# NS109

## Design Standards for Overhead Developments

February 1998

**Amendments included from:** CIAs 1122 Jul 2000, 1129A Sep 2000, 1223 Apr 2002, 1250A Jun 2002, NSAs 1262 Jul 2002, 1293 Sep 2003, 1297 Aug 2003, 1310a Oct 2003, 1317A Nov 2003, 1325 Mar 2004

SUMMARY

Network Standard NS109 provides the design criteria for 415V and 11kV overhead supply reticulation systems.

ISSUE

This Standard is subject to amendment by Ausgrid at any time.

**Ausgrid staff:** This Standard is for issue to all staff involved with the design and installation of overhead supply reticulation systems.

Where this document is issued as a controlled document replacing an earlier edition; remove and destroy the superseded document.

**Accredited Service Providers and Contractors:** This document is issued on an uncontrolled basis. It is the user's responsibility to ensure that the document being used is current and includes all amendments issued since the date on the document.

Ausgrid offers a subscription service, which provides for updates and amendments to standards on payment of an annual fee.

Current network standards are also available on Ausgrid's Internet site at www.ausgrid.com.au.

DISCLAIMER

This Standard 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. Any proposed deviation from this Standard must be submitted to Ausgrid for approval before it is implemented.
It is the responsibility of all persons involved to ensure that a safe system of work is employed and that statutory requirements are met.

Ausgrid will not accept any liability for work carried out to a superseded standard. Ausgrid may not accept work carried out which is not in accordance with current standard requirements.

Ausgrid's standards are subject to ongoing review. It is possible that conflict may exist between standard documents. In this event, the most recent standard is to prevail.

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 were 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.

# Network Standard
# NS109
# Design Standard
# For Overhead Supply Developments
# February 1998

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# 1. DEFINITIONS

| | |
|---|---|
| **Easements** | An easement is a right of a definite limited character secured by one party to use a portion of land which is owned by another party. Common examples are rights of way, drainage easements and easements for services. Easements are created in accordance with the Conveyancing Act and the Real Property Act. Easements may be created for a definite period of time or in perpetuity. |
| **Leases** | A lease is a contract by which one party, the lessor, usually in consideration of rent, conveys exclusive possession of land or premises to another party, the lessee, for a specified time. The rights and obligations of both parties are usually set out in a lease document. |
| **Licences** | A licence in relation to land or premises may convey similar rights to a lease, the consideration generally being described as a fee. The existence of a licence is not recorded on a certificate of title. |
| **Low Voltage Distributor** | An electricity line rated at 1000V AC which originates at the low voltage end of a distribution substation and serves to convey electrical energy to end users via their service mains. Low voltage distributors are constructed in public roadways or through easements on private land. |
| **Pole** | Overhead mains conductor support, substantial composed of either wood, concrete or metal. |
| **LV Link** | A 3 phase set of individual overhead links which serve as a switching point using removable links. |
| **Overhead Service mains** | The dedicated overhead mains extending from the overhead low voltage distribution network to customers point of attachment. |

| | |
|---|---|
| **Service Enclosure** | An enclosure providing a point of connection of service mains to the low voltage network. A service enclosure can be either a pillar or a pillar-standard. |
| **Street Alignment (or Building Line)** | The boundary line between the dedicated roadway and the adjoining subdivision lots. This is also known as the building line. |
| **Lot Boundary** | The dividing boundary line between adjoining lots. |
| **Street Lighting Customer** | The Body controlling the standard of lighting and responsible for the applicable Street Lighting charges.<br><br>For dedicated roadways, the Street Lighting customer is the local Council, and for Community Land Title developments under the Community Land Development Act, 1989 it is the Community Association responsible for that particular development. |
| **Accredited Service Provider** | An Accredited Service Provider is an individual or an entity which has responsibility for the design and construction of the electricity reticulation installation, and which enters into an agreement/contractual arrangement with accredited personnel and/or Ausgrid for developing the installation. An Accredited Service Provider could be a developer, accredited contractor or customer. |
| **Customer** | A customer is an individual or an entity who is an end-user of electricity. |

## 2. 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 Occupational Health and Safety Act 2000 (NSW) together with the Occupational Health and Safety Regulation 2001 (NSW) and confirm in writing that all products supplied to Ausgrid contain no Asbestos related materials.

# 3. GENERAL

Distribution Centres and the electricity reticulation systems in overhead supplied developments must be installed in accordance with the requirements of this Network Standard and all design and construction standards and specifications referenced in this document or issued by Ausgrid.

Detailed design of electricity reticulation systems depends on assessed maximum demands, building and street layouts, street lighting requirements and other local factors. The design information and parameters specified in this Network Standard provide for minimum acceptable standards. Any deviations from this specification must be submitted to Ausgrid for approval before they are implemented.

Where new developments take place in overhead reticulated areas, Ausgrid will determine the extent of undergrounding of existing overhead mains that may be necessary. For new subdivisions, dedicated roadway sites for future substations and cable easements for future use may also be required by Ausgrid. For underground supply requirements refer to NS112.

Street lighting design may form part of the low voltage system design in new developments and must conform to the requirements of both the street lighting customer and Ausgrid. Approval of the street lighting customer for the applicable street lighting charges must be obtained first before construction work commences. Refer also to NS118 *Design and Construction Standards for Public Lighting (Sydney)* and NS119 *Design and Construction Standards for Public Lighting (Hunter and Newcastle).*

All future rail crossings (overhead or underground) should allow for all poles or the ends of ductlines to be located OFF rail property wherever possible.

Poles should be located in the road either side of a rail crossing, provided Rail's technical requirements on maximum span lengths etc permit this.

Ducts should be run the full width of the rail corridor, finishing just outside the rail property boundary. Note that this does not necessarily require a bore across the entire width of rail land, only that the ductline protecting any cables should continue the entire width of the crossing, so that the need to enter rail land for works is minimised.

Where new works on existing crossings permit, advantage should be taken of the opportunity to extend ductlines or relocate poles where this is appropriate. Any such projects should be referred to Network Asset and Investment Management for a decision on what work should be included in these cases.

This document should be read in conjunction with the Electrical Standards and Network Standards in Appendix G *References*.

# 4. RESPONSIBILITIES

During the course of supply negotiations the Accredited Service Provider shall provide all information to allow Ausgrid to determine the most appropriate method of supply. Ausgrid will prepare and provide design information sufficient to enable design and construction drawings to be completed.

The Accredited Service Provider is responsible for the design, supply of some materials and construction of the electricity reticulation system (including substations) to supply the new development as detailed in Ausgrid's Electrical Standard ES10 *Requirements for Electricity Supply to Developments*. The Accredited Service Provider can use either Ausgrid staff or Accredited Contractors to complete the electrical design and construction for which he/she is responsible, as detailed in Electrical Standard ES4 *Service Provider Authorisation*. Reference should be made to Ausgrid's Electrical Standard ES9 *Agreement for Supply to Developments*. The Accredited Service Provider is also responsible for providing local authorities and the RTA (as appropriate) with copies of the proposed construction plans at least 40 days before work is to commence, and must comply with any special requirements of these authorities. Refer also to Network Standard NS104 *Network Project Design Plans*. In addition, where other authorities such as the State Rail Authority or Waterways Authority have jurisdiction over land or water impacted by development, special additional conditions may apply. As these may vary from time to time, current applicable conditions must be checked at the time of the development.

The customer (end user) is responsible for supplying and installing the portion of service mains from the street alignment to the customer's terminals in accordance with the NSW Service and Installation Rules and Ausgrid's Local Service and Installation Rules.

# 5. DESIGN INFORMATION

## 5.1 Methods of Supply

There are four approved methods of supply. The appropriate choice to be utilised is dependent on the assessed and foreseeable maximum demand of the development.

The decision as to the most appropriate method of supply will be made by Ausgrid as part of the supply negotiation phase. This initial step in the process of establishing an electricity supply involves exchange of details pertaining to the development between the developer and Ausgrid. The options for electricity supply are:

- Service from the existing low voltage reticulation system - nominally 415/240V. This may provide for the connection of services (overhead or underground) rated at 100, 200, 300 or 400 amps.

  This method of supply is limited by the available capacity of the existing reticulation system and the associated distribution substations.

  Reference should be made to the NSW Service and Installation Rules and Ausgrid Local Service and Installation Rules.

- Direct Distributor - nominally 415/240V.

  Overhead mains taken from a distribution substation remote from the customers premises which can usually supply up to 400 amps. This method of supply is restricted by voltage drop and the capacity of the distribution substation. As well as interference consideration.

- Customer Substation - nominally 11000V/415/240V.

  Ausgrid may determine that the existing network is unable to meet the Accredited Service Providers supply requirements. Therefore, in accordance with the NSW Service and Installation Rules, the Accredited Service Provider may be required to provide a suitable space and approved easement or lease to accommodate Ausgrid transformer(s), pole, switchgear and other associated equipment. Generally supply by this method will be restricted to the capacity of a 400kVA substation rated appropriately for the load cycle imposed by the customer, however larger installation may be possible.

  A list of all distribution substation types and their approximate ratings is as detailed in Appendix B.

  Where supply is taken direct from a customer substation, the customer's main switchboard shall, wherever practicable, be located immediately adjacent to the substation. If the customer's main switchboard cannot be located immediately adjacent to the substation, the proposed location must be approved by the local Ausgrid Customer Supply Planning Section before the design proceeds.

  Refer also to Note 8 of Appendix B.

- High Voltage Supply - nominally 11kV, 33kV and 66kV.

  Consideration will be given to application for high voltage supply where, in the opinion of Ausgrid, it satisfies technical or economic considerations and the customer is able to safely operate and maintain the high voltage network. This option is not available in some areas and is restricted to premises with single customers. Where this option is considered a possibility and the supply voltage is higher than 11kV, Ausgrid will provide the design information to the developer as required on a project specific basis..

## 5.2 Underground/Overhead Policy

Refer to Section 6 of ES 10 *Requirements for Electricity Supply to Developments* for details of Ausgrid's overhead and underground mains policy.

The general guidelines for the form of construction for each development shall be determined by Ausgrid and shall be in accordance with the prevailing Policy of the time. The final interpretation and decision as to the type of construction to be used shall be Ausgrid's, notification of the type of construction shall be issued in the design information.

## 5.2.1 Materials to be used for Construction

Materials to be used for all overhead construction works are to be equivalent or superior in terms of total life time performance as those issued and used by Ausgrid. Where materials are intended to be supplied that are not sourced directly from Ausgrid or do not meet Ausgrid's specifications, these shall be indicated for assessment during the design checking phase, i.e.; the design shall be assessed for compliance with this standard on the basis that materials and equipment to be used are of equivalence to that which would be used and supplied by Ausgrid

Where materials are sourced from other then Ausgrid evidence of compliance with Ausgrid's specifications or manufacturer certificate of equivalence to that supplied Ausgrid shall be required.

Designers intending to use alternate materials are advised to discuss this situation with Ausgrid's Engineering Group before making such decisions for evaluation of the alternatives proposed. There will be a charge for these services based on the fees established by the Independent Pricing and Regulatory Tribunal.

## 5.3 Overhead Construction

### 5.3.1 Cables and Ratings

Standard cables approved by Ausgrid for use in overhead network design covered by this standard are described below. Refer to Appendix K for cable nomenclature.

### 5.3.2 Reporting Potentially Dangerous Conditions

If the Level 3 Accredited Service Provider (Designer) during the design phase, or the Level 1 or 2 Accredited Service Provider during the pre-job hazard assessment check, or during the progress of work, believes that a pole or other network component may be in an unsafe or dangerous condition, the pole or other component must be reported immediately to the local Customer Supply Office for assessment and remedial action.

Refer to Ausgrid's *Electrical Safety Rules* Clause 6.2 for requirements for immediately dangerous situations, such as fallen mains that may be alive.

## 5.4 Conductor Rating

### 5.4.1 11kV

Thermal rating for overhead bare conductors shall be calculated in accordance with ESAA D(b)5 Current Rating of Bare Overhead Line Conductors using a wind velocity of $1.0ms^{-1}$ for Sydney and $0.5ms^{-1}$ for the Hunter Valley. The maximum design temperature shall be $75^{o}C$.

### 5.4.2 Low Voltage

Thermal rating for overhead bare conductors shall be calculated in accordance with ESAA D(b)5 Current Rating of Bare Overhead Line Conductors using a wind velocity of $1.0ms^{-1}$ for Sydney and $0.5ms^{-1}$ for the Hunter Valley. The maximum design temperature shall be $75^{o}C$.

LV Aerial Bundled Conductor (LVABC) shall be designed for the conditions specified above, but with a maximum operating temperature of 80°C.

### 5.4.3 Overhead Services

Overhead services shall be installed in accordance with Appendix A of the New South Wales Service and Installation Rules 1996.

**Service Cables**

Will be in accordance with those indicated in Ausgrid's Local Service and Installation Rules.

**Street Lighting Cables**

For conventional street light standards, the minimum cable standard is 16mm$^2$ two-core copper, XLPE insulated PVC sheathed cable. Four core 16mm$^2$ copper, XLPE insulated, PVC sheathed cables may be used.

Dedicated street lighting circuits shall not be used in overhead developments. Street lights shall be supplied direct from the low voltage network via photo electric cells.

### 5.4.4 Cable Installation and Bonding

All civil work, construction and bonding of cables must be carried out in accordance with:

| | |
|---|---|
| NS125 | *Specification for Low Voltage Overhead Conductors* |
| NS126 | *Specification for High Voltage Overhead Conductors* |
| NS128 | *Specification for Pole Installation and Removal.* |

## 5.5 Distribution Substations

### 5.5.1 Types and Ratings

Supply negotiations between the client and Ausgrid may conclude that a distribution substation is required to satisfactorily supply the development. Substation options available and conditions of use are detailed in Appendix B.

Overhead networks may be used to supply underground supplied kiosk or chamber type substations. Details of these substations should be obtained as required from the relevant network standards.

For types and ratings of pole mounted substations, refer to Network Standard NS122 *Pole Mounted Substation Construction*. For types and ratings of kiosk type substations, refer to Appendix B of this Network Standard and the additional information in Network Standard NS112 *Design Standards for Commercial / Industrial Developments*.

J type and H type kiosks are generally not suitable for industrial, commercial or high / medium density domestic supply areas. Approval for the use of J type or H type kiosks in other than low density domestic supply areas will be at the discretion of Ausgrid.

In the case of pole mounted substations and other single transformer substations, interruptions to supply will be necessary for periodic maintenance of equipment and will occur in the event of equipment failure.

Unless approved otherwise by the Manager – Network Assets; K type and I type kiosks and single transformer high voltage circuit breaker controlled substations are restricted to installations for single industrial customers or single commercial customers. Intending customers should be made aware of the regular supply interruptions required for maintenance of these substations.

In the case of multiple transformer substations, the appropriate ratings given in Appendix B are firm ratings based on one transformer out of service. Maintenance or failure of transformer or transformer associated equipment can generally be accommodated without restriction of supply. Loads in excess of the firm rating (up to the non-firm rating) can be accommodated by some substation options but will have the following consequences:

- Load must be restricted to allow periodic maintenance of each transformer.
- An interruption to supply for failure of any transformer or associated equipment will occur. However, restricted supply can be given normally within approximately one hour by re-energising healthy transformers.

The minimum design and construction requirements for pole mounted substations, kiosk substations, surface chamber, basement chamber and upper level substations are as defined in the following network standards:

NS113 *Site Selection and Civil Design Standards for Chamber Type Substations*
NS114 *Electrical Design Standards for Chamber Type Substations*
NS115 *Electrical Construction Standards for Chamber Type Substations*
NS116 *Design Standards for Distribution Earthing*
NS117 *Design Standards for Kiosk Type Substations*
NS122 *Pole Mounted Substation Construction*
NS128 *Specification for Pole Installation and Removal*
NS140 *Construction Standards for Kiosk Type Substations - Sydney Region*
NS141 *Specification for Site Selection for Kiosk Type Substations*
NS142 *Construction Standards for Kiosk Type Substations - Hunter Region.*
NS167 *Pole Positioning*

### 5.5.2 Substation Siting

Where maximum demand information is available at the time of subdivision development, and the required substation sites are able to be decided during the early stages of development, these sites shall form part of the dedicated roadway and shall be shown on the subdivision survey plan as unencumbered, obstruction free sites.

The substations shall be sited close to the load centre to fully utilise the substation capacity. The electrical network designer shall also consider any requirements to feed future extensions to the subdivision.

Ausgrid reserves the right to approve or reject proposed sites.

All necessary approval shall be obtained for the proposed siting of any pole mounted substations. Particular concern must be given to the potential aesthetic impact of the proposed site as well as future access requirements. NS143 (Network Standard for Easements) should be consulted whenever other than dedicated roadway is proposed for such installations.

Kiosk substations must be sited in compliance with Network Standard NS141 *Specification for Site Selection for Kiosk Type Substations*.

Where substation sites cannot be decided during the early stages of development, substation site leasing arrangements will be negotiated between Ausgrid and the Developer when supply requirements are better defined.

## 5.6 Vegetation Clearances

Vegetation clearances must be in accordance with the requirements of Network Standard NS179 *Vegetation Safety Clearances*.

# 6. NETWORK CONFIGURATION

## 6.1 11kV Overhead Feeders (also 22kV)

Overhead 11kV networks shall be formed as radial feeders with normally open line switches to alternate feeds from adjacent radial feeders. Closed rings are not permitted for overhead 11kV feeders.

The feeders shall be formed as 3 phase 3 wire lines supplying distribution transformers having high voltage delta-connected windings. Single phase distribution transformers may only be connected line to line.

Underground cable sections may be tee connected or looped into the overhead feeder and may supply kiosk or chamber type substations. The feeder so formed however will be treated as an overhead feeder for operating and protection purposes.

Single wire earth return systems (SWER) are not covered by this standard.

## 6.2 33kV and 66kV Overhead Feeders

Subtransmission 33kV and 66kV overhead feeders may be configured as radial feeders but usually will be formed as closed rings or multi-feeder networks. Where 33kV feeders are used to supply distribution transformers (33kV/415V) they will be configured as radial feeder.

At this level of the Network design of feeders and their protection will be individually engineered by Ausgrid.

## 6.3 132kV Overhead Feeders

132kV overhead feeder arrangements and their protection will be individually engineered by Ausgrid.

# 7. PROTECTION OF HV OVERHEAD NETWORKS

Protection of all overhead high voltage feeders will be provided by Ausgrid at the source substation or intermediate substation by relaying and circuit-breakers.

## 7.1 11kV/22kV Feeders

These feeders will normally be provided with the following:

- 3 phase overcurrent
- earth fault
- high set instantaneous overcurrent
- sensitive earth fault
- an earth fault indicator.

Reclosing will be provided at the source substation initiated by all protection other than sensitive earth fault. The reclosing will be one reclose attempt after a nominal 10 second delay and then lock-out. Reclosing will be rendered non-operative:

- during switching between feeders
- during live line work
- during tree trimming
- on bushfire designated feeders on days of high fire danger.

Back-up protection will be provided in one of several ways.

This protection will improve limitations in the design of the feeder configuration as follows:

- a minimum conducted size will be nominated by Ausgrid for the particular feeder depending on fault levels and protection clearing times. This also applies to any underground cable connected and to the cable sheath
- a maximum feeder impedance will be specified or engineered to ensure minimum fault levels at feeder extremities is adequately detected by protection including back-up protection. All designs must account for these aspects and will be checked for compliance.

## 7.2 Line Fuses

Line fuses may occasionally be used on 11kV and 22kV feeders but their use is kept to an absolute minimum.

## 7.3 Line Reclosers

Pole mounted line reclosers will be used in overhead distribution feeders where nominated by Ausgrid. These will be of a type complying with Ausgrid's specification and will provide protection, reclosing, and remote control (SCADA) facilities.

## 7.4 33kV, 66kV and 132kV Feeders

Protection will be provided by Ausgrid at source substations and zone substations. In general, duplicate protection will be provided comprising a relocation of either distance, pilot wire, overcurrent and earth fault, and intertripping relay.

In most cases suitable pilot cables will be required with 33, 66 or 132kV feeders for protection and intertripping functions and also communications. These pilot cables may be overhead or underground and will be secure, high insulation cables.

Reclosing will not be used on 33, 66 or 132kV feeders as a matter of policy except for a small number of individually approved cases.

# 8. PROTECTION OF LOW VOLTAGE OVERHEAD NETWORKS (415V)

All 415V overhead bare conductor or aerial bundled conductor (ABC) networks are to be protected by current limiting HRC fuses at the distribution substation.

Fuse types and application are to be in accordance with Ausgrid's Technical Instruction TS4200 *Fuse Standards* in the former Sydney Electricity area and with Orion Energy's Technical Instruction 4208 in the former Orion area. The fuse size to be used will be nominated by Ausgrid's liaison officer in accordance with the above documents.

**Note:** TS4200 and Orion equivalent are not public domain documents.

The maximum rating fuse to be used on an overhead low voltage network or distributor is 400A and all fuses shall be fast characteristic as defined in TS4200. Small rating distributor fuses shall be used in small transformer installations as defined in TS4200.

There are limitations on the use of ABC conductors for protection reasons. The maximum impedance of LV network to the extremity of the ABC conductor is defined as follows:

**Table 1: Fault protection maximum cable lengths**

| **Fuse** | **Max loop impedance** | **Max distributor length** | | |
|---|---|---|---|---|
| **Size** | **for the distributor** | 1 x 95 | 2 x 95 | 1 x 150 |
| 400A | 160 + j32 mΩ | 200m | 400m | 300m |
| 200A | 280 + j56 mΩ | 350m | 700m | 530m |
| 100A | 720 + j144 mΩ | 900m | - | 1360m |

**Note:**

1. Refer to TS 4200 Fuse Standards for fuse sizes.
2. The loop impedance of a LV distributor is defined as the total impedance, measured from a Distribution Centre to the network extremity, of a phase conductor plus the return neutral or other phase conductor.
3. The maximum distributor length do not take into account voltage drop considerations.
4. The intention is to clear the worst possible faults in approximately 10 seconds. Fuse clearing times are based on the slowest characteristic compatible with Ausgrid's specified bandwidth for fuse time-current characteristics.
5. Source impedances at the commencement of the distributors have been taken as 6 + j24 mΩ, 85 + j150 mΩ and 165 + j290 mΩ for the 400A, 200A and 100A fuses respectively. These represent long overhead feeders with reasonably high transformer impedances.

   The above maximum distributor length could be exceeded for a particular situation provided that the 10 second clearing time is maintained.
6. The above lengths are based on the maximum loop impedance for a distributor with a constant cable configuration, i.e. 1 or 2 cables per phase for their entire length. Where a mixed configuration is used an equivalent proportional length can be used, eg, 200m of parallel cable and 100m of single cable for a 400A fuse (see Figure 1).

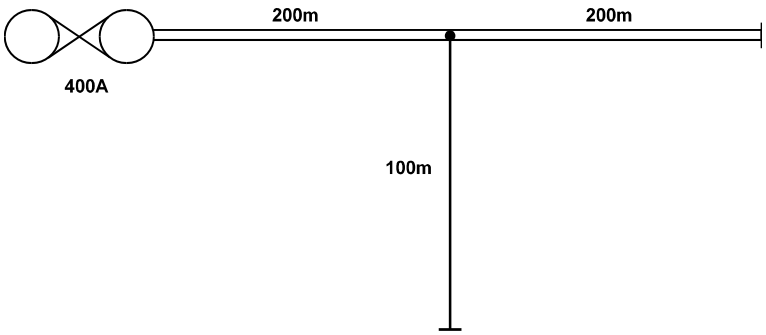



**Figure 1 - Mixed cable configuration**

# 9. INSULATION CO-ORDINATION AND OVERVOLTAGE PROTECTION

In general Ausgrid's overhead line designs and standards are based on co-ordinated levels of insulation withstand voltages for the various line configurations and equipment types together with the correct application of surge arresters. Failure performance of the installation is very adversely affected by apparently minor departures from construction standards affecting clearances or configuration.

The basic insulation levels applying to the standard designs are:

for 11kV

- open wire line BIL 130-150kV
- line switches and fuses 100-120kv
- reclosers 110-120kV
- transformers and substation switchgear 75 or 95kV

Principles to be followed are:

- Every pole substation to have surge arresters at the transformer HV terminals
- Every pole substation and ground substation to have surge arresters at the transformer terminals or LV busbar.
- Every HV underground to overhead connection shall have surge arresters fitted.
- All surge arresters must comply with Ausgrid's specifications and AS 1307 and shall in particular comply with the specification in respect to:
  - spark performance
  - shattering performances.
- Surge arresters are to be installed at line reclosers.
- No surge arresters are to be installed at line switcher or links (except for metal enclosed line switches - no longer to be used.)
- Earthing systems shall comply with the requirements of Network Standard NS116.
- Pin insulators on timber crossarms are not to be bonded together (as this reduces BIL and does not make use of the one-quenching properties of timber).

## 9.1 Earthing

All substations are required to have an accompanying electrode type earthing system suitable for its purpose.

The earthing electrodes for Pole Mounted substations are generally installed in the dedicated Roadway or easement area surrounding the pole base.

Special earthing designs and segregation limits may be required in situations relating to swimming pools, communication centres, petrol and liquid fuel centres etc. For the principles of earthing, reference can be made to EC5 Electricity Council of NSW document *Guide to Protective Earthing*.

The design and construction of all earthing systems forming part of the works to be vested to Ausgrid shall comply with Network Standard NS116 *Design Standards for Distribution Earthing*.

## 9.2 Street Lighting

Street lighting equipment to be installed in association with Overhead supplied developments will be determined by the requirements of the Street Lighting Customer (the local council for streets to be dedicated, or the Community Association in the case of Community Land Title developments under the Community Land Development Act 1989).

Lighting requirements should be determined at an early stage of negotiations between the Electricity reticulation Designer and the Street Lighting Customer. Design parameters which need to be identified include the standard of lighting to be provided and any preferences for lamp types and sizes, luminaire types and standards, and any other requirements for street lighting furniture.

All lighting designs must be referred to Ausgrid for approval. The submission must include a schedule of all street lighting furniture and associated hardware proposed to be used.

Approval of the customer to accept annual charges for the proposed street lighting must be obtained before construction work commences.

The design and construction of street lighting in Industrial/Commercial developments shall comply with Network Standard NS*118 Design and Construction Standards for Public Lighting (Sydney) and NS119 Design and Construction Standards for Public Lighting (Hunter)*.

# 10. DESIGN PARAMETERS

## 10.1 Assessment of Maximum Demand

**Individual Customer Development**

The demand shall be assessed by Ausgrid based on appropriate diversity factors being applied to a submitted list of the Accredited Service Providers maximum demands for all items of equipment. These factors should be used in conjunction with discussions with the Accredited Service Provider to ensure there are no mitigating circumstances that would negate or reduce their use.

If a full list of connected loads is not initially available Ausgrid will nominate a load density value in VA per square metre for floor area used.

It is also essential that the assessed maximum demand appropriately incorporates any definitive plans that the Accredited Service Provider has for expanding or augmenting the development in the foreseeable future.

## 10.2 Maximum Low Voltage Distributor Loading

The following design criteria for the initial electrical loading on low voltage distributors must be satisfied:

The designed maximum load on any distributor must not exceed 75 per cent of the distributor's nominal rating, unless nominated by Ausgrid. This provides a reasonable margin for load growth and paralleling requirements. Distributors are nominally rated in accordance with the ambient temperature, the temperature rating of the style of construction and type of conductor and associated cross sectional area materials used.

- The load to be connected to a distribution centre must be balanced across the distributors and their respective phases, unless agreed otherwise.

## 10.3 Maximum Voltage Drop

The ultimate voltage level to be maintained at the customer terminals should be ±6% of the normal 240V supply at full load.

The designed maximum voltage drop in a low voltage distributor must not exceed 9V at the extremities when the distributor is loaded to 75% of its nominal rating.

**Note:** Service mains are not regarded as part of the distributor.

The voltage drop in the service mains must not exceed 1% at full load.

The Maximum three Phase Volt Drop Constants for Distributor and Service must be calculated and supplied with the design details.

## 10.4 Quality of Supply

The designer shall ensure that his design is satisfactory to supply customer equipment that has the potential to cause interference to other customers. Arc furnaces, welding machines, X ray units and frequently started large motors are examples of equipment that can cause excessive fluctuation of voltage. The design shall comply with the limits specified in the New South Wales Service Rules, Clauses 9.8 to 9.14 and meet the requirements of the flicker curves" shown in Appendix D.

The assessment of step voltage fluctuations is usually made using conservatively high system characteristics and the equipment is regarded as suitable for connection to the system if the point showing the voltage drop and frequency fluctuation is below the curve designated “Border line of Irritation” for industrial areas, non urban areas and primary and secondary distribution systems supplying small populations. The threshold of perceptibility is generally used for transmission and subtransmission systems which supply large populations and for primary distribution systems requiring a high quality of supply. The threshold of objection is included for reference purposes.

## 10.5 Levels of Reliability

**Low Voltage**

Alternate supply to LV distributors must be provided from adjacent distribution centres where practicable. Each distributor will normally require two alternate points of supply to allow low voltage paralleling under maximum demand conditions.

Every opportunity must be taken to establish loop feeds where loop roadways exist ( ie interconnection between distributors from the same distribution centre or between different branches of the same distributor). Extension of distributors beyond that necessary to provide a paralleling path will not normally be required unless specified otherwise by Ausgrid.

**High Voltage**

During the course of supply negotiations Ausgrid will determine the minimum level of high voltage reliability required and provide this information as part of its design information. In doing so, Ausgrid will take into account the level of reliability of the existing network, type of existing construction (ie. overhead or underground), permissible number of 'Tee off connections” allowed, permissible number of substations on a radial supply (both on a temporary and permanent basis), future load growth, and any other network requirements. All costs associated with levels of reliability in excess of Ausgrid’s requirements shall be met by the Accredited Service Provider.

## 10.6 Network Design

The development of new Overhead Areas does not usually target certain industries or commercial ventures. So, electrical load requirements at the initial design and development stages are not known. This makes the task of designing for optimum performance for such developments an impossible task. In these circumstances, Network Designers will need to use previous experience and good judgement in their attempt to produce designs which are economically and operationally acceptable.

To help overcome these difficulties in the absence of reliable load information, the following guidelines should be followed.

- Substation(s), if initially considered necessary, should be strategically positioned to cater for immediate and medium term load requirements. The estimated maximum demand should be based on average developments of a similar nature maximum demand statistics. High voltage mains may be erected on the same poles as low voltage mains.
- Poles for Low voltage construction should be positioned, generally, every second property boundary on the optimum side of the roadway. The optimum side of the roadway is that side which would minimise the construction cost and ongoing maintenance requirements once service lead in poles and service mains are integrated into the whole development. Note the use o lead in poles in discouraged and will only be accepted by Ausgrid under the most extreme circumstances.
- The last pole of any radial Low voltage distributor shall be earthed in accordance with NS116 to ensure continuity of the MEN system.

- Street lighting design should be based on using conventional street lighting construction (or approved decorative lighting) in accordance with Ausgrid's Network Standard NS0118 - *Design and Construction Standards For Public Lighting Sydney and NS119- Design and Construction Standards For Public Lighting Hunter* and the requirements of the street lighting customer
- Services up to 400 Amps can be supplied from Overhead Distributors.

**Low Voltage Services**

The Accredited Service Provider is responsible for providing separate service mains to all lots in a new development.

Service mains must be installed from the pole nearest service point of attachment terminated inside the lot boundary. Refer to Ausgrid's Local Service and Installation Rules for more specific details of service requirements. Under no condition are service mains to cross over the boundary of any property other than that property for which the service is intended.

**Standard Symbols**

All design and conduction plans *will* use the standard symbols as shown in Appendix E.

# 11. LEASES, EASEMENTS AND RIGHT OF WAYS

Leases, licences, easements and right of ways are generally required where distribution centres and mains that will be vested to Ausgrid on completion of the works, are not sited on dedicated roadway.

*Leases* - The requirements for leases and their duration are as listed below.

*Easements* - An easement generally clear of other construction is required for the installation and future maintenance of mains associated with substations. The width of an easement is normally 2 metres for direct laid cables or the approximate width of construction for pit and duct systems, and seven metres wide for overhead reticulation.

*Right of Ways* - A suitable access way, at least 1.2 metres wide is required for personnel and equipment to gain access to substations on private land.

Where required, easements must be provided by the Developer in favour of, and at no cost, to Ausgrid's easement sites must be free of encumbrances and satisfactory for their purpose. The complete restoration of landscaping within easement sites is the responsibility of the Developer.

The Developer must include details of all easements to be created in favour of Ausgrid on the final subdivision plan lodged with the Land Titles Office. If land involved with the required easements is not subject to sub-division, a separate Plan of Easement and the required Transfer of Grant shall be prepared.

Easements are to be created in accordance with:

| | |
|---|---|
| *For Torrens Title* | Section 88B of the Conveyancing Act, 1919 as amended |
| *For Community Title* | Section 36 of the Community Land Development Act, 1989. |

NS143 *Easements* further details Ausgrid's requirements for easements.

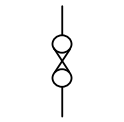
# APPENDIX A – KIOSK SITING DIAGRAMS

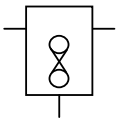
For kiosk siting diagrams and the requirements for siting of kiosk substations, refer to Network Standard NS141 *Specification for Site Selection for Kiosk Type Substations*.

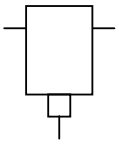
# APPENDIX B – DISTRIBUTION OPTIONS AVAILABLE FOR 11KV OVERHEAD SYSTEMS

The following table lists those substation arrangements which are permitted to be connected to 11kV overhead 3 phase systems. This includes the tee connection or looping-in by underground cable to overhead feeders. Protection requirements and limitations are also shown for each arrangement.

**Symbols**


Fuse: 11kV or LV


11kV ringmain fuse switch unit

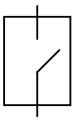

11kV ring main circuit-breaker switchunit

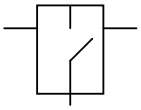

Transformer: 11kV/415V nominal

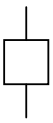

Low voltage link


Low voltage air circuit-breaker

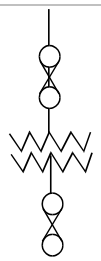
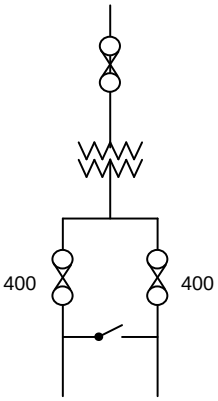
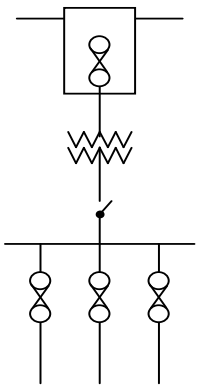
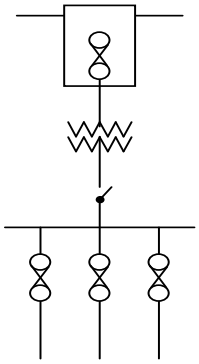

Current transformer

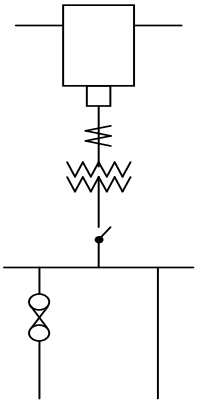
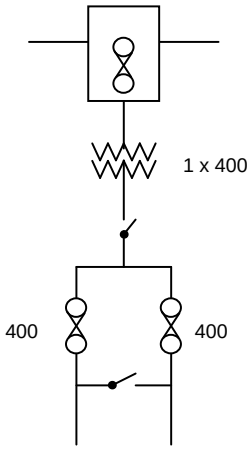
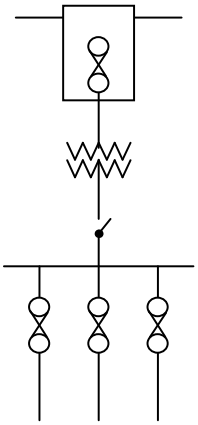

Isolating and earthing switch (City System only)

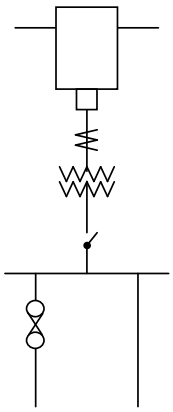
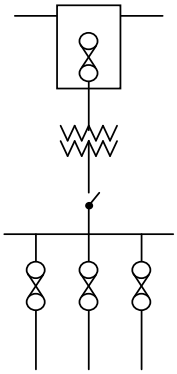
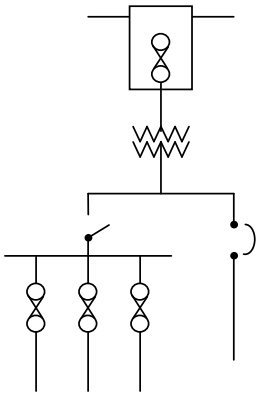

3-way isolating and earthing switch (City System only)

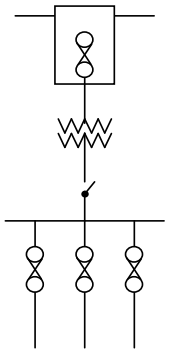
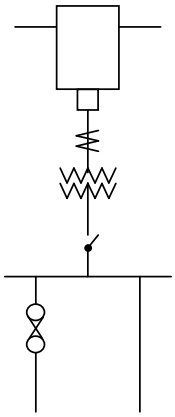
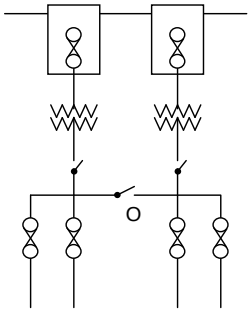

Circuit-breaker

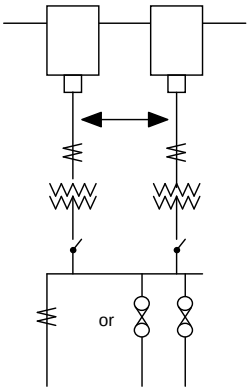
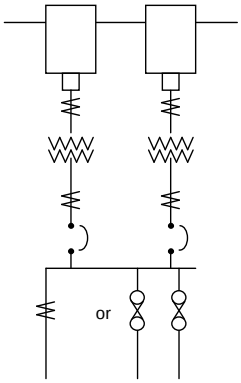
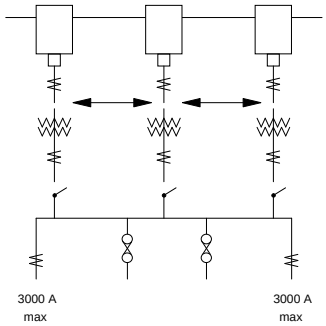

Metering Unit

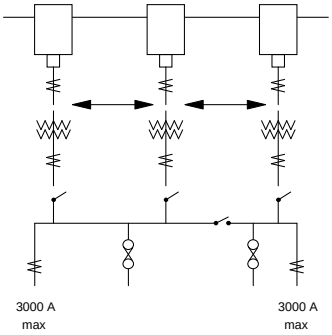
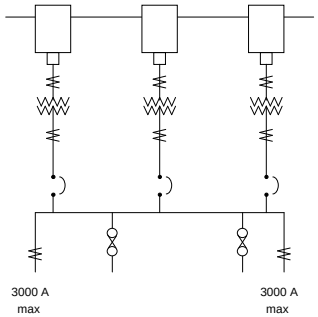
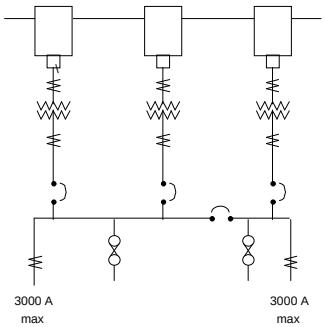
| Substation Type | Transformers kVA | Approximate Rating Amps per phase (Refer to Note 3) | Application |
|---|---|---|---|
|  | From 10kA single phase to 200KVA 3 phase | | |
| **Pole Substation**   | From 1 x 100 up to 1 x 400 | 600 | Overhead 11kV and LV areas only |
| **Kiosk Substation** J Kiosk  | 1 x 160<br>1 x 315<br>1 x 400<br><br>Refer to Clause 5.4.3 for fuse options. | 200<br>400<br>600 | Underground 11kV radial or closed network feeders.<br>Refer also to limitations on usage, in Clause 5.5.1. |
| L Kiosk  | 1 x 400<br>1 x 600<br>1 x 800<br>1 x 1000<br><br>Refer to Clause 5.4.3 for fuse options. | 600<br>900<br>1100<br>1400 | Underground 11kV radial or closed network feeders. |

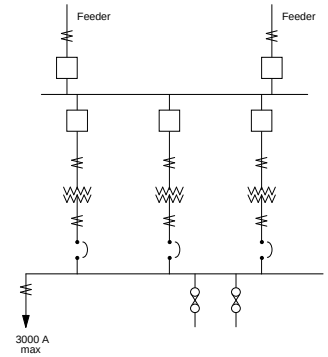
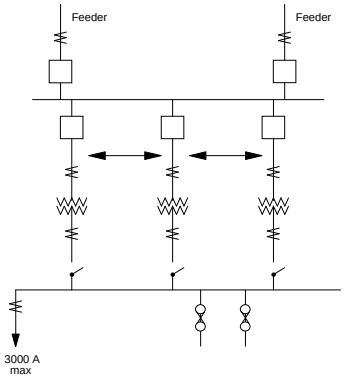
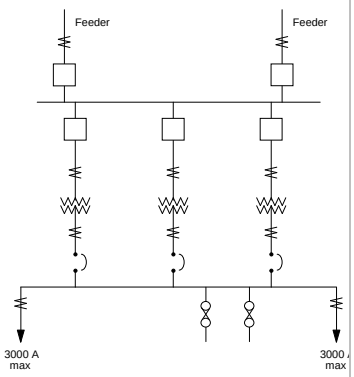
| **Substation Type** | **Transformers kVA** | **Approximate Rating Amps per phase** (Refer to Note 3) | **Application** |
|---|---|---|---|
| K Kiosk  | 1 x 1500<br><br>Refer to Clause 5.4.3 for fuse options. | 2000 | Underground 11kV radial feeders only.<br><br>Refer also to limitations on usage, in Clause 5.5.1. |
| H Kiosk   | 1 x 400 | 500 | Overhead 11kV radial feeder (Sydney Area only) |
| E Kiosk  | 1 x 400<br>1 x 600<br>1 x 750<br><br>Various LV fuse options from 3 x 400A up to 1 x 1200A | 500<br>800<br>1000 | Overhead 11kV radial feeder (Sydney Area only) |
| | | | |

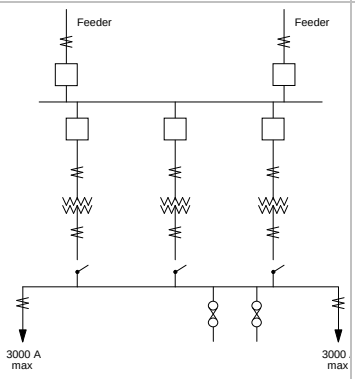
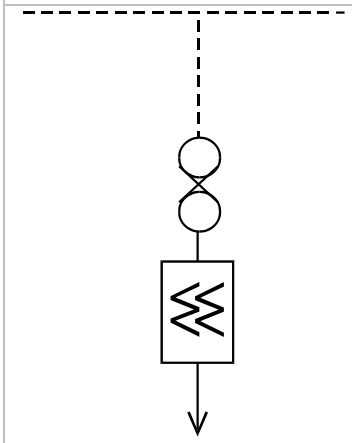
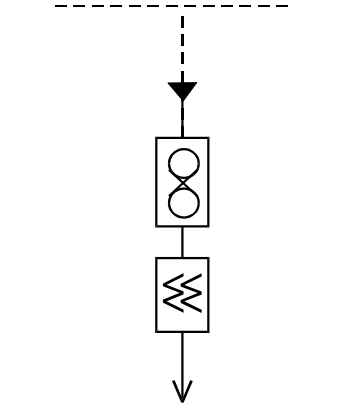
| Substation Type | Transformers kVA | Approximate Rating Amps per phase (Refer to Note 3) | Application |
|---|---|---|---|
| I Kiosk  | 1 x 1500<br><br>various LV fuse options up to 1 x 1600A or 2000A relay protected | 1900 | Overhead 11kV Radial Feeders (Sydney or Newcastle area) Not after Recloser<br><br>Refer also to limitations on usage in Clause 5.5.1. |
| Small Orion Kiosk  | 1 x 315<br>1 x 500<br><br>Various LV fuse options up to 3 x 315A | 400<br>700 | Overhead 11kV Radial feeders (Newcastle area only) |
| Large Orion Kiosk  | 1 x 800<br>1 x 1000<br><br>Various LV fuse options and/or circuit breaker | 1100<br>1400 | Overhead 11kV Radial feeders (Newcastle area only) |
| **Chamber Substations** | | | |

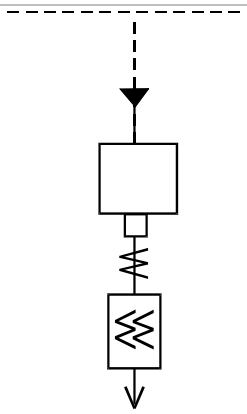
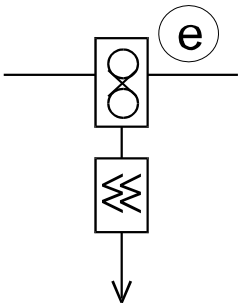
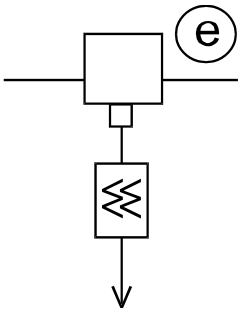
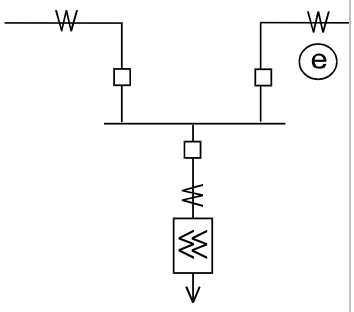
<table>
<tr><th>Substation Type</th><th>Transformers kVA</th><th>Approximate Rating Amps per phase<br>(Refer to Note 3)</th><th>Application</th></tr>
<tr><td>Single Transformer<br>  </td><td>Up to 1 x 1000<br><br>Various LV fuse options up to 1 x 1600A</td><td>1300</td><td>Overhead 11kV Radial Feeders</td></tr>
<tr><td rowspan="2">  </td><td rowspan="2">1 x 1500<br><br>Various LV fuse options up to 1 x 1600A or 2000A Relay Protected</td><td>2000</td><td>Overhead 11kV Radial Feeders only. Not after Recloser</td></tr>
<tr><td colspan="2">Unless approved otherwise by the Manager – Network Assets, single transformer high voltage circuit breaker controlled substations are restricted to installations for single industrial customers or single commercial customers. Intending customers should be made aware of the regular supply interruptions required for maintenance of these substations.</td></tr>
<tr><td>Two Transformer<br>  </td><td>2 x 750<br>2 x 1000<br><br>Various LV fuse options up to 1 x 1600A per transformer</td><td>1400 (Firm)<br>1800 (Firm)</td><td>Overhead 11kV Radial Feeders</td></tr>
<tr><td colspan="2">Notes: The bus section links must be normally open.<br>The arrangement shown is only permitted with Ausgrid “H” type board construction.</td></tr>
<tr><td></td><td>2 x 1500<br><br>11kV circuit breakers tripping parallelled</td><td>3000 (Firm)</td><td>Overhead 11kV Radial Feeders only. Not after Recloser</td></tr>
</table>

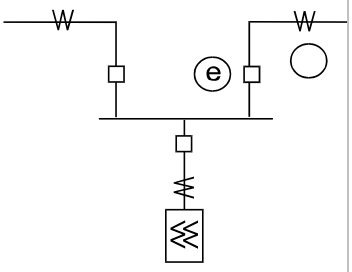
<table>
<tr><th>Substation Type</th><th>Transformers kVA</th><th>Approximate Rating Amps per phase<br>(Refer to Note 3)</th><th>Application</th></tr>
<tr><td> 
</td><td>Various LV options up to 1600A fuses or 3000A relay protected busbar or cable supply</td><td colspan="2">Note:<br>This substation type is not available as a design option after 5/7/2000. Design instead for circuit breakers on the low voltage side of the transformers.</td></tr>
<tr><td> 
</td><td>2 x 1500<br><br>Various LV options up to 1600A fuses or 3000A relay protected busbar or cable supply</td><td>3000 (Firm)</td><td>Overhead 11kV Radial Feeders. Not after Recloser</td></tr>
<tr><td>Three Transformer<br> 
</td><td>11kV circuit breakers tripping parallelled<br>3 x 1500<br><br>Various LV options up to 2 x 3000A busbar or cable supplies</td><td>5500 (Firm)</td><td rowspan="2">Overhead 11kV Radial Feeders. Not after Recloser<br><br>Load must be restricted to 2600A total for outage of No. 2 RM Unit</td></tr>
<tr><td colspan="2">Note:<br>This substation type is not available as a design option after 5/7/2000. Design instead for circuit breakers on the low voltage side of the transformers.</td></tr>
</table>

| Substation Type | Transformers kVA | Approximate Rating Amps per phase (Refer to Note 3) | Application |
|---|---|---|---|
|  | 11kV circuit breakers tripping parallelled<br>3 x 1500<br><br>Various LV options up to 2 x 3000A busbar or cable supplies | 5500 (Firm) | Overhead 11kV Radial Feeders. Not after Recloser<br><br>LV Bus Section Link to be opened before outage of No. 2 RM Unit |
| | | **Note:**<br>This substation type is not available as a design option after 5/7/2000. Design instead for circuit breakers on the low voltage side of the transformers, and a bus section circuit breaker. | |
|  | 3 x 1500<br><br>Various LV options up to 2 x 3000A busbar or cable supplies | 5500 (Firm) | Overhead 11kV Radial Feeders. Not after Recloser<br><br>Load must be restricted to 2600A total for outage of No. 2 RM Unit |
|  | 3 x 1500<br><br>Various LV options up to 2 x 3000A busbar or cable supplies | 5500 (Firm) | Overhead 11kV Radial Feeders. Not after Recloser<br><br>LV Bus section link to be opened before outage of No. 2 RM Unit |
| **High Voltage Switched Substations (Chamber Type)** | | | |

| Substation Type | Transformers kVA | Approximate Rating Amps per phase (Refer to Note 3) | Application |
|---|---|---|---|
|  | 1, 2 or 3 x 750<br>1, 2 or 3 x 1000<br>1 or 2 x 1500<br><br>Various LV options up to 1 x 3000A busbar or cable supply and/or fused supplies up to 1600A | | Overhead 11kV Radial Feeders. Not after Recloser |
|  | 1, 2 or 3 x 750<br>1, 2 or 3 x 1000<br>1 or 2 x 1500<br><br>11kV circuit breakers tripping paralleled<br><br>Various LV options up to 1 x 3000A busbar or cable supply and/or fused supplies up to 1600A | | Overhead 11kV Radial Feeders. Not after Recloser |
| | | **Note:**<br>This substation type is not available as a design option after 5/7/2000. Design instead for circuit breakers on the low voltage side of the transformers. | |
|  | 3 x 1500<br><br>LV options up to 2 x 3000A busbar or cable supplies and/or fused supplies up to 1600A | 5500 (Firm) | Overhead 11kV Radial Feeders. Not after Recloser |
| | 11kV circuit breakers tripping paralleled<br><br>3 x 1500 | 5500 (Firm) | Overhead 11kV Radial Feeders. Not after Recloser |

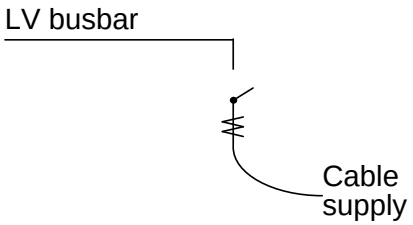
| Substation Type | Transformers kVA | Approximate Rating Amps per phase (Refer to Note 3) | Application |
|---|---|---|---|
|  | LV options up to 2 x 3000A busbar or cable supplies and/or fused supplies up to 1600A | **Note:** This substation type is not available as a design option after 5/7/2000. Design instead for circuit breakers on the low voltage side of the transformers. | |
| **High Voltage customers (from 11kV Overhead Feeders)** | | | |
|  | | | |
|  | Fuse Switch | | |

| Substation Type | Transformers kVA | Approximate Rating Amps per phase (Refer to Note 3) | Application |
|---|---|---|---|
|  | Circuit Breaker plus Isolator | | |
|   | | | |
|   | | | |
|   | May require Feeder protection | | |

| Substation Type | Transformers kVA | Approximate Rating Amps per phase (Refer to Note 3) | Application |
|---|---|---|---|
|  | | | |

**Notes:**

1a. Where 3000A cable supplies are used as an alternative to 2000A to 3000A busbar supplies, isolating links are required.




1b. Length limitations, positioning restrictions and restrictions on exit points from the substation apply to busbar and cable supply options.

2. All substation arrangements shown are nominally 11kV/415V.

3. Unless indicated otherwise, the ratings are based on transformers operating on a commercial load cycle and a system primary voltage of 11 kV. They are to be taken as a guide only to the ratings that are generally obtainable. Actual ratings will depend on the particular substation equipment installed and other factors including protection requirements and ventilation limitations. Actual ratings will be as determined by Ausgrid.

4. In the event of failure of plant or periodic maintenance, load taken by the premises supplied from a substation connected to a suburban network, will be restricted to that which can be met by the supply capacity which can be provided at the time.

5. Supply at high voltage is not available to customers in the area served by the City system zones.

6. The type of high voltage switchgear installed will depend on the transformer rating, the type of substation and whether the substation is supplied from a closed or radial network system.

7. The Ausgrid Liaison Officer or Negotiating Officer may specify that LV isolation links are to be installed between the LV busbar and 1200 / 1600 Amp bolted fuse panels, to avoid or reduce interruptions to other customers, e.g. when the bolted fuses are being replaced.

   The links are not to be used to break load current.

8. Except where permitted in accordance with Note 9 of Appendix B, the route length of consumers mains supplied directly from a customer substation (see Clause 5.1), must not exceed limits determined by Ausgrid, as follows:

   (a) For 2000 A to 3000 A busbar supplies, or alternative 2000 A to 3000 A cable supplies, the maximum route length permitted is nominally 5 metres, as indicated in Clause 10 of Network Standard NS114 *Electrical Design Standards for Chamber Type Substations.*(Note: Busbar or cable supplies above 3000 A are not permitted.)

   (b) For cable supplies connected to substation fuses, the maximum route length permitted depends on the rating of the substation fuses, the characteristics of the cables and fault current clearance criteria.

   The following limitations apply:

   - Substation fuses 1600 A – consumers mains route length not to exceed 5 metres.
   - Substation fuses 600 A to 1200 A inclusive – consumers mains route length not to exceed 30 metres.
     (Note: The 30 metres limitation applies in cases where the fuses and consumers mains cables are of similar nominal

current rating. Limitations in other cases will be as determined by Ausgrid.)

(c) For cable supplies other than in Note 8 (a), connected to substation circuit breakers (e.g. O type kiosks), or relay protected (e.g. I type kiosks), the maximum route length permitted depends on the substation circuit breakers, the characteristics of the cables and fault current clearance criteria. The following limitations apply:

- Substation circuit breakers 1600 A and above – consumers mains route length not to exceed nominal 5 metres.
- Substation circuit breakers 600 A and above, but less than 1600 A – consumers mains route length not to exceed 30 metres.

(Note: The 30 metres limitation applies in cases where the circuit breakers and consumers mains cables are of similar nominal current rating. Limitations in other cases will be as determined by Ausgrid.)

In each case, the route length of consumers mains includes the component within the substation.

9 Consumers mains having route lengths in excess of the limits specified in Note 8 of Appendix B, may be permitted by Ausgrid, provided electrical protection equipment is installed to meet the requirements of Ausgrid.

To comply with this requirement, it would be necessary for the customer to provide additional protection on the consumers mains and on the customer's main switchboard, to the satisfaction of Ausgrid.

# APPENDIX C - TABLES FOR ASSESSMENT OF MAXIMUM DEMAND

## C1 Typical Load Density Values (VA/m$^2$) for Different Types of Floor Area Usage (Nett Areas)

These load density values depend on many factors including:

(a) the effects of the outside environment on the building structure and type of air conditioning system;

(b) the effects of heat or electrical equipment loads within the premises;

(c) the proposed lighting design; and

(d) the degree of environment control and load management within the premises.

The figures in the Table below may be used as a guide only to typical load densities. Higher load densities may apply for some types of buildings and occupancies.

| Type of Development | | Range VA/m$^2$ | Average VA/m$^2$ |
|---|---|---|---|
| Offices - | - Not air-conditioned | 40-60 | 50 |
| | - air-conditioned - cooling only | 70-100 | 85 |
| | - reverse cycle | 60-90 | 75 |
| | - electrical reheat open areas | 80-120 | 100 |
| | - electrical reheat zonal or package units | 90-130 | 110 |
| | - variable volume | 60-80 | 70 |
| Car parking | - open air | 0-10 | 5 |
| | - ventilated | 10-20 | 15 |
| Warehousing | - unventilated | 5-15 | 10 |
| | - ventilated | 10-20 | 15 |
| Shops | - Not air-conditioned | 40-100 | 70 |
| | - air conditioned | 60-140 | 100 |
| Shopping centres (assumed air-conditioned shops) | - Not air-conditioned public areas | 60-140 | 100 |
| | - air conditioned public areas | 80-160 | 120 |
| Industrial | - light | 10-20 | 15 |
| | - if ventilated add | 10-20 | 15 |
| | - if air-conditioned add (see note) | 30-50 | 40 |
| Theatres, halls, etc | - ventilated | 50-70 | 60 |
| | - air-conditioned | 80-120 | 100 |
| Hotels, Taverns, Restaurants (Residential section, use Appendix C) | | 60-100 | 80 |

*Note: Medium and heavy industrial areas require full details of connected load before an assessment of demand can be made. Only uniformly distributed loads such as lighting and air-conditioning can be assessed using this area usage method.*

## C2 Provision for Future Load Growth

In order to make provision for future load growth, the following general allowances may be used:

(a) Residential premises; 10%.

(b) Fully air-conditioned, modern offices; 15-20%.

(c) Commercial premises where computer equipment not installed initially; 20-25%

(d) Shopping centres and zoned light/medium industrial premises; 25%.

Where advised of specific proposed future equipment to be connected, this should be diversified in order to ensure that the initial installation is adequate or can be economically up rated.

Undeveloped space should also be taken into account and if likely to be developed by the customer. Full discussion on the matter of future load growth is necessary to minimise the costs involved in future re-arrangement of supply.

*Note: Increased industrial production is frequently achieved by working longer hours rather than installing additional plant, and this has only a minimal effect on maximum demand.*

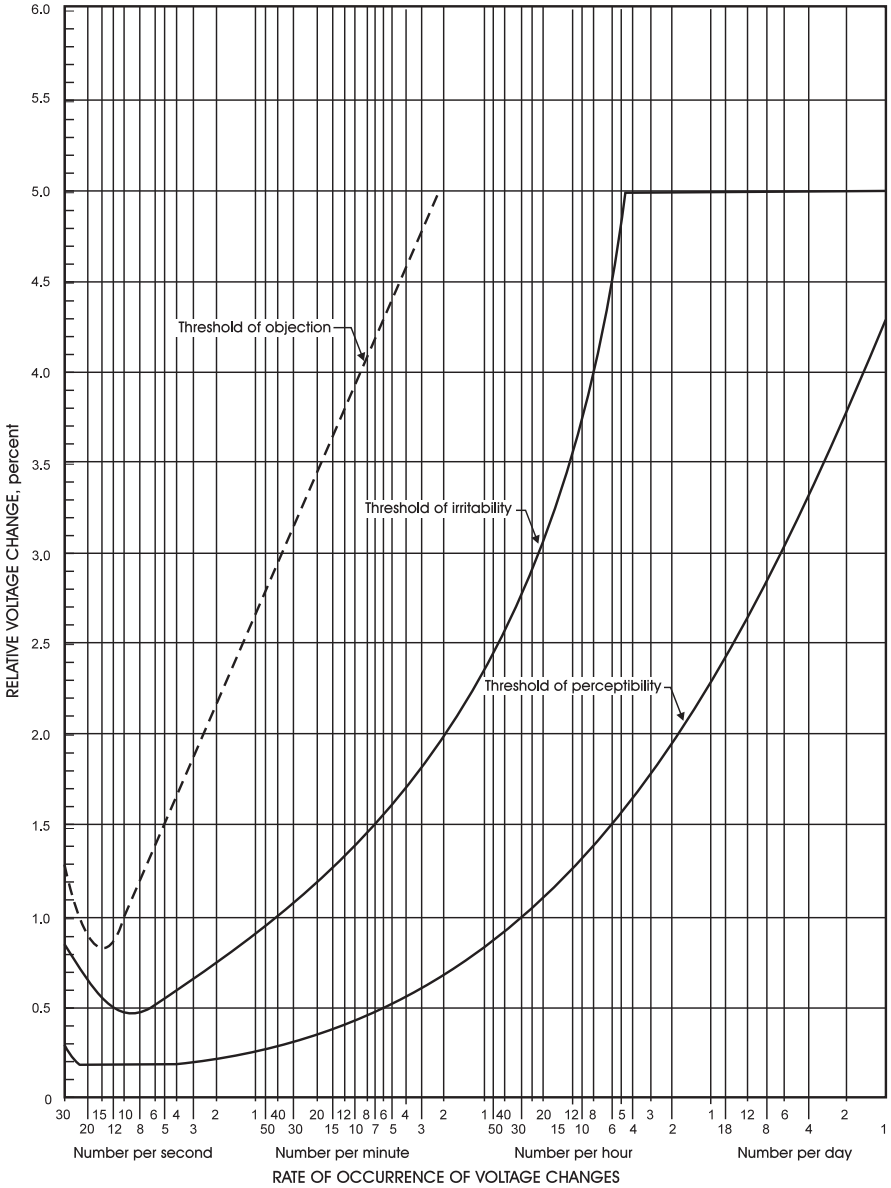
# APPENDIX D - FLICKER CURVES

**Voltage Fluctuations**

If load is switched frequently, it will result in voltage fluctuations above and below the supply systems' steady state values. These voltage fluctuations may cause visual flickering of light sources or even mal-operation of certain voltage sensitive equipment.

In determining whether equipment is suitable for connection to the supply system, the likely voltage drop which will result from the switching of equipment is assessed and the planned frequency of switching determined.

The following figure is based on a curve given in AS2279 Disturbances in Mains Supply Networks and is referred to in deciding if equipment is suitable for connection to the point of common supply with other customers.

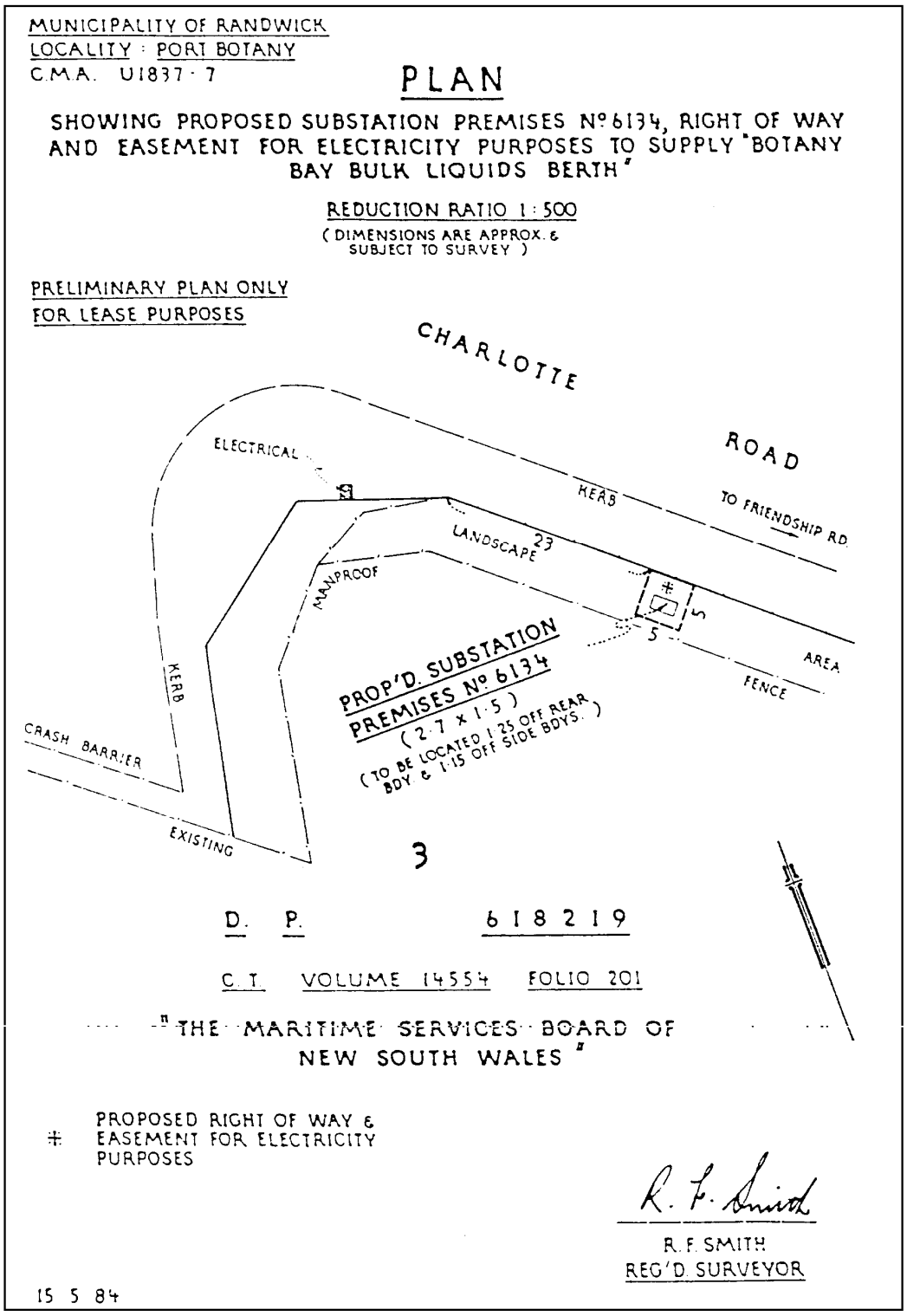


# APPENDIX E - STANDARD DRAWING SYMBOLS

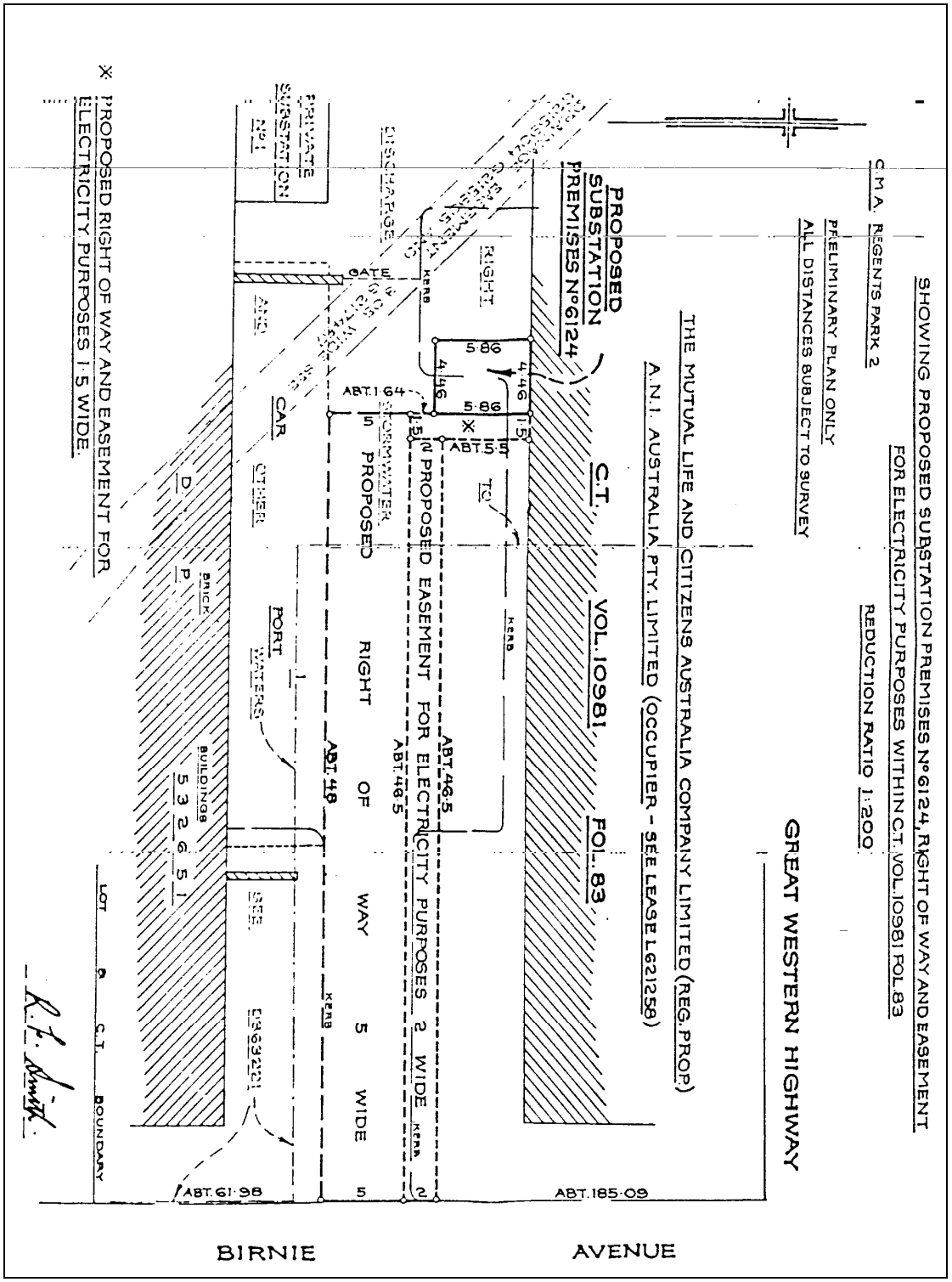
Refer to Network Standard NS104 *Network Project Design Plans* for standard drawing symbols.

# APPENDIX F - TYPICAL LAYOUT FOR LEASE, EASEMENT AND RIGHT-OF-WAYS

## F1



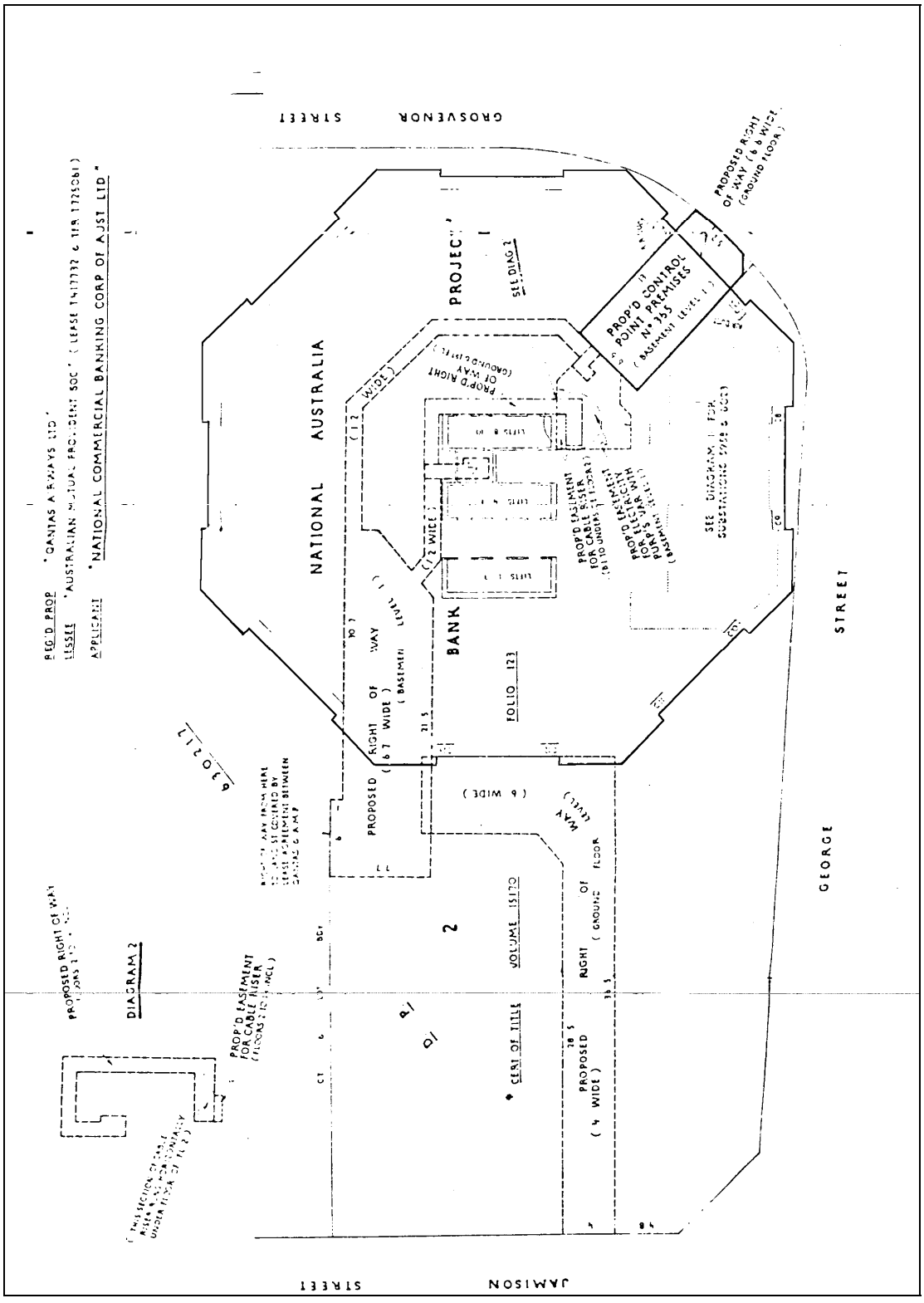
## F2 Surface Chamber in a Building



## F3

Deleted

F4 City Basement Switching Station and Two Upper Level Substations Part (1)



**F5**

CITY OF SYDNEY

LOCALITY WYNYARD

# PLAN

SHOWING PROPOSED SUBSTATION PREMISES Nos 5958 & 6023, CONTROL POINT N° 365, RIGHTS OF WAY, EASEMENT FOR CABLE RISER & EASEMENT FOR ELECTRICITY PURPOSES

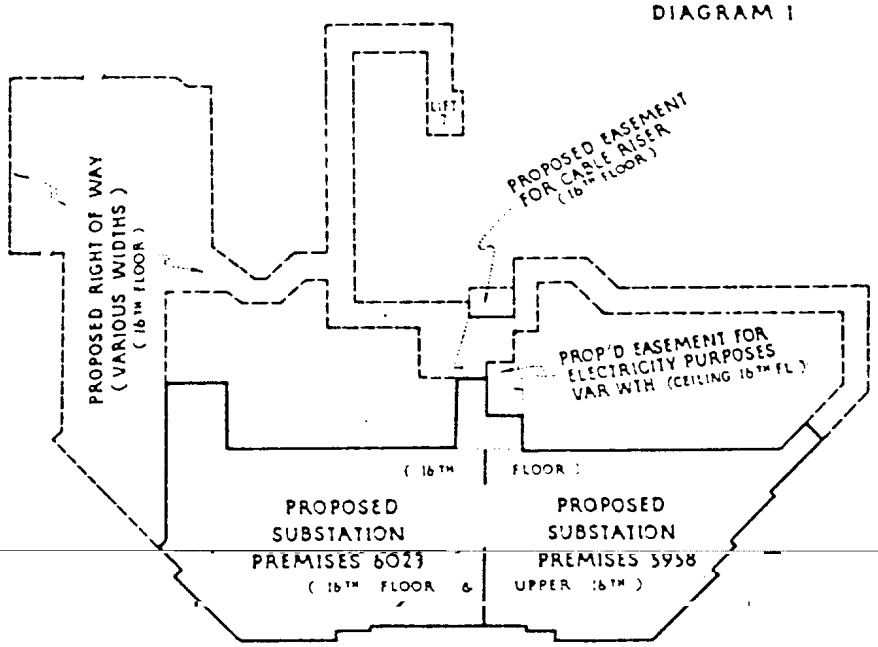
REDUCTION RATIO 1 200

( DIMENSIONS ARE APPROX & SUBJECT TO SURVEY )

PRELIMINARY PLAN ONLY

FOR LEASE PURPOSES

DIAGRAM 1




W. H. Thorne.

REG'D SURVEYOR

ROW ( 16TH FLOOR ) AMENDED - 8 10 84

11 8 84

SAW / 17C / 007 / 000 / 5958, 6023, KRS

# APPENDIX G - REFERENCES

**Electrical Standards**

| | |
|---|---|
| ES1 Part A | Customer Supply Information |
| Part B | Ausgrid's Local Service and Installation Rules |
| ES4 | Service Provider Authorisation |
| ES5 | Network Miscellaneous Connection Charges |
| ES8 | Capital Contributions and Recoverable Work Guidelines |
| ES9 | Agreement for Supply to Developments |
| ES10 | Requirements for Electricity Supply to Developments |

**Network Standards**

| | |
|---|---|
| NS104 | Network Project Design Plans |
| NS112 | Design Standards for Industrial/Commercial Developments |
| NS113 | Site Selection and Civil Design Standards for Chamber Type Substations |
| NS114 | Electrical Design Standards for Chamber Type Substations |
| NS115 | Electrical Construction Standards for Chamber Type Substations |
| NS116 | Design Standards for Distribution Earthing |
| NS117 | Design Standards for Kiosk Type Substations |
| NS118 | Design and Construction Standards for Public Lighting |
| NS127 | Construction Standards for Low Voltage Cable Joints and Terminations |
| NS129 | Construction Standards for High Voltage Cable Joints and Terminations |
| NS130 | Specification for Underground Cable Laying |
| NS140 | Construction Standards for Kiosk Type Substations - Sydney Region |
| NS141 | Specification for Site Selection for Kiosk Type Substations |
| NS142 | Construction Standards for Kiosk Type Substations - Hunter Region |
| NS161 | Specification for Testing of Cables after Installation |

# APPENDIX H - SPECIAL ELECTRICITY SUPPLY REQUIREMENTS FOR THE 2000 OLYMPIC SITES

## H1 Introduction

This guidelines document applies to all Olympic Games venues. Some of the guidelines apply only to venues located at Homebush Bay and these particular guidelines are necessary as a result of the large number of venues that share the major electricity supply infrastructure at Homebush Bay.

The strategy for Homebush Bay venues involves a greater diversity of electricity infrastructure, including providing the option of supply from either of two zone substations, an arrangement named the Dual Zone Concept. There is a full explanation of this dual Zone Concept in Section 2, Homebush Bay 11kV Supplies to venues.

There are operational constraints on Olympic venues that are more onerous than would apply to normal venues. An example is the constraint imposed on lighting levels during competitive events by sporting bodies, such as the IAAF and by television broadcasters. In general, lighting levels must be maintained at or above 50% of specified requirements throughout an event. Also, critical functions, such as timekeeping, scoreboards, data systems and emergency systems must remain continuously operational during events. The necessary reliability cannot be provided from the NSW State power grid alone. Other reliability initiatives, such as the use of Uninterruptible Power Supplies (UPS) and temporary local generation, are critical to meeting Olympic reliability requirements.

## H2 Reliability Guidelines - Dual Zone Concept

The Homebush Bay reliability strategy provides for two supplies from different zone substations but recognises they are not totally independent. Alternate, totally independent power for critical loads is required, provided by temporary generation, UPS equipment or other appropriate measures.

The reliability guidelines are:

(a) An integrated approach will be taken to electricity supplies to venues to ensure that the arrangements for supplying end use applications within the venues and the supply to the venues are effectively coordinated, to deliver the most cost effective and environmentally acceptable infrastructure solutions. Each design should be venue specific.

(b) Cables, acting as alternate supplies, should ideally be run by totally different routes. If different routes are not feasible or cost effective, segregation by concrete encasing, or other appropriate means, should be provided.

The use of rigid wall underground ducts (Class 6 or better) with at least one spare duct between ducts containing normal and alternate supplies, and sand backfill, is acceptable, subject to the ability to supervise the area during critical periods.

(c) Electricity supply to Olympic venues from single transformer distribution substations is acceptable only if arrangements are made to provide supply to critical Olympic loads from an alternative source that is not time limited.

Multiple transformer distribution substations must be firm rated, that is, full rating must be maintained with one transformer out of service. Arrangements

are also to be made to provide supply to critical Olympic loads from an alternative source.

(d) Substations acting as alternate supplies, or redundant substation equipment provided to increase reliability, should be appropriately segregated electrically and environmentally, eg, appropriately segregated cable ways, fire segregated physical barriers, choice of equipment with non destructive failure mode.

(e) System protection will have discrimination graded from 132kV to local distribution board.

(f) A SCADA control centre will be located at Homebush Bay, with facilities to monitor and control much of the electricity supply equipment.

(g) 11kV system and substations should be based on standard designs with an emphasis on a modular approach.

(h) Operators will be familiar with the total system.

(i) Maintenance personnel will have experience with the systems and equipment on site.

(j) If 11kV or 415V circuit breakers are required at specific substations to meet operational requirements for Olympic mode they should be installed initially as future refitting of switchgear is uneconomic.

(k) Spares will be available on site, either within venues or in nearby clean areas:

- modular units (eg, kiosk substation
- high voltage/low voltage circuit breakers
- transformers
- cables
- ATS units
- contactor blocks, coils
- cable repair kits,
- etc.

## H3 Olympic Sites - Additional Requirements

All distribution substations shall have provisions for SCADA connection, the wiring details of which shall be provided by Ausgrid.

All HV switchgear shall have facilities to allow for remote switching.

All three transformer substations shall have a sectionalising switch at the low voltage board to allow for 1 and 2 transformer isolation.

# APPENDIX K - CABLE NOMENCLATURE

Refer to Appendices B and C of Network Standard NUS100 – *Field Recording of Network Assets*, for the Cable Nomenclature and Cable Codes.

Revision History

| | |
|---|---|
| Initial issue: | 1 February 1998 |

Document Control

| | |
|---|---|
| Authorised By: Terry Lampard<br>Manager – Standards & Communications | Date: 18/03/2004 |
| Document Number: | NS109 |