Chapter 6

WIRING SYSTEMS

Safe Electrical Design

Topic 6-2

MAXIMUM DEMAND

ENPRA101A – Engineering Practices

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MAXIMUM DEMAND ON CONSUMERS MAINS (DOMESTIC)

- When designing a new electrical installation it is necessary to predict the power requirements for all parts of the installation.
- This is especially so for consumers mains and sub-mains
- The methods of determining maximum demand (MD) of consumers mains and sub-mains are outlined in AS/NZS 3000. **Fig PF-6-2-1** shows an example of a typical installation.

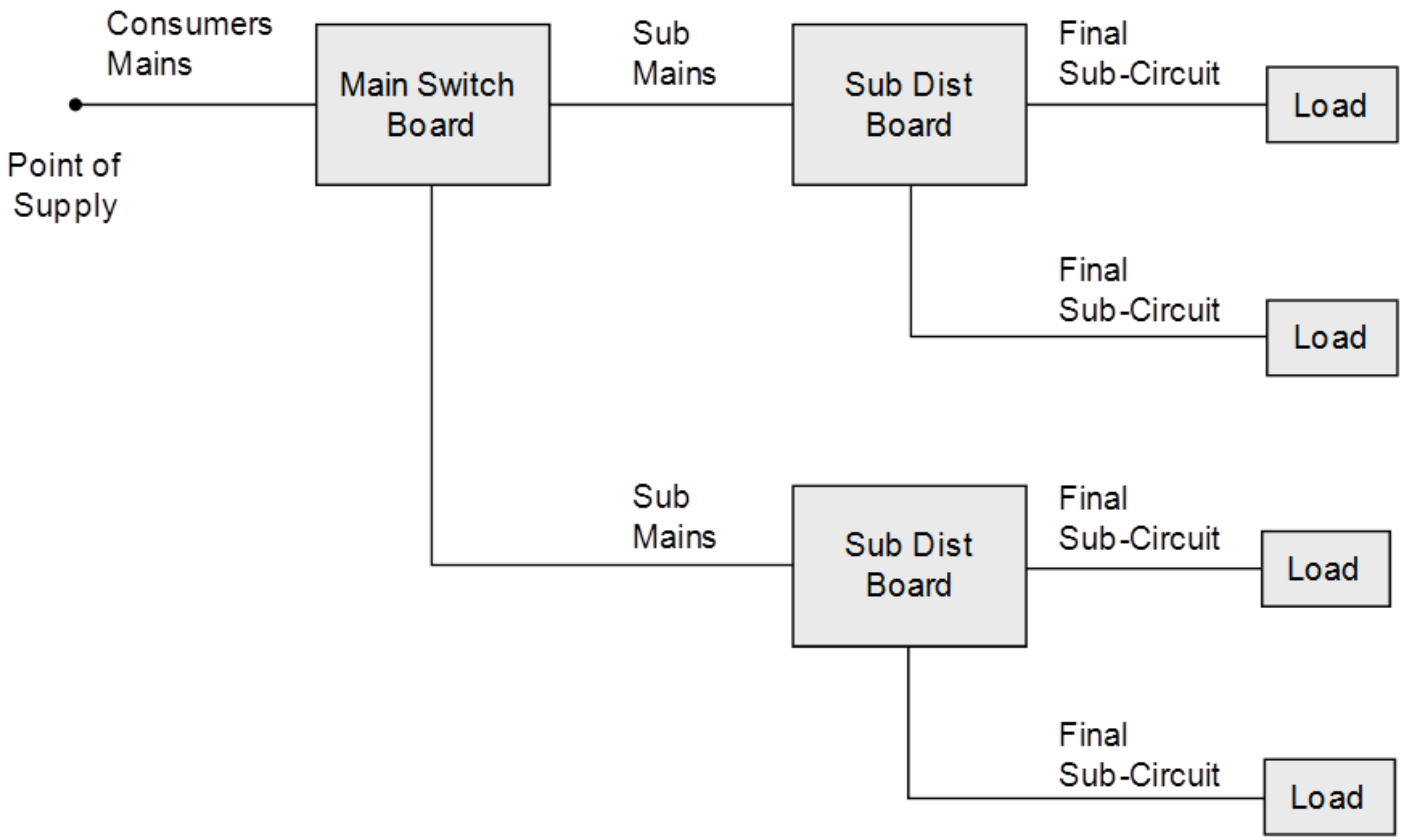

Fig F-6-2-1
Typical Electrical Installation

MAXIMUM DEMAND ON CONSUMERS MAINS (DOMESTIC)

CONSUMERS MAINS DEFINITION

- From Ref **R-6-C (1.2.5)** the definition of consumers mains is:

  “Consumers' mains are the conductors between the point of supply and the main switchboard and form part of an electrical installation. Consumers' mains may be overhead, underground or within a structure. Refer Figures **F-6-2-2** and **F-6-2-3** .

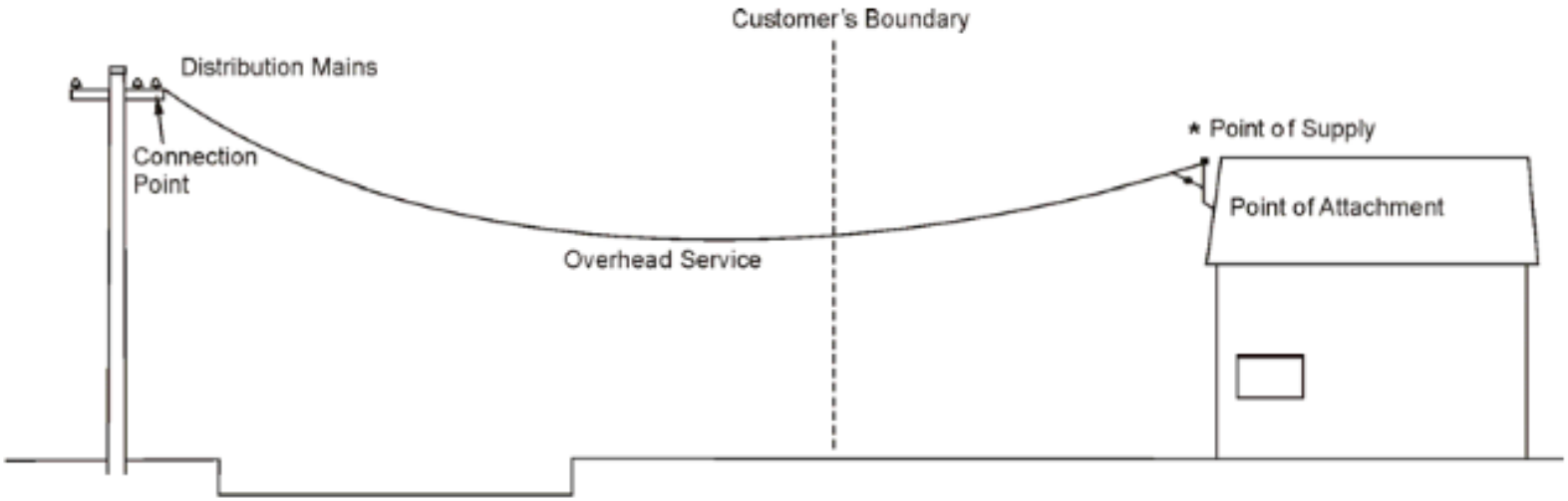

Fig PF-6-2-2(a) – Supply from Overhead Distribution Mains via Overhead Service

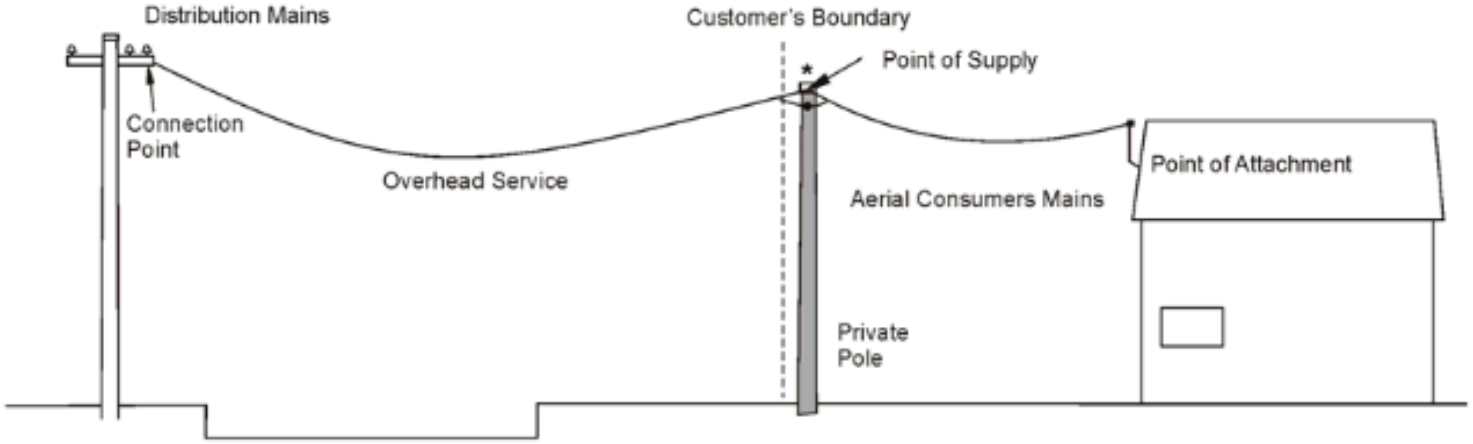

Fig PF-6-2-2(b) – Supply from Overhead Distribution Mains via Overhead Service and Aerial Consumer Mains

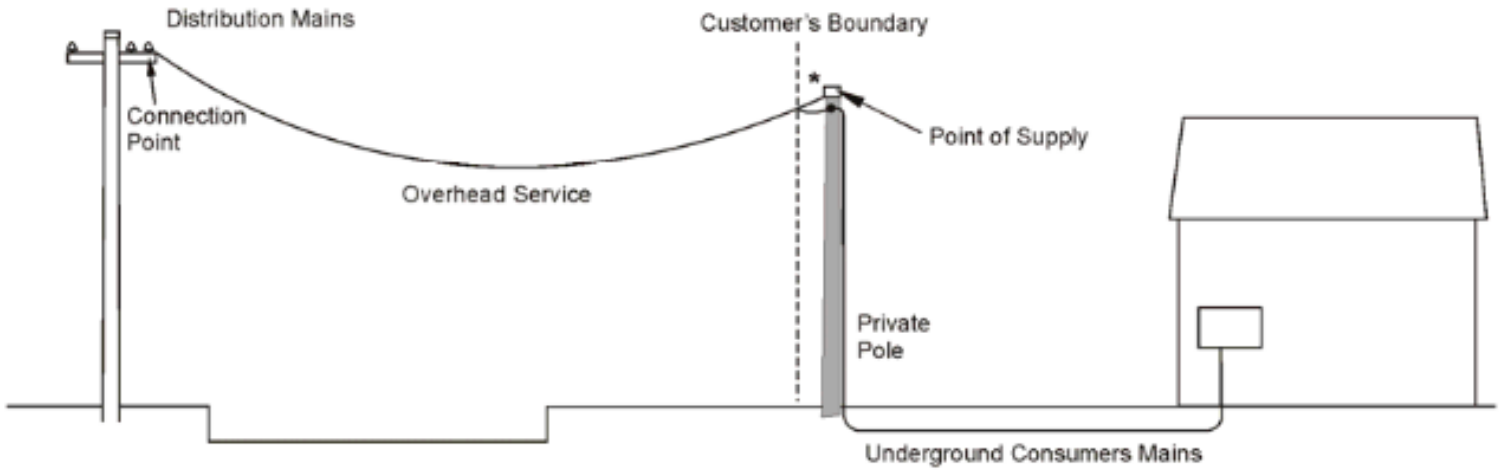

Fig PF-6-2-2(c) – Supply from Overhead Distribution Mains via Overhead Service and Underground Consumers Mains

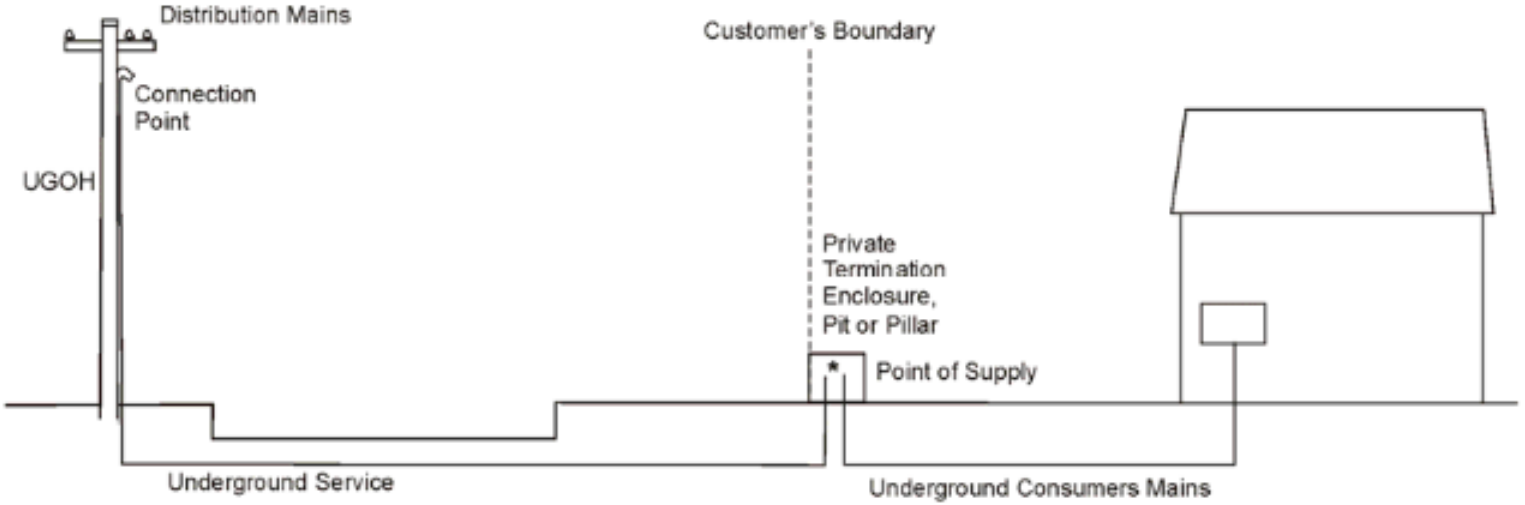

Fig PF-6-2-2(d) – Supply from Overhead Distribution Mains via Underground Service and Consumers from Overhead Mains on Electricity Distributers Pole

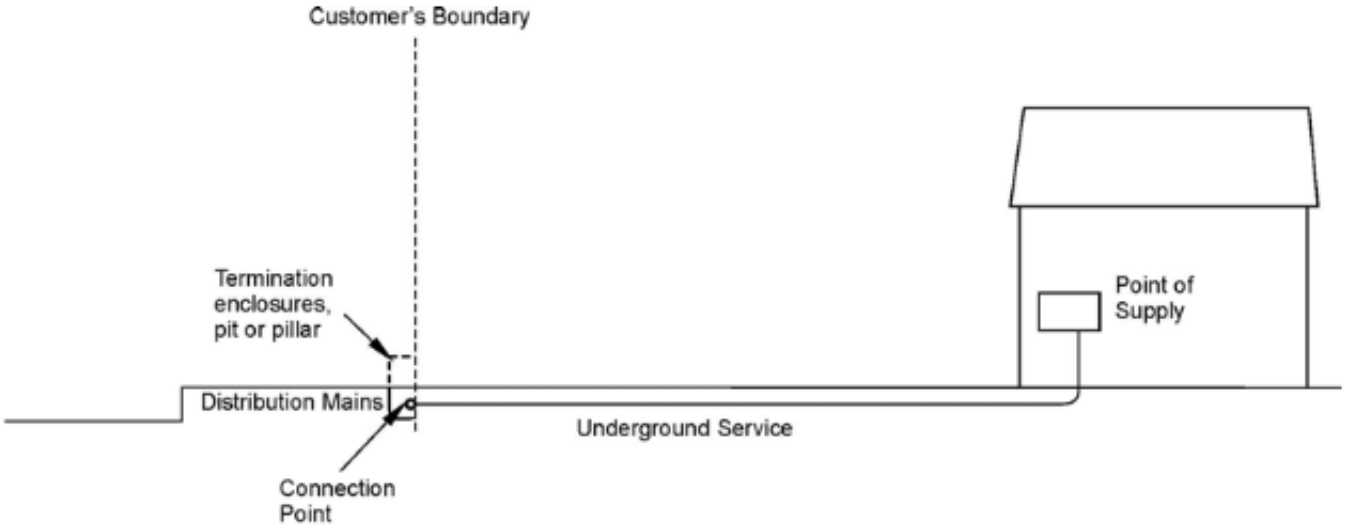

Fig PF-6-2-3(a) – Supply from Underground Distribution Mains via Underground Service

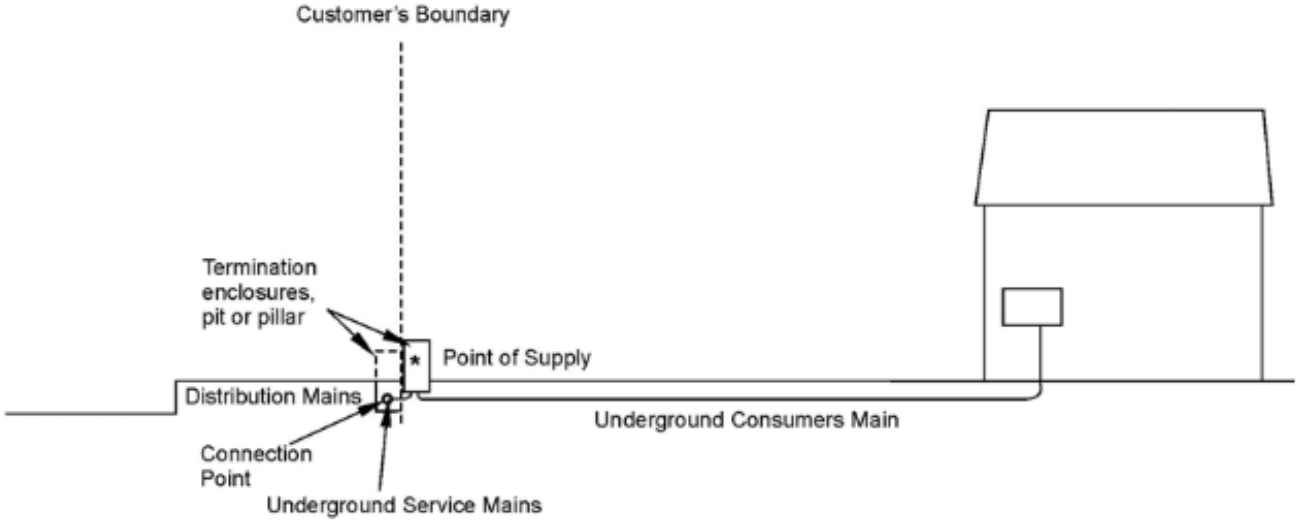

Fig PF-6-2-3(b) – Supply from Underground Distribution Mains via Underground Service and Unde

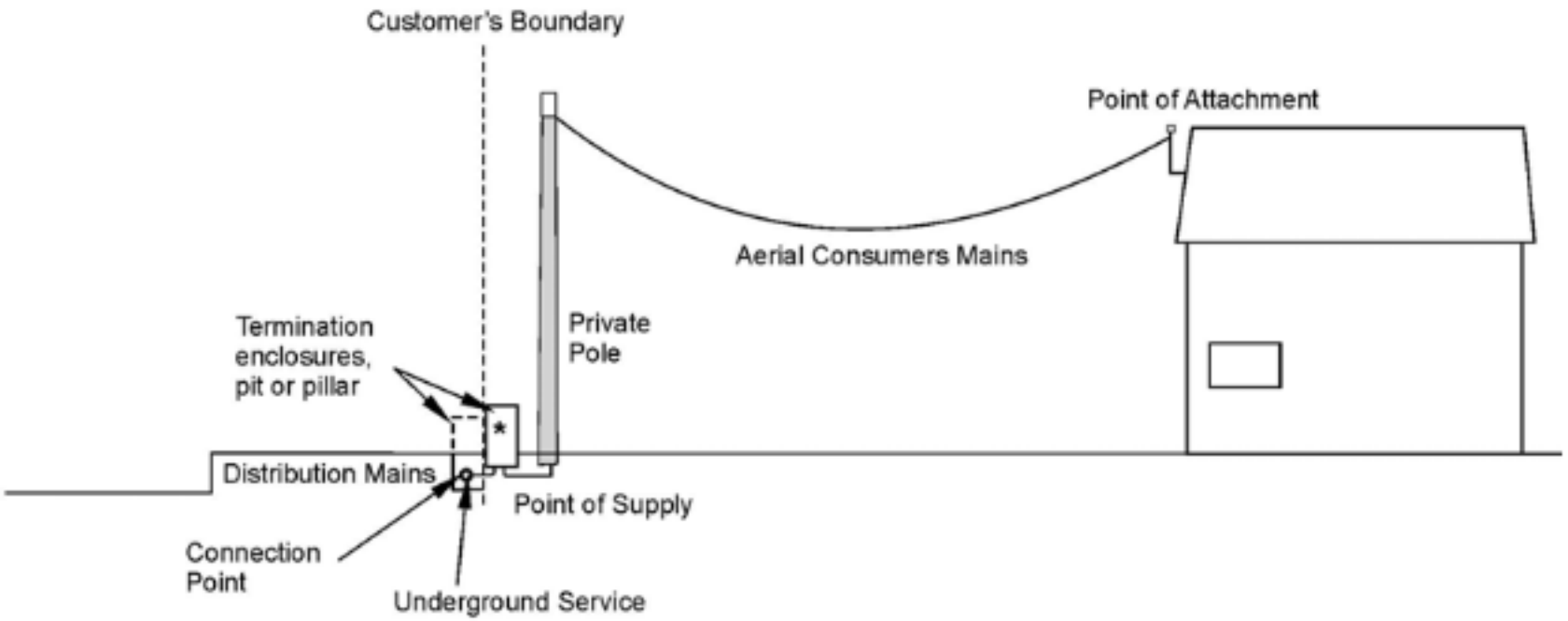

Fig PF-6-2-3(e) – Supply from Underground Distribution Mains via Underground Service and Aerial Consumers Mains

MAXIMUM DEMAND ON CONSUMERS MAINS (DOMESTIC)

METHODS OF DETERMINING MD

- The MD of consumers mains and sub mains is the subject of Clause 2.2.2 of AS/NZS 3000:2007 and may be determined by:-
  - measurement (only possible in existing installations);
  - calculation, using Appendix C of AS/NZS 3000:2007;
  - limitation by fixed current circuit breaker;
  - assessment (used for unusual loads, or installations where the number and type of loads is not known) (See Table C3 of AS/NZS 3000:2007)
  - The supply authority may set minimum cable sizes and types and installation conditions for consumer's mains.

MAXIMUM DEMAND ON CONSUMERS MAINS (DOMESTIC)

UNDERGROUND CONSUMER'S MAINS

- All underground services must be 4-wire 3-phase, except for single domestic premises, duplexes and builder's services.
- In these cases a 2-wire 1-phase service is permissible provided the service cable does not require a direct buried joint.

MAXIMUM DEMAND ON CONSUMERS MAINS (DOMESTIC)

UNDERGROUND CONSUMER'S MAINS

- Service cables must be XLPE insulated PVC sheathed, and be comprised of either:
  - Single core cables; or
  - One 4-core circular cable; and
  - Must comply with AS/NZS 4026:2001.
- Service cables with a cross-sectional area (CSA) of 240mm^2 must be of 4-core aluminium, XLPE insulated, PVC sheathed construction.
- Single core cables shall only be connected at pillars or to service tails.

MAXIMUM DEMAND ON CONSUMERS MAINS (DOMESTIC)

OVERHEAD CONSUMER'S MAINS

- Overhead service cable must comply with AS/NZS 3560.1 *Electric cables - 'XLPE insulated-aerial bundled -For working voltages up to an including 0.6/1 kV*.

MAXIMUM DEMAND ON CONSUMERS MAINS (DOMESTIC)

CALCULATION OF MD

- Calculation is the simplest method of determining MD

  NOTE: For installations supplied by 2 or 3 phases the MD must be calculated for each active conductor separately

  The 1-phase loads must be arranged so that the loads in each phase are balanced to within specified limits (25 A is the maximum difference allowed by Clause 1.10.3 of **Ref. R-5-C**).

  The MD in the consumer's mains (or sub-mains) is the MD of the highest loaded active conductor.

MAXIMUM DEMAND ON CONSUMERS MAINS (DOMESTIC)

CALCULATION OF MD

- Many loads in an installation are not always turned on at the same time allowing for application of some 'diversity‘ in determining the MD
- Effectively this means that cables smaller than that required to carry the total connected load may be selected

MAXIMUM DEMAND ON CONSUMERS MAINS (DOMESTIC)

LOAD GROUPS AND CONTRIBUTION TO MD

When calculating MD in consumer's mains and sub-mains:-

- Individual loads are allocated to load groups
- Each load group is assessed as contributing a value of current to the MD
- The assessed contribution to the MD of each load group is given in Table C1, Table C2 and Clause C2.5.2 of AS/NZS 3000:2007
- The MD per phase is the sum of the contributions by all the load groups on that phase supplied by that active conductor.

MAXIMUM DEMAND ON CONSUMERS MAINS (DOMESTIC)

LOAD GROUPS AND CONTRIBUTION TO MD

- For determining maximum of final sub-circuits tables C4 to C6 of AS/NZS 3000:2007 apply.
- Local supply authorities stipulate the maximum total load for single and two phase supplies, e.g.:
  - Up to 100A : 1-phase
  - 100A to 200A : 2-phase
  - Greater than 200A or where 3-phase equipment installed : 3-phase

MAXIMUM DEMAND ON CONSUMERS MAINS (DOMESTIC)

LOAD GROUPS AND CONTRIBUTION TO MD

- Calculations must be done separately for each conductor and only for the loads connected to it.
  - Column 2 of Table C1 of AS/NZS 3000:2007 gives instructions for each load group in single domestic installations (consumers mains) or individual home units in a block (sub mains).
  - Columns 3, 4 or 5 of Table C1 of AS/NZS 3000:2007 gives instructions for each load group in multiple domestic installations .

MAXIMUM DEMAND ON CONSUMERS MAINS (DOMESTIC)

LOAD GROUPS AND CONTRIBUTION TO MD

- Column 2 of Table C2 of AS/NZS 3000:2007 gives instructions for each load group in non-domestic residential installation such as hospital, hotels etc.
- Column 3 of Table C2 of AS/NZS 3000:2007 gives instructions for each load group in non-domestic installation such as factories, shops, offices.
- The contributions of each load group for each conductor are added together to obtain the MD in each active conductor.
- A check is made to ensure the load across all conductors is balanced to satisfy the local supply authority and may need to be re-arranged if necessary

MAXIMUM DEMAND ON CONSUMERS MAINS (DOMESTIC)

LOAD GROUPS AND CONTRIBUTION TO MD

- **Ref R-6-C** (1.10.3) stipulates that in a multiphase installation there should be no more than 25A difference between highest and lowest phases:
- The electricity distributor may agree to other limits.

EXAMPLE Ex-6-2-1
MD of Single Domestic Installation

Calculate the maximum demand of the single phase consumer's mains for a single domestic dwelling (house) with the following loads:-

15 - lighting points;

16 - double 10A sockets outlets (doubles count as 2);

4 - single 10A socket outlets;

1 - 4.6 kW storage type hot water system;

1 - 11.4 kW cooking range.

Solution to EXAMPLE Ex-6-2-1
MD of Single Domestic Installation

- **Maximum Demand is: 62.8A**
- For detailed procedure in arriving at the above answer see Workbook Chapter 6, Topic 6-2

MAXIMUM DEMAND ON CONSUMERS MAINS (DOMESTIC)

MULTIPLE DOMESTIC INSTALLATIONS

- The MD of consumer's mains in multiple domestic premises (blocks of home units) is calculated using columns 3, 4 or 5 of Table C1 of AS/NZS 3000:2007.

Unit Loads

- Unlike single domestic installations where MD is assesses based on the number and rating of loads, multiple domestic MD is assessed based on either a fixed value (e.g. 15A total for ranges in load group C, column 3) or assigned values per unit (e.g. 2.8A/unit for load group C column 4)

MAXIMUM DEMAND ON CONSUMERS MAINS (DOMESTIC)

MULTIPLE DOMESTIC INSTALLATIONS

Community Loads.

- Loads in common areas (foyers, stairwells, etc) are covered in load groups H to M.
- In large blocks the community loads may be connected over three phases (due to lifts, and other 3-phase loads)
- In smaller blocks, the supply authority may allow connection of these loads to single phase only.
- If this is the case the number of units per phase may need to be assigned to allow for community loads.

EXAMPLE Ex-6-2-2

MD of Multiple Domestic Installation

Determine the Maximum Demand of the consumer's mains for a block of 24 home units connected across three phases. Each unit is fed with single phase supply only. Each unit has the following load:-

- 11 - lighting points;
- 7 - double socket outlets;
- 3 - single socket outlets;
- 1 - 15A socket outlet;
- 1 - 9.2kW range;
- 1 - 4.4 kW storage water heater.
- There is no communal load

Solution to EXAMPLE Ex-6-2-2
MD of Multiple Domestic Installation

- **Maximum Demand is: 132.2A per phase**
- For detailed procedure in arriving at the above answer see Workbook Chapter 6, Topic 6-2
- For this example, as the load is identical on each phase the load is balanced. The CSA of the consumer's mains can now be determined using AS 3008.1. Table C6 of AS 3000 does not specify cable sizes above 25mm^2

MAXIMUM DEMAND ON CONSUMERS MAINS (DOMESTIC)

MULTIPLE DOMESTIC INSTALLATIONS

Example of Load Balancing.

- A block of 24 home units, with 8 units connected per phase, and a community load of 35 amperes would have an out of balance in the maximum demands per phase of 35 amperes, outside the maximum of 25A.
- If the number of units per phase were reassigned as 9 units per phase on A and B phases, then 6 units plus community loads on C phase the balance would lead to a smaller difference in currents between highest and lowest loaded phases.

MAXIMUM DEMAND ON CONSUMERS MAINS (NON DOMESTIC)

- When calculation non domestic installations such as factories, shops and offices, table C2 of AS/NZS 3000:2007 is used.
- The load that is installed is more likely to be used more frequently than in a domestic installation, therefore less diversity is applied.
- The contribution to the maximum demand of each load group will be closer to the connected load.

EXAMPLE Ex-6-2-3

MD of Industrial Installation

Determine the maximum demand of an industrial installation comprising:-

- 1 single phase 3.6kW storage water heater;
- 1 three phase 5 kW, 9A compressor;
- 1 three phase 4.1 kW, 8A milling machine;
- 1 three phase 2.2 kW, 5A lathe;
- 1 three phase 370W, 1A pedestal drill;
- 1 three phase 560W, 3A grinder;
- 1 single phase, 400V electric arc welder rated at 14A.
- 6 twin x 36W fluorescent lights rated at 0.46A each;
- 12 mercury vapour high bay lights rated at 1.8A each;
- 21 single phase double 10A socket outlets;
- 2 three phase 10A socket outlets;
- 2 15A single phase socket outlets;
- 2 three phase 20A socket outlets;
- 1 single phase 2.2kW instantaneous water heater;

Solution to EXAMPLE Ex-6-2-3 MD of Industrial Installation

- **Maximum Demand is:**

  A-phase 137.3A

  B-phase 142.7A

  C-phase 137.1A

- For detailed procedure in arriving at the above answer see Workbook Chapter 6, Topic 6-2

MAXIMUM DEMAND ON CONSUMERS MAINS (NON DOMESTIC)

ENERGY DEMAND METHOD

- Where the load details of equipment being installed in non domestic installations is unknown, an estimate is made using table C3 of AS/NZS 3000:2007 and then converting the VA value to a current using the formula:

$$I_L = \frac{S}{\sqrt{3}V_L}$$

where

I_L = the line current /MD in Amperes

S = the energy demand in VA

V_L = the line voltage of the supply in volts.

EXAMPLE Ex-6-2-4
MD of a Small Retail Complex

A small retail complex consisting of 3 shops at street level (280m^2 each) and 3 offices (250m^2 each) on the first floor. All shops and offices have reverse cycle air conditioning. Determine the maximum demand of this commercial installation.

Solution to EXAMPLE Ex-6-2-4 MD of a Small Retail Complex

- **Maximum Demand is: 140250 VA = 203 A per phase**
- For detailed procedure in arriving at the above answer see Workbook Chapter 6, Topic 6-2

MAXIMUM DEMAND ON SUB MAINS (DOMESTIC AND NON DOMESTIC)

- The methods used to calculate the MD of sub-mains are exactly the same as for consumer's main as stated in AS/NZS 3000:2007 clause 2.2.2;
  - Calculation
  - Assessment
  - Measurement
  - Limitation
- The only variation is that only the load connected to the sub-main is included in the calculation of the sub-main.

MAXIMUM DEMAND ON SUB MAINS (DOMESTIC AND NON DOMESTIC)

SUB-MAINS IN SINGLE DOMESTIC INSTALLATIONS

- In modern domestic installations the space available on the customer's main switchboards has decreased.
- Supply authorities are requiring larger "foot prints" for metering equipment.
- There has also been an increase in the number of final sub-circuits and protection devices such as 2-pole combination RCD/MCB and voltage surge diverters fitted in main switch boards.

MAXIMUM DEMAND ON SUB MAINS (DOMESTIC AND NON DOMESTIC)

SUB-MAINS IN SINGLE DOMESTIC INSTALLATIONS

- It is now common practice in larger installations, to run a sub-main to a location such as the garage or kitchen.
- A distribution board placed in the kitchen shortens the runs of a majority of the final sub-circuits, reducing cost and provides the convenience to customer of not having to go outside to reset a tripped circuit breaker.
- Sub-mains are also used to supply out buildings such as granny flats or garages.

MAXIMUM DEMAND ON SUB MAINS (DOMESTIC AND NON DOMESTIC)

SUB-MAINS IN SINGLE DOMESTIC INSTALLATIONS

- Unlike consumer's mains, sub-mains are **electrically protected** at their origin.
- The nominal rating of the protection device is set by the sub-mains MD.
- Column 2 of Table C1 in AS/NZS 3000:2007 is used to calculate the MD.
- For multiple domestic installations, each unit is treated as a single domestic installation for the purpose of calculating MD for sub-mains

MAXIMUM DEMAND ON SUB MAINS (DOMESTIC AND NON DOMESTIC)

SUB-MAINS IN NON-DOMESTIC INSTALLATIONS

- The procedure to determine the maximum demand of sub-mains in a non domestic installation is the same as for consumer's mains, but only the load in that section of the building is included.

EXAMPLE Ex-6-2-4

Non Domestic Energy Demand Method

A small retail complex consisting of 3 shops at street level (280m^2 each) and 3 offices (250m^2 each) on the first floor. All shops and offices have reverse cycle air conditioning. Determine the maximum demand of the sub-main supplying the individual shops and offices.

Solution to EXAMPLE Ex-6-2-4
Non Domestic Energy Demand Method

Shop Maximum demand :

28000 VA = 41 A per phase

Office Maximum demand :

18750 VA = 28 A per phase

- For detailed procedure in arriving at the above answer see Workbook Chapter 6, Topic 6-2


END