

Network Standard

NETWORK

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NS114 ELECTRICAL DESIGN AND CONSTRUCTION STANDARDS FOR CHAMBER TYPE SUBSTATIONS



ISSUE

For issue to all Ausgrid and Accredited Service Providers' staff involved with the electrical design and construction standards for Chamber type substations and is for reference by field, technical and engineering staff.

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

Where this standard is issued as a controlled document replacing an earlier edition, remove and destroy the superseded document

DISCLAIMER

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

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

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

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

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

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

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

INTERPRETATION

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

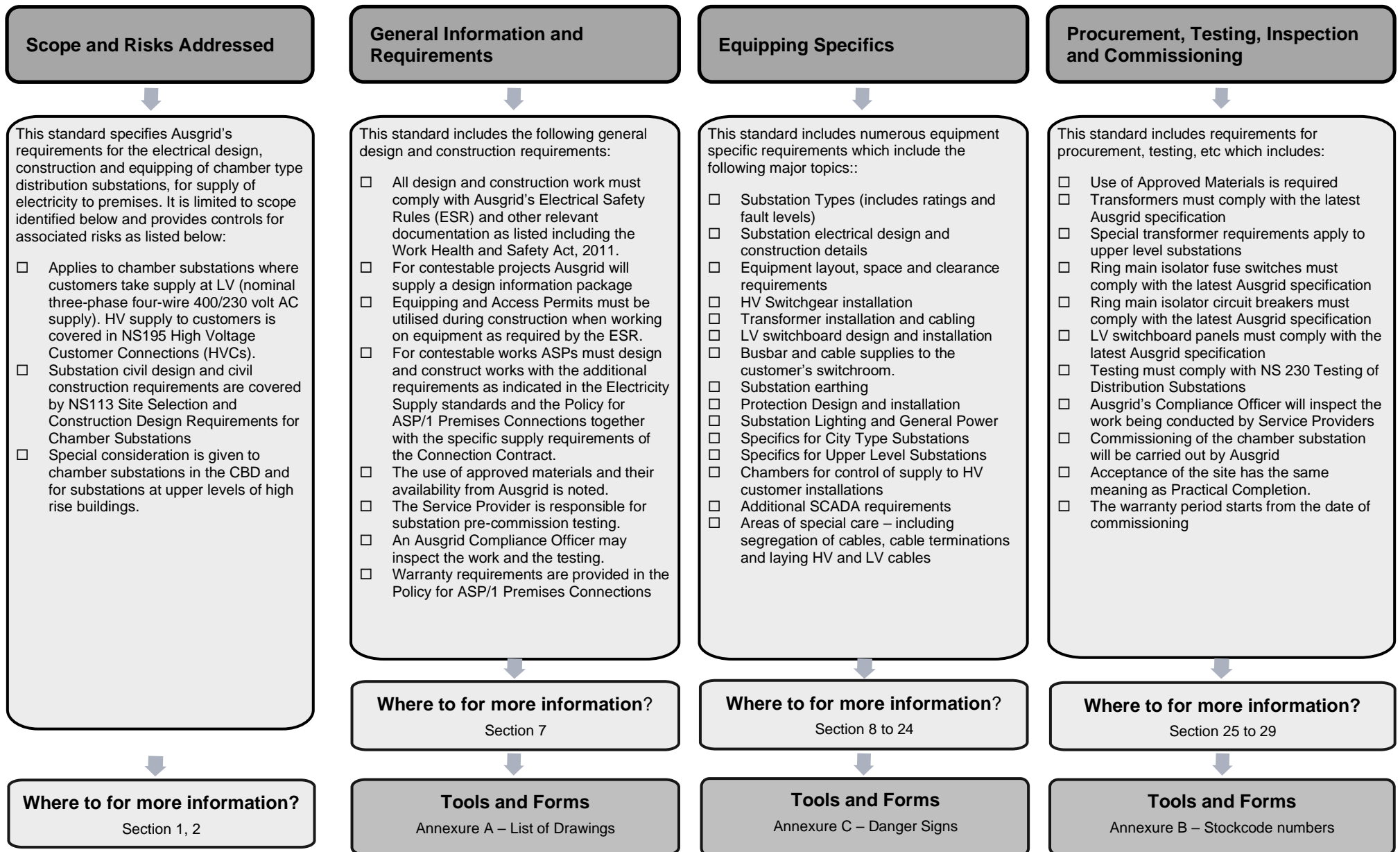
KEYPOINTS

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

AMENDMENTS TO THIS STANDARD

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

KEY POINTS OF THIS STANDARD



Network Standard
NS114
Electrical Design and Construction Standards
for Chamber Type Substations

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1.0 PURPOSE

This Network Standard specifies Ausgrid's requirements for the electrical design, construction and equipping of chamber type distribution substations, for supply of electricity to premises. The requirements of this Standard shall apply throughout Ausgrid's supply area, for contestable and non-contestable projects.

Requirements are included for chamber type distribution substations designed to provide customers with nominal three-phase four-wire 400 / 230 volt AC supply.

As an alternative to 400 / 230 volt supply, high voltage supply may be available for customers under special conditions. High voltage supply is not covered by this Standard and shall be negotiated and designed on an individual basis. Refer to NS195 High Voltage Customer Connections (HVCs) for further information.

Ausgrid is responsible for the management and operation of Ausgrid's electricity supply network. The network is a major infrastructure investment, and is required to operate economically and reliably in all weather and environmental conditions.

The design and construction requirements specified in this Network Standard are intended to satisfy electrical performance and economy requirements, and to meet all statutory obligations. The substations specified utilise readily available components which have demonstrated reliability.

This Network Standard may be amended or updated at any time to reflect improvements in design, technology advances etc. The Service Provider shall ensure that the latest version of this Network Standard is used for the equipping of the substation to which it applies.

2.0 SCOPE

This Network Standard:

- applies to nominal 11kV primary voltage systems
- applies to nominal 400 / 230 volt distribution systems
- applies to chambers used for control points and for control of supply to high voltage customer (HVCs) connections
- does not apply to SWER systems
- does not apply to nominal primary voltage systems higher than 11kV
- does not apply to zone or sub-transmission substations, 11kV regulators or auto transformers.

Substation civil design and civil construction are not covered in this Standard. These topics are covered in NS113 Site Selection and Construction Design Requirements for Chamber Type Substations.

3.0 COMPLIANCE FRAMEWORK

Where non-compliance is the result of specific site conditions or design decisions this needs to be identified in the notes section of the form for each non-compliance and approval sought as per NS181.

4.0 REFERENCES

4.1 General

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

4.2 Ausgrid documents

- Connection Policy – Connection Charges
- Customer Standard Connection Contracts (NECF)
- Electrical Safety Rules
- Electricity Network Safety Management System Manual
- ES 4 Service Provider Authorisation
- NS001 Glossary of Terms
- NS100 Field Recording of Network Assets
- NS104 Specification for Electrical Network Project Design Plans
- NS109 Design Standards for Overhead Supply Developments and Distribution Centres
- NS112 Design Standards for Industrial and Commercial Developments
- NS113 Site Selection and Construction Design Requirements for Chamber Substations
- NS116 Design Standards for Distribution Equipment Earthing
- NS127 Low Voltage Cable Joints and Terminations
- NS129 11kV Joints and Terminations – Paper Insulated Lead Covered Cables
- NS130 Laying Underground Cables up to and Including 11kV
- NS143 Easements, Leases and Rights of Way
- NS149 Drawing Content for Chamber Type Substations, Control Points, Cable Risers and Ductlines
- NS156 Working Near or Around Underground Cables
- NS158 Labelling of Mains and Apparatus
- NS161 Specification for Testing of Underground Cables
- NS171 Fire Stopping in Substations
- NS174 Environmental Procedures
- NS177 11kV Joints (including Transition Joints) and Terminations – Polymeric Insulated Cables
- NS181 Approval of Materials and Equipment and Network Standard Variations
- NS195 High Voltage Customer Connections (HVCs)
- NS212 Integrated Support Requirements for Ausgrid Network Assets
- NS230 Testing of Distribution Substations
- NS252 Secondary Systems – Requirements for wiring within panels
- NS253 Termination of wiring in Substation Control & Protection Equipment
- Policy for ASP/1 Premises Connections
- Public Electrical Safety Awareness Plan
- Tree Safety Management Plan

4.3 Other standards and documents

- AS/NZS 3000:2007 Electrical installations (known as the Australian/New Zealand Wiring Rules)
- AS/NZS 3003:2011 Electrical installations - Patient areas
- AS/NZS 3439.2:2002 Low-voltage switchgear and controlgear assemblies - Particular requirements for busbar trunking systems (busways)
- AS/NZS 4325.1:1995: Compression and mechanical connectors for power cables with copper or aluminium conductors - Test methods and requirements
- AS 1319-1994 Safety signs for the occupational environment
- AS 1566-1997 Copper and copper alloys - Rolled flat products
- AS 2700-2011 Colour standards for general purposes
- AS 4169-2004 Electroplated coatings - Tin and tin alloys
- BS 4579-2:1973 Specification for performance of mechanical and compression joints in electric cable and wire connectors. Compression joints in nickel, iron and plated copper conductors
- ENA Doc 001-2008 National Electricity Network Safety Code
- IEC 61238-1 Ed. 2.0 (Bilingual 2003) Compression and mechanical connectors for power cables for rated voltages up to 30 kV ($U_m = 36$ kV) - Part 1: Test methods and requirements
- ISSC 28 Guideline for Enclosed Spaces

4.4 Acts and regulations

- Electricity Supply (General) Regulation 2014 (NSW)
- Electricity Supply (Safety and Network Management) Regulation 2014
- Work Health and Safety Act 2011 and Regulation 2017

5.0 DEFINITIONS

Refer to NS001 Glossary of Terms

6.0 ASBESTOS

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

7.0 GENERAL INFORMATION AND REQUIREMENTS

7.1 Safety

All work is to be carried out in accordance with the National Electricity Network Safety Code (ENA DOC 001-2008) and Ausgrid's network management plans - Bushfire Risk Management Plan, Customer Installation Safety Plan, and the Electricity Network Safety Management System Manual.

In addition, all work must be carried out in accordance with Ausgrid's Electrical Safety Rules. If there is any conflict between the requirements of these documents, Ausgrid's Electrical Safety Rules shall prevail.

The substation design and construction shall (at least) comply with the minimum safe working clearances detailed in Ausgrid's Electrical Safety Rules.

The installation of cables for underground to overhead terminations (UGOHs), and the installation of substation equipment by crane or other lifting device, near or in the vicinity of exposed high or low voltage mains must (at least) comply with the requirements of the Work Health and Safety Act 2011 (NSW) together with the Work Health and Safety Regulation 2011 (NSW), and the minimum safe working clearances detailed in Ausgrid's Electrical Safety Rules, and documents referred to in those Rules.

The Service Provider shall be responsible for ensuring that all construction staff are fully conversant with the necessary clearances from exposed live conductors. Refer also to the warning regarding pilot cables, in Clause 20.1.

NS113 Site Selection and Construction Design Requirements for Chamber Substations requires that a substation chamber and its access route must not be within an area that is deemed to be a confined space. However under certain conditions, parts of existing substations or chambers or switching stations (including control points) may potentially be subject to atmospheric contamination (or oxygen deficiency). They then become classified as 'confined spaces' under the Work Health and Safety Regulation 2011. Refer also to ISSC 28 Guideline for Enclosed Spaces in NSW Electricity Networks.

Service Providers are responsible for ensuring that all personnel that enter an area classified as a confined space comply with the regulations for confined spaces, including the requirement to hold a current authority for entry and work in a confined space. Permits to enter and work in confined spaces must be completed and displayed in accordance with the regulations. Refer to Ausgrid's Electrical Safety Rules for additional information and compliance requirements.

Gas Detectors with a current calibration sticker affixed by an NATA Approved Testing Organisation must accompany personnel entry to a confined space. The gas detector must be checked before entry to the confined space, for correct operation, in accordance with the manufacturer's instructions.

7.2 Project details

For contestable projects a design information package will be issued by Ausgrid which provides a job specific design brief for the substation project, as per the Policy for ASP/1 Premises Connections.

7.3 Equipping permit

Service Providers may only commence work at the substation site after they have received an Equipping Permit for the particular project. The purpose of the Equipping Permit is detailed in Ausgrid's Electrical Safety Rules. In general, it is intended to prevent the energising of equipment until all staff have acknowledged by their signature that the work is complete and the equipment can be connected to the supply system and shall be considered as "live".

The Equipping Permit must be displayed at the substation construction site at all times while work is being carried out under the Equipping Permit. Refer to Ausgrid's Electrical Safety Rules for further information, and for details of the Equipping Permit procedure.

Any further work after withdrawal of the Equipping Permit can only be performed under the authority of an Access Permit.

7.4 Access permit

When the construction of the substation nears completion, the connection of high and/or low voltage cabling to the supply system will allow the substation to be energised. At this stage, the Equipping Permit that has been displayed on site, must be "signed off" and recovered by an authorised Ausgrid officer. The officer will then issue an Access Permit for Work that will detail exactly the mains and equipment allowed to be worked on. By signing the Access Permit, the recipient acknowledges a full understanding of the extent of the equipment to be worked on, and claims to have completed a personal check and to have been satisfied that the isolation and earthing of the adjacent network components is effective.

The issue, acceptance and the conditions under which an Access Permit shall be issued are contained in Ausgrid's Electrical Safety Rules. The Service Provider must work in accordance with the provisions of these Electrical Safety Rules.

The Access Permit must be displayed at the substation at all times while work is being carried out under the Access Permit. Refer to the Electrical Safety Rules for further information, and for details of the Access Permit procedure.

7.5 Service provider

In this Network Standard, reference to the term Service Provider includes Accredited Service Providers and Accredited Designers carrying out contestable works, and Ausgrid staff and its contractors carrying out non-contestable works.

Requirements for Accredited Service Providers and Designers are included in ES4 Service Provider Authorisation, Ausgrid's Standard Connection Contracts, and Ausgrid's Policy for ASP/1 Premises Connections.

7.6 Contestable project management

For contestable works, Ausgrid will appoint a Contestable Project Coordinator to assist the Service Provider in all dealings with Ausgrid and a Network Compliance Officer to assist the ASP Level 1 during the construction phase. The Contestable Project Coordinator is primarily responsible for determining the method of supply, providing design information and certifying designs submitted by Service Providers and will arrange for milestone inspections and approvals.

The Contestable Project Coordinator will provide specific information on the requirements for each particular substation project and will coordinate primarily the design phase of the project for Ausgrid.

The Contestable Project Coordinator can also provide advice on services available from Ausgrid that may assist the Service Provider in the completion of the project.

Note: The Contestable Project Coordinator and the Network Compliance Officer are NOT responsible for the quality of the contestable works, or the programming of the contestable works. These are the responsibility of the Service Provider.

7.7 Design life and maintenance periods

The substation target design life of 50 years sets particular requirements for the careful selection of materials and equipment and for high standards of workmanship.

Maintenance periods for the substation and substation equipment are specified in the relevant Technical Maintenance Plan.

The Service Provider's quality of work and materials supplied must be adequate for the substation to meet or exceed its design life and maintenance performance requirements.

7.8 Provision of approved materials

All materials necessary for contestable work shall be new Approved Materials supplied by the Service Provider and shall be in accordance with the Ausgrid Approved Material List available on the Ausgrid website under Network Standard NS181.

Refer to Section 25 and Annexures A and B of this Network Standard, and to NS181 Approval of Materials and Equipment and Network Standard Variations.

Ausgrid's ASP Materials Sales can provide Approved Materials from its stores system at commercial rates. Whilst this method of obtaining materials has a number of advantages for Service Providers, it is not compulsory. Materials may instead be purchased directly from the manufacturers, in accordance with the Approved Material List.

To order substation items from Ausgrid, quote the appropriate stockcode number from Annexure B. Ausgrid's ASP Materials Sales can be contacted via email – aspsales@ausgrid.com.au

7.9 Reporting

The Service Provider shall provide Ausgrid with reports on the project as specified in NS100 Field Recording of Network Assets and NS104 Specification for Electrical Network Project Design Plans, and as indicated in Section 30 of this Network Standard.

7.10 Testing and inspecting

Refer also to the information on substation pre-commission testing in document Ausgrid's Policy for ASP/1 Premises Connections.

The Service Provider is responsible for testing, as per NS230 Testing of Distribution Substations, to ensure the completed substation is fit for its duty and meets the requirements.

Ausgrid's Compliance Officer in response to notification for inspections will inspect the work being performed by the Service Provider. The level of inspection carried out on any particular project will depend upon the grade of accreditation of the Service Provider, the complexity of the project and the reports of the Compliance Officer.

7.11 Warranty

Refer to Ausgrid's Standard Connection Contracts and Ausgrid's Policy for ASP/1 Premises Connections for details of the responsibility for the warranty, and warranty period, for contestable work.

7.12 Environmental constraints

Refer also to environmental assessment requirements in Ausgrid's Policy for ASP/1 Premises Connections, and to NS174 Environmental Procedures.

7.13 Reporting of accidents/incidents

The Service Provider is responsible for the reporting of any accidents/incidents that occur, whether to personnel, general public or to equipment owned by Ausgrid or others. The report must be made immediately to the Ausgrid Network Compliance Officer as well as to the Statutory Authorities (including WorkCover and Department of Trade & Investment) as required. Refer to Ausgrid's Standard Connection Contracts for responsibilities.

7.14 Danger signs

The Service Provider shall supply and attach danger signs in accordance with the specifications and requirements indicated in Annexure C.

7.15 Substation locking and security

As well as the procedural requirements indicated in Clauses 7.3 and 7.4, substation access, locking and security must be in accordance with Ausgrid policy as specified by the Contestable Project Coordinator.

7.16 Application of network standards to alterations at existing chamber substations

When existing substations are to have alterations or refurbishments carried out, opportunities should be taken, where reasonably economically and technically practicable, for the substations to be brought up to current network standard requirements. Otherwise a risk assessment shall be conducted to identify residual risk and the implications for Ausgrid's determination.

8.0 SUBSTATION TYPES

8.1 General

Distribution substations generally obtain their supply from the primary distribution system, which is a three-phase three-wire AC system with a nominal system voltage of 11 kV (11,000 volts).

In all cases the substation output is a nominal 400 volts three-phase four-wire AC supply.

Distribution substations are connected to the 11kV system by use of either a ring main isolator fuse switch (RMIFS), an isolator and earth switch (I & E switch), or a ring main isolator circuit breaker (RMICB).

8.2 Standard options

The line diagrams for the following standard distribution substation options are shown in NS112 Design Standards for Commercial and Industrial Developments.

Protection details for each type of substation are outlined in Section 17 of this Standard.

8.2.1 Ring main isolator fuse switch (RMIFS) suburban type substations

This type of substation is limited to one or two transformers with rating of up to 1000 kVA each. The RMIFS is connected with the isolators in series with the HV feeder and with the fuse switch as a branch connection to the transformer.

The low voltage switchboard is equipped with switch/disconnectors for each transformer and fused customer cable supplies of rating 400A, 630A, 800A, 1000A, 1200A or 1600A. Fused network distributors rated at 400A may also be supplied from the low voltage switchboard. Two transformer substations are also equipped with a LV bus section switch/disconnector which is normally open.

8.2.2 Isolator and earthing (I&E) switch Sydney central business district type substations

This type of substation is equipped with three I & E switches. Each I & E switch is supplied from a separate 11kV feeder. Each 11kV feeder is a radial cable supply from the zone substation and each bank of three feeders supplies up to approximately eleven other Sydney Central Business District substations. The substation may be equipped with three transformers each rated at 750kVA or 1500kVA.

The low voltage switchboard is equipped with circuit breakers for each transformer. Various options are available for customer supplies, including up to two 3000A busbar or cable supplies. Fused customer cable supplies of rating 400A, 630A 800A, 1000A, 1200A or 1600A and network distributors rated at 400A may also be supplied from the low voltage switchboard.

8.2.3 Suburban ring main isolator circuit breaker (RMICB) type substation

This type of substation is equipped with up to three transformers each rated at 1000kVA for 5kV and 1500kVA for 11kV. The RMICBs are connected with the isolators in series with the 11kV or 5kV feeder, and with a circuit breaker branch connection to each transformer.

For all these substations the low voltage switchboard is equipped with circuit breakers for each transformer. Various options are available for customer supplies including up to two 3000A busbar or cable supplies. Fused customer cable supplies of rating 400A, 630A, 800A, 1000A, 1200A or 1600A and network distributors rated at 400A may also be supplied from the low voltage switchboard. The switchboard may also be equipped with a bus section switch/disconnector.

8.3 Rating and fault level

The nominal three-phase fault levels for the various standard distribution options are listed in Table 1. The nominal transformer impedance voltage is selected to limit the fault current at the LV board to the value or less than the value specified in the table.

Table 1 - Nominal Three-phase Fault Levels

1	2	3	4
Substation Type and High Voltage Switchgear (see Note (d))	Transformer Size (see Note (a)) (see Note (c))	Nominal Transformer Impedance %	Nominal Prospective Short Circuit Current at Substation Low Voltage Board (see Note (a)) (see Note (b)) (see Note (c))
City Types			
Isolator and Earth Switch	3x750 kVA 3x1500 kVA	5.3% 8.5%	50 kA 63 kA
Suburban Types			
RMIFS, RMICB	1x750 kVA	5.3%	50 kA
	1x1000 kVA	5%	50 kA
	1x1500 kVA	8.5%	50 kA
	2x750 kVA	5.3%	50 kA
	2x1000 kVA	5%	50 kA
	2x1500 kVA	8.5%	50 kA
	3x1500 kVA	8.5%	63 kA

Note (a): All equipment installed in the substation must be designed to meet the maximum fault level for the substation when equipped to its maximum capacity. For example, if 2x1500 kVA transformers are installed in a 3x 1500 kVA chamber substation option, the substation shall be equipped with equipment with a fault rating suitable for the 3x1500 kVA substation.

Note (b): The nominal prospective short circuit currents at the substation low voltage board, as quoted in Table 1 Column 4, and in Note (c), refer to the maximum point of supply values, relevant for calculations for equipment fault duty. They are not relevant for calculations of consumers' mains length limitations as specified in NS109 Design Standards for Overhead Supply Developments and Distribution Centres. In these cases, if calculations are required, the minimum fault levels specified by Ausgrid must be used.

Note (c): Refer also to Clause 1.10.4 of the Service and Installation Rules of New South Wales. This Clause quotes nominal prospective short circuit current at the point of supply, of 25 kA for commercial and industrial areas, and 10 kA for suburban residential areas. Unless advised otherwise by Ausgrid, these values should be accepted by customer's installation designers, as the maximum point of supply values in calculations for equipment fault duty from substation installations that can only be equipped with a single transformer.

Note (d): 11kV system prospective fault levels are typically in the range 7 kA to 13 kA, however in some areas prospective fault levels may approach 20 kA. For 11kV switchgear fault level requirements, refer to Ausgrid's specifications for each switchgear type.

9.0 SUBSTATION ELECTRICAL DESIGN AND CONSTRUCTION - GENERAL INFORMATION

9.1 General

Refer also to the civil design requirements as specified in NS113 Site Selection and Construction Design Requirements for Chamber Substations.

9.2 Ausgrid substation drawings

For contestable works, the relevant Ausgrid standard substation drawings shall be downloaded by the Service Provider from the Ausgrid website.

Drawings not available from the Ausgrid website can be requested either through the Contestable Project Coordinator or the Network Compliance Officer. Drawings are generally provided in an electronic PDF format.

Annexure A lists reference drawings for the electrical construction of chamber type substations.

The minimum design clearances and requirements indicated in Section 10 take precedence over any lesser design clearances, requirements or arrangements of equipment shown on the drawings listed in Annexure A of this Network Standard.

9.3 Environmental constraints

Electrical design of chamber type substations must comply with EPA (the Environment Protection Authority) requirements.

Where oil filled equipment is used, the chamber shall be designed to contain oil spills within the chamber as detailed in NS113 Site Selection and Construction Design Requirements for Chamber Substations. In this regard all ducts, whether used or not used, shall be sealed to prevent water ingress to the substation and oil egress from the substation.

9.4 Electromagnetic fields (EMF)

Substations are designed and shall be constructed so as to minimise magnetic fields within and external to the substation chamber.

This is achieved by locating heavy current low voltage conductors away from walls and ceilings and by bundling conductors where possible, i.e. by laying A, B and C phases and neutral together as a group rather than in different ducts or in flat formation.

Site selection of the substation may also be important in reducing EMF in some situations. A substation shall not be located adjacent to, above, or below operating theatres or similar areas where sensitive instrumentation is to be installed. (Refer also to AS/NZS 3003:2011 Electrical installations - Patient areas).

Magnetic shielding can be incorporated within walls, floor and ceiling of substation chambers, but installation inside substation chambers is not permitted. Magnetic shielding is less effective than bundling of conductors and increasing the separation distance from the conductors.

Loads with high third harmonic content (or multiples of the third harmonic) increase the difficulty of minimising EMF.

9.5 Other equipment

An "Operators' locker", is to be installed in each chamber substation. The locker may be located in any convenient location subject to compliance with clearance requirements for other equipment.

The substation shall be designed with due regard to fire safety. The Service Provider must supply and install fire extinguishers inside each entrance door for multiple transformer substation chambers or a single unit inside one entrance door for a single transformer or control point chamber. Fire extinguishers must be 5 kg capacity CO² type. Each fire extinguisher installed, and its installation date, must be notified by the Service Provider to the Network Compliance Officer, for recording purposes.

9.6 Confined spaces

Refer to NS113 Site Selection and Construction Design Requirements for Chamber Substations (Clauses 5.2, 6.1 and 8.6) regarding confined spaces, and to Clause 7.1 of this Network Standard regarding entry to confined spaces. Refer also to ISSC 28 Guideline for Enclosed Spaces in NSW Electricity Networks.

10.0 EQUIPMENT LAYOUT, SPACE AND CLEARANCE REQUIREMENTS

10.1 General

Substation equipment shall be located with due regard to safety of personnel working in the substation. In addition all designs shall (at least) comply with the minimum safe working clearances detailed in Ausgrid's Electrical Safety Rules. Equipment shall be located such that any one item of equipment may be removed from the substation with the remaining equipment in service and under load. In this regard crane or other lifting device clearance should be considered when locating equipment.

The minimum design clearances and requirements in this clause as depicted in drawing 127332 shall be adhered to with the exception of the following controlled designs which shall be constructed in accordance with the specified drawings in lieu of requirements in Clauses 9.2 and 9.3 in this standard:

- Standard Surface Chamber Distribution Substation Single Transformer Up to 1000kVA Layout 1 drawing 224407.
- Standard Surface Chamber Distribution Substation Single Transformer Up to 1000kVA Layout 2 drawing 224408.

10.2 Transformers

The space to be provided for each oil filled transformer, in chambers designed for oil filled transformers, must be not less than 2000 mm x 2100 mm. Note that the 2100 mm dimension comprises 1400 mm for the maximum allowable transformer width, 400 mm for the high voltage cabling and supports etc. and 300 mm for the low voltage cabling and supports.

The space to be provided for each dry type transformer, in chambers designed for dry type transformers, must be not less than 2200 mm x 1525 mm.

It should be noted that in the case of upper level chambers and elevated surface chambers, oil filled transformers are not permitted, and dry type transformers must be used.

Transformer spaces must be separated from walls, other equipment, pit edges or obstructions by at least 1000 mm. Each transformer space must be separated from other transformer spaces by at least 1000 mm.

Transformers including their connecting cables, cable supports, CTs and CT supports, connection covers etc. must be physically located totally within their designated spaces. The clearances of 1000 mm must be maintained after providing for the required bending radius of cables.

Provision for installation of low voltage transformer tails shall be made by means of cable chases in the substation floor. Cable chases shall comply with drawing 48008. Each transformer shall have a separate cable chase from the low voltage pit. Transformer cable chases must be covered with floor plates in accordance with drawing 48008. Transformer cable chases must not be located where the floor plates will be under the wheels of any transformer, when the transformer is within its designated transformer space. Floor plates must be able to be removed without having to move any transformer or other item of equipment.

Provision for installation of high voltage transformer tails shall be made by means of conduits from the high voltage switchgear pit. Each transformer shall have a separate conduit from the high voltage switchgear pit.

At each transformer, the high voltage conduit outlet and the end of the low voltage cable chase shall be located immediately inside the designated transformer space and centrally under their respective cable termination points on the transformer. The LV cable chase shall extend into the designated transformer space and its width may be splayed etc, sufficiently to allow sufficient space for LV cable bending radii and to ensure that LV cables do not rest on sharp chase edges etc.

In addition to the high voltage conduit and low voltage cable chase, each transformer is to have a separate conduit installed for the earthing cable, and separate conduits for the signal cables and protection cables. Refer to Annexure A of NS113 Site Selection and Construction Design Requirements for Chamber Substations for details of typical conduit allocations and sizes.

At the transformer end, the earthing cables conduit and the protection cables conduit shall terminate immediately inside the designated transformer space and adjacent to the conduit for the high voltage transformer cables, in the positions indicated on drawing 162655.

Note: SCADA signals cables, where required, may be installed in the protection cables conduit, in accordance with the Schedule of Conduits in NS113 Site Selection and Construction Design Requirements for Chamber Substations.

All conduits must be clear of the path required for installation or removal of any transformer.

Transformers must not be placed directly under ventilation duct openings.

Sufficient clearance is required over the top of each transformer to allow for in-situ maintenance. With the exception of fire damper trip wires, no item of equipment or installation or obstruction is to be placed over a designated transformer space. (Note also that the minimum height of the substation chamber is 3200 mm).

The positioning of transformers in any type of chamber must satisfy the following requirements:

- no other equipment or structures or cables associated with other transformers or equipment are required to be moved to enable any transformer to be installed or removed, and
- no other transformer or other equipment or cables associated with other transformers or equipment are required to be de-energised to enable any transformer to be installed or removed, and
- unless otherwise agreed by Ausgrid, the movement of the transformer to or from the allocated access door or hatch is achievable by means of a straight pull route, and in accordance with Section 12 of NS113, and
- clearance of not less than 1100 mm will be maintained from low voltage switchboard equipment, high voltage switchgear, protection equipment, protection battery installation and equipment, at all stages in the movement of any transformer.

In surface chambers and elevated chambers, the transformers are to be located directly in front of the transformer access doors. If an oil containment ramp is required (ie. because the substation is equipped with oil filled transformers), the transformers are to be located at the bottom of the oil containment ramp (ie. approximately 1000 mm from the doors), unless otherwise approved in writing by Ausgrid. Approval for alternative transformer locations will not be given by Ausgrid unless:

- ventilation requirements and effectiveness are not reduced, and
- each transformer can be conveniently moved, to the satisfaction of Ausgrid, to its allocated doorway, and
- suitable equipment handling facilities are installed in the chamber, as described in Section 8 of NS113 Site Selection and Construction Design Requirements for Chamber Substations, and
- the positioning requirements as listed above for any type of chamber are satisfied.

10.3 HV switches

10.3.1 General

High voltage switches shall be positioned so that the operating side is **not** the nearest side to the associated transformer.

In addition to satisfying the specific positioning requirements for fixed front type switchgear as indicated below, the positioning of HV switches in any type of chamber must also satisfy the following requirements:

- there must be sufficient clear space to manoeuvre each switch between its position on the HV pit and the personnel access door which is designed to be also suitable for equipment access,
- no other equipment or structure or cables not directly associated with the high voltage switch are required to be moved to enable the high voltage switch to be installed or removed, and
- clearance of not less than 1100 mm will be maintained from low voltage switchboard equipment, protection equipment, protection battery installation and equipment, at all stages in the movement of any high voltage switch.

Sufficient clearance is required over the top of each switch unit to allow fuse replacement or in-situ maintenance. (Note also that the minimum height of the substation chamber is 3200 mm.)

Cable access is to be from the bottom. Suitable clearance for cable terminations and bending radius must be allowed. Any HV switch is to be capable of accepting termination of Ausgrid's approved cables.

It should be noted that in the case of upper level chambers and elevated surface chambers, oil filled switchgear is not permitted to be used.

10.3.2 Fixed front type (non-racking) HV switchgear (includes ring main isolator types)

The dimensions and design details for pits to be used with fixed front type HV switchgear in substations, and control points and chambers for control of supply to high voltage installations (HVCs), shall be as shown on drawing 191085.

For three transformer substations, other pit dimensions (eg “L” shape) may be submitted to Ausgrid for consideration prior to design approval.

High voltage switches shall be positioned so that their operating side is **not** the nearest side to the associated transformer. For each of the pits indicated in drawing 191085, the switchgear operating side is to be placed along the longer dimension. The operating-side edge of the pit is referred to in this clause as the “front edge”.

Larger pit dimensions may be necessary to accommodate the bending radii of cables. Such designs should be submitted to Ausgrid for consideration prior to design approval.

As much as practicable, depending on the type of HV switchgear used, the switchgear should be positioned wholly behind the front edge of the pit, and centrally over the pit.

The HV pit and HV switchgear must be positioned such that the following clearances are achieved:

- Not less than 1500 mm between the **front** edge of the pit or the front of the HV switchgear and any wall or obstruction, whichever is the least
- Not less than 2000 mm between the **front** edge of the pit or the front of the HV switchgear and the front of a “E-type” LV switchboard (whichever is the least) including equipment on protection panels forming an extension of the low voltage switchboard (This allows for 1000 mm of covered LV pit plus 1000 mm of solid floor between the HV and LV switchgear. With this arrangement there should be approximately 1600 mm between the HV switchgear and any withdrawn LV CB on the LV switchboard).
- Not less than 1000 mm from the **back** of the HV switchgear and any wall or obstruction
- Not less than 1000 mm from the **side** of the HV switchgear and any wall or obstruction
- For side connected HV switches: not less than 1000 mm **between** each HV switch (if more than one is used)
- For front/back connected HV switches: not less than 600 mm **between** each HV switch (if more than one is used) provided there are no cable connection boxes or ancillary equipment items required to be accessed from the sides.

The minimum clearances are to be achieved with all cable connection boxes and ancillary equipment items fitted.

Any sections of high voltage pits not covered by switchgear must be covered with floor plates in accordance with drawing 191085.

Common HV switchgear as listed below shall be installed in accordance with the installation drawing shown:

Table 2 - Common HV Switchgear

HV Switchgear	Installation Drawing
Lucy Sabre VRN6a and VRN2a RMICB	192908
ABB Safelink 3 Way I & E Switch	192910
ABB Safelink CFC RMI	224420
Siemens 8DJH RMICB, RMIFS and I & E	234377

10.4 Low voltage switchboard

10.4.1 General

The various Chamber Substation configurations can be found in NS109 Design Standards for Overhead Supply Developments and Distribution Centre. Substations can incorporate either an “E-type” or Chamber Disconnecter / Fused Strip Type LV switchboard.

The application of these switchboards is:

- Single and two transformer suburban installations with transformers $\leq 1000\text{kVA}$ nominal rating and controlled by HV RMI Fuse Switch switchgear are to use Chamber Disconnecter/Fused Strip Type LV switchboard, see drawings 224407 and 224408.
- All CBD & Suburban single and multi transformer installations controlled by HV RMICB switchgear are to use “E-type” LV switchboards.

10.4.2 Chamber disconnecter/fused strip-type LV switchboard

The low voltage switchboard shall be positioned, over a low voltage pit, and supported on standard Ausgrid pit steelwork refer drawing 178228.

There must be a minimum clearance of 250 mm between the chamber wall behind the switchboard and the rear of the switchboard. The chamber wall behind the low voltage switchboard may have projections, such as columns, provided that the minimum clearance of 250 mm to the switchboard is maintained.

No part of the low voltage switchboard or its components or equipment is to be closer than 1100 mm to the nearest access doorway or opening.

A clear passageway or operating clearance of 1500 mm shall be allowed in front of the switchboard.

The switchboard shall not be located where it would obstruct equipment removal from the substation.

The space above and behind the low voltage switchboard, must be clear of any ventilation duct or louvre opening. Light fittings if mounted on the wall behind the switchboard shall be offset with consideration of the need to maintain or replace them.

10.4.3 “E-type” LV switchboard

The low voltage switchboard shall be positioned, over a low voltage pit, and supported on steelwork, in accordance with the following Ausgrid drawings.

- 178229: Type E LV Board Supporting Steelwork General Arrangement.
- 178228: Type E LV Board Clearances, Pit Design and Construction.

The front edge of the pit shall be not less than 1000 mm in front of a wall of the chamber.

There must be a minimum clearance of 600 mm between the chamber wall behind the switchboard and the rear of the switchboard. A sturdy metal rail mounted 1m above floor level and attached to the rear wall only shall block access to the space behind the switchboard, details of barrier and sign are shown on drawing 178229. The chamber wall behind the low voltage switchboard may have projections, such as columns, provided that the minimum clearance of 600 mm to the switchboard is maintained. No cables or other attachments other than those required for OAFD protection are permitted to be attached to the rear of the switchboard or to the wall behind a low voltage switchboard.

A clearance of not less than 600mm shall be provided between the end of the switchboard and the chamber wall to the side of the switchboard.. Where the side area is part of a passageway, a clearance of not less than 1000 mm shall be provided between the end of the switchgear and the wall. The 1000 mm dimension is to be achieved between:

- any part of the switchboard or attachments to it, and
- a wall or column, or any projections from a wall or column, or any other equipment or other objects.

No part of the low voltage switchboard or its components or equipment is to be closer than 1500 mm to the nearest wall edge of an access doorway or opening.

Refer also to Clause 10.3 for additional clearance requirements from high voltage switchgear.

A clear passageway at least 1000 mm wide shall be allowed from the switchboard for personnel access to all access doors to the substation.

The switchboard shall not be located where it would impede air flow to any transformer or interfere with equipment access to or from the substation.

The space above the low voltage switchboard pit and above the switchboard and switchboard equipment, plus the space above the additional area up to 1000 mm around the outside edges of the pit and switchboard and switchboard equipment, must be clear of any ventilation duct opening, ventilation duct or other installation or equipment, other than busbars, cables and OAFD equipment etc associated with the low voltage switchboard or protection panels. This requirement is to prevent any item which requires maintenance (such as light fittings), or which could fall (such as dampers and wires), from being installed above or on the wall behind the low voltage switchboard.

Floor chases or conduits for low voltage transformer tails, network distributors, customer cable supplies, earthing conductors, protection wiring, etc should be directed towards the centres of their associated panels on the low voltage switchboard. This is to reduce cable crossings in the low voltage pit and also prevent supporting steelwork interfering with cable routes.

The width of the LV switchboard will be dictated by its configuration as indicated in Table 1 of drawing 178228 - Type E LV Board Clearances, Pit Design and Construction. The configuration of the low voltage switchboard is to be determined in accordance with the requirements of NS109 Design Standards for Overhead Supply Developments and Distribution Centre.

10.5 Cabling

Cables to be used within the substation chamber shall be multi-stranded copper (See Note) with PVC or XLPE insulation. Connections to equipment are to be as per requirements of NS177 11kV Joints (including Transition Joints) and Terminations – Polymeric Insulated Cables or NS127 Specification for Low Voltage Cable Joints and Terminations as appropriate.

Note: This does not preclude aluminium conductor cables to or from the low voltage network or high voltage network.

Cables entering and leaving the substation chamber are to be in conduits as specified in NS113 Site Selection and Construction Design Requirements for Chamber Substations. Cable reticulation within the substation chamber is to be via conduits and a pit and duct system. Where possible, cables should be run in a trefoil configuration to reduce electromagnetic interference (EMF).

Conduit bends shall allow for the bending radius of cables and shall comply with the requirements of NS113. Floor chases must be constructed to take into account the bending radius of cables, and must be constructed as specified in NS113.

In cable risers, cables are to be securely cleated to the wall with commercial cable cleats spaced at not more than one metre. Cleats should be free from sharp edges and burrs. To prevent local heating of cables caused by eddy currents, cleat halves should be fixed together using non-ferrous nuts, washers and bolts. Cable cleats can be directly bolted to cable riser walls or via unistrut type channels. For contestable work, the type of cable cleating system to be used should be submitted to Ausgrid's Contestable Project Coordinator for acceptance prior to ordering.

Where protection panels are required to be installed, suitable provision should be made by means of chases or concealed conduits, to enable installation of cables to the panels.

Surface wiring is not permitted unless the cables are enclosed in conduits complying with NS113.

Plastic troughing may be permitted for enclosure of protection cables, but only in the following situations and subject to all of the following limitations:

- Troughing is permitted only in unexposed locations where the troughing would not impede access for personnel, and would not be at risk of damage or dislocation during movement or maintenance of equipment, such as transformers, switchgear, switchboards or cables.
- Troughing or troughing covers are not permitted to have joints, except at 90° changes in direction.
- Troughing may only be installed in vertical runs, except for horizontal runs which are both behind and at or below the base level of low voltage switchboard panels, or short horizontal runs not exceeding 1 metre in length from wall mounted protection panels.

Protection wiring is not permitted in low voltage or high voltage cable chases, ducting or conduits.

Where protection panels are required to be installed, suitable provision should be made by means of chases or concealed conduits, to enable installation of cables to the panels. Surface wiring or surface mounted conduits are not permitted unless the cables are enclosed in Class 6 PVC conduit or equivalent strength plastic troughing.

For "E-type" LV switchboards, secondary wiring (protection, control, and indication) shall be installed and connected to individual panels LV panels in accordance with Clause 14.3.4.3.

10.6 SCADA equipment

SCADA equipment is required to be fitted to:

- all City CBD type substations,
- substations with optical arc flash detection protection relays and
- may also be required in other substations where specified by Ausgrid.

All SCADA equipment must be compatible with the current Ausgrid signalling system and signal cabling.

Where SCADA equipment, including pilot cable isolation boxes and signal cable disconnection boxes is required, it must be located as follows:

- (a) For basement chamber substations, with two door/stairway accesses, the equipment must be located in one of the lower access chambers.
- (b) For basement chamber substations with one door/stairway access and one hatch/ladder access, the equipment must be located in the door/stairway access lower chamber.
- (c) For City CBD type surface chamber substations with access chambers, the equipment must be located in one of the access chambers.
- (d) For other surface chamber substations, the equipment may be located in one of the access chambers if the substation has access chambers, or it may be located in the substation chamber. If the equipment is located in the substation chamber, all specified access requirements and clearances from other equipment must be satisfied.
- (e) For upper level substations, the equipment must be located in the control point or in one of its access chambers, in accordance with the control point chamber type, as indicated in a), b), c) or d) above for substation chambers. An additional connection box must be installed in the upper level substation.

SCADA equipment, including pilot cable isolation boxes and signal cable disconnection boxes, must only be located where there is a clear space of at least 1500 mm in front of each item, and where they would not be at risk of damage when other equipment, tool boxes, oil drums etc. are being moved through the chamber. The selected chamber may need to be enlarged to ensure that this requirement is satisfied. Refer drawing 121156 for further details.

Where SCADA equipment is required, a signal marshalling box as shown on drawings 115836 and 115837 must also be installed. It should be located on the wall adjacent to but not behind the low voltage switchboard, and with the top of the box 1500 mm above the substation floor level.

10.7 Protection panels

10.7.1 General

Protection panels must comply with the current Ausgrid approved designs, and may be:

- free standing cabinet mounted against a wall, or
- wall mounted panel.

10.7.2 Free standing protection cabinets (Sydney CBD substations only)

Free standing protection cabinets, either single cabinets or groups of two cabinets maximum, are to be mounted against a wall. In all installations, free standing cabinets must be solidly attached to the floor so as to be shockproof. The cabinets shall be arranged such that the hinged side of each cabinet is external to the group to ensure relays when mounted on the front door do not impact adjacent relays when the doors are opened.

Free standing protection cabinets must have the following clearances:

- not less than 1500 mm clear space in front of equipment on the protection cabinet(s),
- not less than 1000mm clear space at the sides of the cabinet or cabinet group.

10.7.3 Wall mounted protection panels

Wall mounted protection panels must be mounted on a solid masonry wall with four (4) x M12 fasteners and be mounted so as to be shockproof.

The top of any wall mounted protection panel must be 1850 mm above the adjacent floor level.

A clear space of not less than 1500 mm shall be allowed in front of any equipment mounted on a protection panel. Refer also to Clause 10.3, for additional clearance requirements from high voltage switchgear.

Wall mounted protection panels must not be located above or below any other equipment or obstructions. This includes equipment or obstructions offset by less than 500 mm from a vertical line at either side of the panel.

The spacing between wall mounted protection panels, and the spacing between wall mounted protection panels and other equipment or obstructions, must also comply with the following requirements:

- the minimum distance between a closed wall mounted protection panel including housing and supports, and any fixed obstruction, such as a side wall, must be not less than the width of the panel, and
- the minimum distance between closed wall mounted protection panels including housings and supports must be not less than the width of the larger of the panels, and
- except as indicated in the previous point, the distance between a closed wall mounted protection panel including equipment on the panel, housing and supports, and any movable obstruction, such as any part of a door in any opened position, must be not less than 1000 mm.

Clearances associated with all protection panels & cabinets must also comply with any additional requirements for spacing from other items of equipment, such as HV switches, transformers, and LV switchboard.

10.8 Protection battery and battery charger

Where a battery is required for protection equipment, the positioning requirements and clearances for the installation comprising protection battery and battery charger are equivalent to the positioning requirements and clearances for wall mounted protection panels, as described in Clause 10.7, excepting that the top of the batteries must be not more than 1200 mm above the adjacent floor level. The 48V DC charger shall be nominally at 1500mm above adjacent floor level.

In addition to these requirements, the protection battery must not be located in close proximity to protection panels or control equipment (eg SCADA) where vapour from the battery could increase the risk of corrosion.

The battery trickle charger shall be located as close as practicable to the battery. The battery trickle charger must not be located over or under the battery.

The battery test box shall be mounted with the OAFD indication panel adjacent to the substation access door which is readily visible and accessible, and connected to the end of the DC circuit remote from the battery.

Refer also to Clause 17.6.

10.9 Earth fault indicators (EFIs) – suburban substations only

It is generally preferred that the HV Earth Fault Indicators (EFI) are mounted on the Right Hand Side (RHS) of the HV switchgear and connected to CTs mounted on the “outgoing” (load-side) mains, which should also be connected to the RHS of the HV switchgear. However where this is not practicable the EFI may be installed and/or connected on either side of the HV switchgear i.e on the “incoming” or “outgoing” mains.

Note however, that on whichever side the EFI is installed it is important that this is shown correctly on the relevant Network Diagram.

For switchgear that does not come with integral EFIs already installed, Ausgrid’s standard EFI as detailed on the Ausgrid Approved Material List, shall be installed utilising the facilities provided for the purpose on the HV switchgear, or otherwise in a suitable location on the HV switchgear support frame with indication readily visible from the operating position.

11.0 HIGH VOLTAGE SWITCHGEAR - INSTALLATION

Refer also to Section 10 – Equipment Layout, Space and Clearance Requirements.

The switchgear shall be mounted in accordance with the substation layout drawing. High voltage switches shall be positioned so that the operating side is **not** the nearest side to the associated transformer. The switchgear shall be anchored with M12 bolts when mounted on a steel channel.

A complete set of operation handles for each high voltage switchgear unit shall be provided.

Each item of high voltage switchgear, including the transformer circuit breakers or fuse switches, the “in-line” isolators and the earthing switches, shall be labelled in accordance with NS158 Labelling of Mains and Apparatus.

Transformer differential current transformers shall be mounted in accordance with Section 17.

In each case, the current transformers shall be mounted:

- securely to prevent movement during fault conditions,
- with the nameplate label visible, and
- with current transformer polarity towards the circuit breaker.

12.0 TRANSFORMERS - INSTALLATION

Refer also to Section 10 – Equipment Layout, Space and Clearance Requirements.

The transformers shall be located in accordance with the substation layout drawings, and the wheels shall be locked by the studs provided or by other means approved by Ausgrid. The outside of the transformer wheels must be located at least 100 mm from the closest edge of the low voltage cable chase rebate.

Each transformer shall be labelled in accordance with NS158 Labelling of Mains and Apparatus.

All oil-filled transformers in Sydney CBD chamber substations shall be fitted with oil temperature indicators. These indicators are normally fitted to the transformers at the time of installation. Transformers in chambers outside of the Sydney CBD shall have oil temperature indicators fitted when specified by the Contestable Project Coordinator. Dry type transformers are supplied with temperature indicators already fitted.

In Sydney CBD substations, these indicators also provide the thermal signal from each transformer via the SCADA to the Ausgrid Central Control Room. The indicators in dry type transformers also provide a trip signal. Service Providers must provide and install the necessary indicators and the wiring within the substation from the transformers to the protection panel and to the SCADA, in accordance with Ausgrid's drawings and specifications.

At each Sydney CBD substations with oil-filled transformers, two of the transformers shall be fitted with an additional thermostat to control the operation of the substation outlet ventilation duct fan, as described in NS113 Site Selection and Construction Design Requirements for Chamber Substations. The additional thermostat shall be installed on the transformer nearest to the substation fan and the transformer furthest from the substation fan. Dry type transformers are supplied with the thermostat and temperature indicator combined. Service Providers must provide and install the necessary wiring within the substation, in accordance with Ausgrid's drawings and specifications, from the transformers to the protection panel and from the protection panel to the ventilation duct fan and to the SCADA. Refer to Clause 20.4 for further details regarding thermal ventilation fan control systems.

Refer also to Clauses 17.7 and 24.2 of this Network Standard regarding segregation of cables and Clause 10.5 regarding installation of cables to protection panels.

13.0 TRANSFORMERS - CABLING

The cross-sectional area and the number of cables per phase for the HV and LV connections of each transformer shall be in accordance with Table 3.

All cables are stranded copper conductors.

Table 3 – Cross-Sectional Area and the Number of Cables

Location of Substation & Transformer Size	High Voltage			Low Voltage		
	Cable Cross Sectional Area mm ²	Number of cables per phase	Cable Type	Cable Cross Sectional Area mm ²	Number of cables per phase	Cable Type
City or Suburban						
750 kVA	70	1	polymeric insulated (XLPE or EPR)	300 phase 300 neutral	2/phase 1 neutral	XLPE/PVC
1000 kVA	70	1	polymeric insulated (XLPE or EPR)	500 phase 500 neutral	2/phase 1 neutral	XLPE/PVC
1500 kVA	70	1	polymeric insulated (XLPE or EPR)	500 phase 500 neutral	3/phase 2 neutral	XLPE/PVC

The cross-sectional area and type of HV cable for the connection of the chamber substation to Ausgrid's 11kV network shall be determined by Ausgrid and shall be dependent on the cable type and cross sectional area of the 11kV feeders to which the substation is to be connected.

For Dry Type Transformers the low voltage cables will approach the terminals vertically from below. The LV end box is supplied with a removable, split, drilled, non-magnetic gland plate. Each cable must be fitted with a 50mm compression gland at the gland plate. The HV end box terminations are to be made as per requirements of NS177, 11kV Joints (including Transition Joints) & Terminations Polymeric Insulated Cables.

14.0 LOW VOLTAGE SWITCHBOARDS – DESIGN AND INSTALLATION

14.1 General

Refer also to Section 10 – Equipment Layout, Space and Clearance Requirements.

A low voltage switchboard, rated at 415 volt, 50 Hz is required in each chamber type substation for all Ausgrid's chamber substation option as detailed in NS109 Design Standards for Overhead Supply Developments and Distribution Centres.

The "E-type" LV switchboard is a modular dead-front enclosed assembly, consisting of manufactured panel modules. The Chamber Disconnect/Fused Strip LV switchboard is a complete assembly per transformer, with the two assemblies being coupled via a bus section module where two transformers are required. Both switchboards are available in a range of configurations to accommodate a variety of supply arrangements.

The LV switchboard shall be located within the substation chamber with the minimum allowable clearances as specified in Section 10.

14.2 Chamber disconnect/fused strip-type LV switchboard

Each LV switchboard is to be supplied by only one transformer with a maximum nominal rating of 1000kVA. The range of LV switchboard configurations can be found in Annexure B. The range of suitable transformer configurations is summarised in Table 4 below:

Table 4 - Suitable Transformer Configurations

Preferred Switchboard Configurations*	Suitable for use with Transformers (kVA) nominal
4 x 400A	1000, 750
5 x 400A	1000
1 x 800A, 2 x 400A	1000, 750
1 x 800A, 3 x 400A	1000, 750
2 x 800A, 1 x 400A	1000, 750
1 x 1600/1200A, 2 x 400A	1000

*Note this does not depict physical arrangement; refer to relevant drawings for physical arrangement of fuseways within each board.

While the 400A Ausgrid rated strips have a manufacturer's labelled rating of 630A the maximum fuse to be used in these strips is 400A.

Each LV switchboard is fully rated for 2000A including the bus section disconnect in a "double" switchboard configuration. They are to be equipped with either 1600A, 1200A, or 1000A "T" type bolt-in LV fuses or for the 800A and 400A panels equipped with "J" type LV fuses (92 mm centres).

The maximum low voltage transformer cable configuration is 2 x 500mm² XLPE/PVC cables per phase, the limitation being the transformer LV palm configuration. The transformer cables normally enter vertically from below the switchboard.

14.3 “E-type” LV switchboards

14.3.1 “E-type” switchboard panels

The individual LV switchboard panels available include:

- 3000A incoming ACB (motorised)¹
- 3000A incoming ACB² (un-motorised)
- 2000A incoming ACB² (un-motorised)
- 3000A bus-section ACB²
- 3000A customer cable supply – ACB²
- 3000A customer busbar supply – ACB²
- 1000A - 1600A customer supply - disconnect controlled fuse
- 4x400A fuse distributor
- 2x800A fuse distributor
- 2x400A + 1x800A fuse distributor

Note 1: Motorised ACBs & switch/disconnectors panels are required to be fitted in all City CBD type substations, and may be required in other substations where specified by Ausgrid.

Note 2: Where required, 3000A and 2000A incoming ACB panels are also utilised as switch/disconnector panels, but in such cases protection circuits are not connected to the ACB.

14.3.2 “E-type” switchboard panel combinations

The acceptable “E-type” switchboard panel combinations are shown on drawing 178227 Type E LV Board Acceptable Combinations. The panel combination for any particular substation shall be as specified in the Design Information document.

IMPORTANT: The switchgear’s main busbars are rated at 3000A. Panel combinations must be carefully selected to ensure that, under operating conditions, the current in any section of the switchboard does not exceed 3000A under any switching arrangement. Extreme care must be exercised when isolating transformers to ensure that the current in any section of the switchboard does not exceed 3000A. In some situations load restrictions may be necessary. Similarly, the combination chosen must not allow the overall rating of the substation to be exceeded under operating conditions.

14.3.3 Use of customer supply panels

14.3.3.1 Dedicated busbar or cable supply to one customer only

For substations supplying one dedicated busbar supply, to one customer only, the customer should be supplied via a “3000A customer busbar supply – ACB” panel. Protection systems should be configured such that a fault on the customer supply trips the whole substation.

14.3.3.2 Two busbar or cable supplies to one or multiple customers

For substations supplying two busbar or cable supplies to one or multiple customers, each customer should be supplied via “3000A customer cable or busbar supply - ACB” panel for each supply. Protection systems should be configured such that a fault on any of the customer supplies trips the whole substation via Transformer ACB’s. In such circumstances operation of the busbar supply ACB’s should enable timely isolation of the fault and restoration of supply to the unfaulted section of the customer’s installation. It is acknowledged that this provides less selectivity in the unlikely event of a fault on a customer’s main switchboard however, this arrangement negates the need for regular interruptions of supply to a customer for protection trip checks.

14.3.3.3 Protection of consumer's mains that are excessively long

Ausgrid protection systems shall not be relied on to protect consumer's mains that are deemed by Ausgrid to be excessively long. The customer shall make their own arrangements in such circumstances.

14.3.4 “E-type” switchboard component design and installation details

“E-type” switchboard components shall comply with Ausgrid's current specification, and shall be assembled and installed in accordance with this document, and Schneider Electric's installation manual, entitled *Ausgrid - Product Manual for Chamber Substation indoor switchgear*, which can be obtained from the manufacturer. For Ausgrid personnel, the manual can be found in Balin – Manufacturers' Equipment Manuals – Switchgear-Isolators-Fuses.

Switchboard panels shall be manoeuvred into position within the substation using a suitable mobile crane or trolley /skates.

When lifting the switchboard panels from above care must be taken to ensure that lifting chains/ropes are the correct length (2000mm). Where it is not practicable to use lifting chains/ropes of this length suitable spreader bars must be used to ensure that no undue horizontal forces are placed on the switchgear lifting points.

Steelwork to support the switchgear above the LV pit shall be installed in accordance with the detail shown on drawing 178229 - Type E LV Board Supporting Steelwork General Arrangement.

14.3.4.1 LV surge arrester panel

Two versions of the Surge Arrester Panel are available – one for installation of the left hand side of the switchboard, and one for installation on the right hand side of the switchboard. Both panels incorporate fuses and a neutral link for connection of the substation auxiliary LV supply. Cables between the surge arrester panel and the LV pit shall be installed via the cable ladder described in Clause 14.3.4.4.

For switchboards that incorporate a Bus-Section Panel that is normally open, a separate Surge Arrester Panel must be installed on each section of busbar. In this case the auxiliary LV supply fuses and neutral link on only one of the Surge Arrester Panels should be connected.

Otherwise, only one Surge Arrester Panel shall be installed and this may be installed on either end of the switchboard. Wherever practicable it should be installed on the end closest to protection and substation service panels to minimise the length of the secondary cables. Where the switchboard is intended to be extended at a later date by adding panels to one end, the LV surge arrester panel should be installed on the opposite end to which the additional panels are intended to be installed.

14.3.4.2 Connections to the neutral bar

Connections to the neutral bar must be made with bolts, washers and nuts of the sizes specified. Where the bolt size is not specified, the bolt and bar hole must be of an appropriate size consistent with the diameter of the hole in the lug being attached. Each cable lug must be separately connected under its own bolt or bolts. Cable lugs must be connected directly to the bar. Connection extension pieces, such as bar stubs, flags, etc must not be used. Slotted lugs are not permitted. Full hole crimp lugs must be used. Bolts, washers and nuts must be stainless steel grade 316, except that hot dipped galvanised (or other approved corrosion resistant) steel bolts, washers and nuts may be used for bolt diameters M16 and above. Lug holes must not be enlarged to accommodate larger bolts. Brass bolts must not be used.

The switchboard neutral bar shall be connected to the switchboard earth bar (refer Clause 16.5), with stranded copper black PVC or polyethylene insulated earth conductors as follows:

- 2 x 70 mm² per transformer at each installed transformer ACB panel

These connections shall be made between the neutral bar and the switchboard earth bar in the cable connection area of each transformer ACB panel installed in the substation.

Each circuit neutral conductor connection to the neutral bar shall be made at the switchboard panel where the associated circuit active conductors are terminated.

Each cable connected to the neutral bar shall be adequately labelled to indicate its origin.

14.3.4.3 Installation of secondary cables

Secondary wiring (protection, control, & indication) shall be connected to individual panels via the terminal blocks provided in the auxiliary duct chamber of each panel.

Cables between switchgear and protection panels, etc shall be installed via the vertical auxiliary wiring ducts provided in each panel except bus-section panels. A cable duct is provided on each side of the panels which allow secondary cables to be drawn into the LV pit. Secondary wiring for bus-section panels should be routed through the ducts on panels on either side, via the auxiliary wiring aperture of the panel.

14.3.4.4 Cable ladder for secondary wiring

A cable ladder shall be installed on the same end of the LV switchboard as the LV surge arrester panel, and as shown in drawing 178230. Secondary cables passing from the surge arrester panel, to the LV pit, shall be installed via this cable ladder.

14.4 Labelling

All distributor circuits, and all items of equipment on the low voltage switchboard, shall be labelled in accordance with NS158 Labelling of Mains and Apparatus.

All secondary control and protection wiring shall be fitted with approved cable ferrules and wire numbers in accordance with Ausgrid's substation standard schematic diagram.

14.5 Maximum demand indicators (MDIs)

Each "E-type" LV switchboard panel comes complete with CTs and MDIs already fitted for the associated circuit.

For multi transformer substations an additional MDI shall be installed and shall record the summated maximum demand of all of the transformers in the substation. This summated MDI shall record the demand on B phase, and shall display the maximum twenty minute demand recorded and the instantaneous demand (the demand during the present twenty minute period).

The summated MDI shall be labelled with the constant K of the MDI and an engraved label or adhesive backed tape label identifying its function.

The summated MDI shall be connected in accordance with

- For E Type LV switchboards, drawing 178238 and located on the substation service board – refer Clause 18.1.
- For Disconnector/Fused Strip-Type LV switchboards, drawing 224431 and located on the wall adjacent to the LV board.

Note: For CBD substations a transducer for SCADA is installed instead of the summated MDI.

14.6 Phasing

For Chamber Disconnector/Fused Strip type LV switchboards the phase sequence of the low voltage switchboard shall be A B C corresponding to Top, Middle & Bottom busbars. Where either rolls or crosses of the LV connections are required these are to be performed in the cables to the transformer terminals and not in the LV distributor cables.

For “E-type” LV Switchboards the phase sequence of busbars in the low voltage switchboard shall be Neutral (N), C, B, A from the front to rear of the switchboard (i.e. when viewed from the right hand end of the switchboard N, C, B, A from left to right, the front of the board being the reference).

The connections within the substation together with its high and low voltage cabling must “phase” with the surrounding high and low voltage networks. Phasing of the substation means the orientation of the high and low voltage cables and connections will exactly match with the phase orientation of the surrounding network.

The Service Provider is responsible for designing the cable installation such that it will phase with either the existing and/or the new primary and secondary distribution systems. Phasing details will be provided by Ausgrid as part of the Design Information for contestable works.

The phasing of the new substation will be tested by Ausgrid at the time of commissioning. The Service Provider must be in attendance at the time of commissioning, and will be responsible for any required alterations resulting from incorrect phasing.

15.0 BUSBAR AND CABLE SUPPLIES FROM THE SUBSTATION CHAMBER TO THE CUSTOMER’S SWITCHROOM

15.1 Busbar and cable supplies – general

NS109 Design Standards for Overhead Supply Developments and Distribution Centre indicates various busbar supply or cable supply options. The substation general layout design must provide for the busbars or cables from the substation chamber to the customer’s switchroom to be installed in a generally direct route and in an arrangement satisfactory to Ausgrid. No more than 2 busbar supplies shall be connected to the LV switchboard in a chamber type substation. The busbars and cables shall comply with the following requirements.

15.2 Consumers’ mains cable types

Table 5 outlines the restrictions on the maximum number and size of consumers’ mains cables that can be terminated at the low voltage board panel.

Table 5 - Restrictions on the Maximum Number and Size of Consumers’ Mains Cables

LV Panel Rating	Maximum Number of Cables per Phase	Maximum Size of Cables
400A fuse distributor	1	300mm ² CU1XQZ
800A fuse distributor	2	300mm ² CU1XQZ
1200/1600A fuse supply	4 (see Note 1)	500mm ² CU1XQZ
3000A customer cable supply	4 (see Note 1)	630mm ² CU1XQZ

Note 1: It is essential to ensure that all consumers’ mains cable lugs, when terminated on the LV switchboard, are adequately insulated phase to phase and phase to earth. Supplementary insulation sleeving shall be added around the barrel of cable lugs.

Note 2: Equivalent sized fire rated cables can also be used, with the exception of MIMS cables.

15.3 Busbar and cable supplies - “E-type” LV switchboards

Busbar Supplies:

- For “E-type” LV switchboards, busbar supplies shall be Vass Electrical Industries Pty Ltd HFC busway system, or similar commercially available bus trunking system meeting Ausgrid’s requirements.
- The busbar trunking system shall comply with AS 3439.2 – Low-voltage switchgear and control gear assemblies – Part 2: particular requirements for busbar trunking systems (busways).
- The switchboard has been designed to accept a Vass Electrical Industries Pty Ltd HFC3780 flanged end termination, as shown in drawing 204115. Irrespective of the manufacturer or rating of the busway system ultimately used it will be necessary to provide a flanged termination equivalent to the Vass HFC3780 flanged end termination to facilitate connection to the E-type switchboard.
- Phasing at the flanged end termination shall be such that when viewed from the front of the switchboard Red phase is located on the left; Neutral is on the right, white phase is next to red phase and to the right of it; Blue phase is next to Neutral and to the left of it. i.e. Red - White – Blue – Neutral, left to right, when viewed from the front of the switchboard.
- The busway must be fitted and supported to the manufacturer’s instructions and must not exert any weight or pressure on the Vass flange termination or the “E-type” Switchboard.
- The length of a busbar supply shall be kept to a minimum, in accordance with NS112 Design Standards for Industrial and Commercial Developments. In this regard, the point of connection from the busbar supply to the customer’s switchboard shall be as close as practicable to the substation wall opening for the busbar. The busway may exit the substation through:
 - the ceiling directly above the connection to the “E-type” switchboard, or
 - the rear wall directly behind the connection to the “E-type” switchboard, or
 - the end wall directly adjacent to the connection to the “E-type” switchboard.
- The height of the exit point through the walls must be no lower than the connection to the “E-type” switchboard. The exit point may be higher than the connection to the “E-type” switchboard, provided the busway uses standard elbows and the assembly is fitted and supported in accordance with the manufacturer’s instructions.
- Penetrations through walls or ceiling shall be in accordance with the requirements of the manufacturer of the busway, and shall be sealed on each side via a suitable flange. The space around the busway between the flanges shall be sealed with fire stopping material in accordance with the requirements of NS171 Fire Segregation in Substations.

Cable Supplies:

- Customer Cable supplies shall be provided and terminated in accordance with Ausgrid requirements.
- Cables must not exert any weight or pressure on the switchgear terminations
- Cable supplies shall exit the substation through the shortest route that is practicable. Acceptable exit points are through the rear or side walls or floor of the LV Pit. Cable exit points must provide a cable route which directs the cables towards the LV Board terminations.
- The size of the opening for the exit point shall be determined to suit the particular cable(s) being used.
- Penetrations for cable exit points, shall be sealed with fire stopping material in accordance with the requirements of NS171 Fire Segregation in Substations.

16.0 SUBSTATION EARTHING

16.1 General

The substation earthing shall be arranged so that:

- the step and touch voltage limits will not be exceeded,
- the flow of fault current will not be restricted due to excessive resistance of the earthing circuit, and
- the short-time current carrying capacity of the earthing conductors and electrodes will not be exceeded.

The integrity of the substation earthing system is critical in providing a safe electricity supply. The earthing system must comply with the requirements of NS116 Design Standards for Distribution Equipment Earthing and NS113 Site Selection and Construction Design Requirement for Chamber Substations.

Unless directed otherwise by Ausgrid the MEN system of earthing shall be installed throughout the supply network. A modified direct earthing system may be specified by Ausgrid in some instances such as where LV bus ducting from the substation is used and other arrangements as determined by Ausgrid.

The Service Provider shall be responsible for advising the Contestable Project Coordinator of any potentially hazardous situation arising from metallic structures in contact with or near the substation. Such structures include but are not limited to metallic fences, swimming pools, flammable gas or liquid storage tanks, electric railway lines, pipelines, high voltage substations, high voltage transmission lines, operating theatres or similar facilities, communication centres, pits, pillars and metallic sheathed communication cables. Any potentially hazardous situation shall be referred immediately to the Contestable Project Coordinator to allow if necessary a detailed earthing system design review for the substation.

16.2 Earthing arrangement

A combined system of earthing shall be used consisting of two groups of electrodes, labelled as A group and B group. These groups shall be located so as to minimise the interaction effects between them. The minimum number of electrodes in each group shall be as specified in NS116 Design Standards for Distribution Equipment Earthing.

The A and B earth electrode groups shall be independently connected to the substation earth busbar.

Where Ausgrid specifies a direct earthing system, multiple earthing conductors are to be provided from the customer's main switchroom earth bar to the Ausgrid's substation earth bar. Under this arrangement no MEN connections between neutral and earth is to be made within the customer's installation. Note labelling requirements of AS/NZS 3000:2007 Electrical installations (Australian/New Zealand Wiring Rules), clause 5.5.1.3 will be required at each direct earth conductor termination point with the following wording.

WARNING: 'MAIN ELECTRICAL EARTHING CONDUCTORS FOR CUSTOMER'S DIRECT EARTHED INSTALLATION - DO NOT DISCONNECT'

Substations supplying electric traction installations, or located on sites owned or controlled by electric traction organisations, may require special earthing arrangements. In these situations, any special arrangements required will be specified on a case by case basis by Ausgrid's Contestable Project Coordinator.

16.3 Earth electrodes

The earth grids shall consist of a deep electrode system interconnected with earthing cable as specified in NS116 Design Standards for Distribution Equipment Earthing.

The location of all earth electrodes shall be fully dimensioned on the layout of equipment drawing for each chamber type substation.

16.4 Substation earth bar

In each substation chamber and in each control point chamber, an earth bar shall be installed, in accordance with the following specifications.

The substation earth bar shall be located approximately 300 mm above the substation floor level, on a wall adjacent to the low voltage switchboard, but not directly behind the low voltage switchboard. The substation earth bar must not be located where it would impede access to the low voltage pit, and must not be located where it would cause a hazard to personnel. The earth bar must not intrude into the minimum required clearances for personnel and equipment, as specified elsewhere in this Network Standard and NS113 Site Selection and Construction Design Requirement for Chamber Substations.

The control point earth bar shall be located on the wall, in a location where it would not create an access hazard, near the high voltage switches and the cable entry point, and approximately 300 mm above the control point floor level.

The earth bar shall be suitably spaced to provide a clearance from the wall of not less than 60 mm and not more than 100 mm, to enable the cable lug bolts to be inserted and removed from the wall side of the bar. The bar shall be not less than 1000 mm long for multi transformer chamber or 500 mm long for single transformer substations, manufactured from a single piece of tin-plated copper 100 mm x 6.3 mm for multi transformer substations or 50 mm x 6.3 mm for single transformer substations, complying with the following specifications:

- The bar shall be hard drawn high conductivity copper.
- The surface of the bar shall be clean, smooth and free from defects which are detrimental to its use.
- Manufacturing tolerance shall comply with Table 3 of AS 1566-1997 Copper and copper alloys - Rolled flat products.
- The bar shall have 1 mm radius at corners.
- The bar shall be of copper alloy 110, electrolytic tough pitch copper as designated in AS 2738.2 – 1984 and of temper designation to AS 1566 / 110-M.
- The bar shall be tin plated all round with minimum coating thickness of 10 micrometres for service condition Number 2 as stipulated by AS 4169-2004 Electroplated coatings - Tin and tin alloys and matt finish.

In a control point chamber or in a substation chamber; where A and B earth electrode group cables are installed, in accordance with NS113 Site Selection and Construction Design Requirements for Chamber Substations and NS116 Design Standards for Distribution Equipment Earthing, the cables shall be independently connected to the respective earth bar.

Each upper level substation, or substation near its control point, shall have the substation earth bar connected to the control point earth bar with 2 x 70 mm² stranded copper black PVC or polyethylene insulated cables.

At each transformer, all metalwork that is not attached to the transformer, including high voltage and low voltage cable support brackets, and the mechanical protection device for the high voltage cables (refer Clause 24.3), must be earthed to the transformer earth bar, with 70 mm² copper conductor black single insulated PVC or polyethylene insulated cables.

Where a substation is near another substation, or near an unassociated control point with or without an earth electrode system, the earth bars in each chamber shall, wherever practicable, be connected together with 2 x 70 mm² stranded copper black PVC or polythene insulated cables. This interconnection must not be made if one or both of the chambers has a segregated earthing system or is associated with a traction system. In these cases, specific earthing arrangements should be discussed with Ausgrid.

Connections to the substation earth bar or control point earth bar must be made with bolts, washers and nuts of the sizes specified in the drawings. Where the bolt size is not specified, the bolt and bar hole must be of an appropriate size consistent with the diameter of the hole in the lug being attached. Each cable lug must be separately connected under its own bolt or bolts. Cable lugs must be connected directly to the bar. Connection extension pieces, such as bar stubs, flags, etc must not be used. Slotted lugs are not permitted. Full hole tinned copper solid barrel compression lugs must be used. Lugs must be affixed to the cable with an approved crimping tool and die suitable for the cable size and lug. Bolts, washers and nuts must be stainless steel grade 316. Brass bolts must not be used.

The location of the substation earth bar (and control point earth bar, where applicable), must be shown on the Service Provider's (Designer's) plans.

16.5 Equipment earthing

Substation equipment earths shall be connected to the substation earth bar, and control point equipment earths shall be connected to the control point earth bar, in accordance with the following specifications.

Each installed item in the following list shall be separately connected as specified to the respective earth bar, with one (or more where indicated), 70 mm² copper conductor black single insulated PVC or polyethylene earthing cable:

- connection from electrode group A,
- connection from electrode group B,
- connection from the sheaths of armoured or screened low voltage cables, or metallic sheathed low voltage cables, where the metallic sheath is not used as a neutral,
- a separate set of 4 x 70 mm² cables (or 2 x 185 mm² cables), from each transformer tank, or 2 x 70 mm² cables where a single transformer substation of 1000kVA rating or less,
- a separate set of 2 x 70 mm² cables from each transformer earth bar,
- connection to the LV switchboard frame earth by 4 x 70 mm² cables (or 2 x 185 mm² cables) for E type boards or 2 x 70 mm² cables for disconnector/fuse strip type board.,
- connections between the "E type" LV Switchboard frame earth to the substation neutral bar by 2 x 70 mm² cables where one transformer is installed, 4 x 70 mm² cables (or 2 x 185 mm² cables) where two transformers are installed, and 6 x 70 mm² cables (or 3 x 185 mm² cables) where three transformers are installed),
- connections between the disconnector/fused strip type LV Switchboard neutral bar and substation earth bar by 2 x 70 mm² cables from each transformer LV switchboard assembly,
- connections to nearby substations and unassociated control points (refer to Clause 16.4),
- separate earth cables (2 x 70 mm² cables) from each item of high voltage switchgear (eg RMIFS, RMICB, I & E switch); or two earthing cables (2 x 70 mm² cables), being the ends of an earthing loop around all high voltage switchgear earth bars, as indicated below.

The substation Service (light & power distribution) switchboard shall be separately connected to the substation earth bar with 16mm² copper conductor black single insulated PVC or polyethylene earthing cable

The following shall be separately connected to the substation earth bar with 6mm² copper conductor black single insulated PVC or polyethylene earthing cable:

- For protection panels which do not form part of the low voltage switchboard: one separate cable for each protection panel, or two cables being the ends of an earthing loop formed by interconnecting all protection panels in a group with 6mm² copper conductor.
- Other panels or groups of panels or equipment required to be earthed (eg SCADA panels).

Each cable connected to the substation earth bar or control point earth bar shall be adequately labelled to indicate its origin.

At each item of high voltage switchgear; a switchgear earth bar is to be installed for connection of switchgear frame earths and high voltage cable metallic sheath or screen wire earths. The switchgear earth bars are to be not less than 40 mm x 6.3 mm tin-plated copper, complying with the specifications in Clause 16.4. The bars shall be of adequate length for the connections required.

The earth bar at each item of high voltage switchgear shall be either:

- connected directly to the substation earth bar, or control point earth bar, as applicable, with 2 x 70 mm² cables, or
- connected into an earthing loop formed by interconnecting all high voltage switchgear earth bars with 70 mm² cables.

Connections to the switchgear earth bars must be made with bolts, washers and nuts of the sizes specified in the drawings. Where the bolt size is not specified, the bolt and bar hole must be of an appropriate size consistent with the diameter of the hole in the lug being attached. Each cable lug must be separately connected under its own bolt or bolts. Cable lugs must be connected directly to the bar. Connection extension pieces, such as bar stubs, flags, etc must not be used. Slotted lugs are not permitted. Full hole tinned copper solid barrel compression lugs, Ausgrid approved tinned copper braids with specially formed lugs, or Ausgrid approved mechanical cable lugs, must be used. Where compression lugs are used, they shall be installed strictly in accordance with the manufacturer's specification for crimping dies, number of crimps and position of crimps. Bolts, washers and nuts must be stainless steel grade 316. Brass bolts must not be used.

At each transformer, all metalwork that is not attached to the transformer, including high voltage and low voltage cable support brackets, and the mechanical protection device for the high voltage cables (refer Clause 24.2), must be earthed to the earthing facility provided on the transformer earth bar, with 70 mm² copper conductor black single insulated PVC or polyethylene insulated cables.

Where screened dead-break separable connectors (screened elbows) are used for 11kV transformer connections, refer to the additional requirements for earthing of the screened elbows in NS177, 11kV Joints (Including Transition Joints) and Terminations – Polymeric Insulated Cables. Refer also to drawing 162655 for equipment earth bar and current transformer mounting arrangements.

Where customer busbar supplies are utilised with E type LV switchboards, each busway metal housing shall be earthed by a solid copper earth bar extending from the bus way housing earth point externally down the side of the E type LV board and connected to the LV board main earth busbar extension point. This earth bar shall be adequately supported throughout its run by appropriate attachment to the side of the LV board.

17.0 PROTECTION – DESIGN AND INSTALLATION

17.1 Protection general

Refer also to Section 10 – Equipment Layout, Space and Clearance Requirements.

Protection systems shall be installed in all distribution substations equipped with high voltage and low voltage circuit breakers.

Ausgrid shall nominate the protection schemes, relay types and current transformer classes to be installed in the chamber type substation and determine the protection settings required to protect the substation, personnel and public and to ensure grading with Ausgrid's network and the customer's installation. These protection settings are to be detailed on a Relay Test Instruction which shall also include the relevant schematic diagram drawing number, relay types and function and the ratio of current transformers and auxiliary transformers to be used.

Ausgrid's protection for distribution substations is dependent on the design requirements of the high voltage network supplying the substation, and the customer's installation requirements. The present standard Ausgrid protection requirements are detailed in the following clauses for the applicable type of substation.

The maximum size of fuse to be used on LV network distributors shall be 400 amperes.

All customer cable supplies up to 1600 amperes shall be fused. Busbar or cable supplies are permitted up to a maximum of 3000 amperes and must have busbar overcurrent protection fitted.

For contestable works, the Contestable Project Coordinator shall include in the Design Information document the protection requirements for the substation, including as a minimum requirement:

- the high voltage fuse types and ratings to be used in RMIFS,
- the protection schemes to be installed for the substation including the type of protection relays in each scheme, current transformer class and ratio and any special protection requirements for the substation, and
- the low voltage fuse types and ratings for network distributors and supply to the customer's installation.

Ausgrid shall make available for the Service Provider via Ausgrid's store the required protection panels wired and loose relays for mounting by the Service Provider.

Ausgrid shall complete all protection pre-commissioning tests, which include testing circuit breaker trip mechanisms and trip coils, current transformer saturation, ratio and polarity tests, protection wire checks, calibration of relays, protection balance tests and trip checks.

17.2 Optical arc flash detection protection

17.2.1 Purpose of optical arc flash detection

To minimise the effects of LV arcing faults all suburban multi transformer RMICB controlled substations and Sydney CBD substations, optical arc flash detection (OAFD) protection shall be installed.

17.2.2 Optical arc flash sensors

Where optical arc flash detection protection is required, optical arc flash fibres shall be installed and connections shall be made between the sensors and optical arc flash detection relay(s).

A fibre sensor support structure fabricated from 25mm LD rigid PVC conduit components shall be fitted to the rear of the E Type LV board attached via standoff brackets, refer drawings 227350 sheet 5 & 227359 sheet 1. The fibres shall be held in place by Velcro ties to the exterior periphery of the conduit closest to the switchboard rear cover.

Note: The fibres are pre-terminated and are not to be cut or damaged. The installation of the clear jacketed fibres externally on the rear of the E type LV board is to be conducted as close as practical to the end of the substation equipping process. This is to ensure that the exposure to mechanical damage of the fibres during the substation equipping period is minimised.

17.2.3 Switchgear trip coil requirements for optical arc flash detection

Where optical arc flash detection protection is provided the HV RMICBs and LV ACBs shall both be provided with two trip coils.

However **for HV RMICBs**, where due to equipment designs this is not technically practical and cost effective, an alternate configuration utilising a single trip coil will be considered and, if acceptable, approved.

17.2.4 Optical arc flash detection indication box

Where optical arc flash detection protection is installed, an indication box as shown on drawing 227354 shall be installed internally on the wall adjacent to the main personnel entrance to the substation. The indication box indicates the health of the optical arc flash detection protection system, including the optical arc flash detection 48V battery system.

The test box for the standard 30V protection battery shall be located adjacent to the optical arc flash detection indication box (refer Clause 10.8), so that both can be checked together upon entry to the substation. The test box shall be connected to the remotest end from the battery of the 30V bus.

The main personnel entrance to the substation is generally defined as the one that provides the most ready access from the street and is therefore the one which is most likely to be used. Where multiple access points are available and neither is considered to be main then advice should be sought from Ausgrid.

The optical arc flash detection indication box should be located in an unexposed location, where it will not be prone to accidental damage, especially during movement of other equipment. The indication box shall be located in a position which is readily visible and accessible. The positioning requirements are that the top of the indication box must be not more than 1500 mm above the adjacent floor level.

17.2.5 Optical arc flash detection warning labels

Where optical arc flash detection protection is installed, warning labels as shown below, are to be attached in a prominent position on each substation personnel access door.



Label 1 – to be installed on the main personnel access door leading to the Optical Arc Flash Detection Indication box (Black 8mm height lettering on white Traffolyte or Gravoply label size 150mm x 50mm)



Label 2 – to be installed on all other personnel access doors (Black 8mm height lettering on white Traffolyte or Gravoply label size 150mm x 50mm)

Labels shall be fastened in position with 8 gauge wafer head self drilling screws. Where they are located outdoors the fasteners shall be corrosion resistant.

17.3 Protection schemes for substation types

Substations shall be equipped with protection systems in accordance with Table 6 below.

Table 6 - Substation Protection Systems

Substation Type	Protection Schematic Diagram Drawing	
	Description	Number
Sydney CBD isolator & earthing (I&E) switch	CBD Substation with E-Type LV Board AC & DC Schematics (with optical arc flash detection)	227380
Suburban ring main isolator circuit breaker (RMCB)	RMICB Substation with "E-type" LV boards AC & DC Schematics (with optical arc flash detection)	227350

17.4 Protection panels

17.4.1 Protection panels - general

For “E-type” LV switchboards, protection relays shall be mounted on a wall mounted panel or for CBD substations on free standing cabinets only.

All protection panels and cabinets shall be adequately fastened and if necessary braced to ensure rigid support for the relays. Relay panel layouts and construction details must conform to Ausgrid drawings. All wiring and terminations within protection and control panels shall be in accordance with Ausgrid Network Standards NS252 and NS253.

The protection panel/cabinets shall be manufactured and cut out free of sharp edges and burrs. A tinned copper earth bar shall be installed at the bottom rear of each protection panel/cabinet and connected to the substation earth bar with a 0.6kV insulated 6 mm² conductor. Earth connections designated on the drawing to be individually connected to the earth bar, shall be connected to a dedicated termination point on the earth bar, such that no other earth connection will have to be removed to disconnect any earth connection.

17.4.2 Wall mounted protection panels

Wall mounted protection panels shall be in accordance with drawing 28632. Wall mounted transformer protection panels shall be painted with a metal sealant and two finishing coats of preferably N22 gloss Cloud Grey to AS 2700 gloss paint.

The protection relays shall be projection mounted on the front of wall mounted panels.

Each protection scheme (i.e. transformer differential, LV overcurrent for each installed transformer and optical arc flash detection, busbar overcurrent, etc) shall be mounted on individual dedicated wall mounted panels. Customer overcurrent protection schemes should also be mounted on individual dedicated wall mounted panels, however where this is not practicable due to limited wall space within the substation chamber a double panel, as shown on drawing 227353, can be used with approval from Ausgrid.

17.4.3 Free-standing protection cabinets (Sydney CBD only)

Free standing protection cabinets shall be in accordance with drawing 205952. Free standing protection cabinets shall have a powder coated finish of preferably N22 gloss Cloud Grey.

The protection relays shall be projection and flush mounted on the front of the doors of the free standing cabinets as detailed in the applicable drilling drawings.

Up to two protection schemes can be mounted on one free standing cabinet; one protection scheme on the top door of the cabinet, and one protection scheme on bottom door of the cabinet.

Transformer differential and LV overcurrent protection schemes, for each installed transformer, shall be mounted on a door of a free standing cabinet. Up to two transformer protection schemes may be mounted on one free standing cabinet.

Busbar overcurrent protection can only be mounted on a dedicated, wall mounted panel.

17.4.4 Wiring

All interior panel/cabinet wiring shall be at least seven stranded 2.5 mm² for AC circuits and 1.5mm² for DC circuits un-tinned copper conductor, 0.6/1kV V90 grade PVC single insulated cable to AS/NZS5000.1. All wiring is to be coloured grey except for earth wiring which is to be green/yellow. Both ends of each wire must carry an approved ferrule indicating the wire numbers shown on the relevant Schematic/Panel Wiring Diagram. The ferrules must be fitted firmly and as close as practicable to the cable lug. Clip on ferrules or printing directly onto the cable insulation is not permitted.

The cables shall be securely fixed to panels by means of cable tray, PVC slotted troughing with cover or secured in wiring looms in accordance with Ausgrid reference drawing 52474. Wiring looms only are to be used in free standing cabinets. Looming is to be made so as to allow for easy inspection and replacement of wiring.

The wiring loom between the panel door and the terminal rails in the cabinet is to be provided with sufficient flexibility to allow the door to be fully opened without placing excessive strain on the wiring.

Common connections between equipment are to be achieved by looping wires to achieve the shortest possible path, however at no time is there to be more than two cables terminated at any link or relay terminal.

Wiring is to be in one continuous length between equipment. Joints are not permitted in any length of wire.

An earth wire is required to be connected to each panel/cabinet door and is to terminate on the panel earth bar.

Any earth connections are to be connected individually to the panel/cabinet earth bar.

All interior panel wiring shall be terminated to approved terminal blocks, relays or links using approved terminal lugs, correctly applied with a crimping tool designed for the lug and cable size. No more than two cables shall be terminated to any single terminal of a terminal block or test link and relay with other than stud type terminals.

17.4.5 Terminal blocks and cable lugs

Terminal blocks shall be Utilux H3820 with G Rail mounting channel or Phoenix Contact RTO5 with DIN mounting rail unless otherwise stated.

Wires are to be terminated onto the stud type terminal blocks and relays using Utilux H2036 M5 pre-insulated cable lugs. Wires are to be terminated onto test links using Utilux H2037 M6 pre-insulated cable lugs.

17.4.6 Test links and battery links

Test links and battery links are to be mounted so that the link falls into the open position.

Test links and battery links are to be mounted so that the link falls into the open position and assembled as per drawing 50992.

17.4.7 Labelling

Each protection panel, and all of the components on each protection panel/cabinet, shall be labelled. Labels are to be made and positioned as shown on drawing 178241.

Labels are to be engraved as indicated by the Labelling Details table shown on the relevant Protection Panel Drilling and Wiring Diagram.

17.4.8 External wiring entry

For wall mounted panels, appropriately sized holes are to be drilled on site to allow cables from other substation equipment to enter protection panels. Where they enter protection panels, cables are to be protected from sharp edges by bushings or glands.

For free standing protection panels and cabinets, cables shall enter the cabinets from beneath. If the free standing panels or cabinets form extensions of the LV Switch board, they are to be mounted in a similar manner as the LV Switchboard, with cable entry from the extended LV Switchboard pit.

For free standing panels or cabinets not forming part of the LV Switchboard, suitable conduits or floor chases will need to be provided in the substation floor slab to facilitate cable entry.

17.5 Protection current transformers

“E-type” low voltage switchgear panels will generally have all necessary current transformers supplied already installed, and wired to marshalling terminal blocks in the relevant switchgear panels.

All other current transformers including the OAFD Neutral Check CT which is to be mounted to the transformer LV cable cleat bracket shall be securely mounted to prevent movement during fault conditions, and shall be mounted with the nameplate clearly visible.

All CT secondary leads shall be fitted with ferrules and wire numbers, in accordance with the standard schematic.

Both the current transformer polarity and non-polarity secondary leads shall be loomed or enclosed in PVC conduit or installed in PVC slotted troughing with cover and terminated at a terminal block as per clause 17.4.5.

The marshalling terminal blocks shall be positioned such that the current transformer secondary leads, when fitted as a composite part of the current transformer, reach the terminal blocks without the need for extension of the leads.

For high voltage switchgear the terminal blocks shall be housed in a polyester type box with a screwed type front removable cover.

All current transformer star point connections and earthing thereof shall be made at the protection panels. The star point earth connection shall be connected direct to the panel earth bar.

The current transformers for transformer differential protection located on the high voltage side of the transformer should be installed at the high voltage circuit breaker or switch rather than at the transformer, except in the following cases:

- Installation at the transformer is permitted where the space available at the high voltage circuit breaker or switch is inadequate.
- For upper level substations the current transformers must be installed at the transformer.
- Where the substation has an associated control point, and the control point is not adjacent to the substation, the current transformers must be installed at the transformer.

The following requirements apply to the cable sheath earthing connections where transformer differential protection is installed and single core earthed sheath cables are installed between the high voltage circuit breaker or switch and the transformer. Irrespective of whether the differential protection current transformers are installed at the high voltage circuit breaker or switch, or at the transformer, the earthing connections from the high voltage cable sheaths must be installed on the transformer side of the current transformers, so the current transformers will register the fault current for a cable phase to sheath fault. Gland isolation must be applied at the sheath terminations at the high voltage switch or circuit breaker. No other cable sheath earthing connection arrangements are permitted.

Where screened dead-break separable connectors (screened elbows) are used for 11kV transformer connections, refer to the additional requirements for earthing of the screened elbows in NS177, 11kV Joints (Including Transition Joints) and Terminations – Polymeric Insulated Cables. Refer also to drawing 162655 for equipment earth bar and current transformer mounting arrangements.

Optical arc flash protection utilises the HV Differential CTs in conjunction with a LV Neutral check CT for the current check facility.

On the high voltage differential current transformers, the current transformer secondary wiring polarity and non-polarity leads shall be a minimum of 3 metres continuous length, 7/0.67 stranded untinned copper conductor 0.6/1kV PVC or polyethylene insulated, soldered to the CT winding. The secondary cable insulation shall be coloured either black or grey.

17.6 Protection battery and battery charger

Every substation with protection relays requires a standard 30V protection battery system as discussed in clause 17.6.1 below. For substations with only Ausgrid standard electromechanical protection relays no additional batteries are required. However, for substations with optical arc flash detection protection relays a 48V battery system, as discussed in Clause 17.6.2 below, is required in addition to the standard 30V battery system.

Where the two battery systems are installed, 'A' and 'B' protection systems shall be provided; The 'A' system supplied by the standard 30V protection battery, and the 'B' system supplied by the 48V optical arc flash detection protection battery (including a 30V tap). Each battery and charger system, including wiring, shall be separately grouped together so delineation and electrical isolation exists between each system to ensure that potential problems with one system does not affect the other. Each battery shall have a separate dedicated charger, with independent and separately, permanently wired AC supply circuits each supplied from separate dedicated sub-circuits originating from the auxiliary services board.

17.6.1 Standard 30V protection battery and charger

The protection battery, battery trickle charger and battery test box should be located in unexposed locations, where they would not be prone to accidental damage, especially during movement of other equipment. Specific requirements for positioning and clearances are indicated in Clause 10.8 and drawing 244218.

Note: The top of the battery installation must be not more than 1200 mm above the adjacent floor level.

The rating of the protection battery shall be 10 ampere-hours comprising 24 nickel cadmium cells, each 1.25 volts. The cells shall be mounted on a steel frames, fixed to the substation wall on stand-off insulators. Refer to drawing 10635 for details of the double-tier supporting frames and fixing arrangements for the 30 volts battery. Two double-tier supporting frames shall be mounted side-by-side.

The battery trickle charger is to supply battery losses only. It must not have a boost charge option available. The trickle charger shall have 240 volts AC input and 15mA DC rated output capable of driving into the 30 volt battery.

Battery trickle chargers are not required to be connected to supervision or alarm systems. If non-standard circumstances require battery chargers other than trickle chargers to be specified, then supervision and alarms will be required for the battery installation.

Battery installation stockcode numbers are included in Annexure B.

17.6.2 48V optical arc flash detection protection battery and charger

A 48V protection battery and charger is only required in substations with optical arc flash detection protection relays. The 48V battery and battery charger should be located in unexposed locations, where they would not be prone to accidental damage, especially during movement of other equipment. Specific requirements for positioning and clearances are detailed in Clause 10.8 and drawing 244218.

Note: The top of the battery installation must be not more than 1200 mm above the adjacent floor level.

The 48V battery shall be provided with a 30V tap which is to be utilised for the 'B' protection system tripping supply.

The battery has sufficient capacity to continue to supply the optical arc flash relays for over 8 hours in the event of a 240V AC power failure. This capacity is in addition to the capacity required in Clause 17.6.1 for tripping purposes.

The battery charger has sufficient capacity to carry the standing DC load of the optical arc flash detection relays in addition to charging the batteries.

The rating of the 48V protection battery shall be 10 ampere-hours comprising 40 nickel cadmium cells, each 1.25 volts. The cells shall be mounted on steel frames, fixed to the substation wall on stand-off insulators. Refer to drawing 10635 (double-tier supporting frame and fixing arrangements). Three double-tier supporting frames shall be mounted side-by-side.

Cables for DC tripping circuits shall have stranded copper conductors of not less than 4 mm² cross sectional area.

Battery chargers are required to be connected to supervision (or SCADA) and alarm systems. There is no need for a separate battery test box for the 48V battery (including the 30V 'B' protection supply) as the 48V DC system is monitored directly by the optical arc flash detection relay and the health of the whole optical arc flash detection system is indicated locally via the optical arc flash detection indication box refer Clause 17.2.4.

17.7 Protection and control multicore cables

Multicore control and protection cable shall be 7/0.67 mm² untinned copper conductor, 0.6/1kV PVC insulated, PVC sheathed cable in accordance with AS/NZS5000.1.

Multicore cables shall be installed in accordance with the relevant substation cable schedule. The cables shall be fully segregated from high voltage cables, AC light and power circuits and transformer low voltage tails i.e. multi core cables shall be installed in ducts or conduits or PVC slotted troughing designated to protection and control circuits. All control circuits shall be installed with mechanical protection to a height of 1 metre from the floor.

All multi core cable cores, necessary for the installation, shall be fitted with an approved ferrule and wire numbers in accordance to the Ausgrid standard schematic diagram.

All unused multi core cable cores shall be of sufficient length to reach the top of the terminal block or the most distant equipment terminal and included in the in the PVC slotted troughing with cover or the cable wiring loom in accordance with drawing 52474.

18.0 SUBSTATION LIGHTING AND GENERAL POWER

18.1 Substation service (light and power distribution) board

With the exception of Standard Surface Chamber Distribution Substation Single Transformer Up to 1000kVA which are to be constructed as detailed on the relevant drawing, lighting and general power for chamber and control point substations is to be provided from a distribution board supplied from the LV switchboard. The distribution board is to contain miniature circuit breakers or Fault Current Limiting (FCL) fuses of a suitable capacity and fault duty.

The distribution board is shown in the following Ausgrid drawings:

- 227356 sheet 1 for use in suburban substations (i.e. with active protection systems, OAFD and without substation ventilation fans).
- 169392 for use in suburban substations without active protection systems.
- 227387 for use in Sydney CBD substations with SCADA and active protection systems.
- 169393 for use in Control Points.
- 121949 for use in single transformer 1500kVA suburban substations (i.e. with active protection systems and without substation ventilation fans or SCADA).

As the details shown in these drawings are subject to amendment, ensure that the copy being used is current.

The substation light and power distribution board shall be labelled in accordance with NS158 Labelling of Mains and Apparatus.

Light and power for a control point is generally to originate from the associated substation, which is to provide supply through sub-mains to a suitable wall mounted sub-distribution board in the control point in accordance with drawing 169393. Separate dedicated circuits for control point lighting and power requirements are to be provided from the sub-distribution board, as specified for substation chambers. Where there is another substation in the same premises adjacent and closer to the control point than the associated substation, the sub-mains for light and power for the control point may originate from the adjacent substation, provided suitable labelling is attached at each end of the circuit.

18.1.1 “E-type” LV switchboards

For “E-type” LV switchboards the distribution board shall be mounted as a wall mounted panel with clearances and positioning requirements equivalent to those specified for wall mounted protection panels (refer to Clause 10.7).

Primary supply for the distribution board shall be from 63 amp FCL fuses mounted on the Surge Arrester Panel on the low voltage switchboard. These fuses are supplied from the main busbars. For switchboards with a Normally Open bus section switch a Surge Arrester Panel shall be installed on each end of the switchboard, but the auxiliary fuses on only one of these should be connected to the busbars and utilised. Cables connecting the FCL fuses to the distribution board shall be 16 mm² 0.6/1kV double insulated single core. The cables shall be installed by the Service Provider and shall be as short as practicable. For this reason it is preferable that the surge arrester panel be mounted on the end of the low voltage switchboard that is closest to the distribution board.

Alternative supplies to the multi-position changeover switch on the distribution board shall be from the 40 amp FCL fuses mounted on each transformer LV circuit breaker panel and connected to the line side of the respective low voltage transformer CBs. Cables connecting the FCL fuses to the changeover switch, shall be 16 mm² 0.6 / 1kV double insulated single core cables. The cables shall be as short as practicable and shall be installed by the Service Provider.

18.2 Light and power circuits

Light and power circuits shall be wired in accordance with AS/NZS 3000:2007 Electrical installations (Australian/New Zealand Wiring Rules) utilising 0.6/1kV 7/0.67mm² minimum untinned copper conductors complying with AS/NZS5000.1. PVC conduits shall be used when single insulated cable is selected for the wiring of the light and power circuits. Double insulated cable if selected shall be installed on cable tray or PVC duct with cover.

Battery chargers, as specified in Clause 17.6, are to be provided for protection equipment in substations with high voltage and/or low voltage circuit breakers.

The battery chargers shall be supplied by permanently connected separate dedicated circuits, from the distribution board.

18.3 Power outlets

General power is to be provided for a minimum of one single-phase, double, 10 amp 240 volt general purpose outlet. This power outlet shall be located on the Service Board unless it forms part of the standard LV board design, and shall be supplied from a dedicated circuit. Depending on the equipment installed in the substation, a three-phase outlet may also be required – refer to the appropriate Service Board General Arrangement and Wiring Diagram as detailed in Clause 18.1.

18.4 Lighting

The substation and associated chambers are to be provided with lighting sufficient to ensure an adequate level of illumination. Fluorescent style lighting shall be installed and shall provide a minimum of 160 lux throughout a horizontal plane one metre above the floor level.

Light fittings are to be positioned where they will not be susceptible to damage, and where the fittings and their associated conduits do not interfere with doors, hatchways, cables, ventilation ducts, trip wires or other pieces of equipment in the substation chamber. Light fittings must be wall mounted and be installed such that the centreline of the light fitting is 2200 mm above floor level. Refer Clause 10.4.2 in respect of light fittings not to be located behind E type LV boards.

For multi-transformer chambers with doorway type personnel access, lights are to be controlled by two-way heavy duty switches positioned adjacent to each doorway. For single transformer chambers a single light switch shall be provided adjacent to the entrance door closest to the low voltage board.

For hatchway type personnel access, a suitable limit switch is to be positioned under each hatchway, and is to operate when the hatch cover is opened, to activate the lighting in the chamber below that hatch cover only.

In the chamber below each hatch cover, a two-way heavy duty switch is to be installed to control the lights in the substation chamber and access passageways.

All fittings and wiring are to be in accordance with AS/NZS 3000.

19.0 REQUIREMENTS

19.1 Hatch covers

On the completion of the substation, the hatch cover shall be sealed in accordance with Ausgrid's present practice, detailed on reference drawing 50740 Substation Construction Detail Transformer Hatch.

19.2 Fire equipment and ventilation

No service shall be installed in the substation ventilation ducts. The substation shall be equipped with a mechanical operated system for tripping of fire damper fitted to the opening of each substation ventilation duct. The Service Provider shall install the tripping mechanism and shall ensure that moving parts do not fall onto live equipment. No other equipment, fitting or conduits shall interfere with the operation of the mechanical tripping of the dampers.

Provision in the building and construction of the substation must allow for the injection of Carbon Dioxide gas (CO₂) by the fire brigade. The Service Provider shall ensure that the point of entry for the CO₂ gas is not obstructed by the equipping of the substation.

Fire protection equipment (CO₂ injection and fire dampers) shall be installed in accordance with NS113 Site Selection and Construction Design Requirements for Chamber Substations, Section 14 Fire Protection.

19.3 Buildings below potential water table

Refer to NS113 Clause 11.3 for additional requirements for buildings below potential water table.

19.4 Cable entry ducts

All cable entry ducts, including both unused ducts and ducts containing cables are to be sealed against water entry to the basement and oil egress from the substation.

20.0 CITY TYPE SUBSTATIONS ADDITIONAL REQUIREMENTS

20.1 Signalling pilot cables

WARNING

**Pilot cables entering the substation
from the network must be regarded "alive".
The requirements of the Electrical Safety Rules
must be complied with when working
on or near pilot marshalling cabinet / box.**

It is mandatory for Ausgrid to terminate pilots to the marshalling box and commission pilots to the substation. For contestable projects, the cost for this work is included in the cost for mandatory protection commissioning.

The Service Provider shall install pilots from the marshalling cabinet to the SCADA and protection panels in accordance with the cable schedule.

20.2 Emergency push-button switches

Sydney City CBD type substations are fitted with emergency push-button switches to enable help to be summoned. These switches are connected via the SCADA system to operate an alarm in the Network Control Room. They must be installed at 1400 mm above floor level, just inside each substation or control point personnel access door. The pushbutton shall be a turn to release emergency stop station (Telemecanique Part No. XALK 174 or similar). A suitable sign shall also be installed adjacent to the switch stating:

**“EMERGENCY USE ONLY
This switch alarms to the System Operator
(ext 31151) who will contact Emergency Services
In case of false operation, turn knob
clockwise to reset and notify
System Operator of false alarm.”**

The Service Provider must make provision for installation of the emergency switches in accordance with the details shown on the substation light and power diagram. The actual connection to the SCADA system will be carried out by Ausgrid as part of the SCADA system installation.

20.3 Pull-out gear

All high voltage switches connected to triplex networks, in substations and control points in the Sydney City CBD, are to be fitted with pull-out gear to enable the high voltage switches to be tripped remotely, from inside access hatchways or entrance chambers, without having to enter the transformer chamber or control point chamber. The pull-out gear operating handles must be located at the street entrance end of the accessway. The Service Provider must install the pull-out gear in accordance with the detail shown on drawings 18894, 16500 and 10578.

20.4 Ventilation fan control

Sydney City CBD substations, which are required by NS113 to include a ventilation fan, shall be fitted with the fan control systems as shown on drawing 228912. The associated air vane switch and fan control thermostats shall be installed as shown on drawings 228912 and 228913.

20.5 Water level rise indicator (float switch)

A water float switch and cabling to provide for a water level rise signal to the SCADA system must be installed in all basement chamber substations and basement control point chambers in the Sydney CBD. A suitable float switch is available from NHP type CF5.

The float shall be installed at the lowest point of the chamber, which may be in the high voltage cable pit or in a sump to which water would flow from the bottom of the low voltage pit and the bottom of the high voltage pit. The float switch must be set to operate when the water level is not more than 50 mm above the lowest point.

Service Providers must provide and install the necessary wiring within the substation, in accordance with Ausgrid's drawings and specifications, from the water level rise indicator to the protection panel and from the protection panel to the SCADA.

Refer also to Clause 24.2 regarding segregation of cables.

21.0 UPPER LEVEL SUBSTATIONS ADDITIONAL REQUIREMENTS

21.1 General

No oil filled switchgear and transformers shall be installed in upper level chamber substations.

21.2 Transformers

Ausgrid will provide approved 1000kVA or 1500 kVA dry type transformers. The customer must pay the cost difference between the dry type transformers and oil filled transformers of equivalent rating. The transformer rating must be accepted by Ausgrid to be economical for the installation. For substations that are deemed to be uneconomical, the customer must pay the full cost of dry type transformers. This method of obtaining dry type transformers has a number of advantages for the Service Provider, however it is not compulsory. Service Providers are free to source dry type transformers directly from the suppliers; however the transformers must be approved by Ausgrid. Refer also to section on Materials in Ausgrid's Policy for ASP/1 Premises Connections.

Note: All transformers and switchgear must conform with Ausgrid's specifications.

21.3 Cable risers

For contestable works, high voltage cables shall be installed by the Service Provider in the building's cable riser from the high voltage control point to the upper level substation. The cable riser installation shall comply with the requirements of NS113 Site Selection and Construction Design Requirements for Chamber Substations.

The substation earth groups A and B shall be installed in the footprint below the high voltage control point. The earth group tails shall be installed by the Service Provider in the building's cable riser with the 11kV cables.

The cleating of the high voltage and earthing cables shall be detailed in the design drawing for the cable riser installation and is subject to Ausgrid approval.

Where a cable riser does not directly enter the associated substation and/or control point, conduits shall be installed between:

- the lower end of the cable riser and the control point and/or
- the upper end of the cable riser and the substation.

The conduits shall be installed in accordance with NS113 Clause 11.8, and NS113 Annexure A.

All doors accessing cable risers shall be labelled with a suitable danger sign conforming to AS1319 with the words "DANGER HIGH VOLTAGE CABLES INSIDE". The doors shall also be fitted with an Ausgrid approved keying system.

21.4 Equipment delivery

Upper level substations require different methods of equipment delivery than surface and basement chamber substations.

Refer to Section 8 of NS113 Site Selection and Construction Design Requirements for Chamber Substations for further information.

22.0 CHAMBERS FOR CONTROL OF SUPPLY TO HIGH VOLTAGE CUSTOMER INSTALLATIONS (HVC'S) - SPECIAL REQUIREMENTS

The requirements for supply to high voltage customer installations, as included in NS195 High Voltage Customer Connections (HVCs), must first be satisfied before supply will be provided at high voltage.

Where Ausgrid agrees to the provision of supply at high voltage from equipment installed in a chamber, Ausgrid's space and equipment requirements will be negotiated on a case by case basis. Project details will be provided by Ausgrid as indicated in Clause 7.2 of this Network Standard, and NS195 High Voltage Customer Connections (HVCs). Refer also to NS113 Site Selection and Construction Design Requirements for Chamber Substations for further information on the requirements for chamber construction, access, equipment clearances, ventilation and fire segregation.

A chamber for control of supply to a high voltage customer installation must be equipped with a lighting installation and a power installation similar to that required for a control point chamber (see Section 18) and drawing 169394. In addition, the high voltage switchgear specified may require installation of protection equipment including a relay panel, battery, battery stand and charger (see Section 17). In the project details, Ausgrid will specify the source of supply for the lighting and power installations. It is mandatory that, the source of supply will be from the customer's metered installation and must be a separate dedicated circuit without any RCD protection at the origin. In each case, the installation of cables and other equipment to provide supply for the lighting and power installations is the responsibility of the Service Provider.

Note: The auxiliary supply sub-circuit is not to contain any earthing conductor, this is to ensure that the sub circuit wiring is not damaged in case of HV earth fault current flow. Earthing of the sub circuit equipment will be at the HVC chamber only.

Suitable labelling must be attached to each end of each circuit. Where the source of supply is not from within the customer's metered installation, Ausgrid may charge for energy consumed, on an ongoing unmetered supply basis.

23.0 SUBSTATIONS EQUIPPED WITH SCADA – ADDITIONAL REQUIREMENTS

23.1 Signalling equipment (SCADA)

SCADA shall be installed in all city chamber substations and other substations where optical arc flash detection relays are installed, in accordance with drawing 121156 for CBD substations and 227358 for Suburban substations. The Service Provider shall install the SCADA cabinet and install cables to the cabinet in accordance with the cable schedule for the substation.

It is mandatory for Ausgrid to terminate cables at the SCADA cabinet. For contestable projects, the cost for this work is included in the commissioning costs.

23.2 Communications signalling

WARNING

**Pilot cables entering the substation
from the network must be regarded “alive”.
The requirements of the Electrical Safety Rules
must be complied with when working
on or near pilot cables.**

For suburban substations communications to Ausgrid's Central Control Room for SCADA will generally be provided via wireless devices. However in some circumstances (particularly in the Sydney City CBD) SCADA communications are via pilot cables, and in such cases it is mandatory for Ausgrid to terminate pilot cables to the pilot isolation box and commission pilots to the substation. For contestable projects, the cost for this work is included in the cost for mandatory protection commissioning.

The Service Provider shall install pilots to the SCADA and protection panels in accordance with the cable schedule.

24.0 AREAS OF SPECIAL CARE

24.1 General

The experience of Ausgrid and of other supply authorities has shown that certain aspects of substation projects require special care so as to avoid reliability and/or maintenance problems. Service Providers' attention is drawn to these areas so that they can ensure that special care is given during construction.

24.2 Segregation

The high voltage cables, low voltage transformer tails and low voltage distributor cables shall be fully segregated from the secondary protection and control cables; i.e. primary and secondary cables are to be installed in separate ducts, chases and on separate cable trays. Spatial separation of protection and control cables shall suffice within the LV switchboard pit.

24.3 HV and LV cable installation

The low voltage network distributors and the high voltage cables from the substation to the dedicated roadway shall be installed in accordance with NS130 Specification for Laying Underground Cables up to and Including 11kV. All high voltage cables and the transformer tails shall be tested in accordance with the requirements of NS161 Specification for Testing Cables After Installation.

The high voltage cables shall be installed in the ducts provided. Where the high voltage cables emerge from floor ducts at the transformers, the cables shall be supported as shown in drawing 162655.

The low voltage cables shall be installed in the cable chases provided for transformer tails or in ducts for network low voltage distributor cables.

High voltage and low voltage cables shall not be installed in a common duct or cable chase.

The high voltage cables shall be installed into the cable end box of the high voltage switch in such a manner that the earth fault indicator CTs can be installed over the single core cables and that the current in each of the single core cables can be easily measured using a “tong ammeter”.

Wherever practicable the low voltage cables shall be installed at the transformer and LV switchboard in such a manner that the current in each of the single core cables can be easily measured using a “tong ammeter”.

24.4 Cable terminations

All cable terminations shall be in accordance with the applicable clauses of NS127 Specification for Low Voltage Cable Joints and Terminations, NS129 11kV Joints and Terminations – Paper Insulated Lead Covered Cables and NS177 11kV Joints (including Transition Joints) and Terminations – Polymeric Insulated Cables.

High voltage terminations shall be of a type approved by Ausgrid.

The LV terminals of transformers and associated LV cable terminations shall be insulated via a correctly installed approved Ausgrid shroud. Where “E Type” LV switchboards are used the transformer LV cabling lug barrels at the LV switchboard end, shall be fitted with supplementary insulation sleeving.

Cable lugs used outdoors must be closed-end/sealed to prevent the ingress of water. Forged open-end lugs may be used in indoor situations.

Compression cable lugs should be designed to comply with:

- AS/NZS 4325.1:1995 : Compression and mechanical connectors for power cables with copper or aluminium conductors - Test methods and requirements
- IEC 61238-1 Ed. 2.0 (Bilingual 2003) Compression and mechanical connectors for power cables for rated voltages up to 30 kV ($U_m = 36$ kV) - Part 1: Test methods and requirements, or
- BS 4579-2:1973 Specification for performance of mechanical and compression joints in electric cable and wire connectors. Compression joints in nickel, iron and plated copper conductors, and shall be installed in the manner specified by the manufacturer with regard to:
 - Width of crimp die,
 - Across flats (A/F) dimension or compacted circumference of crimp,
 - Number of crimps,
 - Position of crimps, and
 - Type of compression tool used.

The hole in the palm of any lug must be compatible with the size of the bolt used to connect the lug to the equipment. The use of ferules is not permitted.

24.5 Secondary cable terminations

All secondary cables are to be fitted with an approved type cable ferrule and a wire number fitted in accordance with the substation electrical schematic diagram.

Solid barrel tinned copper type compression lugs shall be installed on all secondary control and protection cable terminations. Only one cable shall be installed to each cable lug. The barrel of all spade type lugs shall be insulated.

Split barrel spade and pin crimp lugs and push on spade type terminations are NOT permitted on protection or control circuits.

24.6 Stainless steel bolts and set-screws – lubrication of threads

Before installation of each stainless steel bolt or set-screw, the thread shall be lubricated with specially formulated anti-seize grease containing nickel (eg Loctite Nickel Anti-Seize, or equivalent). Ausgrid stockcode is 177212.

Where the lubricating grease will be in contact with an electrical insulating medium (eg heatshrink), the supplier of the insulating medium shall be consulted to ensure product compatibility.

24.7 Information plan

An appropriately sized laminated copy of the Information Plan as detailed in NS149 Drawing Content for Chamber Type Substations, Control Points, Cable Risers and Ductlines shall be framed and securely mounted in a suitable readily viewable position within the substation or control point chamber immediately adjacent to each personnel access door for multi transformer substations or one only for single transformer substations.

25.0 SUBSTATION EQUIPMENT PROCUREMENT

25.1 Approved materials

Only materials approved by Ausgrid shall be used in the equipping of distribution substations. These materials shall comply with the requirements of Ausgrid's specifications.

Refer also to Clause 7.8 for information on provision of Approved Materials from Ausgrid.

Materials must be type and/or routine tested at the manufacturer's works in accordance with the Ausgrid specification for procurement and/or the relevant Australian Standard. Should an Australian Standard not exist, the relevant International Standard or the standard referred to in Ausgrid's Specification for Purchase shall apply. Where there is a discrepancy between the Australian (or International) Standard and Ausgrid's Specification for Purchase, Ausgrid's Specification for Purchase shall apply.

Acceptance testing and pre-commission testing by Ausgrid or a third party approved by Ausgrid may be required for individual types of equipment as listed below:

- high voltage switchgear
- transformers
- low voltage air circuit breakers
- protection relays
- high and low voltage fuses
- high and low voltage cables
- high and low voltage termination kits
- protection and metering current transformers and auxiliary transformers

Unless otherwise specified in this standard, all bolts, nuts and washers, shall be galvanised or otherwise treated for corrosion resistance by an approved method in accordance with the relevant Australian Standard. Exceptions apply for the stainless steel bolts required for connections to the neutral bar and earth bar. Refer to the relevant clause.

25.2 Transformers

Transformers shall comply with the latest Ausgrid's specification for purchase of distribution transformers. This specification includes the required transformer impedance percent and tapping range. Table 1 of Clause 8.3 indicates nominal impedances for the transformer sizes shown.

Transformers shall normally be the oil filled type. Transformers in upper level substations and elevated surface chamber substations must be dry type. Ausgrid may permit or may require dry type transformers for other special locations.

All dry type transformers shall be supplied and installed with transformer fans fitted and operative. For substations equipped with SCADA monitoring of the transformer cooling fans, ie Sydney City CBD substations, the Air Forced (AF), Normal and Emergency rating of the dry type transformers may be utilised in determining the rating of the substation (firm or non-firm). For substations that are not equipped with SCADA monitoring of the transformer cooling fans, ie suburban substations, the Air Normal (AN) Normal and Emergency rating of the dry type transformers shall be utilised in determining the rating of the substation (firm or non-firm).

No polychlorinated biphenyl (PCB) or silicon oil filled transformers shall be used.

25.3 Ring main isolator fuse switch

Ring main isolator fuse switches (RMIFSs) shall comply with the latest Ausgrid Specification for the purchase of 11kV RMIFSs.

All RMIFSs shall be fitted with fuse cartridges having striker pins.

25.4 Fuses

The correct use of HV and LV fuses is critical to the reliable and safe supply of electricity and shall be in accordance with Ausgrid's Approved Material List.

25.5 Ring main isolator circuit breaker

RMICBs shall be purchased in accordance with the latest Ausgrid specification for the purchase of RMICBs.

25.6 Low voltage switchboard

All low voltage switchboard panels shall comply with the latest Ausgrid specification.

26.0 TESTING

For testing requirements refer to NS230 Testing of Distribution Substations.

27.0 INSPECTION

Ausgrid's Network Compliance Officer will inspect the work being conducted by the Service Provider, the Service Provider's employees and sub-contractors.

The level of inspection carried out on any particular project will depend upon the:

- grade of accreditation of the Service Provider for contestable work,
- complexity and criticality of the particular project, and
- reports of the project's Contestable Project Coordinator.

Inspections may take two broad forms; review of progress inspections and milestone inspections.

Review of progress inspections: are general inspections normally carried out by the project's Compliance Officer. Review of progress inspections are intended to keep the Compliance Officer up

to date with the project's progress, to maintain good working relationships, and to assist in the smooth running of the project.

Milestone inspections: are specifically arranged for inspection of a particular aspect of the project. The milestones for each particular project will be in accordance with relevant Ausgrid requirements set out in Ausgrid's Standard Connection Contracts and Ausgrid's Policy for ASP/1 Premises Connections.

Once the substation testing is complete, a final inspection shall be carried out by the Service Provider and a report produced to ensure:

- the substation is complete to the relevant drawings and is ready for service
- all operational and asset numbers and labels are correctly in place
- all danger signs and warning signs are correctly in place
- all workmanship has been performed in a tradesperson-like manner and is fit for purpose.

Following the successful completion of the above inspection, all personnel involved in the construction shall be advised that the construction phase of the project is complete and that access is no longer available without the relevant safety procedures being adopted. The Equipping Permit shall then be signed-off and left on-site in its holder.

28.0 COMMISSIONING

The commissioning of the chamber type substation shall be carried out by Ausgrid. The Service Provider shall attend the commissioning to rectify any defects including phasing errors detected during commissioning and to witness the phasing tests.

29.0 ACCEPTANCE

Following a satisfactory final inspection, the construction of the substation shall be accepted at a time prior to the commissioning of the substation. The date of commissioning of the substation shall initiate the start of the warranty period (see Clause 7.11). Acceptance has the same meaning as Practical Completion in Ausgrid's Standard Connection Contracts. Acceptance shall occur on the date on which Ausgrid's Compliance Officer determines that all of the following requirements have been satisfied.

- the works have been completed in accordance with the Certified Design,
- the works are free from Major Defects,
- all fees and charges payable in respect to the works have been paid to Ausgrid,
- all required certificates and all required agreements for leases, easements and rights-of-way have been provided,
- satisfactory test reports and inspection reports have been made available to Ausgrid,
- all danger signs and warning signs are correctly in place,
- all equipment reports have been made available to Ausgrid.

Any damage, including marking of the painted walls and ceiling, shall be repaired by the Service Provider prior to hand over of the substation to Ausgrid. In this regard Ausgrid will not formally accept the substation until all specified work, including repair of damage during the course of the works, has been satisfactorily completed.

On acceptance of the substation, Ausgrid will change all construction lock cylinders to their own series.

30.0 REPORTING

The Service Provider shall provide Ausgrid with reports on the project as indicated below. Refer also to Clause 7.9.

For a single substation with no complications or delays during construction, a single report is required. This report is to be submitted immediately following the successful commissioning of the substation. For projects involving multiple substations or complications during the procurement or construction phases, the Contestable Project Coordinator may require intermediate reports.

“As Constructed” Changes. For contestable work, the Certified Design should be reviewed and any “as constructed” changes accepted by the Compliance Officer noted. All “as constructed” changes to the Certified Design, including the project identification, project location, design drawings, substation model and operational details should be re-submitted together with a statement confirming the accuracy.

Note: Any proposed changes from the project details provided in the Certified Design document must be resubmitted to the Contestable Project Coordinator as a design for re-certification and approved before being implemented by the Service Provider.

“As constructed” changes must be reported as specified in NS104 Specification for Electrical Network Project Design Plans.

Asset Details – Substation Inventory List. Full details of the significant components of the substation shall be provided in writing to the Network Compliance Officer. Significant components include the HV and LV switchgear units, the LV surge arresters, the transformer, the earthing system and any options fitted.

Test Reports. The formal test reports of the insulation resistance, voltage withstand, earthing impedance and substation inspection, must be provided.

The Service Provider shall provide the Ausgrid Network Compliance Officer with the following information:

- Transformer nameplate details
- High voltage switchgear nameplate details
- Low voltage switchgear nameplate details
- Low voltage surge arrester details
- High and low voltage fuse type and size
- MDI type, rating and constant “K”
- CT type and size (for MDI circuit)
- Transformer tapping ratio setting
- a copy of the formal test results, and all field recordings
- a description of the access/site restrictions for the substation.

The results of the tests detailed in Section 26 shall be reported to the Compliance Officer.

The Service Provider shall complete a previously approved itemised checklist for the substation construction and provide it to the Network Compliance Officer.

All information shall be produced and provided to the Network Compliance Officer in both hard and soft copy. The soft copy must be in a format compatible with AutoCad (dwg or dxf) or Adobe Acrobat (pdf).

31.0 RECORDKEEPING

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

Table 7 – Recordkeeping

Type of Record	Storage Location	Retention Period*
Approved copy of the network standard	Document repository Network sub process Standard – Company	Unlimited
Draft Copies of the network standard during amendment/creation	HPRM Work Folder for Network Standards (HPRM ref 2014/21250/321)	Unlimited
Working documents (emails, memos, impact assessment reports, etc.)	HPRM Work Folder for Network Standards (HPRM ref 2014/21250/321)	Unlimited

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

32.0 AUTHORITIES AND RESPONSIBILITIES

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

33.0 DOCUMENT CONTROL

Content Coordinator : Head of Network Strategy & Future Grid

Distribution Coordinator : Manager Asset Standards

Annexure A – List of drawings

IMPORTANT: Users must ensure that the drawings they are using are the current versions with all amendments.

A1 Ausgrid drawings

Table 8 Drawings List

Number	Title
2064	Basement Substation Chamber CO ₂ connection Union & CO ₂ Nozzle Details
10578	Sydney CBD Type Substations & Control Points Isolating Switch Operating Wheel for Pull-Out Gear Arrangement & Details
10635	Distribution Substations Wall Mounted Double Tier Supporting Frame For Tripping Batteries Manufacturing and Installation.
16500	Sydney CBD Type Substations & Control Points Emergency Pull-Out Gear Operating Equipment Typical Arrangement
18894	Sydney CBD Type Substations & Control Points Emergency Pull-Out Gear Operating Equipment Arrangement & Details
22212	Tripping Battery Test Assembly & Wiring Details
25121	Substation Earthing Typical Installation of Earthing Electrodes.
28632	Wall Mounted Relay Panels detail
28949	Personnel and Equipment Hatch Installation.
31858	Substations Operators Locker
42416	Basement Substation Fan Mounting Plate (*Sydney CBD Substation only).
43140	Details of Standard Louvred Doors.
48008	Miscellaneous Construction Details.
48009	Details of Standard Weatherproof Louvred Panels for Ventilation.
48546	Low Voltage Transformer Termination Shroud for 750kVA, 1000kVA & 1500kVA Oil Filled Transformers Arrangement.
48849	Multi-blade Fire Damper Details.
50740	Transformer Hatchcover and Rebate.
52474	Moulded type Link Assemblies Wire Terminations Coding and Looming Style Details
56197	Wall Mounted CO ₂ Connection Box.
115065	City Distribution Centres Pilot Isolating Boxes and Interconnector Pilot Boxes General Arrangement
117632	Basement Substations Typical Fan and Damper General Arrangement.
117633	Basement Substations Exhaust Fan Damper Details.
121156	City Distribution Centres Preferred Layout of Pilot, DLAC and Fibre Equipment in Access Chamber
121949	Standard Services Boards Suburban Type Substations Arrangement & Diagram with Drilling Details. (For use in suburban substations with active protection systems (1500 kVA transformers and without substation ventilation fans or SCADA).
127332	Minimum Clearances for Chamber Type Substations Using Current Equipment

Number	Title
162655	Indoor Distribution Transformers – Mounting Details of Current Transformers and Earth Bar
169392	Standard Services Boards Suburban Type Substations Arrangement & Diagram with Drilling Details. (For use in suburban substations without active protection systems (1000 kVA or less transformers)
169393	Standard Services Boards Control Points Arrangement & Diagram with Drilling Details
169394	HVC Substation Service Board General Arrangement & Wiring
191085	Customer Chamber Substations HV Pit Construction and HV Switchgear Support Steelwork
191086	City and Suburban Distribution Substations Protection Relays Drilling Details
192908	Customer Chamber Type Substations Installation of Lucy Sabre VRN6a RMICB
192910	Customer Chamber Type Substations Installation of ABB Safelink 3 Way I & E Switch
192959	ABB Safelink for Chamber Substations Mounting Stand
204115	Vass Electrical Industries Standard Flanged End To Suit E Type LV Board
205952	City Distribution Substations Free Standing protection Cabinet specification
224407	Standard Surface Chamber Distribution Substation Single Transformer Up to 1000kVA Layout 1
224408	Standard Surface Chamber Distribution Substation Single Transformer Up to 1000kVA Layout 2
224420	Customer Chamber Type Substations Installation of ABB Safelink CFC RMI
224431	Two Transformer Chamber Type Distribution Substation With Fused Strip Style LV Board Summated MDI Panel Drilling, Wiring and Connections.
227356 sheet 1	Standard Services Boards Suburban Type Substations Arrangement & Diagram with Drilling Details. (For use in suburban substations with active protection systems, OAFD (1500 kVA transformers) and without substation ventilation fans).
227359 sheet 01	RMICB Substations with E Type LV Board OAFD Standoff Bracket for Fibre Sensor Conduit Mounting
227387	City Distribution Centres with E Type LV Board and Optical Arc Flash Detection Protection Service Board Layout, Wiring & Cabling
234377	Chamber Substations Installation of Siemens 8DJH Switchgear
244218	RMICB Substations with E Type LV Board OAFD Preferred Layout of Batteries, Battery Chargers and SCADA

Chamber Disconnect/Fused Strip-type LV Switchboard

Number	Title
205769	Single Transformer LV Board General Arrangement (Typical)
224233	Two Transformer LV Board with Bus Section General Arrangement (Typical)
230701	Fuse Strip Type LV Board Reference Drawing List

“E-type” Low Voltage Switchboards

Number	Title
178227	Type E LV Board Acceptable Combinations
178228	Type E LV Board Clearances, Pit Design and Construction
178229	Type E LV Board Supporting Steelwork General Arrangement

Number	Title
178230	Type E LV Board Auxiliary Cable Ladder Installation Detail
178238	Type E LV Board Summated MDI Wiring Diagram
215882	Type E LV Board Reference Drawing List

LV Switchboard Protection Schematics and Wiring and Connection Diagrams - General

Number	Title
1856	City Distribution Substations Details of Signal System Disconnection Box
50992	Substation Moulded Type Link Assembly
52474	Moulded Type Links Assemblies Wire Terminations Coding and Looming Style Details.
113432	City Distribution Centres Signal Disconnection Box Label & Connection Details
115065	City Distribution Centres Pilot Isolation Boxes and Interconnector Pilot Boxes General Arrangement
115150	City Distribution Centres Pilot Isolating Boxes and Interconnector Pilot Boxes Label Details
115836	City Distribution Centres Using Motorised ACBs Signal Marshalling Box Connections
115839	City Distribution Centres Using Motorised ACBs Pilot Marshalling Box Connections
116004	City Distribution Centres Pilot Isolating Boxes and Interconnector Pilot Boxes Connection Details
227388	City Distribution Centres Distribution Local Automation Control Panel Layout & Label Details
228912	City Distribution Substations Fan Control Mark IV Schematic
228913	City Distribution Substation Ventilation Fan Air Vane Switch Assembly

“E-type” LV Switchboard Protection Schematics and Wiring and Connection Diagrams

Number	Title
178231	RMICB Suburban Substations with Type E LV Board Cable Connections & Schedule
178237	E Type LV Board Merlin Gerin Masterpact Air Circuit Breakers External Connections
227350 sheet 01	RMICB Substations with E Type LV Board AC Schematic with Optical Arc Flash Detection
227350 sheet 02	RMICB Substations with E Type LV Board Transformer DC Schematic with Optical Arc Flash Detection
227350 sheet 03	RMICB Substations with E Type LV Board Customer Overcurrent DC Schematic
227350 sheet 04	RMICB Substations with E Type LV Board DC Supply and Cable Looping Schematic
227350 sheet 05	RMICB Substations with E Type LV Board Fibre Looping & General Mounting Details
227351 sheet 01	RMICB Substations with E Type LV Board Transformer Wall Mounted Protection Panel with Optical Arc Flash Detection Style 1 Layout and Label Details Diagram
227351 sheet 02	RMICB Substations with E Type LV Board Transformer Protection Panel Style 1 Wiring Diagram
227351 sheet 03	RMICB Substations with E Type LV Board Transformer Protection Panel Style 1 Cable Connection Diagram
227352 sheet 01	RMICB Substations with E Type LV Board Transformer Wall Mounted Protection Panel with Optical Arc Flash Detection Style 2 Layout and Label Details Diagram
227352 sheet 02	RMICB Substations with E Type LV Board Transformer Protection Panel Style 2 Wiring Diagram
227352 sheet 03	RMICB Substations with E Type LV Board Transformer Protection Panel Style 2 Cable Connection Diagram
227353 sheet 01	RMICB Substations with E Type LV Board Customer Overcurrent Wall Mounted Protection Panel Layout and Label Details Diagram
227353 sheet 02	RMICB Substations with E Type LV Board Customer Overcurrent Wiring Diagram
227354 sheet 01	RMICB Substations with E Type LV Board Optical Arc Flash Detection Indication Panel Schematic, Drilling and Wiring Diagram
227355 sheet 01	RMICB Substations with E Type LV Board and Optical Arc Flash Detection Cabling Diagram
227355 sheet 02	RMICB Substations with E Type LV Board and Optical Arc Flash Detection Cable Schedule
227357 sheet 01	E Type LV Board Merlin Gerin Masterpac Air Circuit Breaker External Connections for Optical Arc Flash Detection
227358 sheet 01	RMICB Substations with E Type LV Board and Optical Arc Flash Detection Scada Panel Wiring & Cabling Details
227358 sheet 02	RMICB Substations with E Type LV Board and Optical Arc Flash Detection Scada Panel Layout Details
227379	Distribution Centres with Optical Arc Flash Detection Terminal Box Details for 48V ‘B’ Battery System

Number	Title
227380 sheets 1-4	City Distribution Centres with E Type LV Board and Optical Arc Flash Detection AC Schematic/DC Schematics/DLAC panel Schematic
227381	City Distribution Centres with E Type LV Board and Optical Arc Flash Detection Transformer/Customer Overcurrent Protection Panel Layout Details
227382	City Distribution Centres with E Type LV Board and Optical Arc Flash Detection Protection Panel Label Details
227383 sheets 1-2	City Distribution Centres with E Type LV Board and Optical Arc Flash Detection Protection Transformer Panel Wiring Diagram
227384 sheets 1-2	City Distribution Centres with E Type LV Board and Optical Arc Flash Detection Protection Transformer Panel Cable Connection Diagram
227385	City Distribution Centres with E Type LV Board and Optical Arc Flash Detection Protection Customer Overcurrent Panel Wiring & Cable Connection Diagram
227386 sheets 1-3	City Distribution Centres with E Type LV Board and Optical Arc Flash Detection Protection Cabling Schedule & Diagram

Annexure B – Stockcode numbers

PURCHASE OF APPROVED MATERIALS

B1 Purchase form

To order substation material items from Ausgrid please quote the appropriate stockcode number. Contact email is aspsales@ausgrid.com.au. All materials will be made available to be picked up from:

Somersby Warehouse
Dock 1, External Sales
33 Kangoo Rd (Cnr Wella Way)
Somersby NSW 2250

Materials are not held in stock for immediate availability, therefore Service Providers are requested to notify in writing all material requirements in advance taking into account the lead times to meet the programmed installation dates. Ausgrid takes no responsibility for changes in lead times that are beyond its control.

B2 Stockcodes

Transformers

Table 9 Equipment stockcodes

Stockcode	Description
180357	750 kVA 11/0.433kV Oil Filled Transformer
180358	1000 kVA 11/0.433kV Oil Filled Transformer
180359	1500 kVA 11/0.433kV Oil Filled Transformer
180371	1000 kVA 11/0.433kV Dry Type Transformer
180361	1500 kVA 11/0.433kV Dry Type Transformer

Switchgear

Switchgear stockcodes are based on Ausgrid's period contracts at the time of publishing this Standard. These stockcodes are subject to change without notice. It is the responsibility of the Service Provider to advise Ausgrid's Procurement Officer the details of equipment required.

Table 10 Switchgear stockcodes

Stockcode	Description
184921	11kV 630 amp ABB Safelink2 SF6 3 Way Ring Main Isolator Switch Fuse Unit w/o stand c/w integrated Sigma F+E 3 EFI
180232	11kV 630 amp ABB Safelink SF6 3 Way Isolating and Earthing Switch c/w stand
181813	Support Stand for ABB Safelink RMI Switch Fuse Unit (Suburban subs)
184765	11kV 630 amp Lucy SABRE VRN2A SF6 Ring Main Isolator with 250 amp Circuit Breaker
185191	11kV 630 amp Siemens 8DJH SF6 Ring Main Isolator Type RRR
185192	11kV 630 amp Siemens 8DJH SF6 Ring Main Fuse Switch Type RTR
185193	11kV 630 amp Siemens 8DJH SF6 Ring Main Isolator with 250 amp Circuit Breaker Type RLR

Table 11 Copper Busbar stockcodes

Stockcode	Description
41400	25 mm x 2.5 mm Flat Copper Bar
41087	50 mm x 6.3 mm Flat Copper Bar, 3.6 m length
41020	100 mm x 6.3 mm Flat Copper Bar, 3.6 m length

Table 12 Chamber disconnecter/fused strip-type LV switchboard stockcodes

Stockcode	Description*
Left Hand Side Boards for single Tx installations	
181791	4 x 400A
181792	5 x 400A
181793	1 x 800A, 2 x 400A
181790	1 x 800A, 3 x 400A
181834	2 x 800A, 1 x 400A
181835	1 x 1600/1200A, 2 x 400A
Right Hand Side Boards for two Tx installations only**	
181836	4 x 400A c/w bus section isolator
181837	5 x 400A c/w bus section isolator
181838	1 x 800A, 2 x 400A c/w bus section isolator
181839	1 x 800A, 3 x 400A c/w bus section isolator
181841	2 x 800A, 1 x 400A c/w bus section isolator
181842	1 x 1600/1200A, 2 x 400A c/w bus section isolator

* Note this does not depict physical arrangement; refer to relevant drawings for physical arrangement of fuseways within each board.

** Note for two transformer/ LV board configurations both the Left and Right Hand side boards must be ordered

Table 13 “E-type” low voltage switchboard stockcodes

Stockcode	Description
178077	SAIF fuseway operating mechanism
179616	3000A ACB bus section panel
179617	3000A ACB outgoing cable supply panel
179995	3000A ACB/switch outgoing busbar supply panel
179993	2000A switch outgoing with 1000/1600A fuses
179615	3000A ACB incoming panel (unmotorised)
179996	3000A ACB incoming panel (motorised)
179991	2000A ACB incoming panel (unmotorised)
179618	Fused Distributor Cabinet SAIF fuseway panel 4 x 400A
179990	Fused Distributor Cabinet SAIF fuseway panel 2 x 800A
179651	Fused Distributor Cabinet SAIF fuseway panel 2x400A & 1x800A
179619	Surge arrester and 62A auxiliary fuse panel left hand end
180221	Surge arrester and 62A auxiliary fuse panel right hand end

Table 14 Fuses stockcodes

Stockcode	Description
85738	400A FCL 415V J Type Fuse Cartridge
85753	630A FCL 415V J Type Fuse Cartridge
177871	800A FCL 415V J Type Fuse Cartridge
85639	1000A FCL 415V Fuse Cartridge
85654	1200A FCL 415V Fuse Cartridge
85647	1600A FCL 415V Fuse Cartridge

Table 15 Current transformers stockcodes

Stockcode	Description
89722	100/5 High Voltage Differential CT (10P25F20)
60327	200/100/5 High Voltage CT (5kV Areas) (10P30/20F20)
67173	2450/1837/2.89 OAFD EF Check Epoxy CT
89730	600/300/5 10P100/50 F20 CT for HVC application only

Table 16 Relay panels and cabinets stockcodes

Stockcode	Description
123638	Marshalling Box Polyester 600mm x 370mm x 175mm
81208	Pilot Isolation Box – City System
81174	Signal Cabinet – City System
182545	Suburban Wall Mounted Protection Relay panel (Single Customer Overcurrent)
182546	Wall Mounted OAFD/Tx Protection Relay panel RMICB Substations with E Type LV Board
182544	OAFD Indicator Panel
180123	Wall Mounted Protection Relay panel RMICB Substations with E Type LV Board (single Tx 1500kVA substation without OAFD)
182585	SCADA Cabinet (suburban subs only)

Table 17 Cables and lugs stockcodes

Stockcode	Description
61432	0.6/1kV 185 mm ² XLPE cable (37/2.52)(order per metre)
14266	0.6/1kV 300 mm ² XLPE cable (61/2.52)(order per metre)
14258	0.6/1kV 500 mm ² XLPE cable (127/2.25)(order per metre)
59758	Black 0.6/1kV Single Insulated Cable 7/0.67 (2.5 mm ²)
90100	Grey 0.6/1kV Single Insulated Cable 7/0.67 (2.5 mm ²)
59857	Red 0.6/1kV Single Insulated Cable 7/0.67 (2.5 mm ²)
176542	White 0.6/1kV Single Insulated Cable 7/0.67 (2.5 mm ²)
176541	Blue 0.6/1kV Single Insulated Cable 7/0.67 (2.5 mm ²)
59824	Green/yellow 0.6/1kV Single Insulated Cable 7/0.67 (2.5 mm ²)
176544	Grey 0.6/1kV Single Insulated Cable 7/1.04 (6 mm ²)
176540	Single Core 0.6/1kV Double Insulated Cable 7/0.67 (2.5 mm ²) Black PVC Insulation
176546	Single Core 0.6/1kV Double Insulated Cable 7/1.35 (10 mm ²) Red PVC Insulation
176550	Single Core 0.6/1kV Double Insulated Cable 7/1.70 (16 mm ²) White PVC Insulation
61242	Four Core 0.6/1kV Double Insulated Cable 7/0.67 (2.5 mm ²)
65003	Eight Core 0.6/1kV Double Insulated Cable 7/0.67
65078	Twelve Core 0.6/1kV Double Insulated Cable 7/0.67
60111	Single Core 0.6/1kV Black Insulated Cable (19/2.14) 70 mm ²
74773	2.5 mm Lug M5 hole (3/16 inch)
74708	2.5 mm Lug (1/4 inch hole)
62547	16 mm Lug M8 hole
74831	70 mm Compression Lug M12 hole
178471	70 mm Compression Lug M16 hole (for Tx termination on Lucy switchgear).
90167	185 mm Compression Lug M14 hole
58388	300 mm Compression Lug M22 hole
58412	500 mm Compression Lug M22 hole

Table 18 Battery items stockcodes

Stockcode	Description
96529	2 Tier Battery Rack
123703	Tripping Battery Test Box
78493	Battery Links – M6 Moulded Link Terminal Block
123992	Relay Test & Protection Setting Sheet Folder
96602	Battery Set 10 volt 8 Cell Alkaline
75168	Battery Charger 30 volt (trickle type)
182540	Battery Charger 48 volt (float type)
95364	Insulator Epoxy Stand-off M8 Tapped 14NB1 (54mm)

Table 19 Relays stockcodes

Stockcode	Description
60962	FF5 Fan Failure Relay
184993	Earth Fault Indicator (Horstmann Earth Zero Flag c/w oval CT)
62141	DMT Auxiliary Relay
62158	PIR Pilot Interlock Relay
62182	2HS Multitrip Relay
62471	TI3 Relay Projection (NB for wall mounted and free standing panels)
91058	K3M Differential Relay
175103	TI3 Relay Flush Mount (NB for free standing cabinets)
181341	TI2 100/0.2 ohm Thermal Alarm/ Trip Indicator Relay
182548	SEL-751A62C1C1C74851430 Relay (48V DC)
182547	Schneider P11574611111511 Relay (24/48V AC/DC)
182586	Schneider SCD5200 Remote Terminal Unit assembly 1x SY-2003100 SCD5200 5-slot card file 1x SY-0399143 SCD5200 COPE module 1x SY-0399160 SCD5200 ADI 32DI (48V DC)/4AI module
185100	Sierra Wireless Modem AirLink RV50X (LTE Band 28)
185267	SEL Axion Module - RTAC SEL-2241X2X323X0XXXXXX Key:2954
185290	SEL Axion Module - Power Coupler SEL-224321X0 Key: 2054 (48V DC)
185291	SEL Axion Module - Backplane SEL-2242R1X0 Key: 2210
185293	SEL Axion Module - Digital Input SEL-22442222X0 Key 3086 (48V DC)
185294	SEL Axion Module - Digital Output SEL-22443131X0 Key 3084
185295	SEL Axion Module - Analogue Input SEL-22452121XX0 Key 4004
185752	SEL Axion Module – RTAC SEL-2241#FM2N (2x 100BASE-FX Ethernet)
185753	SEL-3530#8FJM (CBD Local Automation Controller)

Stockcode	Description
185754	SEL Axion Module – RTAC SEL-2241#CN4F (2x 10/100BASE-T Ethernet)
Not stocked	Schneider P14222QBBM0B49L Relay (48-110V DC,380-480V AC)
Not stocked	Siemens RS8000-48-MM-MS-XX Ethernet switch (6GK6080-0AS22-0MA0-Z A00) (48V DC)

Table 20 Miscellaneous stockcodes

Stockcode	Description
91710	Utilux Link (slotted) – Stud Type
83469	Utilux Link (solid) – Stud Type Rail Mounted
83352	Klippon End Barriers
77842	Klippon Clamps
78550	Klippon Terminal Rail (length)
123455	Unistrut P1000 (length)
76935	Hatch Cover Weatherproof Micro Limit Switch
123026	Transformer Oil Temperature Indicator
115568	Transformer Fan Control Thermals
77792	Weatherproof 250V 15A Switch Box
113936	Low Voltage Shrouds (90 Degree Type for 2 cables/phase)
182363	Low Voltage Shrouds (90 Degree Type for 3 cables/phase 1500kVA Tx)
10785	50 mm PVC Troughing
10793	75 mm PVC Troughing
10777	100 mm PVC Troughing
123729	CO ₂ Connection Box Wall Mounted
123067	Operators' Locker
128025	RH Steel Earth Fault Indicator Bracket
128033	LH Steel Earth Fault Indicator Bracket
169920	Maximum Demand Indicator (MDI) 6A rated
169946	Maximum Demand Indicator (MDI) 12A rated (multi-transformer subs)
124842	Transducer 5A for CBD substation load indication
72405	Emergency Pull-out gear operating wheel
182541	OAFD Fibre Jacketed Duplex (20m long) clear jacketed Sensor (20m long)
182543	Auxiliary Services Wall Mounted Panel for OAFD protected substations
118133	50mm Polythene Cable Gland

Annexure C – Danger signs

Danger signs must be attached in accordance with the following specifications and requirements:

- Signs (normally at least two) must be attached so as to be readily visible from normal access points. Usual locations are on personnel entrance doors, and on louvered door panels.
- The signs shall be either on:
 - (i) stick-on Scotchlite (or equivalent) reflective sheeting, or
 - (ii) aluminium sheeting.
- The signs shall comply with AS 1319 Safety signs for the occupational environment, for colours and lettering dimensions.
- The dimensions of the signs shall be 350 mm wide x 175 mm high.
- The wording of the signs shall be as indicated below.
- The signs shall be in accordance with drawing 153366.
- Complying signs are available on Ausgrid stockcode 177281 for the stick-on sign, and stockcode 177282 for the sign on aluminium sheeting.
- Aluminium sheeting signs attached to metal shall be attached with suitable sized rivets. A small amount of non-acid cure silicon sealant must be applied to the rivet holes before the sign is riveted in place.

CAUTIONS

1. If it is necessary to replace or retrofit a metal danger sign after the substation is commissioned; the work must be carried out in accordance with the requirements of Ausgrid's Electrical Safety Rules.
2. Danger signs must not be attached in any position where drilling for the attachments, or fixing of the attachments, could possibly endanger the person attaching the sign, or any other persons, or cause damage to the equipment in the substation.



Danger Sign for Substations

Annexure D has been withdrawn

Annex D of this standard, the Merlin Gerin installation and operation manual, has been withdrawn.

The E-type board shall be installed as per Schneider Electric's multi-cubicle switchboard manual:
Ausgrid - Product Manual for Chamber Substation indoor switchgear.

This manual is available from Schneider Electric.

For Ausgrid personnel, the manual can be found in Balin – Manufacturers' Equipment Manuals –
Switchgear-Isolators-Fuses.