets R,G,A indication lamps with 2A MCB<br>Outgoing : 2 sets R,Y,B indication lamps with 2A MCB<br>Outgoing : 2 Nos. Digital multifunction meter | Each | 732,398.90 | 1 | **732,399** |
| | | Expansion Tank, Ventilation Panel-1,2,3 & First floor HVAC Panel inclusive of :<br>Incomer : 1 Nos. x 63 A, Four pole , MCCB, 16kA<br>Incomer 1 : 1 set. x R,Y,B indication lamp with 2A control MCB and 2A control MCB.<br>Incomer 1 :1 Nos. x CT 60/5A, CL:1, 10VA, Ring type<br>Incomer 1: 1 Nos. x Digital Multimeter, 0-130A, with inbuilt selector switch.<br>Bus bar : 1set. x 415V, 50HZ,100 A, Four pole , 16kA CU. busbar<br>Outgoing : 2 Nos. x 32A, TPN , MCCB, 16kA | Each | 68,244.00 | 5 | **341,220** |
| | | | | | 0 | |
| **3.0** | | **Cabling** | | | 0 | |
| 3.1 | | Supplying, Testing and Commissioning of 1.1KV grade XLPE insulated, PVC sheathed aluminium / copper, FRLS/ armoured/unarmoued/flexible cable as specified for the following sizes as required. | | | | |
| 3.1.1 | | 3.5C x 400 sqmm A2XFY | RMT | 2,445.01 | 310 | **757,954** |
| 3.1.2 | | 3.5C x 300 sqmm A2XFY | RMT | 1,855.85 | 62 | **115,063** |
| 3.1.3 | | 3.5C x 185 sqmm A2XFY | RMT | 1,360.96 | 124 | **168,759** |
| 3.1.4 | | 3.5C x 120 sqmm A2XFY | RMT | 922.15 | 320 | **295,089** |
| 3.1.5 | | 3.5C x 95 sqmm A2XFY | RMT | 738.22 | 109 | **80,466** |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| 3.1.6 | | 4C x 35 sqmm A2XFY | RMT | 339.86 | 248 | **84,286** |
| 3.1.7 | | 4C x 25 sqmm 2XFY | RMT | 296.11 | 2344 | **694,086** |
| 3.1.8 | | 4C x 16 sqmm 2XWY | RMT | 1,047.53 | 664 | **695,558** |
| 3.1.9 | | 4C x 10 sqmm 2XWY | RMT | 726.67 | 304 | **220,908** |
| 3.1.10 | | 4C x 6 sqmm 2XWY | RMT | 466.03 | 396 | **184,546** |
| 3.1.11 | | 4C x 4 sqmm 2XWY | RMT | 334.05 | 3074 | **1,026,881** |
| 3.1.12 | | 3C x 300 sqmm A2XFY | RMT | 2,059.85 | 744 | **1,532,529** |
| 3.1.13 | | 3C x 70 sqmm A2XFY | RMT | 455.13 | 318 | **144,730** |
| 3.1.14 | | 3C x 16 sqmm 2XWY | RMT | 712.15 | 8141 | **5,797,590** |
| 3.1.15 | | 3C x 10 sqmm 2XWY | RMT | 563.35 | 4957 | **2,792,550** |
| 3.1.16 | | 3C x 6 sqmm 2XWY | RMT | 362.10 | 714 | **258,538** |
| 3.1.17 | | 3C x 4 sqmm 2XWY | RMT | 263.03 | 6144 | **1,616,059** |
| | | **Control Cables** | | | | |
| 3.1.18 | | 2C x 2.5 SQMM 2XWY | RMT | 186.79 | 980 | **183,055** |
| 3.1.19 | | 4C x 2.5 SQMM 2XWY | RMT | 298.26 | 460 | **137,201** |
| 3.1.20 | | 6C x 2.5 SQMM 2XWY | RMT | 414.76 | 360 | **149,312** |
| 3.1.21 | | 8C x 2.5 SQMM 2XWY | RMT | 530.24 | 200 | **106,049** |
| | | | | | | |
| **4.0** | | **Cable Termination** | | | | |
| **4.1** | | Supplying and making of end terminations of following armoured / Unarmoured/Flexible cables along with testing and commissioning . All the lugs shall be of Cu/Al lugs and glands shall be double compression brass glands as per the technical specifications. The cost shall include the cost of crimping , making suitable end terminations and connections as required along with all tools and accessorised required to complete the job in full respect. | | | | |
| 4.1.1 | | 3.5C x 400 sqmm A2XFY | Each | 2,992.80 | 70 | **209,496** |
| 4.1.2 | | 3.5C x 300 sqmm A2XFY | Each | 2,630.01 | 10 | **26,300** |
| 4.1.3 | | 3.5C x 185 sqmm A2XFY | Each | 2,170.50 | 10 | **21,705** |
| 4.1.4 | | 3.5C x 120 sqmm A2XFY | Each | 974.64 | 22 | **21,442** |
| 4.1.5 | | 3.5C x 95 sqmm A2XFY | Each | 974.64 | 6 | **5,848** |
| 4.1.6 | | 4C x 35 sqmm A2XFY | Each | 639.05 | 14 | **8,947** |
| 4.1.7 | | 4C x 25 sqmm 2XFY | Each | 607.34 | 158 | **95,959** |
| 4.1.8 | | 4C x 16 sqmm 2XWY | Each | 463.65 | 48 | **22,255** |
| 4.1.9 | | 4C x 10 sqmm 2XWY | Each | 354.66 | 32 | **11,349** |
| 4.1.10 | | 4C x 6 sqmm 2XWY | Each | 334.76 | 36 | **12,051** |
| 4.1.11 | | 4C x 4 sqmm 2XWY | Each | 334.76 | 76 | **25,442** |
| 4.1.12 | | 3C x 300 sqmm A2XFY | Each | 2,041.92 | 88 | **179,689** |
| 4.1.13 | | 3C x 70 sqmm A2XFY | Each | 912.57 | 36 | **32,853** |
| 4.1.14 | | 3C x 16 sqmm 2XWY | Each | 354.66 | 198 | **70,223** |
| 4.1.15 | | 3C x 10 sqmm 2XWY | Each | 344.60 | 326 | **112,340** |
| 4.1.16 | | 3C x 6 sqmm 2XWY | Each | 359.04 | 84 | **30,160** |
| 4.1.17 | | 3C x 4 sqmm 2XWY | Each | 324.86 | 738 | **239,747** |
| | | **Control Cables** | | | | |
| 4.1.18 | | 2C x 2.5 SQMM 2XWY | Each | 249.50 | 154 | **38,422** |
| 4.1.19 | | 4C x 2.5 SQMM 2XWY | Each | 278.57 | 86 | **23,957** |
| 4.1.20 | | 6C x 2.5 SQMM 2XWY | Each | 368.07 | 46 | **16,931** |
| 4.1.21 | | 8C x 2.5 SQMM 2XWY | Each | 368.07 | 24 | **8,834** |
| | | | | | | |
| **5.0** | | **G.I. Earthing Strip/Wire:** | | | | |

| HVAC WORKS - NON DSR | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item** | **Description of Work** | **Unit** | **Rate** | **Total Quanti** | **Total Amount** |
| 5.1 | | DEFINATION :<br>1. Items under this section covers Lightning protection of building , earthing pits , earthing conductor and any other accessory required for proper grounding of all exposed and metallic conductors and lightning protection system.<br>2. Earthing shall be connected in equipotential grid fashion.<br>3. Civil works for earthing shall also be included in the rates.<br>4. All tools and accessories required to complete the job in full respect and as per engineer in charge shall be included. | | | | |
| 5.1.1 | | 50 x 6 mm GI Strip | Metre | 193.56 | 600 | **116,133** |
| 5.1.2 | | 32 x 6 mm GI Strip | Metre | 130.42 | 500 | **65,212** |
| | | **TOTAL OF SUB SECTION (F) CARRIED OVER TO SUMMARY** | | | | **43,339,318** |
| | | | | | | |
| | | **GRAND TOTAL OF SUB SECTIONS (A+B+C+D+E+F)** | | | | **479,829,041** |

## SUMMARY OF BMS WORKS

| S.No | Description of Work | AMOUNT (RS.) | |
|---|---|---|---|
| | | DSR | NON DSR |
| | | | |
| A. | **TOTAL FOR BMS WORKS** | - | 59617766 |
| | | | |
| | **TOTAL** | | **59617766** |
| | **TOTAL (NON DSR)** | **59617766** | |

| Building Management System ( BMS WORKS) | |
|---|---|
| | |
| | **IMPORTANT NOTES** |
| 1 | BMS shall be WEB-BASED system on BACnet/ MSTP Protocal offering Multi-user interface without need of any proprietary BMS software License. |
| 2 | Minimum 10 Nos simultaneous users shall be able to log-in to the BMS WEB-SERVER. The number of users otherwise, shall be unlimited. |
| 3 | Web-Server and Embedded Web-Server Engines shall be capable of getting Dynamically Addressed on the DHCP Server. |
| 4 | Number of controllers shall have spare capacity for future expansion upto 15% and at System Level(Software shall have Inbulit licensce of 20 % IO Points and 25% Software Points) |
| 5 | The software shall have the capability to send alarms / alerts to International user's mobile. |
| 6 | The System Shall be 3 Tier Architecture ( Controller, Supervisory & Software ) as per BOQ and Specification |
| 7 | Specifications given for server are minimum. Bidder shall supply server and workstations of latest configuration at the time of supply. |
| 8 | The Bidder shall furnish quantity and unit rate for each type of controller considered by them. |
| 9 | The Bidder shall furnish the Controller's UPS Power requirment on field. The UPS Power Point shall be provided by Electrical Contractor. The co-ordination responsibility for the same shall be of BMS Contractor. |
| 10 | The relevant conditions given in SCC for BMS Works to be referred. |

**Building Management System**

| S.No | DSR Item No. | Description of Work | Unit | Rate | Quantity | AMOUNT (RS.) |
|---|---|---|---|---|---|---|
| **1.0** | | **Server for BMS software** | | | | |
| 1.1 | | **BMS Computer System: Supply, installation, testing and commissioning of I7 Processor or Equivalet Server PC, Intel(R) Xeon(R) Processor, 2.93GHz, 4MB Cache with 4 GB RAM, & 1 TB HDD, 10/100 Mbps Ethernet card, USB connection & internal modem, Microsoft(R) Windows(R) 7 OS Professional Enterprise, Web server software, DVD-ROM Drive (with RAM), 100/1000 Mbps NIC for Network connection and anti virus software with 22" colour graphics monitor as per Tender Specifications. Accessories included Optical Mouse, Key Pad, Laserjet colour A4 printer with the above BMS System configuration.** | Nos. | 178624.5 | 2 | 357249 |
| 1.2 | | 500 VA UPS with half an hour battery backup | Nos. | 20839.5 | 2 | 41679 |
| | | | | | | |
| **2.0** | | **BUILDING MANAGEMENT SYSTEM WEB-BASED SERVER SOFTWARE** | | | | |

| Building Management System | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Quantity** | **AMOUNT (RS.)** |
| 2.1 | | SITC of the unlimited multi user with simultaneous minimum 10 user web based Server Software for Building Management System with dynamic graphics. The software shall have unlimited number of user license with minimum up 10 simultaneous users. The Web-Based Server software shall permit use of Standard Web-Browsers such as Microsoft Internet Explorer, Netscape Navigator, etc and unlimited users. Software should be have licensce of 35,000 points (hardwired 7000 points & software 28000 points both). | Lot | 1297521.8 | 1 | 1297522 |
| 2.2 | | Energy Management & Reporting Tool software capable of fetching the energy data from the BMS and store the data into separate application database (SQL server) for analysis.<br>This Software should have the following Key features:<br>1. SEGMENTATION OF ENERGY INFORMATION AT A GLANCE.<br>2. CUSTOMISABLE ENERGY DASH-BOARD.<br>3. ENERGY REPORT GENERATION AGAINST SELECTION OF TIME AND FREQUENCY.<br>4. WEB BASED TOOL. NO ADDITIONAL SOFTWARE REQUIRED.<br>5. EMAIL / SMS OPTION AVAILABLE<br>6. MULTIPLE DATABASE SOURCES / SITE CAN BE INTEGRATED. | LOT | 513545.5 | 1 | 513545 |
| | | | | | | |
| **3.0** | | **PROGRAMMABLE & APPLICATION SPECIFIC CONTROLLER (DDC) - UL LISTED** | | | | |
| | | SITC of Programmable and Application specific 32 bit, UL Listed BACnet (BTL certified) Real Time controllers, field mounted configured as per Data Point Summary for respective building services and as per below distributions. The controller shall be housed in vandal proof lockable MS cabinets. For AHU's Maximum of One Controller / AHU Shall be used. For Other Equipments, the controller selection shall be such that distance from controller to field devices should not go beyound 40 Mtrs. The Expansion controller connected with Controller shall also be 32 Bit, UL Listed BACnet( BTL) controller and communication with Expansion units to Main Controller shall be on BACnet MS/TP. None of The Controller & Expansion Module shall have more than 34 hard I/Os.<br>Proprietry Protocol shall not be accepted | | | | |
| | | The above shall be housed in a vandal proof, lockable & secure MS Cabinets to be supplied along with the Controllers | | | | |
| 3.1 | | DCC controllers for chiller plant room | Lot | 918761.1 | 1 | 918761 |
| 3.2 | | DCC controllers for Faculty of LSES (Max 1 AHU per Controller) | Lot | 8474298.6 | 1 | 8474299 |
| 3.3 | | DCC controllers for Admin Building (Max 1 AHU per Controller) | Lot | 2518880.8 | 1 | 2518881 |

| Building Management System | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Quantity** | **AMOUNT (RS.)** |
| 3.4 | | DCC controllers for Faculty of PCM & IT (Max 1 AHU per Controller) | Lot | 2257258.1 | 1 | 2257258 |
| 3.5 | | DCC controllers for Faculty of Art & Convention Center (Max 1 AHU per Controller) | Lot | 2430464.3 | 1 | 2430464 |
| 3.6 | | DCC controllers for Faculty of Legal Studies & Humanity (Max 1 AHU per Controller) | Lot | 2029619.0 | 1 | 2029619 |
| 3.7 | | DCC controllers for SAARC Haat (Max 1 AHU per Controller) | Lot | 1573782.5 | 1 | 1573782 |
| 3.8 | | DCC controllers for Library (Max 1 AHU per Controller) | Lot | 2350633.7 | 1 | 2350634 |
| 3.9 | | DCC controllers for Ventillation System | Lot | 670129.0 | 1 | 670129 |
| 3.10 | | DCC controllers for Fire Fighting System | Lot | 291319.4 | 1 | 291319 |
| 3.1 | | DCC controllers for Plumbing / Domestic / Raw System | Lot | 360374.3 | 1 | 360374 |
| 3.12 | | DCC controllers for Elevator System | Lot | 958631.4 | 1 | 958631 |
| | | | | | | |
| **4.0** | | **WEB SERVER ENGINES (NETWORK / SUPERVISORY CONTROLLERS)** | | | | |
| 4.1 | | SITC of Microprocessor based 32 Bit ,UL Listed Embedded Web Server Engine-cum-Network & Supervisory controller on BACnet/IP units for connecting all field DDC controllers and 3rd party System Integration Units to it and for transferring data from field devices to BMS Web-Server Software . The Network Controller shall support BACnet standard MS/TP Protocol and shall be BACnet testing lab certified (BTL) and carry the BTL label .The Network supervisory Controller shall have imbedded graphic capability for generating web based user graphics & support minimum of Five Concurrent User .The Web user shall have the capability to access all system data through one Network Controller. In case of PC/Software Failure, User can access the system using web server using IP Port.The Web server shall allow multiple simultaneous user access( minimum 5). | Lot | 1646589.8 | 1 | 1646590 |
| | | | | | | |
| **5.0** | | **SYSTEM INTEGRATION UNITS FOR 3RD PARTY SYSTEM SOFTWARE INTEGRATION - UL listed Controllers** | | | | |
| | | | | | | |
| 5.1 | | SITC of BACnet/ MSTP Based System Integration unit consisting of microprocessor based controller units as required to communicate between the Network Controller & the individual 3rd party microprocessor system controllers like Chillers, DGs, VFDs, VAV terminal units, UPS, Multifunction Digital Electronic Meters, Fire Detection Systems, STP, Elevators etc. as per distribution given below : | | | | |
| | | | | | | |
| 5.1.1 | | For 6 Nos of Comfort Chillers (40 points/chiller on open Protocol Output BACnet/Modbus) | Set | 3012076.3 | 1 | 3012076 |
| 5.1.2 | | For CHW Variable Pumping Sytem and Pump VFD (10 Soft Point / VFD) | Set | Included in above price | 1 | |
| 5.1.3 | | AHU VFD Integration points mentioned in IO summary (10 Soft Point / VFD) | Set | | 1 | |

| Building Management System | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Quantity** | **AMOUNT (RS.)** |
| 5.1.4 | | Ventillation VFD Integration points mentioned in IO summary (10 Soft Point / VFD) | Set | | 1 | |
| 5.1.5 | | 245 Nos of VAV Integration points mentioned in IO summary (10 Soft Point / VAV) | Set | | 1 | |
| 5.1.6 | | BTU Meter Integration points mentioned in IO summary (20 Soft Point / BTU Meter) | Set | | 1 | |
| 5.1.7 | | For Addressable Fire Detection System Control Panel for 10000 Soft Points | Set | | 1 | |
| 5.1.8 | | 60 Nos of Elevators System points mentioned in IO summary (15 Points / Lift) | Set | | 1 | |
| 5.1.9 | | STP & WTP & FF System points mentioned in IO summary | Set | | 1 | |
| | | | | | | |
| **6.0** | | **SENSORS AND FIELD DEVICES** | | | | |
| 6.1 | | Supplying, installing, testing and commissioning of the following sensors / transducers / transmitters | | | | |
| 6.1.1 | | Resistance type immersion temperature sensors for measuring Chilled water, condenser water supply and return temperature (Range 32-160 deg. F). The accuracy shall be at least ± 0.36 degrees F. The pressure rating shall be 10 kgf/sq cm . | Nos | 4460.3 | 364 | 1623557 |
| 6.1.2 | | Outside air temperature , humidity RH & Wetbulb sensors for measuring outside air temperature (Range 35-130 °F). The accuracy of temperature sensor shall be ± 0.36 degrees F and RH sensor is ± 3% . It should be provided with sun sheild and rain protection. | Nos | 61383.3 | 1 | 61383 |
| 6.1.3 | | UL Listed Current Relay with built in LEDs for On / Off commands Status | Nos | 4346.5 | 64 | 278178 |
| 6.1.4 | | Water Level Switches for indicating level status in Cooling Tower, sumps & Tanks. | Nos | 14835.1 | 26 | 385713 |
| 6.1.5 | | Differential pressure switches across the blowers, Filters for indicating status. Pressure differential – 10 mm – 125 mm. The switch shall be with connecting tube and metal bends for connections to the duct. The housing shall be IP 54 rated. | Nos | 3834.5 | 820 | 3144268 |
| 6.1.6 | | Duct Temperature Sensor shall be with rigid stem and of averaging type. These shall be Platinum sensor suitable for duct installation and accuracy shall be ± 0.06%, for measuring supply -air temperature of AHUs etc. | Nos | 1419.7 | 216 | 306663 |
| 6.1.7 | | Duct Temp & RH Sensor shall capable to measure relative humidity of 0 to 100%, suitable for duct installation and accuracy shall be ± 34°F at 70°F & Resistance Change approx 3ohms/°F, for Measuring return air Temprature & Humidity of AHUs etc. | Nos | 18443.3 | 189 | 3485786 |
| 6.1.8 | | Differential Pressure Switch across the Pumps for indicating the Pump status of Pumps complete with all accessories | Nos | 12572.5 | 13 | 163443 |
| 6.1.9 | | UL Listed Pressure sensor with IP 67 protection for measuring line pressure in Hydrant / Sprinkler lines | Nos | 9172.0 | 30 | 275161 |

| Building Management System | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **DSR Item No.** | **Description of Work** | **Unit** | **Rate** | **Quantity** | **AMOUNT (RS.)** |
| 6.1.10 | | UL Listed Duct / Wall Mount CO2 Sensor, Measuring range 0-2000PPM CO2, Response time (0-63%) should be 1 Minute & Warm-up Time should less than 5 minute. | Nos | 24947.9 | 177 | 4415776 |
| 6.1.11 | | Flame Proof Bi- Level Indicator fo DG Tank | Nos | 12404.5 | 4 | 49618 |
| 6.1.12 | | Ultrasonic Water Flow Meters | Nos | 351230.0 | 1 | 351230 |
| 6.1.13 | | Hardness Analyser | Nos | 1258962.7 | 1 | 1258963 |
| 6.1.14 | | PH Analyser | Nos | 100658.2 | 1 | 100658 |
| 6.1.15 | | TDS Analyser | Nos | 111539.8 | 1 | 111540 |
| 6.1.16 | | Voltage Transducer | Nos | 14845.7 | 8 | 118765 |
| 6.1.17 | | CO Sensor - Space Type for Basement Parking | Nos | 19904.1 | 9 | 179137 |
| 6.1.18 | | UL Listed Differential Pressure Transmitter for Measuring Static Pressure in Duct with ± 1.00% of Full Span Accuracy | Nos | 12695.6 | 140 | 1777380 |
| | | | | | | 0 |
| **7.0** | | **WIRING & CONDUITING** | | | | 0 |
| 7.1 | | Supplying, laying, termination, testing and commissioning of signal cables. (2 core 1 mm2), PVC insulated, tinned copper conductor cable Armoured cable. | Rmt | 93.9 | 20500 | 1925837 |
| 7.2 | | Supplying, laying, termination, testing and commissioning of signal cables. (4 core 1 mm2), PVC insulated, tinned copper conductor cable Armoured cable. | Rmt | 135.0 | 14850 | 2004167 |
| 7.3 | | Supplying, laying, termination, testing and commissioning of signal cables. (8 core 1 mm2), PVC insulated, tinned copper conductor cable Armoured cable. | Rmt | 244.8 | 7500 | 1835863 |
| 7.4 | | Supplying, laying, termination, testing and commissioning of communication cables. (3 core 1 mm2), PVC insulated, Twisted Pair, tinned copper conductor cable Armoured cable. | Rmt | 133.6 | 25600 | 3421122 |
| 7.5 | | Supplying, laying, termination, testing & commissioning of LAN cables for BMS Network. | Rmt | 50.3 | 1220 | 61341 |
| 7.6 | | Supplying and laying of 25mm of Heavy Duty PVC conduit on surface/recess including cutting/filling chases along with conduit accessories etc. complete as required. | Rmt | 66.2 | 1000 | 66157 |
| 7.7 | | GI Flexible conduit for termination in the DDC Pannels | Rmt | 82.0 | 3650 | 299428 |
| 7.8 | | Supplying, installing, testing and commissioning of 2 mm thick GI perforated cable trays of the following sizes complete with angle iron supports/hanging arrangement etc | | | | |
| 7.8.1 | | 25 x 100 x 25 | RM | 534.6 | 400 | 213820 |
| | | | | | | |
| **SUB TOTAL FOR BMS WORKS - A** | | | | | | **59,617,766** |

## SUMMARY OF O & M WORKS

| S.No | Description of Work | AMOUNT (RS.) | |
|---|---|---|---|
| | | DSR | NON DSR |
| | | | |
| A. | OPERATION & MAINTENANCE OF ETP & STP PLANTS | - | 10588000 |
| B. | OPERATION AND MAINTENANCE OF PLUMBING AND FIRE FIGHTING SYSTEM and WTP. | - | 30754000 |
| C. | OPERATION & MAINTAINANCE OF ELECTRICAL EQUIPMENTS & LV SYSTEM | - | 81111000 |
| D. | OPERATION & MAINTAINANCE OF HVAC SYSTEM | - | 47201000 |
| | | | |
| | TOTAL | | 169654000 |
| | TOTAL (DSR + NON DSR) | 169654000 | |

| OPERATION & MAINTENANCE WORKS | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | |
| **Sl No:** | **DSR Code** | **Description** | **Qty** | **Unit** | **Rate** | **Amount** |
| | | | | | | |
| 1 | | **OPERATION & MAINTENANCE OF ETP & STP PLANTS** | | | | |
| 1.1 | **NON-DSR** | Operation of Sewerage Treatment Plant of capacities of 360 KLD -1 No. & 280 KLD- 1 No. and ETP of capacity of 3 KLD -1 No comprising of all the equipments and accessories installed as per BOQ items for the duration of five years as mentioned above. (the agency will deploy minimum 1 operator + 1 helper in three shifts of eight hours each in a day). In addition visit of technical person to be arranged atleast once in a month or as and when required. | | | | |
| a | | 1st year | 1 | Job | 1354000 | **1,354,000** |
| b | | 2nd year | 1 | Job | 1449000 | **1,449,000** |
| c | | 3rd year | 1 | Job | 1551000 | **1,551,000** |
| d | | 4th year | 1 | Job | 1659000 | **1,659,000** |
| e | | 5th year | 1 | Job | 1775000 | **1,775,000** |
| 1.2 | | Maintenance of Sewerage Treatment Plant of capacities of 360 KLD -1 No. & 280 KLD- 1 No. and ETP of capacity of 3 KLD -1 No comprising of all the equipments and consumables and accessories installed as per BOQ items for the duration of three years beyond DLP as mentioned above. | | | | |
| a | | 3rd year | 1 | Job | 800000 | **800,000** |
| b | | 4th year | 1 | Job | 1000000 | **1,000,000** |
| c | | 5th year | 1 | Job | 1000000 | **1,000,000** |
| | | **Total CARRIED OVER TO SUMMARY** | | | | **10,588,000** |
| 2 | **NON-DSR** | **OPERATION AND MAINTENANCE OF PLUMBING AND FIRE FIGHTING SYSTEM and WTP.** | | | | |
| | | Operation of Plumbing and Fire Fighting system and WTP (Water Treatment Plant) comprising of all the equipments including water supply, fire alarm & fire fighting system, plumbing work, water treatment plant including all valves, pumps etc complete for the duration of 5 (five) years for the BOQ items as mentioned above and as specified in special condition of Contract. (O&M for ETP/STP works has been considered in STP head). The agency will deploy following personnel as approved by Engineer-in-Charge.) | | | | |
| | | One Supervisor in three shifts of 8 hrs each | | | | |
| | | For WTP 1 operator + 1 helper in three shifts of eight hours each in a day). In addition visit of technical person to be arranged atleast once in a month or as and when required by SAU. There will be plumbers, pump operators, electricians, conservancy persons for cleaning. | | | | |
| 2.1 | | For Fire Fighting system and Plumbing other than WTP, STP -One Plumber and one helper in Three shift of eight hours each, One fireman in three shifts of eight hours each. | | | | |
| a | | 1st year | 1 | Job | 4599000 | **4,599,000** |
| b | | 2nd year | 1 | Job | 4922000 | **4,922,000** |

| OPERATION & MAINTENANCE WORKS | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | |
| **Sl No:** | **DSR Code** | **Description** | **Qty** | **Unit** | **Rate** | **Amount** |
| c | | 3rd year | 1 | Job | 5266000 | **5,266,000** |
| d | | 4th year | 1 | Job | 5634000 | **5,634,000** |
| e | | 5th year | 1 | Job | 6028000 | **6,028,000** |
| 2.2 | | Comprehensive Maintenance of Plumbing and Fire Fighting system and WTP (Water Treatment Plant) comprising of all the equipments including water supply, fire alarm & fire fighting system, plumbing work, water treatment plant including all valves, pumps etc complete for the duration of 3 (three) years for the BOQ items all complete as per directions of Engineer in Charge as follows:- | | | | |
| a | | 3rd year | 1 | Job | 1213000 | **1,213,000** |
| b | | 4th year | 1 | Job | 1394000 | **1,394,000** |
| c | | 5th year | 1 | Job | 1698000 | **1,698,000** |
| | | **Total CARRIED OVER TO SUMMARY** | | | | **30,754,000** |
| 3 | **NON-DSR** | **OPERATION & MAINTAINANCE OF ELECTRICAL EQUIPMENTS & LV SYSTEM** | | | | |
| 3.1 | | Operation of electrical system comprising of all the equipments installed for the duration of 5 (five) years for the BOQ items with all subhead including transformers. The agency will deploy [1 qualified engineer with required experience in single shift] +[3 electricians + 4 helpers in 3 shifts] + [6 helpers in single shifts] + [10 lift operators in single shifts divided during the entire day of 24hrs] as per the requirement of SAU as approved by Engineer-in-Charge | | | | |
| a | | 1st year | 1 | Job | 10175000 | **10,175,000** |
| b | | 2nd year | 1 | Job | 10887000 | **10,887,000** |
| c | | 3rd year | 1 | Job | 11649000 | **11,649,000** |
| d | | 4th year | 1 | Job | 12464000 | **12,464,000** |
| e | | 5th year | 1 | Job | 13337000 | **13,337,000** |
| 3.2 | | Comprehensive Maintenance (routine & preventive) of all electrical systems comprising of all the equipments installed, for the duration of 3 (three) years for all the BOQ items provided in this contract including transformers, 66kv & 11 KV HT panels, capacitor panels , 11KV DG sets and its panels, Elevators, UPS system , lights , fans, distribution panels, all switchgears including MCB's, MCCB's, ACB's, VCB's, ARD of Elevators, batteries, all systems complete as per directions of Engineer-In-Charge. | | | | |
| a | | 3rd year | 1 | job | 5039000 | **5,039,000** |
| b | | 4th year | 1 | job | 7559000 | **7,559,000** |
| c | | 5th year | 1 | job | 10001000 | **10,001,000** |
| | | **Total CARRIED OVER TO SUMMARY** | | | | **81,111,000** |
| 4 | **NON-DSR** | **OPERATION & MAINTAINANCE OF HVAC SYSTEM** | | | | |

| OPERATION & MAINTENANCE WORKS | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | |
| **Sl No:** | **DSR Code** | **Description** | **Qty** | **Unit** | **Rate** | **Amount** |
| 4.1 | | Operation of Heating Ventilation & Air conditioning system (HVAC) comprising of all the machinery, equipments installed, for the duration of five years including two year guarantee period (Defect Liability Peiod) . The agency will deploy [1 qualified engineer with required experience in single shift] + [2 technicians + 1 helper in 3 shifts] + [2 technicians in two shifts] + [2 helpers in single shift] as approved by Engineer-in-Charge | | | | |
| a | | 1st year | 1 | job | 4729000 | **4,729,000** |
| b | | 2nd year | 1 | job | 4729000 | **4,729,000** |
| c | | 3rd year | 1 | job | 5414000 | **5,414,000** |
| d | | 4th year | 1 | job | 5793000 | **5,793,000** |
| e | | 5th year | 1 | job | 6199000 | **6,199,000** |
| 4.2 | | Comprehensive Maintenance (routine & preventive) and breakdown maintenance of all air conditioning equipments installed for the duration of 3 (three) years for all the BOQ items provided in this contract including chillers, pumps, hot water generators, heat recovery units, cooling towers, AHU's, FCU's, air conditioning units including refrigerants, sensors, valves all systems complete as per directions of Engineer-In-Charge. | | | | |
| | | | | | | |
| a | | 3rd year | 1 | job | 5423000 | **5,423,000** |
| b | | 4th year | 1 | job | 6779000 | **6,779,000** |
| c | | 5th year | 1 | job | 8135000 | **8,135,000** |
| | | **Total CARRIED OVER TO SUMMARY** | | | | **47,201,000** |
| | | | | | | |
| | | **TOTAL FOR OPERATION AND MAINTENANCE CARRIED OVER TO SUMMARY** | | | | **169,654,000** |
| | | | | | | |