Network Standard

NETWORK	Document No	:	NW000-S0058
	Amendment No	:	3
	Approved By	:	Manager – AES
	Approval Date	:	03/10/2019
	Review Date	:	03/10/2022

Supersedes Network Standard (NETWORK) NW000-S0058 Amendment No.2

NW000-S0058 NS186 MAJOR SUBSTATIONS CIVIL WORKS DESIGN STANDARD

ISSUE

For issue to all Ausgrid and Accredited Service Providers' staff involved with the design of major substations, and is for reference by field, technical and engineering staff.

Ausgrid maintains a copy of this and other Network Standards together with updates and amendments on www.ausgrid.com.au.

Where this standard is issued as a controlled document replacing an earlier edition, remove and destroy the superseded document

DISCLAIMER

As Ausgrid's standards are subject to ongoing review, the information contained in this document may be amended by Ausgrid at any time. It is possible that conflict may exist between standard documents. In this event, the most recent standard shall prevail.

This document has been developed using information available from field and other sources and is suitable for most situations encountered in Ausgrid. Particular conditions, projects or localities may require special or different practices. It is the responsibility of the local manager, supervisor, assured quality contractor and the individuals involved to make sure that a safe system of work is employed and that statutory requirements are met.

Ausgrid disclaims any and all liability to any person or persons for any procedure, process or any other thing done or not done, as a result of this Standard.

All design work, and the associated supply of materials and equipment, must be undertaken in accordance with and consideration of relevant legislative and regulatory requirements, latest revision of Ausgrid's Network Standards and specifications and Australian Standards. Designs submitted shall be declared as fit for purpose. Where the designer wishes to include a variation to a network standard or an alternative material or equipment to that currently approved the designer must obtain authorisation from the Network Standard owner before incorporating a variation to a Network Standard in a design.

External designers including those authorised as Accredited Service Providers will seek approval through the approved process as outlined in NS181 Approval of Materials and Equipment and Network Standard Variations. Seeking approval will ensure Network Standards are appropriately updated and that a consistent interpretation of the legislative framework is employed.

Notes: 1. Compliance with this Network Standard does not automatically satisfy the requirements of a Designer Safety Report. The designer must comply with the provisions of the Workplace Health and Safety Regulation 2011 (NSW - Part 6.2 Duties of designer of structure and person who commissions construction work) which requires the designer to provide a written safety report to the person who commissioned the design. This report must be provided to Ausgrid in all instances, including where the design was commissioned by or on behalf of a person who proposes to connect premises to Ausgrid's network, and will form part of the Designer Safety Report which must also be presented to Ausgrid. Further information is provided in Network Standard (NS) 212 Integrated Support Requirements for Ausgrid Network Assets.

2. Where the procedural requirements of this document conflict with contestable project procedures, the contestable project procedures shall take precedent for the whole project or part thereof which is classified as contestable. Any external contact with Ausgrid for contestable works projects is to be made via the Ausgrid officer responsible for facilitating the contestable project. The Contestable Ausgrid officer will liaise with Ausgrid internal departments and specialists as necessary to fulfil the requirements of this standard. All other technical aspects of this document which are not procedural in nature shall apply to contestable works projects.

INTERPRETATION

In the event that any user of this Standard considers that any of its provisions is uncertain, ambiguous or otherwise in need of interpretation, the user should request Ausgrid to clarify the provision. Ausgrid's interpretation shall then apply as though it was included in the Standard, and is final and binding. No correspondence will be entered into with any person disputing the meaning of the provision published in the Standard or the accuracy of Ausgrid's interpretation.

KEYPOINTS

This standard has a summary of content labelled "KEYPOINTS FOR THIS STANDARD". The inclusion or omission of items in this summary does not signify any specific importance or criticality to the items described. It is meant to simply provide the reader with a quick assessment of some of the major issues addressed by the standard. To fully appreciate the content and the requirements of the standard it must be read in its entirety.

AMENDMENTS TO THIS STANDARD

Where there are changes to this standard from the previously approved version, any previous shading is removed and the newly affected paragraphs are shaded with a grey background. Where the document changes exceed 25% of the document content, any grey background in the document is to be removed and the following words should be shown below the title block on the right hand side of the page in bold and italic, for example, Supersedes – document details (for example, "Supersedes Document Type (Category) Document No. Amendment No.").

KEY POINTS OF THIS STANDARD

Scope and Risks Addressed

This standard details the performance and design criteria for the civil works design of major substations with the voltages of 132kV, 66kV, 33kV and 11kV. This standard is limited to scope identified below and provides controls for associated risks as listed below:

- ☐ Applies to all new major substation designs
- ☐ Other network standards also apply
- ☐ Some site specific requirements may apply in addition to the requirements of this standard
- ☐ Ausgrid will determine and advise the required design life (100, 50 or 20-years)

Where to for more information?

Section 1, 2

Functional Requirements

The functional design requirements for the major substation design includes:

- ☐ Nominated design life of 100, 50 or 20-years
- ☐ Components not expected to reach the design life nominated will be included in the Life Cycle Cost assessment and included in the schedule of required maintenance works
- ☐ Replacement of components is allowed for accessible and non-structural components
- ☐ Preliminary Maintenance and Operational Schedules shall be supplied with the design documentation
- ☐ For the 50 and 100-year design life allowance shall be made for mid-term refurbishment and associated activities
- ☐ Life Cycle Costing shall be included in the Design supplied to Ausgrid where requested
- ☐ The principles of Economically Sustainable Development will be applied

Where to for more information?

Section 6

Tools and Forms

Annexure B – Economically Sustainable Development

General Substation Design Requirements

The general substation design requirements include:

- ☐ List of civil works as given in Cl. 7.1
- ☐ Designer Safety Report will be supplied to Ausgrid in accordance with NS210
- ☐ A CHAIR review will be undertaken and presented to Ausgrid prior to completion of the design
- ☐ Low maintenance materials which do not require applied finishes to be frequently retouched are preferred.
- ☐ External finishes should be self-cleaning where possible
- ☐ Noise and vibration requirements are listed
- ☐ Site assessment to be in accordance with NEG-SM05 Site Assessment Process for Major Projects
- ☐ Site should be above the 1 in 100 year flood level
- ☐ Preference is given to site topography that allows for gravity drainage
- ☐ Provision is to be made for fire services, hydraulic services, stormwater and other services.
- ☐ Oil containment considerations
- ☐ Segregation of transformers

Where to for more information?

Section 7

Tools and Forms

Annexure A – Architectural Finishes

Substation Civil Design Requirements

The substation civil design requirements include:

- ☐ Permanent and imposed loads
- ☐ Wind loads
- ☐ Earthquake loads
- ☐ Transformer roadways and equipment access
- ☐ Access roadways and parking areas
- ☐ Stormwater drainage and onsite retention
- ☐ Switchyard design
- ☐ Cable trenches and covers
- ☐ Retaining walls
- ☐ Landscaping and external works
- ☐ Perimeter security fencing

Where to for more information?

Section 8

Tools and Forms

Annexure C – Compliance Checklist

Network Standard
NS186
Major Substations Civil Works Design Standard

Contents

1.0 PURPOSE

This Network Standard details the general requirements for various construction, architectural, civil and structural engineering aspects to be considered and included into the design of major substations.

2.0 SCOPE

This standard details the performance and design criteria for the civil works design of major substations with the voltages of 132kV, 66kV, 33kV and 11kV.

The design of all Ausgrid major substations shall comply with this standard.

An associated standard, NS185 Major Substations Building Design Standard, details the performance and design criteria for the architectural and structural design of buildings for major substations.

This standard should be read in conjunction with other Ausgrid standards relevant to the requirements for active and passive fire mitigation, fencing and security. Refer to Section 3 References for specific details.

Ausgrid may have some site specific design requirements which apply in addition to those in this standard. This standard draws attention to the unique requirements of substations to meet the Ausgrid performance expectations of the asset.

This document does not include detailed information for yard structures in substations, nor does it include provisions or information for distribution substations, kiosks or pole top equipment such as transformers, regulators or capacitors.

3.0 REFERENCES

3.1 General

All work covered in this document shall conform to all relevant Legislation, Standards, Codes of Practice and Network Standards. All work covered in this document shall conform to all relevant Legislation, Standards, Codes of Practice and Network Standards. Current Network Standards are available on Ausgrid's Internet site at www.ausgrid.com.au.

3.2 Ausgrid documents

- Bush Fire Risk Management Plan
- Company Form (Governance) - Network Technical Document Endorsement and Approval
- Company Procedure (Governance) - Network Technical Document Endorsement and Approval
- Company Procedure (Network) – Network Standards Compliance
- Company Procedure (Network) - Production / Review of Engineering Technical Documents within BMS
- Customer Installation Safety Plan
- Division Workplace Instruction (Network) – Production /review of Network Standards
- Electrical Safety Rules
- Electricity Network Safety Management System Manual
- Be Safe Hazard Guideline 01: Asbestos
- EG 320 Major Substation Embodied Impacts
- NEG EP07 Network Access and Security – Locks and Keys
- T0057 NEG EP09 Intruder Resistant Fences for Zone & Subtransmission Substations
- NEG SM04.8 Specification for Design and Construction of Major Substations Earthing.
- T0007 NEG SM04.21 Light & Power

- NEG SM04.25 Switchyard Steelwork
- T0053 NEG SM04.27 Power Cable Conduits
- NEG SM05 Site Assessment Process for Major Projects
- T0059 NEG SM07 Active Fire Systems for Substations
- NEG SM08 Noise Assessment
- T0083 NEG SM22 Blasting Near Ausgrid Substations and Power Lines
- NS130 Specification for Laying of Underground Cables Up to 22 kV
- NS158 Labelling of Mains and Apparatus
- NS171 Fire Stopping in Substations
- NS174 Environmental Procedures
- NS181 Approval of Materials and Equipment and Network Standard Variations
- NS185 Major Substations Building Design Standards
- NS187 Passive Fire Mitigation Design of Substations
- NS189 Oil Containment for Major Substations
- NS203 Telecommunications Network: Master Policy Document
- NS210 Documentation and Reference Design Guide for Major Substations
- NS212 Integrated Support Requirements for Ausgrid Network Assets
- NS261 Requirement for Design Compliance Framework for Network Standards
- Public Electrical Safety Awareness Plan
- Public Lighting Management Plan
- Section 170 Register
- Tree Safety Management Plan

3.3 Other standards and documents

- ANZECC & ARMCANZ – Australian and New Zealand Guidelines for Fresh and Marine Water Quality, October 2000
- AS/NZS ISO 14040: Environmental management - Life cycle assessment - Principles and framework.
- AS/NZS 1158 Lighting for roads and public spaces (Set)
- AS/NZS 1170.0 Structural design actions – General principles
- AS/NZS 1170.1 Structural design actions – Permanent, imposed and other actions
- AS/NZS 1170.2 Structural design actions – Wind actions
- AS/NZS 1170.4 Structural design actions – Earthquake actions in Australia
- AS 1319 Safety Signs for the occupational environment
- AS 1530.4 Methods of fire tests on building materials, components and structures - Fire-resistance test of elements of construction
- AS 1657 Fixed platforms, walkways, stairways and ladders – Design, construction and installation
- AS/NZS 1680.2.4 Interior lighting - Industrial tasks and processes
- AS/NZS 1680.5 Interior and workplace lighting - Outdoor workplace lighting
- AS 1940 The storage and handling of flammable and combustible liquids
- AS 2159 Piling – Design and Installation
- AS 2187.2-2006 Explosives - Storage and use - Use of explosives
- AS/NZ 2312 Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings
- AS 2484.1 Fire – Glossary of terms – Fire tests
- AS/NZS 2699 Built-in components for masonry construction (Set)
- AS 2865 Confined Spaces
- AS 2870 Residential slabs and footings
- AS/NZS 2890.1 Parking facilities – Off-street car parking
- AS/NZS 3000 Electric installations - (Australian/New Zealand Wiring Rules)

- AS/NZS 3500 National Plumbing and Drainage (Set)
- AS 3600 Concrete structures
- AS 3700 Masonry structures
- AS 3745 Emergency control organisation and procedures for buildings
- AS 4072.1Components for the protection of openings in fire-resistant separating elements – Service penetration and control joints
- AS 4100 Steel Structures
- AS 4282 Control Of The Obtrusive Effects Of Outdoor Lighting
- AS/NZS 4536 Life Cycle Costing – An Application Guide
- AS 4678 Earth-retaining structures
- AS 5100 Bridge Design (Set)
- Australian Rainfall and Runoff - A Guide to Flood Estimation
- Austroads Framework for Specifying Asphalt, Austroads 2002 (AP-T18-02)
- Department of Environment and Heritage – Coastal Risk Management Guide.
- Department of Environment and Heritage – Flood Risk Management Guide
- Department of Environment & Heritage – Managing Urban Water Series.
- Department of Planning & Infrastructure – Hazardous Industry Planning Advisory Paper No 1 – Emergency Planning January 2011
- Department of Sustainability, Environment, Water, Population and Communities – National Strategy for Ecologically Sustainable Development
- Electricity Supply Act (NSW)
- ENA Standards/Guidelines (www.energynetworks.com.au/industry-guidelines)
- ENA Doc 001-2008 National Electricity Network Safety Code
- ENA Doc 015 - 2006 National Guideline for Prevention of Unauthorised Access to Electricity Infrastructure
- ENA EMF Management Handbook 2016
- ENA Guideline Seismic Security of Power Systems ND/S/-01 (ESAA, ESC158 January 1994) (For Information only)
- ENA Guideline Substation Seismic Design Application Guide ND/S/-02 (ESAA, ESC156 September 1994) (For Information only)
- EPA: Environment Protection Authority (EPA), NSW Industrial Noise Policy, January 2000
- EPA: Environment Protection Authority (EPA), NSW Environment & Heritage – Assessing Vibration: a technical guideline, February 2006
- EPA: Environment Protection Authority (EPA), Specification of Supply of Recycled Materials for Pavements, Earthworks and Drainage, June 2003
- Guide for Design of Substations in Cyclone and Other High Wind Areas – D(b)36-1990 (ESAA, May 1990)
- Landcom - Water Sensitive Urban Design (WSUD) - 2010.
- Mobile Crane Code of Practice 2006 (Queensland Government Workplace health and safety)
- National Construction Code Series (NCC)
- Pavement Design: A Guide to the Structural Design of Road Pavements (Austroads)'
- RMS document: RTA 45070666E Heavy Vehicle Mass, Loading and Access

3.4 Acts and regulations

- All Relevant SafeWork NSW documentation
- Electricity Supply (General) Regulation 2014 (NSW)
- Electricity Supply (Safety and Network Management) Regulation 2014
- Environmental Planning and Assessment (EP&A) Regulation 2000
- Protection of the Environment Administration Act 1991 (NSW)
- Protection of the Environment Operations Act 1997 (NSW)
- Work Health and Safety Act 2011 and Regulation 2011

4.0 DEFINITIONS

Active System	A system that has moving parts or relies on mechanical, chemical or electrical controls in order to function. Examples of active systems include fire protection systems such as sprinklers and smoke detection systems.
Access requirements	Requirements for openings, loading docks corridors and passages and for supporting the weight of all equipment and personnel.
Accredited Service Provider (ASP)	An individual or entity accredited by the NSW Department of Industry, Division of Resources and Energy, in accordance with the Electricity Supply (Safety and Network Management) Regulation 2014 (NSW).
Approved	Requires written consent from Ausgrid. Such written approval may contain authorised specific departures from the Standard.
BCA	The Building Code of Australia (BCA) is Volume One and Volume Two of the National Construction Code Series (NCC).
Business Management System (BMS)	An Ausgrid internal integrated policy and procedure framework that contains the approved version of documents.
Cage	As defined in Ausgrid Electrical Safety Rules.
Crushed rock	Coarse gravel specifically used for earthing purposes in switchyards to Ausgrid specification.
Design	The substation design that is to be provided by the Designer in compliance with Ausgrid requirements.
Designer	The Designer is the nominated party responsible for the layout and design of the project under the overall direction of Ausgrid. The Designer may be an internal group within Ausgrid, or an external party appointed for the project.
Design Life	The timeframe in which the building can operate efficiently and be fit for purpose without break down of the building fabric or structure.
Document control	Ausgrid employees who work with printed copies of document must check the BMS regularly to monitor version control. Documents are considered “UNCONTROLLED IF PRINTED”, as indicated in the footer.
Dolly	A device used to split the load from the transformer float to the prime mover.
Electrical Layout Plan	A concept plan showing the spatial arrangement of equipment and the minimum dimensions of the substation building and yard. Electrical Layout Plans are provided for specific projects by Ausgrid.
ENA	The Energy Networks Australia (ENA) is the peak national body representing gas and electricity distribution businesses throughout Australia. See ENA Industry Guidelines (www. energynetworks.com.au/industry-guidelines).
Equipment Handling Plan	A plan that clearly illustrates and shows consideration for the movement of plant for equipping, replacement and maintenance/operation.
Equipping	Installation of substation equipment, including but not limited to cables, busbars, switching and control equipment and transformers.
Fire stopping	Measures that are adopted to prevent the spread of fire, smoke and acid residues from one compartment to another.

GIS	Gas Insulated Switchgear.
High voltage	A voltage above 1,000 volts alternating current or 1,500 volts direct current.
Impact Resistance	Offers resistance to accidental impact from ordinary day to day operations without suffering mechanical damage sufficient to adversely affect the fire rating performance.
Layout Drawings	Drawings to scale showing the dimensions and relative locations of substation equipment and infrastructure.
Low maintenance	Low required return period for inspection and maintenance.
Major Substation	Zone and sub-transmission substations with primary voltages of 132, 66 or 33 kV.
Network Standard	A document, including Network Planning Standards, that describes the Company's minimum requirements for planning, design, construction, maintenance, technical specification, environmental, property and metering activities on the distribution and transmission network. These documents are stored in the Network Category of the BMS repository.
Overpressure	A rapid rise in the enclosure pressure caused by high voltage electrical equipment failing in an enclosed compartment.
Passive System	Describes a system of fire protection with no moving parts which does not rely on other external controls in order to function as intended. Examples of passive systems are: fire rated building elements such as fire barrier walls, fire doors in the closed position etc.
Review date	The review date displayed in the header of the document is the future date for review of a document. The default period is three years from the date of approval however a review may be mandated at any time where a need is identified. Potential needs for a review include changes in legislation, organisational changes, restructures, occurrence of an incident or changes in technology or work practice and/or identification of efficiency improvements.
Self cleaning	Uses natural weather conditions to remove dust, debris and other airborne materials.
Social impact	A social impact may exist where changes to Ausgrid’s network standard would cause changes to new or existing customer installations, potential impacts to the public in general (e.g. electromagnetic fields associated with power lines) or changes to Ausgrid’s service options.
STS	Sub-transmission substation. Normally 132/33 kV or 132/66 kV.
Substation	In this standard, the term substation refers only to Zone or Sub-transmission substations. This includes substations with 132/11 kV, 66/11 kV, 33/11 kV, 132/66 kV and 132/33 kV. This may include temporary STS or Zone substations as defined below.
Switchgear	Equipment for controlling the distribution of electrical energy or for controlling or protecting circuits, machines, transformers, or other equipment.
Switching equipment	Switchgear, circuit breakers, fuse switches, ring main switches and isolators.
Switchyard	Outdoor yard containing high voltage electrical substation equipment.
Temporary	Relates to substations with a design life of 20 years. Refer to Clause 6.3 for a further explanation on the various substations.

Transformer	A static piece of apparatus with one or more windings which, by electromagnetic induction, transforms a system of alternating voltage and current into another system of voltage and current usually of different values but with the same frequency, for the purpose of transmitting electrical power.
Transformer float	A transformer transport trailer towed by a prime mover with or without a dolly.
TSB	Thermal Stable Bedding material as specified in NS130 Specification for Laying of Underground Cables Up to 22 kV.
Turning circle	The area required for access by a transformer float to allow the replacement of a transformer.

5.0 ASBESTOS

All materials and equipment used for construction of Ausgrid's assets are to be free from Asbestos and or Asbestos related products. Suppliers are expected to comply with the Work Health Safety Act 2011 (NSW) together with the Work Health Safety Regulation 2011 (NSW) and confirm in writing that all products supplied to Ausgrid contain no Asbestos related materials.

If any asbestos is encountered during construction or maintenance activities then safe work method statements and appropriate practices must be implemented. Materials containing asbestos must be handled by a licensed contractor. This material should be disposed of offsite to an appropriately licensed landfill.

All work must be in accordance with Ausgrid's Be Safe Hazard Guideline 01: Asbestos.

6.0 FUNCTIONAL REQUIREMENTS

6.1 General

Substations are classified by the required Design Life which is based on issues relevant to calculated load, system reliability and criticality as determined by Ausgrid. Three classifications are used in the design for Major substations:

- 100 year Design Life,
- 50 year Design Life, and
- 20 year Design Life.

The applicable Design Life for each substation is project specific, and shall be included in the Design Brief issued to the Designer by Ausgrid / Development Services.

6.2 Design standards

Substation civil works in external yards shall be designed to comply with all relevant legislation, Australian Standards, Codes of Practice and the Building Code of Australia (BCA), relevant statutory and approving authorities and any other requirements as directed by Ausgrid.

Ausgrid requirements are described in this Network Standard, other Network Standards, Network Engineering Guidelines (NEG) and Technical Guides.

6.3 Design life of structural components

6.3.1 General

Design Life in this Network Standard refers to the ability of the substation civil works to maintain functionality and operation in a safe, effective and cost efficient manner. All substation civil works shall be designed to withstand all loads and other forces to ensure the civil works attains, as a minimum, the required Design Life.

Ausgrid shall determine and advise the required Design Life for each substation. The Design Life of all components shall be assessed and taken into account when designing the civil works to ensure compliance with, and achievement of, the specified Design Life.

6.3.2 100 year design life

Architectural, Civil and Structural design shall ensure all structural components of the civil works are designed for a Design Life of 100 years.

Replacement of nominated non-structural components during the Design Life is allowed. Refer to Clause 6.3.5.

Components which do not have a 100 year design life, unless maintained, shall be included in the schedule of required maintenance works. Preliminary Maintenance Procedures and Operation Schedules (PMPO) shall be included in the Compliance Certificate (CC) submission and Tender documentation.

6.3.3 50 year design life

Architectural Civil and Structural design shall ensure all structural components of the civil works are capable of a Design Life of 50 years.

Replacement of nominated non-structural components during the Design Life is allowed. Refer to Clause 6.3.5.

Components which do not have a 50 year design life, unless maintained, shall be included in the schedule of required maintenance works. Preliminary Maintenance Procedures and Operation Schedules (PMPO) shall be included in the Compliance Certificate (CC) submission and Tender documentation.

6.3.4 20 year design life

Temporary substations are generally required as a means of supplementing the Network, or for emergency situations whilst other work is undertaken for a more permanent solution. Temporary Substation buildings will generally require only limited civil works as part of their installation on site.

All Architectural, Civil and Structural design shall ensure all structural components of the civil works are capable of a minimum Design Life of 20 years.

6.3.5 Replacement of components

For a Design Life of 100 years or 50 years, replacement of components is allowed for accessible and replaceable non-structural elements. These may include, but are not limited to, the following items;

- Aesthetic or outer protective materials.
- Exposed external metalwork such as guardrails, ladders, trench covers etc.
- External finishes
- Flexible roadway pavements.
- External security fencing, gates etc.

Replacement may also be possible for external switchyard steelwork, some of which may be accessible under restricted access or controlled outage conditions.

Any proposal for replacement of components during the substation Design Life shall be subject to a Life Cycle Cost assessment in accordance with Clause 6.7. Where applicable, the cost of any necessary power outages to enable replacement shall be factored into the Life Cycle Cost assessment.

6.4 Design of the components for design life

The current Australian Standards are based on a Design Life of 50 years. Where an extended Design Life is required by Clause 6.3, details of measures to achieve this required Design Life shall be provided by the Designer to Ausgrid for approval for use prior to design.

The durability requirements in AS 5100:5 Bridge Design - Concrete shall be utilised in designs requiring a 100 year Design Life

Substation designs shall be accompanied by a Design Statement for the specified Design Life and adequacy, prepared by the appointed Architects, Structural Engineers and Civil Engineers prior to acceptance of the design drawings for review by Ausgrid. The Design Statement shall detail the standards, codes, practices or other literature and information which supports the recommendation of materials, products or finishes utilised to achieve the required Design Life.

The certification of the civil works being designed for the required Design Life shall be referenced in the Design Certificates required from the Designer as part of the Compliance Certificate process.

Design Certificates shall specifically:

- Refer to the Design Life of the substation civil works.
- Include full referencing to the Standards utilised for the design.
- State the design has considered and is in accordance with relevant Codes and Standards to achieve the Design Life specified by Ausgrid.
- Be approved by Ausgrid prior to submission of the Compliance Certificate documentation to the Local Approval Authority.
- Contain approved Preliminary Maintenance Procedures and Operation Schedules (PMPO).

6.5 Preliminary maintenance procedures and operation schedules

As part of the Design documentation, the Designer shall provide Preliminary Maintenance Procedures and Operation Schedules (PMPO) to Ausgrid.

The PMPO Schedules are to include expected time frames and procedures to enable maintenance to be planned in compliance with the manufacturer’s and designer’s requirements and recommendations to achieve the required Design Life and service life.

The PMPO Schedules shall include information on the suitability of all components to achieve Design Life including finishes, maintenance procedures and inspection regimes.

The PMPO Schedules shall accompany the documents submitted for approval.

6.6 Maintenance and operation manuals at practical completion

Maintenance Procedures and Operation Manuals shall:

- Be prepared based on information contained in the Preliminary Maintenance Procedures and Operation schedules.
- Be submitted to Ausgrid for review and approval prior to an application being submitted for Practical Completion.
- Include recommended procedures for all maintenance and operation.
- Ensure the specified Design Life complies with Life Cycle Costing requirements.
- Include information regarding operation and replacement instructions for items which have been amended during construction.
- Include all items added to the project due to revised construction, design, security or organisational issues encountered in the design and construction phases.
- Comply with the relevant requirements of NS212 Integrated Support Requirements for Ausgrid Network Assets.

6.7 Life Cycle Costing (LCC)

6.7.1 Definition

Life Cycle is defined in AS/NZS 4536 as the “sum of acquisition cost and ownership cost of a product over its life cycle”.

Where requested, designs shall be assessed on Life Cycle Costing (LCC) to determine the most suitable components. Calculations shall be based on the Design Life period allowing for the varying design lives of components. The LCC should also assess alternative options and include a sensitivity analysis.

6.7.2 LCC assessment and report

LCC techniques shall be applied to projects as specified in the Design Brief documentation and where requested in writing by Ausgrid.

To ensure the most cost efficient design is selected, LCC techniques shall be utilised, where requested, in the selection of all options for design and material selection.

LCC shall consider the capital and recurrent costs involved with the ownership and operation of the asset. Recurrent costs include, but are not be limited to, maintenance, on-going operation, refurbishment and disposal.

The Designer shall provide to Ausgrid all of the relevant information illustrating the use of LCC techniques in the selection of designs, construction options/activities, materials and finishes. This information shall form part of the design and options recommended to minimise overall LCC of the asset components and structure.

All LCC assessments shall comply with AS/NZS 4536 Life Cycle Costing – An Application Guide and AS/NZS ISO 14040: Environmental management - Life cycle assessment - Principles and framework.

6.7.3 Mid-term refurbishment requirements and activities

All options for design of 50 and 100 year Design Life substations shall take into account the re-equipping of switch rooms, control rooms and replacement of transformers in an operational substation.

The Design shall allow for the efficient and cost effective replacement of components. The Design shall include assessment and consideration for a whole of life costing including replacement costs undertaken in an operational substation.

The Life Cycle Costing shall include the cost of complying with all of Ausgrid's requirements for work undertaken in an operational substation.

6.8 Ecologically sustainable development

The design of the substation civil works should take into account the principles of ecologically sustainable development (ESD).

Ecologically sustainable development can be achieved through the implementation of the general principles and programs as outlined in Annexure B.

As part of the ESD process, EG 320 Major Substation Embodied Impacts provides some guidance on the initiatives that may be applicable for reducing embodied impacts associated with major substation projects.

7.0 GENERAL SUBSTATION DESIGN REQUIREMENTS

7.1 General

The substation civil works shall be designed with an Importance Level of 4, in accordance with Clause 8.1.

The following site and civil works shall be completed at the substation site:

- excavation, benching, backfilling and consolidation of the entire site to cater for the ultimate development of the substation;
- final levelling, consolidation, surfacing and compaction of entire switchyard area with crushed rock (where required) to cater for the ultimate development of the substation;
- installation of retaining walls, as necessary, to cater for the ultimate development of the substation;
- installation of an all-weather access road and a substation roadway for motor vehicles and all items of plant and equipment,
- security fencing and a landscaping buffer to cater for the ultimate development of the substation;
- installation of a water supply, drainage, oil containment and sewage facilities;
- installation of footings and bunding for all main transformers and associated coolers;
- environmental management facilities including oil separation, oil containment provisions and site run-off control to cater for the ultimate development of the substation;
- installation of conduits or ducts;
- provision of pulling pits as necessary to facilitate the installation of cables;
- installation of footings and structures for all plant and equipment;
- provision of safe access to routine operating and visual monitoring locations;
- installation of a station earth grid; and
- construction of a switch room/control room building (covered by NS185 Major Substations Building Design Standard).

Suitable allowance shall be made for safe work at heights with adequate space provided around equipment to ensure that ladders, scaffolding, elevated work platforms etc, can be utilised when required.

7.2 Designer safety reports

For structures, including civil works, the WHS Regulation 2011 (NSW) requires a written safety report to be provided by the designer of a structure, or any part of a structure, to the person who commissioned the design.

The Designer Safety Report shall comply with the requirements of NS 210 Documentation and Reference Design Guide for Major Substations and shall be prepared at the completion of the design development process.

7.3 Design risk assessment.

The substation civil works shall be designed to respond to particular performance requirements of Ausgrid and inherent site conditions.

A Construction Hazard Assessment & Implementation Review (CHAIR) shall be undertaken in accordance with the WHS Regulation 2011 (NSW). A copy of the CHAIR review documentation shall be forwarded to Ausgrid / Development Services, for review and approval prior to completion of the Design phase.

The Designer shall include sufficient resources and staff to coordinate advice and participate in the CHAIR process to enable full assessment of the civil works and the construction methodology to gain compliance with all SafeWork NSW requirements.

7.4 Durability

Low maintenance materials are preferred, with any applied finishes not required to be frequently retouched or re-coated during the life of the system. Where applied finishes are required such finishes shall comply with the requirements in Annexure A and Clause 6.3.

Applied finishes that require re-application during the Design Life of the substation shall be subject to a Life Cycle Cost assessment in accordance with Clause 6.7. Where applicable, the cost of any necessary power outages to enable re-application shall be factored into the Life Cycle Cost assessment.

All external finishes and fittings are to be self-cleaning where possible.

Refer to NS187 Passive Fire Mitigation Design of Substations for material limitations.

7.5 Noise and vibration

The design of substation civil works and equipment shall ensure all equipment which generates noise is orientated in a manner that ensures noise is transmitted away from all sensitive receivers. Equipment location, orientation and topography should be used to minimise the line of sight exposure of noise sources to neighbouring properties.

Sensitive receivers include residential properties, land on which residential dwellings can be constructed without rezoning, health facilities, motels, aged care facilities, schools, child care facilities and any other receivers which may be considered sensitive due to operational issues. Consideration should also be given to wetlands of high ecological value, national parks and habitat of any endangered or threatened species.

A noise and vibration assessment shall be carried out as early as practicable in the design stage and should consider realistic operating conditions including maintenance activities. Refer to NEG SM08 Noise Assessment for noise assessment requirements.

Operational noise levels shall comply with the EPA NSW Industrial Noise Policy. Refer to NS174 Environmental Procedures and NEG SM08.

Where the assessment shows that mitigation measures are required for realistic operating conditions, suitable allowances for measures shall be incorporated in to the substation design. These measures shall enable compliance with the maximum allowable noise levels, as defined in the appropriate legislation / regulation.

Where the assessment shows that mitigation measures may be required for more severe (but less likely) operating conditions, suitable allowances should be provided for the future installation of sound barriers, enclosures or other methods of mitigation. These mitigation measures may then be implemented if, and when, deemed to be necessary.

Penetrations in walls such as air ducts, ventilators and grills should be minimised in areas facing sensitive receivers. Openings in all surfaces facing sensitive noise receivers should be treated with appropriate acoustic louvres to baffle or redirect noise generated from the substation.

Outdoor transformer enclosures should be treated to minimise reverberant noise, consistent with fire rating requirements.

The use of acoustically rated walls shall only be considered appropriate for reduction of noise from transformers or equipment onto nearby sensitive receivers following acoustic testing of the area.

7.6 Site investigation

7.6.1 General

The requirements for site inspection and investigation are described in NEG SM05 Site Assessment Process for Major Projects. The site investigations required are divided into the following two stages:

- Stage 1 – Preliminary Site Assessment (Property Acquisition)
- Stage 2 – Detailed Site Assessment (Design Stage)

7.6.2 Site investigation

NEG SM05 shall form the basis of the required site inspection and investigation requirements.

Ausgrid shall undertake the applicable Stage 1 – Preliminary Site Assessment activities during the site acquisition and concept design phase.

The Designer shall undertake the applicable Stage 2 – Detailed Site Assessment activities during the detail design phase.

Site investigation work for the civil works shall consider site conditions including both the previous and proposed land use. Investigations shall be carried out to ensure compliance with all relevant standards and all other project specific requirements.

Site investigations could include, but are not limited to, electric and magnetic fields, noise and vibration, hydrology, geology, contamination, ecological, bush fire threat, Aboriginal heritage, non-Aboriginal heritage, visual and aesthetics, and traffic and access.

7.7 Topography

Unless otherwise approved in writing by Ausgrid, the final level of the substation site shall be at, or above, the 1 in 100 year flood level or as per Local Council requirements whichever is the higher in level.

To facilitate gravity drainage for general stormwater management, and for any oil containment pipelines (where provided), nominal approved falls are required across the site. Refer to NS189 Oil Containment for Major Substations for oil containment requirements.

Where a site does not have adequate grades for gravity drainage systems, filling of the site may be required.

Ausgrid approval in writing is required prior to any design commencing which incorporates pumping of oil containment or stormwater from any Ausgrid site. Such approval shall require the submission of a full hydraulic design and review of all options.

A substation site layout drawing shall be produced indicating the existing and the finished ground levels. It is the Designer's responsibility to assess the site conditions and determine the method of site preparation and the footings required for the installation of the structures and the specified equipment.

For sites in low-lying areas near coastal locations, suitable provisions shall be made for potential future sea-level rise in accordance with the relevant NSW Government policies, guidelines and management programs. Refer to the national "CoastAdapt" datasets, developed by the National Climate Change Adaptation Research Facility (NCCARF) in conjunction with the CSIRO, which are intended to provide sea-level rise information for coastal councils.

The projections for NSW sea-level rise are indicative and will vary based on a number of factors. Typical estimates for Sydney and Newcastle are an increase above the 1986 to 2005 average sea-level of up to 30cm by 2050, and up to 65cm by 2090 (High greenhouse gas scenario - RCP6.0).

Groundwater ingress management and additional oil containment controls may also be required for low-lying substation sites.

7.8 Site services

7.8.1 General

The Designer shall include the design of all civil earthworks and site services including stormwater, groundwater, oil containment, amenities, fire and associated hydraulic services. The following sections cover typical services incorporated into the substation site area.

7.8.2 Fire services

Fire services shall be installed in accordance with the requirements of the local authorities and may include both passive and active systems.

All passive system requirements are included in NS187 Passive Fire Mitigation Design of Substations which also contains provisions and some applications of active systems.

Refer to T0059 NEG SM07 Active Fire Systems for Substations for active system requirements including detection systems and alarms.

Some special provisions may need to be included in the design of substations in bushfire prone areas. These special provisions are detailed in NS187.

A fire hydrant service, connected to water supply (and electrically isolated for earthing purposes), is to be provided to cover the substation area. However, fire hydrants within the substation area are not required for site locations that can be adequately served by external fire hydrants or street hydrants.

Where fire hydrants are necessary within the substation area, a fire hydrant booster connection, in line with local authority requirements, shall be installed external to the security fence in a readily accessible location for fire service vehicles.

7.8.3 Hydraulic services

The hydraulic services for the substation may comprise some or all of the following:

- Sanitary plumbing.
- Sewer or septic drainage.
- Trade waste plumbing.
- Trade waste drainage.
- Domestic cold water.
- Domestic hot water.
- Fire hydrant service connected to water supply.
- Fire hydrant booster connection.

Refer to the requirements of AS/NZS 3500 National Plumbing and Drainage (Set).

Where a septic tank is employed it shall be installed outside the substation intruder resistant fence.

7.8.4 Stormwater and other services

The stormwater and other services for the substation may comprise some or all of the following:

- Stormwater collection, detention and drainage.
- Oil containment drainage.
- Subsoil groundwater drainage.
- Roadway drainage.
- Surface water drainage.

7.9 Oil containment

Environmental management facilities, including oil separation, oil containment provisions and site run-off control for the ultimate development shall be provided. Calculations shall be provided to support the basis of sizing of the equipment offered. The oil containment facilities shall be installed in accordance with NS189 Oil Containment for Major Substations.

7.10 Segregation of transformers

Separation distances between transformers and between transformers and buildings shall meet the requirements of NS187 Passive Fire Mitigation Design of Substations. Where fire segregation is required and the necessary separation distances cannot be satisfied, Fire Separation Walls (FSW) shall be used to meet the requirements of NS187.

8.0 SUBSTATION CIVIL DESIGN REQUIREMENTS

8.1 Civil design philosophy and criteria

The substation civil works shall be designed with an Importance Level of 4, in accordance with the relevant Australian Standards. The return period applicable for the substation Design Life will affect the wind and earthquake loads only. Such return periods do not have an impact on imposed and permanent loads.

All designs shall comply with the Design Brief issued to the Designer by Ausgrid / Development Services

8.2 Permanent and imposed loads

Permanent and imposed loads shall be in accordance with AS/NZS 1170.0 Structural design actions – General principles and AS/NZS 1170.1 Structural design actions – Permanent, imposed and other actions unless advised otherwise in writing by Ausgrid.

Permanent loads shall be maximum foreseeable loads over the entire Design Life of the substation.

8.3 Wind loads

Wind Loads applicable to the substation structures shall be in accordance with AS/NZS 1170.2 Structural design actions – Wind actions, and shall not be less than the value derived from the following:

Table 1 – Wind Loads

Substation Category	Regional Wind Speed (m/s)
100 year	≥ V_{2500} (See Note)
50 year	V_{2500}
20 year	V_{1000}

Note: Risk Analysis required. Refer to AS/NZS 1170.0 - 2002 Appendix F – Annual Probability of Exceedance.

For structures covered by the BCA, AS/NZS 1170.0 requires the design loads to comply with the annual probability of exceedance as given in the BCA. For these structures the relevant requirements of the BCA shall apply where they are more severe than the values given in the table above.

8.4 Earthquake loads

Earthquake loads shall be obtained from AS/NZS 1170.4 Structural design actions – Earthquake actions in Australia and AS/NZS 1170.0. The ENA guidelines Seismic Security of Power Systems ND/S/-01 (ESAA, ESC158 January 1994) and Substation Seismic Design Application Guide ND/S/-02 (ESAA, ESC156 September 1994) should also be referenced for information purposes.

The annual probability of exceedance and the probability factor (k_p) for earthquake loading shall not be less than that shown in the table below:

Table 2 – Earthquake Loading Probability of Exceedance

Substation Category	Annual probability of exceedance	Probability Factor (kp)
Ultimate Loads		
100 year	≤ 1/2500	Risk Analysis (See Note)
50 year	1/2500	1.8
20 year	1/1000	1.3
Serviceability Loads		
100 year	≤ 1/250	Risk Analysis (See Note)
50 year	1/250	0.75
20 year	1/100	0.50

Note: **Risk analysis required.** Refer to AS/NZS 1170.0 - 2002 Appendix F – Annual Probability of Exceedance.

The serviceability load requirements in Table 2 are intended to ensure acceptable performance of the structure after a moderate earthquake. In particular, the main structure shall not require significant repair after the serviceability limit state earthquake, and shall remain in an acceptable condition for operational continuity.

For the serviceability limit state, the design requirements shall include the following;

- Probability Factor (kp) as per Table 2
- Structural Ductility Factor (μ) = 1.15, to reflect realistic damping for an elastic structure.
- Structural behaviour to remain within the elastic range (i.e. no yielding of reinforcement).
- Allowable lateral movement not to exceed 1.0% of height, to minimise damage to the non-structural components.

For the ultimate limit state, the structural design should aim to reduce the risk of a complete structural collapse, where reasonably practicable. For framed structures, any plastic hinges formed during a major earthquake should occur preferentially in the beams, rather than the columns, to reduce the potential for collapse of the entire structure.

For structures covered by the BCA, AS/NZS 1170.0 requires the design loads to comply with the annual probability of exceedance as given in the BCA. For these structures the relevant requirements of the BCA shall apply where they are more severe than the values given in Table 2.

8.5 Differential settlement

Differential settlement shall be limited or managed to prevent structural damage to the substation and to limit detrimental impact on plant and equipment.

8.6 Vibration limits

Some equipment installed in substations has specific vibration profiles which may affect the natural frequency of the structure.

Measures shall be taken to address the issues involved with vibration.

Vibration levels shall be within the levels described by EPA NSW Environment & Heritage – Assessing Vibration: a technical guideline, February 2006.

Substation sites which may be affected by existing or potential mine blasting activities shall consider the impacts of ground vibration and air blast overpressure. The requirements and limitations of T0083 NEG SM22 Blasting Near Ausgrid Substations and Power Lines and also AS 2187.2-2006 Explosives - Storage and use - Use of explosives should be considered. However, it

should be noted that sensitive electrical equipment may require much more stringent vibration limits.

The blasting induced Peak Particle Velocity (PPV) and air blast overpressure within a substation boundary should not exceed the limits given in T0083 NEG SM22, unless approved by Ausgrid. Blasting activities may also require protective measures to prevent flyrock from entering the site and/or damaging associated overhead transmission lines.

8.7 Transformer and access roadway

8.7.1 General

An access road and substation roadway inside the substation shall be established to cater for the ultimate development of the substation. The substation roadway shall provide sufficient clearance between plant items and the switch room / control room to accommodate for large transport vehicle and cranage access.

8.7.2 Design and performance criteria

Substations shall be designed to enable efficient equipment change-over and general vehicular access for maintenance and operations.

All transformer and access roads shall comply with this Standard and all local and statutory authority requirements including all Development Approval, Construction Certificate conditions and NSW RMS requirements.

Where reasonably practicable, recycled materials should be utilised for the construction of roadways, drainage systems and site work platforms. Recycled materials shall comply with Environment Protection Authority (EPA), Specification of Supply of Recycled Materials for Pavements, Earthworks and Drainage, June 2003. The use of recycled materials shall also comply with Protection of the Environment Operations Act, the recycled aggregate exemption 2010, the excavated natural material exemption 2010 and the recovered fines exemption 2010.

The proposed use of any recycled materials shall be subject to a review of the relevant performance criteria, and will require the review and approval of Ausgrid.

All roadways leading into and within substation areas shall comply with Ausgrid requirements for slopes and falls to facilitate ready access during all weather conditions and allow for efficient replacement of transformers and/or emergency access for works in the yard or substation buildings.

Road designs shall consider turning circles, changes in grade and maximum grades to ensure the access driveway suits the delivery procedures required by the equipment transport process and transport vehicles.

Transformer and access roadways inside the substation may be constructed using unsealed, flexible or rigid pavements. The roadway design shall meet the relevant design requirements of this Standard.

Ausgrid requires that any reinforced concrete roadways near or inside the substation area be bonded to the site Earth Grid. Connection to the Earth Grid increases the potential of reinforcing to corrode if it becomes exposed. Strict adherence to AS 3600 Concrete structures or AS 5100 Bridge Design (Set) as appropriate, is required when specifying the minimum concrete cover requirements of steel reinforcing.

The designated transformer roadway shall allow for site access of an articulated low loader transformer float. The transformer roadway shall be set out and designed to meet specified manoeuvring and loading requirements. Ausgrid shall provide site specific loading requirements.

General access to the site should comply with AS/NZS 2890.1 Parking facilities – Off-street car parking.

The Designer shall review and satisfy all Authorities with regard to associated street works, connections to utilities, footpath crossings and general town planning matters.

Details of the Ausgrid Site Layout Plan may only be amended following approval from Ausgrid. Amendments to suit particular site topography and geology, construction practicalities, town planning requirements or other architectural and road engineering requirements may be considered.

8.7.3 Roadway design loads

Ausgrid shall provide maximum transformer loadings for particular substations and specific manufacturer's drawings of transformer arrangement.

Wherever possible, actual transformer weights, installation methods and crane loads shall be used in the design of the transformer roadway.

Typical design loadings are provided below and should be read in conjunction with the loading schedules and the transformer and transformer manufacturer's drawings.

Road pavements shall be designed for the expected number of equivalent standard axles (E.S.A.), up to a maximum of 10^4 E.S.A., as defined in Pavement Design: A Guide to the Structural Design of Road Pavements (Austroads).

8.7.4 Typical new WTC transformer loads

Table 3 – Wilson Transformer Company Typical New Transformer Loads

Tx size	15/19 MVA	20/33 MVA	30/50 MVA	50 MVA	72/120 MVA
Usage		Typical Hunter	Typical Sydney	Alternate Sydney	STS
Reference Drawing	Wilson 879-9909C	Wilson 879-0117C	Wilson 879-9910C		Wilson Q26585-4E
Transformer Main Tank	N/A*	N/A*	630 kN	900 kN	1,176 kN
Radiator	N/A*	N/A*	180 kN	270 kN	295 kN
Transport weight of Tx (main tank)	210 kN	330 kN	430 kN	650 kN	870 kN
Total load in service	310 kN	470 kN	810 kN	1,170 kN	1,470 kN

*main tank and radiator come in one piece.

Note: Older transformers may be used as spares. These transformers may be heavier, and in some cases may be used in new substations.

8.7.5 Typical transformer roadway load information (based on 50mva transformer)

Table 4 – Typical Transformer Roadway Loads

Load Type	Load
Roadway Blanket Imposed Load	15kPa
Roadway Dynamic Loads	As per AS 5100 series.
Transporter Loading -Transformer:	
Wheel Loadings	Transporter plus transport weight of Transformer (Refer to specific vehicle loading diagrams).
Max Axle Load	Austroads '92 - HLP 320 – 200kN/axle (permit required).
Max Wheel Load	When the dolly is removed the axle loads exceed the RMS maximum for 2.5 m width.

8.7.6 Transformer installation loads

Transformers may be installed by either skating or mobile crane methods depending upon substation layout, site constraints and transformer specifications.

Road pavements for the transformer roadway shall be designed to support and distribute the infrequent but highly concentrated loads associated with skating or mobile crane installation. Suitable design of the road pavement as an equivalent pad footing, or other methodology, may be acceptable where this results in an economical design for the roadway at these locations.

8.7.6.1 Skated transformer loadings

Where skated installation is used the roadway immediately in front of the transformer bases is to be designed to allow for the skated installation of transformers which imposes a rolling load on 4 transformer 'skates' containing rollers of approximately diameter 33mm x 125mm wide. The transport weight shall be used for design installation loads.

Jacking of transformers is required to position and remove skates. Four jacks are required but it shall be assumed that a jack may take up to half of the transport weight of the transformer. The bearing area used in accommodating the jacking loads, and the quantum of the jacking loads used in design shall be stated on the drawings.

Loads on jacks and skates shall attract an imposed load factor of 1.5 and a dynamic factor of 1.4.

Bunds or falls may require the use of jacking and beams.

8.7.6.2 Mobile crane loadings

Transformer installation may be achieved in new outdoor substations using mobile cranes. However, cranes shall not be permitted to lift materials over exposed live electrical apparatus unless approval is granted in writing by Ausgrid.

The design of the transformer roadway for mobile crane loading shall take into account the following aspects:

- Actual crane loadings and crane positions shall be used whenever possible.
- Load factors shall be appropriately adjusted to reflect the low load cycle and well defined loading.
- The roadway design and underground services drawings shall indicate the various loading zones and design load capacity.
- The crane operator shall be required to submit a crane loading diagram to demonstrate compliance.
- The use of staged construction to minimise potential damage to the roadway and pavement shall be considered.

Where crane installation is used the transformer roadway in front of the transformer base and the transformer base itself are to carry the actual crane loads appropriate for the substation but not less than the loads nominated below. The extent of the various loading zones should be indicated on design drawings.

Table 5 – Minimum Transformer Roadway Crane Loadings

Typical Crane Details	Load
Axle (6 off @1.7m centres)	13.0T
Wheel	6.5T min. Check loadings for each installation.
Outrigger Pad (sized for 150 kPa contact pressure).	0.65 x (weight of crane, rigging and the transformer) See Note. The table below gives an indication of crane outrigger loads for various transformers

Note: Based on Mobile Crane Code of Practice 2006 (Queensland Government Workplace health and safety).

Table 6 – Typical Mobile Crane Outrigger Working loads

Tx size	15/19 MVA	20/33 MVA	30/50 MVA	50 MVA	72/120 MVA
Usage		Typical Hunter	Typical Sydney	Alternate Sydney	STS
Reference Drawing	Wilson 879-9909C	Wilson 879-0117C	Wilson 879-9910C		Wilson Q26585-4E
Transport weight of Tx (main tank)	210 kN	330 kN	430 kN	650 kN	870 kN
Outrigger load for Crane with 6m radius lift	60 Tonne crane	80 Tonne crane	100 Tonne crane	Impractical	Impractical
	430 kN	570 kN	720 kN		
Outrigger load for Crane with 10m radius lift	100 Tonne crane	120 Tonne crane	200 Tonne crane	300 Tonne crane	360 Tonne crane
	570 kN	1010 kN	1170 kN	1300 kN	2000 kN

Actual crane outrigger loads should be determined for the site using the largest transformer to be installed.

The installation contractor for the transformer shall ensure that the support of the crane is designed to take account of the available load capacity on site. Prior to commencing work on site the installation contractor shall submit a detailed crane loading diagram to demonstrate this compliance for review and approval by Ausgrid.

8.7.7 Transformer roadway layout and design

(a) The maximum grade on a substation road used for transformer movement shall be 1:10 unless otherwise approved by Ausgrid. The maximum change in slope shall be no more than 500mm from an 18m long straight edge to allow for adequate low loader clearance.

(b) Transformer roadways adjacent to the transformer bays shall have maximum gradients of 1:20 and 1:50 maximum cross fall for drainage. Reverse gradients for loaded vehicles are to be calculated.

(c) Transformer roadways may be constructed with unsealed, flexible or rigid pavements depending on the length of roadway, the site specific conditions and the likely wear on the surface over its expected life.

(d) Use of unsealed or flexible pavements in truck turning areas shall be subject to approval by Ausgrid.

(e) Skated installation procedures for transformers require roadways immediately in front of transformer bases to be at the same level as the finished transformer base slab.

(f) Where required, the locations of transformer pulling eyes built into the roadway or adjacent structure shall be shown on Ausgrid Layout Plans. Pulling eyes shall be designed for 10% of the transformer transport weight.

(g) Oil resistant joint sealant (similar to 'Fireban 1' with “Hydrocore”) is required within 10 metres of the transformers.

(h) Kerbs between the roadway and gravel covered switchyards shall be mountable.

(i) All transformer and access roads shall provide suitably designed allowances for clearances and access including:

- Initial construction activities.
- Installation of the designed transformers.
- Mid-term refurbishment including replacement of transformers and switch equipment.
- Maintenance vehicles.
- Conduits and cabling required under the road.

8.7.8 Minimum transformer roadway dimensions

All transformer access roads shall comply with the following dimensions.

Table 7 – Minimum Transformer Roadway Dimensions

Transformer Access Road Details	Dimensions
Maximum surface deviation of road surface is to be	10 mm in 4 metres
Width of transformer road for outdoor transformers up to 50MVA (excl. kerbs and gutters)	5 metres
Width of transformer road for outdoor transformers up to 120MVA (excl. kerbs and gutters)	6 metres
Width of transformer road for indoor transformers up to 50MVA (excl. kerbs and gutters)	6 metres
Kerb width	150 mm – 200 mm
Gutter width excluding kerb width	300 mm – 600 mm

External to switchyard areas, a 5 metre wide roadway shall be provided unless otherwise approved by Ausgrid. This shall be increased for turning circles or vehicle paths which require additional width.

8.7.9 Pulling eyes

Pulling eyes are generally not required for the installation of main transformers and other large items of plant within major substations.

Where required by the Design Brief, or where otherwise requested in writing by Ausgrid, the design shall allow for the inclusion of pulling eyes to the transformer access road, in accordance with the general intent of Ausgrid Drawing No. 49802.

8.7.10 Clearances and turning circles

All transformer and access roads (including kerb and gutter sections of roads) shall have a minimum of 500mm clearance from any boundary line or boundary fence. See table below for minimum diameter turning circles.

Table 8 – Minimum Design Vehicle Turning Circles

Vehicle Details	Turning Circle
Construction trucks	5 metres inside radius
Low loaders	10 metres inside radius minimum
Test Vehicle	26 metres wall to wall

8.7.11 Access roadways and parking area design

Design for access roads should be in accordance with RMS document: RTA 45070666E Heavy Vehicle Mass, Loading and Access for vehicle axle loadings. General access over driveways and parking areas is to be provided for a 15T total mass limit 'General Access Vehicle'.

All access and maintenance roads shall have a minimum width of 4 metres excluding any kerb or gutter sections and at bends or curves. Access and maintenance roads shall be able to withstand site specific point loads.

Fencing along all access and maintenance roads shall comply with T0057 NEG EP09 Intruder Resistant Fences, for access requirements and distances from fences.

As a minimum, provision shall be made to accommodate the following vehicles and not affect access to the transformer roadway:

- Three standard cars
- A single 15 tonne GVM rigid vehicle.

Consideration should be given to the requirements for turning circles and access in the provision of parking for the above vehicles.

8.7.12 Access for test vehicles

Ausgrid's Test Vehicle will occasionally access switchyards. Provision is to be made to allow access for this vehicle to undertake testing procedures. The Test Vehicle uses a Volvo FL10 Chassis.

Table 9 – Access requirements for Ausgrid Test Vehicles

Vehicle Details	Capacity
Turning circle	24m (12m radius)
Sweep path	26 m
Total vehicle mass (Ausgrid fully equipped)	22,200 kg
Gross Vehicle Mass (GVM) rating	30,000 kg
Front axle rating	12,000 kg
Rear bogie rating	18,000 kg

8.8 Yard structures

8.8.1 General

This section is applicable to the various elements that make up a substation yard, and associated structures. Further information on switchyard steelwork is contained in NEG SM04.25 Switchyard Steelwork.

8.8.2 Footing systems

The requirements of AS 2870 Residential slabs and footings shall be taken as the minimum. The footings for standard yard structures shall be designed for a bearing pressure that does not exceed the maximum allowable bearing pressure as determined from a geotechnical assessment of the actual site conditions. This assessment may include detailed site investigations and soil testing if required.

A Geotechnical Engineer shall check the bearing capacity prior to the concrete being poured. Alternatively, yard structure footings may be supported on piles. Refer to Clause 8.5 for differential settlement limitations. Settlement criteria for yard structures are to be provided by Ausgrid.

The design of these footing systems shall consider the location and entry points of all cables into the substation. Refer to NS185 Major Substations Building Design Standards for requirements where cables enter buildings.

For substations (except temporary types) where rock is within 3 m of the surface, and a geotechnical assessment deems that the surface soil conditions are unsuitable, the affected structures shall be founded on rock. There may be reasons for founding on rock at greater depths as determined by the Geotechnical Engineer. Notwithstanding, all structures shall be founded on material of uniform strength.

8.8.3 Piles

Piles shall be designed and installed to the requirements of AS 2159 Piling – design and installation.

Piles shall be designed for the Design Life of the substation, unless requested otherwise in writing by Ausgrid.

At locations where difficult, aggressive or uncertain ground conditions lead to a significant risk of accelerated pile deterioration, or where it is demonstrated that the incremental cost of an extended Design Life is minimal, piles may be designed for up to a 100 year Design Life, subject to written approval by Ausgrid.

For temporary substations all piles shall be designed for the substation's 20 year Design Life.

Due to trenching and cabling the top 1.5 m of pile length shall not be considered to contribute to the load carrying capacity of the pile.

The design and installation of piles shall consider ground conditions, acid sulphate soils, contamination, disposal of spoil, installation difficulties and limitations, vibration and impact on equipment and buildings. Table 10 below outlines limitations on piling systems:

Table 10 – Limitations on Piling Systems

Pile Type	Appropriate use
Concrete Bored Pier	All substation types.
Grout Injected/ Continuous Flight Auger	All substation types.
Concrete displacement or partial displacement piles	All substation types.
Steel Piles	Temporary substations only.
Steel Screw Piles	Temporary substations only. Not to be used in fill areas and not to be used where rock is expected to be encountered.
Timber	All substation types - subject to Ausgrid review and approval.

Timber should be considered for those situations where water saturated ground or where friction piling is required.

With the pile systems noted above, sufficient geotechnical information shall be required to confirm adequate foundation capacity. Installation logs shall be provided to Ausgrid on a drawing for inclusion into Ausgrid’s Drawing Management System (DMS). Piling shall be tested to the project Geotechnical Engineer’s requirements.

8.9 Stormwater drainage

8.9.1 General

Stormwater drainage shall be designed for the Design Life of the substation.

The design of drainage systems shall consider, but not be limited to, potential ground movement, loading from expected traffic, access for maintenance, silt, slope stability and earthing and shall comply with all authority requirements, conditions and practices including the provision of on-site detention.

Subsoil drains shall be installed within the site area to allow effective groundwater drainage particularly behind retaining walls and at the base of batters. Subsoil drains shall discharge any groundwater in accordance with the requirements of Clause 8.10.2

Areas containing oil filled equipment may require special treatment to reduce the risk of site contamination. Refer to NS189 Oil Containment for Major Substations for oil containment and drainage requirements.

Refer to Australian Rainfall and Runoff - A Guide to Flood Estimation and AS 3500.3 Stormwater Drainage for the design requirements of stormwater drainage systems.

Site drainage provisions shall be such that the all-weather access for motor vehicles and plant is achieved to the entire substation site.

All drainage water shall be collected and reticulated in adequately sized drains to a suitable point for discharge off the site in a manner that complies with local Council and Water Authority Regulations.

8.9.2 Water quality objectives

The water quality objectives for stormwater discharges leaving the site should be based on the following:

- Australian and New Zealand Guidelines for Fresh and Marine Water Quality, October 2000, Australian and New Zealand Environmental Conservation Council.
- Water Sensitive Urban Design (WSUD) - Landcom 2010.
- Managing Urban Water Series - Department of Environment & Heritage.

The water quality objectives adopted for stormwater discharges shall consider the receiving environment associated with each site.

8.9.3 On-site stormwater detention

An On-site Stormwater Detention (OSD) system may be required by local Council requirements for locations which drain directly to a public stormwater drainage system.

The need for an OSD system on a specific site shall be critically assessed and negotiated with the local Council in each case. An exemption should be sought where required due to site constraints, electrical hazards or other conditions on site.

Where an OSD system is deemed to be necessary, the key design requirements shall be reviewed and agreed with the local Council.

At site locations where an OSD system is to be installed, the following hierarchy of design options shall be applied:

(a) Incorporate the OSD function into existing water detention facilities, such as EGOWS tanks, to the fullest extent possible.

(b) Adopt surface detention basins where there is ample space available on-site located away from electrical mains and apparatus.

(c) Provide Council with the option of rainwater harvesting for local re-use as an alternative to an OSD system.

(d) Use above ground tanks where the site can accommodate them. Non-trafficable lightweight removable covers are preferred to facilitate access.

(e) Use in-ground tanks with suitable internal heights. Hatches and/or trafficable removable covers shall be provided to facilitate access.

The key design requirements for OSD systems installed at Ausgrid sites shall be as follows:

- The OSD flowrate and detention capacity shall be determined by Ausgrid's hydraulic designer and based on the site specific requirements. The key design parameters and shall be reviewed and agreed with the local Council.
- All OSD tanks shall have 1.8m internal head clearance or they shall have suitably designed removable covers along the entire length.
- Tanks with fixed roofs shall have suitably designed access hatches located at opposite ends of the tank. Tanks which are longer than 15m also require hatches midway at spacings not exceeding 10m.
- All OSD tanks shall have a suitable inspection opening in the roof (250mm diameter nominal) located above, or near, the discharge outlet.
- Handrails shall be provided for accessible above ground tanks where required.
- Enclosed OSD tanks are confined spaces and will require signage, entry permits, standby personnel, gas detectors, training and rescue/escape procedures in accordance with AS 2865 Confined Spaces and WHS Regulation 2011 (NSW). A suitable fall arrest device may need to be used where vertical ladders are provided for normal access / egress.
- An OSD system that is designed to retain water for re-use shall be provided with suitable pumps or drainage lines to enable emptying of the system.
- All OSD systems shall be suitably located to allow for removal of covers or hatches and to enable ready access by maintenance crews and cleanout tankers.

For enclosed OSD tanks, personnel must enter the tank wearing a full harness and where possible should remain attached to a mechanical retrieval mechanism which can be operated from outside the tank. Class 3 fall arrest devices provide both fall arrest and retrieval functions. Fall arrest protection is generally required when climbing vertical ladders where the fall distance may exceed 2m.

8.10 Civil works below the groundwater table

8.10.1 General

Where possible, substation civil works should be located above the groundwater table to minimise the potential impact of groundwater.

In situations where substation civil works are below the surrounding groundwater table, consideration of groundwater impacts, drainage and water quality shall be made. Where required, the affected civil works shall drain by gravity to a suitable discharge point or collection pit.

An appropriately designed groundwater drainage system certified by a practising Civil or Hydraulic Engineer may be submitted by the Designer to satisfy the design requirements. All proposed groundwater drainage systems shall be subject to the review and approval of Ausgrid.

Any discharge to stormwater must be in accordance with Section 120 of the Protection of the Environment Operations Act 1997. In practice this means ensuring all discharges are in accordance with the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC Guidelines).

The ANZECC Guidelines provide water quality "trigger values" that, if exceeded, indicate a potential environmental impact and so trigger further investigation to determine whether or not the discharge water would pose a risk of harm to the receiving water body.

The investigation and water quality assessment will determine if the water is suitable to be discharged to local stormwater, or requires collection or on-site management.

8.10.2 Discharge of groundwater

Discharge of groundwater to local Council or Water Authority stormwater infrastructure shall only occur where a water quality assessment against the ANZECC Guidelines has been completed. The assessment shall confirm the discharge water would not pose a risk of harm to the receiving water body.

All approved groundwater discharges shall be external to any substation buildings using gravity drainage or an automatic pumping system, as required. Any pumping system shall be installed to the appropriate Australian Standard and use an independent control system.

8.10.3 Collection and management of groundwater

Where a water quality assessment has determined that groundwater is not suitable for discharge to stormwater, an investigation of alternative options shall be undertaken.

Alternative options may include (but are not limited to):

- Options for re-use on-site.
- Infiltration structure (i.e. absorption trench/zone).
- Discharged to an unsealed area (i.e. grassed area, garden bed).
- Collection and treatment on-site.
- Collection via tanker for off-site management.

8.11 Switchyard design

8.11.1 General

Switchyards contain transformers, air-insulated switchgear, oil containment systems etc. The yard grade shall allow for all the falls for drainage but this shall be limited to facilitate the operation of all yard structures and equipment. Any requirements for falls to facilitate the operation of any gravity oil separation facilities shall be provided by Ausgrid. Refer to NS189 for falls required for oil containment gravity drainage.

8.11.2 Equipment handling plans

Equipment Handling Plans shall be prepared for each substation site.

The Equipment Handling Plans shall be prepared in conjunction with the Electrical Layout Plan.

8.11.3 All weather access

The yard platform shall be designed to provide all weather access for vehicles with a 9 tonne axle load or a 3 tonne wheel load (whichever is greater) to all sections of the yard.

8.11.4 Switchyard surface

Generally, the yard is to be topped with 75 to 100 mm of crushed rock to Ausgrid specification and requirements.

The step from a yard structure footing to the top of the yard gravel should be at least 50mm and not more than 300mm.

8.11.5 Earthing

A substation earth grid shall be established for the ultimate development of the substation. Earth connections are required to all plant and equipment items in accordance with NEG SM04.8 Specification for Design and Construction of Major Substations Earthing.

8.11.6 Cable trenches and cable trench covers

Cable trenches consist of concrete bases with brick, reinforced block or concrete sides with removable trench covers. Cable trenches are intended to provide easy access to cables and shall be installed in accordance with Ausgrid Drawing No. 49806 or 125623, as applicable. Special provisions may need to be included for sites with reactive soils or for mine subsidence.

The top of the cable trench should be 50 mm above the level of the crushed rock in the yard to minimise gravel falling into the trench.

Cable trenches shall allow for a suitable bending radius to be provided for cables and other services installed in the trench. In particular, suitable provision shall be made for the installation of fibre optic cables which may have larger bending radii than other services within the cable trench. Refer to NS 185 Major Substations Building Design Standard (Data and Communications section).

Suitable measures shall be taken to ensure that cable trenches do not have exposed sharp edges or corners which may cause damage to cables during installation works.

Cable trench covers are to provide protection for control and other cables installed in cable trenches through substation switchyards and are to provide non-slip trafficable access for personnel working within switchyards. Cable trench cover design shall consider and make allowance for the following aspects:

- Covers shall be designed so the edge deflection under pedestrian loading is limited to 10mm.
- The effects of potential external fires.
- Be manufactured from materials which shall resist corrosion and aging.
- Not be subject to brittle fracture.
- WHS issues regarding lifting and trips.
- Misalignment, dislodgement or movement due to wind.
- Minimisation of damage to cables if dropped.
- The mass of individual trench covers to be lifted by hand shall be limited to 20 kg maximum.
- Covers should have no sharp edges and shall be securely located.
- Trench covers shall be suitable for the Design Life of the substation, using low maintenance materials that do not require frequent reapplication of any applied finishes.
- At locations specified by Ausgrid, cable trench covers may need to be fire rated to address identified external fire risks.

Refer to NS187 Passive Fire Mitigation Design of Substations for limitations on materials to be used in areas exposed to external fires.

Compressed fibre cement is not to be used for cable trench covers.

Vehicles shall not be driven over cable trenches or cable trench covers.

8.11.7 Services in conduits and cable trenches

Control, protection, SCADA, communications, 415V AC power and DC power cables shall be reticulated in conduits or concrete cable trenches, installed between all major plant items and the substation building. At least one additional spare conduit of equivalent size and type, identified at each end and fitted with a draw rope, shall be installed for each major plant item.

Feeder cables shall be installed in conduits. Where the use of TSB backfill is required it shall be installed in accordance with NEG SM 04.27 Power Cable Conduits.

All conduits and cable trenches shall be blocked to prevent the entry of vermin in accordance with NS171 Firestopping in Substations.

8.11.8 Communications conduits

Provision shall be made within the substation for the required data and communication installation works and for suitable access via communications conduits. Refer to NS 185 Major Substations Building Design Standard (Data and Communications section).

8.11.9 Power cable conduits

All underground power cables shall be installed in conduits in accordance with NEG SM04.27 Power Cable Conduits. The size and bending radius of the conduits shall be in accordance with the cable manufacturer’s recommendations.

8.11.10 Retaining walls

Construction of buildings or yard structures above retaining walls shall not be within 3m of the retaining wall, or the maximum height of the retaining wall, whichever is greater. Alternatively, the proposed structure may be supported on piles to a depth specified and approved by a Geotechnical and Structural Engineer.

Retaining walls other than basement walls are not to rely on the substation building or yard structures to provide stability. Propped retaining walls shall be designed for at-rest pressures.

Where maintenance free drainage that is adequate for the building Design Life cannot be achieved, retaining walls shall be designed for the full hydrostatic pressures.

If the loss of the retaining wall is likely to impact on the substation building or yard structures it shall have the same Design Life as the substation building. A retaining wall is considered to have an impact on a building or yard structure if when the wall fails the wall materials could fall onto, against or undermine any building or yard structure.

The base of the retaining wall footings shall be founded a minimum of 500 mm below ground level, cable trenches, cables or any other yard structure footings adjacent to the wall.

Retaining walls shall be designed in accordance with AS 4678 Earth-retaining structures.

Table 11 below lists various types of retaining wall systems and where the use of such walls is acceptable to Ausgrid.

Table 11– Acceptable use of Retaining Walls Construction Types

Retaining Wall System	Appropriate Use
Reinforced Concrete	All substations
Reinforced Concrete Blocks	All substations
Reinforced Soil Structures (RSS)	All substations
Gravity Walls (stone or masonry)	All substations
Concrete Crib	All substations
Timber Crib	Temporary substations
Treated Timber	Temporary substations only
Recycled Tyres (Ecoflex)	Temporary substations only

Where security fences are used in conjunction with retaining walls, the fence may dictate the type of wall chosen. Refer to T0057 NEG EP09 Intruder Resistant Fences for Zone & Subtransmission Substations.

8.11.11 Ground anchors

The use of ground anchors, where these are deemed to be required, shall consider:

- Existing and future cable locations.
- Stray currents and accelerated corrosion.
- Durability - a Design Life of up to100 years may be required as for piles (refer to Clause 8.8.3).
- Earthing requirements.
- Access for inspection and maintenance.

Any use of ground anchors is to be approved by Ausgrid before design or installation.

8.11.12 Batters

Where retaining walls are not provided, top of batter slopes shall be at least 1 m beyond the extremities of the building, yard access, and yard fence or yard structure.

To assist in providing safe pedestrian access the preferred maximum slope in switchyards is 1:8. This may be increased to 1:6 with approval from Ausgrid following detailed design review. Batter slopes may be increased beyond a slope of 1:6 at locations where pedestrian access and regular maintenance access is not required.

Stepped yards may be permitted where the slope of the site exceeds 1:6 and approval is granted by Ausgrid.

8.11.13 Durability requirements

The durability requirements for all concrete structures shall comply with AS 3600 Concrete structures and the requirements of Clause 6.4.

The durability requirements for masonry construction shall be in accordance with AS 3700 Masonry structures and AS/NZS 2699 Built-in components for masonry construction (Set) plus the following additional requirement:

- The reinforcement for concrete block walls shall be galvanised if it is in a situation where it may be continually wet or in exposed locations. This requirement applies to retaining walls and exposed walls in coastal or industrial areas.

8.12 Landscaping and external works

8.12.1 Driveways

The layout and design of substation driveways and switchyards shall include provisions for access by transformer floats. An equipment delivery and handling area is to be provided to suit the particular substation layout and the Equipment Handling Plan (Refer to Clause 8.11.2).

Refer to Clause 8.7 for the requirements of the civil design of transformer and access roadways.

8.12.2 Personnel access paths

External concrete paving shall be provided for personnel access points into the substation buildings. Other locations around the building perimeter shall be suitably sealed or provided with a granular topping (e.g. blue metal) to cater for infrequent access as required.

The paving, seal or topping shall have a minimum width of 1200 mm and be drained appropriately away from the building to the site stormwater system. Some locations may need to be designed to collect roof or site stormwater run-off. Where roof run-off is collected, additional erosion control may be required.

8.12.3 Access to towers, power poles and landing span structures

Provision shall be made for vehicle access (e.g. EWP) to high voltage towers, power poles and landing span structures located within the substation yard.

Access to these structures is required both during initial installation and for future operations and maintenance.

8.12.4 Embankment retention

The use of retaining walls for landscaping is to be minimised as far as possible. Stable banks are preferred.

8.12.5 External landscaping

8.12.5.1 Requirements

This Clause refers to areas outside the switchyard area. There shall be no landscaping inside the live switchyard area.

The Ausgrid Tree Safety Management Plan shall be consulted to determine the appropriate species to be planted. The plan outlines Ausgrid's approach to vegetation management near the electricity network and specifies plants generally suitable for use and those which are unsuitable for use near the network.

Low maintenance landscaping shall be provided for new substations.

8.12.5.2 General landscaping principles

The purpose of landscaping is to provide low level screening for aesthetic relief in line with environmental requirements from the Approving Authority. The landscaping shall have minimal maintenance requirements.

The design shall incorporate screening opportunities and the considered placement of equipment to reduce the visual impact on local residents. However, any landscaping is not to screen the switchyard and/or Ausgrid buildings from sight.

Selected trees and shrubs should be of a type and variety that do not support climbing of any sort, particularly within a three metre range of any part of substation fences. Selected trees and shrubs

should not have invasive root systems and should be located as to avoid all underground cabling, ductlines and the Ausgrid earthing grid.

Low or minimal maintenance ground cover is preferred to any lawn, turfed or grassed areas that may require maintenance.

Irrigation systems are not to be provided and chosen plant materials should preferably not require ongoing maintenance past an initial 12-month period.

A ground cover zone of 1 metre width is required adjacent to transformer and access roadways between the switchyard security fencing and the boundary of the Ausgrid site.

The design should comply with provisions and clearances required in T0057 NEG EP09 Intruder Resistant Fences for Zone & Subtransmission Substations.

All landscaping design shall comply with this Standard, Local Authority requirements, Development Application requirements and Development Approval conditions.

Landscaping should be provided as low-level screening where new buildings are located adjacent or near to neighbouring properties or facing public roads.

All landscaping areas are to have a minimum 3 metres setback from substation yard area.

The maximum expected normal growth height of any landscaping component is to be less than 3 m if within 3 m of a switchyard fence, structure or building.

There should be minimal possibility of any loose or flying debris from plants, shrubs or trees being blown into the substation yard area, up against or near fences. This is to avoid the shorting of electrical equipment caused by a branch or limb dropping onto or near equipment. Branches dropped near fences may allow access into the yard area by unauthorised persons.

Landscaping components are not to allow or provide access as a climb point.

The design is to ensure landscaping components do not provide screening of any unauthorised persons who may enter or be within the switchyard or serve as a visual barrier. Casual surveillance of the switchyard is part of the Ausgrid strategy for security in substation areas.

Landscaping components shall be designed to ensure there is no access provided by landscaping components to any person to the fences or gates of any Ausgrid yard or building.

Landscape design should where possible retard the spread of fire. Landscape design shall comply with all Local Authorities requirements for bush fire, spread of fire and Local Fire Brigade codes, requirements or recommendations.

Maximum tree height adjacent to or near overhead feeders is to comply with the Ausgrid Tree Safety Management Plan.

8.12.5.3 Landscaping materials

Landscaping materials and plants should be indigenous to the locality and procured where possible from suitably qualified local suppliers and sources. Landscape materials should be appropriate for the site soil types and the required visual character of the neighbourhood.

Where possible utilise plants, shrubs or trees which shall not increase the heat or fuel load to a fire, to reduce the possibility of fire near a substation yard or building.

8.12.5.4 Additional information

Ensure finished surface levels direct all run-off or stormwater away from all substation yards and buildings.

Provide as necessary a fully designed stormwater and subsoil drainage system to ensure all surface and groundwater is directed away from all substation yards and buildings.

Ensure landscaping levels do not allow access or provide a climbing point to the substation building, yard or fence and in particular to the restriction of access measures contained in T0057 NEG EP09.

8.13 Perimeter security fencing and access gates

The perimeter of live substation switchyards and the substation building shall be secured to minimise the risk of unauthorised entry.

The live switchyard security fence enclosing live outdoor electrical equipment, and the substation building, shall be designed to be secure against opportunistic intruders without the aid of tools or keys. The live switchyard security fence and the substation building shall be designed to be an intruder resistant and tamper-evident barrier. The barrier shall be resistant to covert attack.

For further details of the substation building security refer to NS 185 Major Substations Building Design Standard.

Special attention shall be paid to personnel and vehicular entry gates within the security fencing and these shall be fitted with Ausgrid padlocks.

The switchyard security fence and gates shall be designed in accordance with the requirements of T0057 NEG EP09 Intruder Resistant Fences for Zone & Subtransmission Substations, and ENA Doc-15 National Guideline for Prevention of Unauthorised Access to Electricity Infrastructure.

Any concealed spaces outside the live switchyard security fence should be minimised where reasonably practicable.

Boundary fencing is to be provided as an initial level of security and to define the site boundary. The height and type of boundary fence will depend on the initial level of security required, the degree of screening necessary (both determined by Ausgrid) and the fencing type permitted by the Local Planning Authority, if applicable. Where possible the boundary fence shall be of open style design such as tubular fence to allow for the principles of CPTED (Crime Prevention Through Environmental Design).

In community sensitive areas, where the need for an upgraded boundary fence has been agreed in writing by Ausgrid, the fence may be of timber, brickwork, blockwork or decorative mesh or a combination of each. Where metallic or conductive fencing material is used for the boundary fence it shall have sufficient separation from the switchyard fence to ensure that it cannot come in contact with the switchyard fence if it were to fall over.

No storage rooms or areas other than those required for approved substation equipment shall be allowed within substations.

All substation building and fencing locks shall be installed in accordance with the requirements of NEG EP07 Network Access and Security – Locks and Keys.

8.14 External substation signage

Standard external substation signs shall be installed in accordance with Ausgrid Drawing No. A1 127 950 and T0057 NEG EP09 and shall include:

- substation name, number and contact details
- substation fence safety signs
- Statutory signage as required by BCA and Australian Standards.

8.15 Emergency drainage diagram

An emergency drainage diagram shall be prepared for the completed substation in accordance with NS 185. The diagram shall incorporate details of the oil containment and stormwater drainage and any operational requirements for the oil tank in an emergency.

Emergency drainage diagrams are to include volume information including liquid and oil capacity if the oil containment system is to be shown. The diagram shall clearly indicate the oil containment system with red marking and the stormwater system with green marking.

An additional copy of the emergency drainage diagram shall be located at the oil containment tank where the tank is located internal to the building.

9.0 RECORDKEEPING

The table below identifies the types of records relating to the process, their storage location and retention period.

Table 12 – Recordkeeping

Type of Record	Storage Location	Retention Period*
Approved copy of the network standard	BMS Network sub process Standard – Company	Unlimited
Draft Copies of the network standard during amendment/creation	HPRM Work Folder for Network Standards (HPRM ref. 2014/21250/295)	Unlimited
Working documents (emails, memos, impact assessment reports, etc.)	HPRM Work Folder for Network Standards (HPRM ref. 2014/21250/295)	Unlimited

* The following retention periods are subject to change eg if the records are required for legal matters or legislative changes. Before disposal, retention periods should be checked and authorised by the Records Manager.

10.0 AUTHORITIES AND RESPONSIBILITIES

For this network standard the authorities and responsibilities of Ausgrid employees and managers in relation to content, management and document control of this network standard can be obtained from the Company Procedure (Network) – Production / Review of Engineering Technical Documents within BMS. The responsibilities of persons for the design or construction work detailed in this network standard are identified throughout this standard in the context of the requirements to which they apply.

11.0 DOCUMENT CONTROL

Content Coordinator : Manager – Asset Engineering Standards

Distribution Coordinator : Senior Engineer Guidelines Policies & Standards

Annexure A – Architectural Finishes

A1 External and internal finishes

External finishes shall comply with this Network Standard and the specific urban design requirements for the locality of the substation.

External and internal finishes to the different areas of the substation shall comply with the following requirements.

Table A1: External and Internal Finishes

Room/Area	Ceiling	Walls	Floors
Transformer Bays	N/A	Acoustic Blocks where required or unpainted off-form concrete or masonry.	Concrete Monolithic Slab with Broom Finish
Transformer Roadway	N/A	N/A	For Concrete Monolithic Slab – Broom Finish For Unsealed or Flexible Pavement – No additional finish
Oil Containment Tanks (Concrete)	Unpainted off-form concrete	Unpainted off-form concrete	Steel Trowel Monolithic Slab
Bunded Areas	N/A	Unpainted off-form concrete	Steel Trowel Monolithic Slab with Concrete Sealer

Note: 1. The required internal finishes in Table A1 may vary for ceilings, walls and floors that use alternative types of substrate materials.

A2 Off-form concrete finishes

The following off-form concrete finishes are to be specified for substation works.

Table A2: Off-form Concrete Finishes

Type	Internal Finish	External Finish
Exposed off-form concrete	Class 2	Class 2
Non-exposed off-form concrete	Class 3	Class 4

Annexure B – Ecologically Sustainable Development

B1 General principles

Ecologically sustainable development (ESD) can be achieved through the implementation of the following principles and programs:

(a) The precautionary principle - if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

(b) In the application of the precautionary principle, public and private decisions should be guided by:

(i) careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment, and
(ii) an assessment of the risk-weighted consequences of various options.

(c) Inter-generational equity - the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations.

(d) Conservation of biological diversity and ecological integrity - conservation of biological diversity and ecological integrity should be a fundamental consideration.

(e) Improved valuation, pricing and incentive mechanisms - environmental factors should be included in the valuation of assets and services, such as:

(i) Polluter pays - that is, those who generate pollution and waste should bear the cost of containment, avoidance or abatement.

(ii) The users of goods and services should pay prices based on the full life cycle of costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste.

(iii) Environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms, that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems.

For additional guidance on ESD refer to the Department of Sustainability, Environment, Water, Population and Communities website www.environment.gov.au/about/esd/index.html#nsesd

In particular, the National Strategy for Ecologically Sustainable Development provides the broad strategic directions and framework for governments to direct policy and decision-making.

Annexure C – Sample Compliance Checklist

Network Standard Checklist Form

NS186 Major Substations Civil Works Design Standard

Project Identification:	
Prepared by: <Name & Position Title>	Date:

This checklist is for internal Ausgrid use and does not apply to ASPs or contractors who have separate compliance requirements. Each network standard has its own check sheet and these are available within BALIN and the BMS as a separate form that can be completed and saved in HPRM with the other project documentation.

This section is used to identify compliance checks that when applied to the work associated with this Network Standard will satisfy an audit process to establish that the requirements of the standard have been followed. It is expected that applicable items would normally be checked as Comply (Yes) as non-compliance is generally not tolerated.

Where non-compliance is the result of specific site conditions or design decisions this needs to be identified in the notes section of the form for each non-compliance and approval sought from an appropriately authorised Ausgrid manager responsible for design approval per NS261 Compliance Framework for Network Standards.

Should additional information be available to document non-compliance decisions, these can be attached to the checklist form. The checklist and any attached explanatory notes should be saved in the project document repository.

Item	Description	Refer Clause	Completed/ Actioned
	Scope		
	Network Standard NS186 details the general requirements for various Construction, Architectural, Civil and Structural engineering aspects to be considered and included into the design of major substations.		
	Ausgrid may have some site specific design requirements which apply in addition to those in this standard.		
	Functional Requirements		
1	Required Design Life advised by Ausgrid	6.1	Yes/No/NA
2	Civil works designed to comply with all relevant legislation, Australian Standards, Codes of Practice and the Building Code of Australia and other requirements as directed by Ausgrid	6.2	Yes/No/NA
3	Components which do not have required design life are listed in schedule of required maintenance works	6.3.2, 6.3.3	Yes/No/NA
4	Replacement of accessible/non-structural elements allowed but must be included in Life-Cycle Cost assessment	6.3.5	Yes/No/NA
5	Details of measures included to provide nominated design life are identified	6.4	Yes/No/NA
6	Substation designs accompanied by Design Statement for the specified Design life	6.4	Yes/No/NA
7	Design certificates include required content	6.4	Yes/No/NA
8	Preliminary Maintenance Procedures and Operation (PMPO) Schedules supplied to Ausgrid	6.5	Yes/No/NA

Item	Description	Refer Clause	Completed/ Actioned
9	Maintenance and Operation Manuals supplied and approved prior to issue Practical Completion	6.6	Yes/No/NA
9	Maintenance and Operation Manuals supplied and approved prior to issue Practical Completion	6.6	Yes/No/NA
10	Life Cycle Costing supplied where requested and comply with AS/NZS 4536 and AS/NZS ISO 14040	6.7	Yes/No/NA
11	Submitted design allows for efficient and cost effective access for replacement of components	6.7.3	Yes/No/NA
12	The design of substation civil works takes into account the principles of ecologically sustainable development	6.8	Yes/No/NA
	General Substation Design Requirements		Yes/No/NA
13	Design meets requirements with Importance level of 4 in relevant Australian Standards	7.1	Yes/No/NA
14	Designer Safety Report supplied to Ausgrid	7.2	Yes/No/NA
15	A Construction Hazard Assessment and Implementation review (CHAIR) supplied to Ausgrid	7.3	Yes/No/NA
16	Durability of finishes compliant with requirements of Annexure A and Cl. 6.3	7.4	Yes/No/NA
17	Design minimises impact of noise and vibration and allows for future fitment of mitigation measures where relevant	7.5	Yes/No/NA
18	Site Assessments undertaken in accordance with requirements	7.6	Yes/No/NA
19	Design of site topology complies with 1 in 100-year flood level	7.7	Yes/No/NA
20	Design of site topology allows for gravity drainage of stormwater and for any oil containment requirements	7.7	Yes/No/NA
21	Provision allowed for future sea level rises where relevant.	7.7	Yes/No/NA
22	Civil Design/Works include provisions for Fire Services and where relevant for special provisions for bushfire prone areas	7.8.2	Yes/No/NA
23	Civil Design/Works include provisions for Hydraulic Services as required	7.8.3	Yes/No/NA
24	Civil Design/Works include provisions for Stormwater and Other Services as required	7.8.4	Yes/No/NA
25	Civil Design/Works include provisions for Oil Containment as required in Ausgrid's design brief	7.9	Yes/No/NA
26	Civil Design/Works include provisions for Segregation of Transformers where site conditions require	7.10	Yes/No/NA
	Substation Civil Design Requirements		
27	Design permanent and imposed loads in accordance with AS/NZS 1170.0 and AS/NZS 1170.1 and any specific requirement of Ausgrid	8.2	Yes/No/NA
28	Design wind loads in accordance with AS/NZS 1170.2 and the details in Table 1 – Wind Loads	8.3	Yes/No/NA
29	Earthquake loads in accordance with AS/NZS 1170.4 and AS/NZS 1170.0 and the other requirements provided	8.4	Yes/No/NA
30	Differential Settlement limited or managed as required	8.5	Yes/No/NA
31	Design allows for known vibration issues of equipment specified	8.6	Yes/No/NA
32	Access and roadway design shall provide for ultimate development of the substation	8.7.1	Yes/No/NA
33	General design and performance criteria for transformer and roadway access met by design	8.7.2	Yes/No/NA
34	Roadway design loads in accordance with Ausgrid's supplied information	8.7.3	Yes/No/NA
35	Design allows for skated installation of transformers where required	8.7.6.1	Yes/No/NA
36	Design allows for installation of transformers using mobile crane	8.7.6.2	Yes/No/NA
37	Specific transformer roadway layout and design requirements met	8.7.7	Yes/No/NA
38	Design of transformer roadway meets dimensional requirements specified	8.7.8	Yes/No/NA
39	Pulling eyes installed in transformer access roadway where required	8.7.9	Yes/No/NA

Item	Description	Refer Clause	Completed/ Actioned
40	Provisions for clearances and turning circles for transformer and general access roads met	8.7.10	Yes/No/NA
41	Access allowed for Ausgrid Test vehicles	8.7.12	Yes/No/NA
42	Footing Systems in design meet requirements specified	8.8.1	Yes/No/NA
43	Piles in design meet requirements specified	8.8.2	Yes/No/NA
44	Stormwater drainage in design meets requirements specified	8.9.1	Yes/No/NA
45	Water quality objectives met by design	8.9.2	Yes/No/NA
46	On-site water detention requirements of Local Council met	8.9.3	Yes/No/NA
47	Where possible civil works located above groundwater table.	8.10	Yes/No/NA
48	Discharge of groundwater from site complies with ANZECC Guidelines	8.10	Yes/No/NA
49	Switchyard design requirements met	8.11	Yes/No/NA
50	Equipment handling plans submitted with design for switchyard	8.11.1	Yes/No/NA
51	Security fencing and access gate design meet Ausgrid requirements	8.13	Yes/No/NA
52	External Substation Signage meets Ausgrid requirements	8.14	Yes/No/NA
53	Emergency Drainage Diagram supplied	8.15	Yes/No/NA
			Yes/No/NA
			Yes/No/NA

Notes:

.....

.....

.....

.....

.....

.....

The signatures panel of this document has been removed for privacy considerations. The remainder of the document is unchanged.