NS113

Site Selection and Construction Design Requirements for Chamber Substations

December 2007

Amendments: NSA 1476 Jun 08, NSA 1503 Dec 08, NSA 1528 May 09, NSA 1544 Jan 10 & 1566 Mar 10.

SUMMARY

Network Standard NS113 provides minimum site selection, building design and construction requirements for the establishment of new Chamber Substations with ratings up to and including 4.5 MVA. This Standard applies to Surface, Elevated, Upper Level and Basement Chamber Substations, Control Point Chambers and Chambers for High Voltage Customer Connections.

ISSUE

Ausgrid staff: for issue to all staff who are involved with site selection and civil design for new chamber type substations forming part of Ausgrid's network, and is for reference by field, technical and engineering staff.

Where this standard is issued as a controlled document replacing an earlier edition; remove and destroy the superseded document.

Accredited Service Providers: document issued on an uncontrolled basis. Users are responsible for ensuring that the document they are using is current and includes any amendments issued since the date on the document. Ausgrid will not accept any liability for work carried out to a superseded standard. Ausgrid may not accept work carried out which is not in accordance with current standard requirements.

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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 is to 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 ensure 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 Network Standard.

This document is **not** intended to address issues that include, but are not limited to:

- Environmental and planning requirements
- Construction, inspection and maintenance safe work practices
- Inspection and maintenance requirements
- Emergency preparedness and response
- Earthing and substation layout design

Note: The use of any steelwork in substations has unique requirements with respect to earthing. All designs involving steelwork are to be reviewed by Network Earthing.

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.

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1 INTRODUCTION

1.1 Foreword

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 both economically and reliably in all weather, loading and environmental conditions.

The design and construction requirements specified in this Network Standard are intended to satisfy Ausgrid performance and economic requirements to meet 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 substation to which it applies.

1.2 Scope

This Network Standard applies to site selection, design and construction of new contestable and non-contestable Chamber Substation installations and refurbishment of existing Chamber Substations.

This Network Standard:

- applies to nominal 11 kV (and 5 kV) primary voltage systems.
- applies to nominal 415 / 240 volt supply systems.
- applies to chambers used for control points.
- applies to chambers utilised 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 11 kV.
- does not apply to Zone or sub-transmission substations, 11 kV regulators or auto transformers.
- does not apply to Kiosk substations.

Note: Special arrangements will be made for voltages higher than 11 kV in consultation with Engineering Transmission & Technology.

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

Substation electrical design and electrical construction and equipping of chamber type substations are not covered in this Standard. These topics are covered in Network Standard NS114.

The requirements of all relevant Australian Standards, the Building Code of Australia as applicable and all statutory bodies are regarded as minimum requirements for the establishment or refurbishment of Chamber Substations. Where this document exceeds those requirements, this document is to become the minimum standard acceptable to Ausgrid.

2 DEFINITIONS

Access/Access Way requirements	Requirements for entry, exit and escape access as described and required by the BCA, Ausgrid Electrical Safety Rules and referenced Ausgrid Network Standards. Includes the requirements for openings, loading docks, corridors and passages allowing the entry of personnel and equipment. This includes requirements for supporting the weight of all equipment and personnel.
Approved	Requires written consent from Ausgrid. Such written consent may contain authorised specific departures from this Network Standard.
BCA	Building Code of Australia
Building Coordinator – External Substations	The Building Coordinator is the person who inspects the project on behalf of Ausgrid for compliance with Ausgrid's requirements.
Chamber Substation	A Chamber Substation is a building of part of a building that contains electrical equipment which receives 11kV and provides 415/240V
Conductor	A conductor is any wire, bar, tube or object that forms part of an electric circuit.
Dedicated Access/Dedicated Access Way	an access way that does not enable or provide access to or from any other place or any thing, other than the substation chamber. A dedicated access way must only allow access by Ausgrid personnel or personnel specifically authorised by Ausgrid. No other personnel are to have access through a dedicated access way. A dedicated access way must not involve fire stairs utilised at any time by the public or the building's occupants. A dedicated access way includes the associated doors, stairs, hatchways, ladders, passages, chambers and corridors.
Equipping	Installation of substation equipment, including but not limited to cables, busbars, switching and control equipment and transformers.
High voltage	A voltage above 1,000 volts alternating current or 1,500 volts direct current.
Firestopping	Measures that are adopted to prevent the spread of fire, smoke and acid residues from one compartment to another
FRL	Fire Resistance Level
Live	Live means that mains or apparatus are connected to an electrical supply source or the mains and apparatus are in danger of becoming energised because of hazardous induced or capacitive voltages
Low Voltage Cable	The electricity cable laid in public roadways and easements which originates at the low voltage end of substations and serves as a connection point for the supply of electricity to end users.
Service Provider	In general the service provider is Ausgrid.
Substation	In this standard, the term substation refers to Chamber Substations.
Switchgear	Equipment for controlling the distribution of electrical energy or for controlling or protecting circuits, machines, transformers, or other equipment.
Switchroom	A room for housing switchgear.

Transformer	A static piece of apparatus with one or more windings which, by electromagnetic induction, transforms a system of alternating voltage and current into another system of voltage and current usually of different values but with the same frequency, for the purpose of transmitting electrical power.

3 REFERENCES

All work covered in this document shall conform to all relevant Legislation, Standards, Codes of Practice and Network Standards including but not limited to:

- AS 1074: Steel tubes and tubulars for ordinary service
- AS 1418: Cranes (including hoists and winches)
- AS 1657: Fixed platforms, walkways, stairways and ladders - Design, construction and installation
- AS 3735: Concrete Structures Retaining Liquids
- AS/NZS 2053.1: Conduits and fittings for electrical installations - General requirements
- AS/NZS 3000: Australian/New Zealand Wiring Rules
- AS/NZS 3003: Electrical installations - Patient treatment areas of hospitals and medical, dental practices and dialyzing locations
- Building Code of Australia (BCA)
- ES 4 Service Provider Authorisation
- ES 8 Capital Contributions Guidelines
- ES 9 Agreement for Electricity Supply to Developments
- ES 10 Requirements for Electricity Supply to Developments
- National Electricity Network Safety Code (ENA DOC 01)
- NS112 Design Standards for Industrial/Commercial Developments
- NS114 Electrical Design and Construction Standards for Chamber Type Substations
- NS116 Design Standards for Chamber Earthing
- NS130 Specification for UG Cable Laying
- NS143 Easements
- NS149 Drawing Content for Chamber Type Substations, Control Points, Cable Risers and Ductlines
- NS171 Fire Stopping in Substations
- NS195 High Voltage Connections
- NSW WorkCover Confined Spaces Regulations or any other OH&S Safety regulations
- Occupational Health and Safety Act 2000 (NSW)
- Occupational Health and Safety Regulation 2001 (NSW)

4 GENERAL INFORMATION AND REQUIREMENTS

4.1 Chamber Substations

This Network Standard provides the minimum design and construction requirements and criteria for site selection for projects involving the construction or refurbishment of Chamber Substations, having ratings up to 4.5 MVA. Chamber Substations referred to in this Network Standard are as follows:

- Surface Chamber Substations
- Elevated Chamber Substations
- Upper Level Chamber Substations
- Basement Chamber Substations
- Chambers for Control of High Voltage Customer (HVC) connections
- Control Point Chambers associated with Upper Level Chamber Substations

In general the construction of Chamber Substations (including access chambers, Control Point Chambers and chambers for the control of HVC connections) shall provide a chamber which is dry and completely isolated from the remainder of the building with walls, floor, ceiling and doors providing a minimum FRL of 180/180/180 where the substation contains oil-filled equipment, or 120/120/120 where there is no oil-filled equipment.

4.2 Chamber Substations in Confined Spaces

Due to requirements for ventilation, fire and explosion ratings, confined spaces legislation, oil containment and other environmental issues, Substations which may be classified under OH&S Legislation as ‘confined spaces’ will not be approved for use or connection of power by Ausgrid.

4.3 High Voltage Customer (HVC) Connections and Control Point Chambers

This Network Standard includes requirements for the establishment of chambers for control of supply to High Voltage Customer (HVC) connections and Control Point Chambers. Unless indicated otherwise, the requirements for HVC chambers and Control Point Chambers shall be the same as requirements for Chamber Substations. Refer to NS195 *High Voltage Connections*.

4.4 Upper Level Chamber Substations

Upper Level Chamber Substations have a floor level that is more than 6000 mm above the lowest point of the adjacent street or roadway or level from where personnel and equipment access is gained.

4.5 Equipment

The following Chamber Substation equipment shall be installed in accordance with the requirements of Ausgrid Network Standard NS114 – *Electrical Design and Construction Standards for Chamber Type Substations*:

- Emergency pull-out gear,
- HV Switchgear,
- Transformers,

- LV Switchgear,
- Cabling,
- Protection schemes, and
- SCADA equipment.

In particular, NS114 details the necessary allowances for equipment sizes, clearances, etc that are essential for determining the overall size of chambers.

4.6 Lighting And General Power

Lighting and general power for the Chamber Substation and any associated chambers is to be provided in accordance with the requirements of NS114.

5 TYPES OF CHAMBER SUBSTATIONS

Chamber Substation shall be limited to the following types of substations and structures.

All proposals and designs associated with chamber substations must be certified in writing by Ausgrid's Customer Operations negotiation officer within the relevant Ausgrid region in accordance with Ausgrid Electrical Standard ES 10 - Requirements for Electricity Connections to Developments

Note: Chamber substations and their associated chambers are not permitted to be designed or constructed if there is any possibility the area could be classified as a confined space.

5.1 Surface Chamber Substations

Surface Chamber Substations are located at or above ground level. For a Surface Chamber Substation the highest point of the floor of the substation chamber shall be not more than 2000 mm above the lowest finished surface level of the roadway or footpath from the point where personnel and equipment access is gained. The substation transformer access doors are to be located such that they have a 120mm minimum and 600mm maximum rise up from outside of the chamber.

5.2 Elevated Chamber Substations

Where there are no technically viable alternatives, Elevated Chamber Substations may be permitted only with the specific written approval of Ausgrid.

Approval must be obtained prior to proceeding with design. Requirements for approval by Ausgrid will include provision of suitable equipment access and handling facilities described in Section 7.

Elevated Chamber Substations have a floor level that is between 2000mm and 6000 mm above the lowest point of the adjacent street or roadway level from where personnel and equipment access is gained.

An Elevated Chamber Substation must not have equipment containing oil.

An Elevated Chamber Substation is different from an Upper Level Chamber Substation, in that the high voltage switchgear is located in the substation chamber and not in a separate Control Point Chamber.

Lifting requirements and personnel access must be in accordance with Section 7.

5.3 Upper Level Chamber Substations

Upper Level Chamber Substations must have a control point with a secure dedicated access at or near the lowest point of the adjacent street or roadway level from where personnel and equipment access is gained. This allows switching of the supply to a higher level chamber from street level.

Upper Level Chamber Substations must be approved in writing by Ausgrid prior to commencement of design. Refer to Section 7 for access requirements.

Upper Level Chamber Substations have a floor level that is more than 6000 mm above the lowest point of the adjacent street or roadway level from where personnel and equipment access is gained.

An Upper Level Chamber Substation must not have equipment containing oil.

Lifting requirements and personnel access must be in accordance with Section 7.

All proposals and designs must be approved in writing by Ausgrid.

Upper Level Chamber Substations must have a Control Point chamber at street level or at a level one floor above or below street level (ie. may be a Surface, Elevated or Basement Control Point Chamber).

5.4 Basement Chamber Substations

Where there are no technically viable alternatives, Basement Chamber Substations may be permitted only with the written approval of Ausgrid and must be approved in writing by Ausgrid prior to commencement of design.

All Chamber substations below footpath or roadway level where access is gained shall be for the purposes of this Network Standard treated as a basement Chamber Substation. Refer to Section 7 for access requirements.

In the case of a building containing multi-level basements, subject to the above clause, the Chamber Substation is to be at the first useable level below constructed final ground level.

In all cases, the chamber floor level of a Basement Chamber Substation is not to exceed 4.3 metres below ground level of the adjacent finished level of the footpath or roadway from where personnel or equipment access is gained.

Basement Chamber Substations are permitted in the Sydney metropolitan area i.e. in Ausgrid's area that is south of the Hawkesbury River. This is because the injection of carbon dioxide (CO_2) is required for the purposes of extinguishing fires in Basement Chambers and a reasonable response time by the NSW Fire Brigade's (NSWFB) CO_2 tender can be assured only in the Sydney metropolitan area.

5.5 Chambers for Control of High Voltage Customer (HVC) Connections

All proposals and designs must be approved in writing by Ausgrid.

High Voltage Customer (HVC) connections provide a connection point where Ausgrid agrees to make supply available to the customer at high voltage.

Further requirements for supply to high voltage customer installations in addition to this Network Standard are included in NS195 *High Voltage Connections*, which must be satisfied and approved by Ausgrid in writing before supply will be provided.

Ausgrid's space and equipment requirements will be negotiated on a case by case basis.

No customer metering or any other customer equipment is permitted to be installed in the chamber for control of HVC connections.

Chambers for control of HVC connections must comply with requirements for construction Control Point Chambers as detailed in this Network Standard.

5.6 Control Point Chambers

A control point chamber is required when a Chamber Substation is considered by Ausgrid to be remote from direct unimpeded personnel access from the street, such as Upper Level Chamber Substations.

Where Ausgrid provides supply to an Upper Level Chamber Substation a Control Point Chamber for connection of high voltage switch gear must be located at ground level as defined for Surface Chamber Substations, or one floor above ground level as defined for Elevated Chamber Substations, or one floor below ground level as defined for Basement Chamber Substations.

The Control Point is dedicated to the high voltage switchgear for the associated Upper Level Chamber Substation. No customer metering equipment (meters, VTs, CTs, etc) are allowed in the Control Point Chamber.

Control Point chamber must comply with the same requirements of Surface, Elevated or Basement Substations as appropriate.

6 SITE SELECTION

6.1 Approvals from Ausgrid

Prior to supply being made available the developer/building owner/builder must apply and obtain all necessary approvals from Ausgrid in accordance with Ausgrid ES 10 Requirements for Electricity Connections to Developments.

6.2 Criteria For Approval

The following items, as a minimum, must be taken into account when assessing a site or location for establishment of a Chamber Substation.

- The substation, the required access ways, conduit routes, ventilation ducts and cable risers as appropriate must in general be provided in accordance with NS143 *Easements*, ES 10 and the associated lease or easement memoranda.
- The substation, the required access ways, conduit routes, ventilation ducts and cable risers as appropriate must be located in areas which are free of any other building, structure or services excluding services or conduits directly related, required and approved by Ausgrid for the chamber substation.
- The selected site is required to be geotechnically stable and certified by a Geotechnical engineer as having sufficient capacity for the intended loadings by the substation building, substation equipment and any underground conduits servicing the substation.
- The structure of the substation or chamber must be certified, as being designed to Australian Standards which provide a 50 year life cycle, by a practicing Structural Engineer prior to Ausgrid approval or supply being made available to the Substation.
- The selected site/location shall be clear of all obstructions which may interfere with the installation of any part of the substation earthing system.

Note: Electrodes from the earthing system may extend some 10 metres into the ground below the substation and/or ground level near the substation. (Refer to Section 9 for earthing requirements.)

- Any services including, but not limited to, stormwater or subsoil drains, sewers, gas, water, fire services, air-conditioning installations, electrical or communications cables, conduits or pipe work other than those specified by Ausgrid, must not pass through or encroach into the substation site area or its required or associated access, services passageways, ventilation duct or cable riser clearances.
- Columns, beams, footings or any part of any other building or structure shall not encroach on the clearances referred to in this Network Standard, within any portion of the substation or associated access or services passageways area or any space required for ventilation ducts.

6.3 Prohibited Locations or Areas

The Substation and the access route to the substation must not be within an area or location:

- classified as a hazardous area as defined in Clause 7.7 of AS/NZS 3000, or
- deemed to be a Confined Space according to NSW WorkCover OH&S Safety regulations, or
- likely to be used for such purposes or in such a manner which would increase the risk of fire, explosion or cause access difficulties in the event of fire or any other environmental issue, or
- which may be utilised as a possible storage or collection area for combustible or dangerous materials or goods, or
- likely to contain any portion of another building other than the building in which the substation is housed, which is not sheltered by a non-ignitable blast resisting barrier and

which is within 3 metres in any direction from the ventilation openings of a Chamber Substation. The blast resisting barrier is required to have a Fire resistance Level (FRL) of not less than 180/180/180 and a blast resistance of 2kPa. Refer to Section 8.7. Refer also to Clause 7.1.2.

6.4 Leases, Easements and Rights Of Way

Refer to NS143 *Easements* and ES 10 for details and requirements for leases, easements and rights of way.

Specific lease and easement requirements are covered in this Network Standard as follows:

- Section 8 for details of ventilation ducts.
- Clause 9.1.4 for earthing cable installations.
- Clause 13.3 for CO2 pipe work where required.

All accesses for Upper Level Chamber through buildings must be subject to an approved and registered Right of Way (ROW) to enable 24 hour unimpeded access seven days a week.

The full length and area of the ventilation ducts from the substation chamber or control point chamber to the outside of the building, including any parts of the ducts constructed outside the building, are to be included in the lease documentation for the substation or control point chamber. Refer also to Clause 8.6.1 for other requirements for ROW requirements for ventilation ducts.

7 ACCESS REQUIREMENTS

7.1 Common Access Requirements

The following requirements are common to all types of Chambers and for personnel and equipment access.

7.1.1 General

Compliance with the following conditions is necessary to gain approval to receive supply from Ausgrid:

- Ausgrid personnel must have 24 hour access seven days a week, through dedicated access ways which must be at least 1200 mm wide. Doorways must be 1000 mm wide when the door is in the open position.
- No public or occupant access must be through the Ausgrid dedicated access ways. This includes periods of emergency evacuation when Ausgrid or fire fighting personnel may require unhindered access into the Chamber Substation and associated access ways.
- There must not be any requirement to move any material or traverse around any item or persons in or at the entry/exit points of the access ways.

All access ways must be located to ensure egress and ingress from or onto a public street or an all-weather heavy-duty access roadway which complies with the BCA egress and ingress requirements. The exception is for Upper Level Chamber Substations which require the registration of a ROW through common areas (Refer to Clause 7.2.4).

7.1.2 Prohibited Locations

Access ways must not be located in areas where access may be obstructed by persons, vehicles, equipment, material storage areas, site usage, enclosed or partially enclosed car parks, loading docks, similar facilities or any other possible impediments.

Access to Chamber Substations must not involve or permit access into or through other parts of the building. The exception is for Upper Level Chamber Substations which require the registration of a ROW through common areas (Refer to Clause 7.2.4).

No access ways must be by or involve access through areas which may be deemed to be dangerous to personnel. This includes, but is not limited to, access through areas patrolled by guard dogs or operations involving vehicles, machinery or equipment.

Access is prohibited where egress or access is into or through enclosed or courtyard locations other than those dedicated to the substation.

7.1.3 Prohibited Items

Except for services, facilities or installations directly associated with the substation; no other services, facilities or installations are permitted within a dedicated access way.

Consumer's mains, switchboards, metering or any other parts of the consumer's installation are not permitted in a dedicated access way for a substation.

No materials, equipment or other object is to be stored or placed within an access way.

7.1.4 Construction and Loadings

All access ways which involve access by stairs or passageway must be constructed from the same material as the substation chamber. This is to include the stairs, floors, support structures, walls and roofs or ceilings.

Substation openings, access ways and building openings in the vicinity of any Chamber Substation openings, must comply with all BCA fire resistant construction requirements and fire segregation requirements.

All openings and access ways must comply with Local Authority requirements.

All public roads, access ways or access roads utilised for access into a Chamber Substation must comply with the requirements in Section 7.4.

All access ways or roadways servicing access points must be capable of withstanding construction and service loadings and loads applied by vehicles transporting or moving equipment to and from the substation and ensure clear access at all times. See Section 7.4.

7.1.5 Fire and Blast Rating

The dividing wall between any access way or corridor and the substation chamber must be fire and blast rated to the same levels as the substation chamber.

Unless noted otherwise and approved by Ausgrid in writing the minimum structural component ratings are FRL 180/180/180 and 2kPa blast rating.

All components of a fire rated access corridor must be constructed from reinforced concrete or reinforced blockwork and achieve 180/180/180 fire rating. All substation chambers and access way walls are to be structurally tied at the floor and the ceiling. Refer to Section 10.4.

7.1.6 Personnel Access Doors

All Chamber Substation personnel entry doors must provide a minimum clear opening of 2400mm high and 1000mm wide when the door is in the fully open position.

For Surface Chamber Substations and Control Points in the Sydney CBD, external personnel access doors must be of solid core pressed metal folded type construction with fire rating to the same levels as the substation chamber.

Outside the Sydney CBD, external personnel access doors may be either solid core pressed metal folded type construction with fire rating to the same level as the substation chamber. Alternatively a louvered personnel door or combined transformer and personnel louvered door may be used as shown on drawing 43140 provided the use of such doors in the particular application complies with all other Ausgrid requirements and the BCA, and only one combined transformer and personnel louvered access door is permitted per substation.

Any internal doors between substation chamber and access passageways are to be fire rated to the same level as the substation.

All doors must swing on heavy duty non corroding metal hinges.

All fire rated doors are to be supplied certified and tagged with the fire rating.

Note: If an access corridor is employed, the substation door should be located on the outer wall.

7.1.7 Transformer Access Doors

Each transformer access door is to provide an opening which is full height (i.e. minimum clear height of 3100 mm high) and minimum clear width of 1700 mm, with the door in the fully open position.

For Elevated and Upper Level Chamber Substations, transformer access doors may be utilised for substation ventilation utilising louvers as detailed on Ausgrid Drawing 43140 provided the use of such doors in the particular application complies with all other Ausgrid requirements and the BCA. Alternatively, doors with solid core pressed metal folded type construction and fire rating to the same level as the substation chamber shall be used, and a ducted ventilation system shall be installed.

For Surface Chamber Substations and Control Points in the Sydney CBD, louvered transformer and equipment external access doors are not permitted. The doors must be of solid core pressed metal folded type construction with fire rating to the same levels as the substation chamber. A ducted ventilation system shall be provided.

For Surface Chamber Substations and Control Points outside the Sydney CBD, external transformer access doors shall be louvered doors as shown on Ausgrid Drawing 43140 provided the use of such doors in the particular application complies with all other Ausgrid requirements and the BCA. Alternatively, doors with solid core pressed metal folded type construction and fire rating to the same level as the substation chamber shall be used, and a ducted ventilation system shall be installed.

For Upper Level Chamber Substations located on the top of a building the transformer access doors may open outwards provided the doors open onto a flat open area, where there is sufficient space. Otherwise the transformer access doors must swing into the substation chamber and these doors must be positioned to ensure the minimum clearances around equipment are maintained when the door is being opened or is in the fully open position.

For all other Upper Level and Elevated Chamber Substations the transformer access doors must swing into the substation chamber and these doors must be positioned to ensure the minimum clearances around equipment are maintained when the door is being opened or is in the fully open position.

For Surface Chamber Substations it is preferable that the transformer access doors swing outwards. If an access door is required to swing into the substation chamber, it must be positioned to ensure the minimum clearances around equipment are maintained when the door is being opened or is in the fully open position. Outward swinging doors may need to be fitted with hinges to allow a swing of 180□ to provide sufficient manoeuvring space in front of the substation entry. Doors are to have a 120 mm minimum and 600 mm maximum rise up from outside of the chamber, the threshold of each step is to be finished with an angle nosing. A raised transformer handling area is to be provided outside the transformer access doors where the rise up from outside the chamber would otherwise be greater than 600 mm.

The inside or substation chamber side of each transformer access is to have facilities to contain any oil spill. Refer to Section 11.

Each door leaf is to swing on its frame using heavy-duty non-corroding metal hinges.

All fire rated doors are to be supplied certified and tagged with the fire rating.

Refer also to Clause 7.4.4 for requirements of access to basement Chambers.

7.1.8 Locks

All Chamber Substation external personnel access doors must be fitted with a Lockwood 3572 series latch bolt or similar, with oval cylinder, operated by key from the outside and a Lockwood 1006 series lever handle or similar on the inside. The latch shall be fitted such that there is no less than 10 mm engagement of the latch bolt into the striker plate when the door is in the closed position. The latch shall have no

less than 65 mm backset. Each door is also to be fitted with a 200 mm D handle to the outside face.

Any internal doors between substation chamber and access chambers or between substation chamber and access passageways are to be fitted with fire rated closers. A push plate is to be provided on the substation side of each door, and a 200 mm 'D' handle is to be provided on the access chamber or access passageway side. No locks are to be fitted to these doors.

Upon Ausgrid acceptance of a Chamber Substation, control point or cable riser, lock cylinders will be changed to the Ausgrid series, by Ausgrid.

Transformer access doors are to be operable from the inside only and each door leaf is to be secured in position with a skeleton bolt at the top and bottom of each panel. The top bolt is to have its shot bolt extended to ensure operation without the use of a ladder. Both bolts are to achieve a minimum of 25 mm penetration into the sockets, and shots are to be machined to allow easy socketing.

7.2 Personnel Access Requirements

7.2.1 General

Each substation chamber must be provided with two separate dedicated access ways for personnel. Where two or more substations are located adjacent to each other, it is not acceptable for any of the access doors, hatches or passageways to be shared between substations. Each substation chamber must be separate and each chamber must have separate access arrangements as applicable.

At each substation both access ways must originate, and allow access from:

- an area which is non-trafficable by vehicles in a public street or,
- an open, uncovered, unenclosed, outer area,

that is acceptable to Ausgrid and in compliance with the BCA.

Within all Chamber Substations personnel access doors must be positioned to enable unimpeded access from all locations within the chamber area which require normal operations and inspection.

Substation chamber access doors should be diagonally opposite where possible or at either extreme of the Chamber Substation.

In particular access is required for operations and inspections involving:

- the front of the low voltage switchboard,
- the operating side of each high voltage switch,
- the locations of the connection housings, and the tap changing switch, on each transformer,
- the front of any equipment mounted on a protection panel, where installed, and the battery charger, where installed.

7.2.2 Surface Chamber Substations

For Surface Chamber Substations outside the CBD of Sydney, each access way may consist of:

- A doorway opening directly from the substation chamber to a public street or open, uncovered, unenclosed, outer area, acceptable to Ausgrid and in compliance with the BCA.
- an adjoining access passageway that leads to a doorway which opens to a public street or open, uncovered, unenclosed, outer area, acceptable to Ausgrid and in compliance with the BCA. There is no need for a door between the substation and the access passageway.

- a combined transformer and personnel louvered door as shown on Ausgrid Drawing 43140, however only one such access way is permitted per substation.

For Surface Chamber Substations in the CBD of Sydney, each access way shall consist of an adjoining access passageway that leads from the substation chamber to a doorway which opens to a public street or open, uncovered, unenclosed, outer area, acceptable to Ausgrid and in compliance with the BCA. A door is to be provided between the substation chamber and the access passageway.

The door on all personnel doorways, between the Surface Chamber substation and external areas, or between access passageway and external areas, shall swing into the substation chamber or access passageway.

7.2.3 Elevated Chamber Substations

Elevated Chamber Substations must comply with all relevant requirements contained within this Section plus the following specific requirements.

All Elevated Chamber Substations are to have two separate dedicated access ways to the substation chamber.

Access ways must be either Option A or Option B as described below.

Option A is strongly preferred. Option B is permitted only when Option A is not physically practicable. All final decisions regarding the use of Option A or Option B shall be made by Ausgrid.

Option A

Each access away is through a separate doorway at street level in an external wall or walls, each door leading into a separate access chamber and stairway, up to another access chamber, with doorway leading into the substation chamber.

Option B

The first access way is through a separate doorway at street level in an external wall or walls, leading into a separate access chamber and stairway, up to another access chamber, with doorway leading into the substation chamber. The second access way is through a separate doorway at street level in an external wall or walls, leading into a separate access chamber and shaft with ladder (compliant with AS 1657 Part 1), up to another access chamber, with doorway leading into the substation.

In either option at least one of the personnel access ways must also incorporate a vertical shaft of at least 1600mm x 900mm, from the lower access chamber to the upper access chamber and be suitable for lifting of small items of equipment to and from the substation chamber. Refer to Section 7.3 for further details

All doors, access chambers and stairways are to be fire and blast rated to the same level as the Elevated Chamber Substation chamber. The stairs must be constructed in reinforced cast in-situ concrete, steel or precast concrete stairs are not acceptable.

7.2.4 Upper Level Chamber Substations

Upper Level Chamber Substations must comply with all relevant requirements contained within this Section plus the following specific requirements.

7.2.4.1 General

ONLY in the case of Upper Level Chamber Substations may access be gained through a building, foyer, loading dock or parking areas within the building. Unimpeded, 24 hour, seven day a week access by Ausgrid personnel is required for Upper Level Chamber Substations.

7.2.4.2 Right of Way (ROW)

A permanent registered Right of Way (ROW) in favour of Ausgrid is required to be created by the customer at the customer's expense. The ROW must cover the following:

- On the same level as the Upper Level Chamber Substation, a ROW from a convenient lift or stairway to the access doors of the Upper Level Chamber Substation. This may be up to 6M difference in floor level with access via stairway.
- At street level, a ROW between the public street and the lift or stairway
- Between street level and the substation level, a ROW covering the lift or stairway.
- ROW at ground level to dedicated access way.
- ROW at substation level in multi-storey building.

All access way stairs covered by the ROW must be constructed of cast in-situ reinforced concrete; steel or precast concrete stairs are not acceptable.

The ROW must enable Ausgrid access at all times 24 hours a day, 7 days a week. Refer to Section 6.4.

7.2.4.3 Personnel Access Requirements

Personnel access to Upper Level Chamber Substations is to be obtained from within the customer's building via the ROW discussed above.

Access must not involve a change in height of more than 3 metres between the ROW access level and the floor level of the Upper Level Chamber Substation.

Access to an Upper Level Chamber Substation is NOT acceptable from a nominated public or occupant fire stair or through parts of the building which may be occupied or tenanted.

Each access to the substation from a common area or lift foyer shall be via an access chamber as discussed in Clause 7.2.4.5.

7.2.4.4 Doors to Upper Level Chamber Substations and Access Chambers

Personnel doors must achieve a FRL of 2 hours or be equal to the substation structure if the substation is rated at more than 120/120/120.

Upper Level Chamber Substation chambers, substation chamber openings and building ventilation openings in the vicinity of substation openings must comply with BCA fire resistant construction and fire segregation requirements. Refer to Section 13.

7.2.4.5 Access Chambers

Upper Level Chamber Substations located within buildings must have a dedicated access chamber outside each substation chamber access door. Upper Level Chamber Substations with personnel access doors which open onto open outdoor areas (e.g. on the roof of a building) and which also have SCADA equipment installed, must have a dedicated access chamber, suitable for installation of the SCADA equipment, outside one substation chamber access doors.

The access chamber must comply with and be of the same construction and fire resistance level (FRL) required for the Upper Level Chamber Substation.

Doorways must be provided to form an airlock within the access chamber, i.e. doors must be provided between the substation chamber and access chambers and between the access chambers and the common area or lift foyer.

The door on the doorway between the common area or lift foyer and the access chamber shall swing into the access chamber. The door between the substation chambers and the access chamber shall also swing into the access chamber.

Access chambers to Upper level Substations should be a minimum of 1200mm wide. Where SCADA equipment is present additional width is required. Refer to Section 4.5. The space between the access chamber and substation access doors must be a minimum of 1200mm when both doors are in the open position.

7.2.5 Basement Chamber Substations

Basement Chamber Substations must comply with all relevant requirements contained within this Network Standard plus the following specific requirements.

7.2.5.1 General

Generally personnel access to Basement Chamber Substations must:

- Provide two separate dedicated means of access from an access roadway which must comply with the requirements in Section 12.
- Be located in areas which provide unimpeded 24 hour seven day a week access by Ausgrid personnel.
- Not be located where the access is off or through foyers, alarmed or secured areas, loading docks, storage areas, enclosed car parks, courtyard type areas or enclosed or partly enclosed areas or similar facilities or installations.
- Comply with BCA fire resistant construction requirements and fire segregation requirements regarding building and ventilation openings in the vicinity of basement substation or substation ventilation openings.

7.2.5.2 Dedicated Access Ways

The dedicated access ways must be approved in writing by the Ausgrid.

Access ways can only be one of the options described below.

Option A is strongly preferred. Option B or C are permitted only when Option A is not physically practicable. All final decisions regarding the use of Options A B or C shall be made by Ausgrid.

Option A

Each access way is through a separate doorway which is located at street level in an external wall of the building. Each door opens into an access chamber which leads to a descending stairway. At the foot of the stairway is another access chamber containing the doorway into the substation chamber.

Option B

One access way is as per Option A. The second access way is through a separate doorway which is located at street level in an external wall of the building. This door opens into an access chamber which contains a shaft fitted with descending ladder (compliant with AS 1657 Part 1), At the foot of the ladder is another access chamber containing the doorway leading into the substation chamber.

Option C

One access way is as per Option A. The second access way is through a hatchway which must be located entirely on the premises at street level. The hatchway provides access to a fixed descending ladder. At the foot of the ladder is another access chamber containing the doorway leading into the substation chamber.

In Options A and B at least one of the personnel access ways must also incorporate a vertical 1600mm x 900mm shaft from the upper access chamber or hatch to the lower access chamber, suitable for transport of small items of equipment to and from the substation chamber. In Option C it is acceptable to use the hatchway as the means of small equipment access to the substation level. Refer Section 7.3 for further details.

All doors, access chambers and stairways are to be fire rated to the same level as the Elevated Chamber Substation chamber. The stairs must be constructed in reinforced cast in-situ concrete, steel or precast concrete stairs are not acceptable.

7.2.6 Control Point Chambers and Chambers for Control of Supply to High Voltage (HVC) Connections

Unless specified otherwise in this Network Standard, the requirements for Control Point Chambers and Chambers for the Control of Supply to HVC Connections are the same as requirements described for Surface, Elevated or Basement Chamber Substations as appropriate, subject to Ausgrid approval.

7.3 Personnel Access Ways for Chamber Substations

7.3.1 General

The use of the following access ways for personnel and small equipment shall be in accordance with Clauses 7.2.3 and 7.2.5.

All personnel access doors that are also used for small equipment access must provide a clear opening of not less than 2400mm high by 1000mm wide, when the door is in the fully open position.

Where Chamber Substations are serviced by a shaft from an access chamber, the shaft must have clear access of not less than 1600mm x 900mm, for small equipment access to the substation level. All street level access chambers must be located at the same level as the public roadway which services the access chamber.

All street level access chambers, which can not provide level access from a public roadway, will be subject to review and approval from Ausgrid before design is finalised or construction commences.

All doors, access chambers and stairways are to be fire rated to the same Fire Resistance Level as the Substation chamber.

All street level personnel access chambers and hatchways, which are intended for small equipment access, must be located in a position where a truck with a hoist can stand and deliver tool boxes and small items of equipment.

7.3.1.1 Doorways Between External Areas and Substation Chambers or Access Chambers or Control Point Chambers

Each doorway leading from an external area into a substation, access chamber, or control point is to:

- have a 120 mm minimum, 190 mm maximum step up from the external level to the access chamber. If more than one (1) step up is required, these additional steps shall be accommodated on the outside of the substation, access chamber or control point and include an appropriate handrail.
- have the threshold of each step up finished with an angle nosing as shown on Ausgrid Drawing 48008.
- if at street level it is to have bollards placed around doors where there is a risk of personnel stepping onto roadways when using them or there is a risk of the door being blocked by such things as motorcycles, bicycles, delivery vans or the storage of goods being delivered or awaiting collection.

- be positioned such that their use does not create a personnel hazard.
- be fitted with doors that;
    - swing into the substation, access chamber or control point.
    - are positioned so that suitable clearances are maintained from any internal stairways when the doors are in the fully open position.
    - have an appropriate safety sign fixed to it as indicated by Clause K10 of AS/NZS 3000.
    - are fire resistant.
    - are weatherproof if leading from an outdoor area.
    - are fitted with fire rated hydraulic door closers.

7.3.1.2 Stairways

All stairs must be constructed in reinforced cast in-situ concrete. Steel or precast concrete stairs are not acceptable.

Stairways must be large enough to allow for the passage of equipment or personnel, and must be not less than 1200mm wide. Stairway headroom must be a minimum of 2200mm.

Stairways must be fitted with appropriate handrails, and must be constructed and installed in accordance with AS 1657 and other relevant Australian Standards and Building Codes.

7.3.1.3 Doorways Between Access Chambers and Substation Chambers

Each doorway leading from an access chamber into a substation chamber is to:

- have a step of 120mm from the substation chamber up to the access chamber level at the threshold of the doorway.
- have the threshold of the 120mm step finished with angle nosing as shown on Ausgrid Drawing 48008.
- not be positioned behind substation equipment.
- provide a non-tortuous path for personnel and equipment entry and exit.
- be located on opposite sides of the chamber in diagonally opposite corners
- be fitted with doors that;
    - are positioned to ensure the minimum clearances around equipment are maintained when the door is being opened or is in the fully open position.
    - swing into the access chambers.
    - are 3 hour fire resistant.
    - are fitted with fire rated hydraulic door closers.
    - are fitted with a push plate on the substation side of each door, and a 200 mm ‘D’ handle is required on the access chamber side.
    - swing on their frame with heavy-duty non-corroding metal hinges.

7.3.1.4 SCADA Requirements

In Sydney CBD substations and Control Points, SCADA equipment, pilot cable isolation boxes and signal cable disconnection boxes must be installed as specified in NS114. Where SCADA equipment etc is required, one of the substation level access

chambers must be adequate to accommodate this equipment, and will need to be enlarged accordingly.

SCADA equipment must not be installed in any access chamber intended for small equipment access, ie. SCADA equipment should only be installed in access chambers intended for personnel access only.

7.3.2 Combined Personnel Stairway and Small Equipment Access Way Requirements

This access way is for personnel and small equipment access.

The upper access chamber must incorporate a landing of not less than 1600mm x 1600mm, to facilitate moving and turning of equipment. A shaft from the upper access chamber to the lower access chamber must be located beside the upper access chamber landing. A one tonne monorail and trolley, suitable for attaching a lifting device for lifting and lowering tool boxes and small items of equipment from the upper access chamber to the lower access chamber, must be located over the centre lines of the shaft and the upper access chamber landing. It is also preferable to have the centre line of the door align with shaft centre line. Ausgrid personnel will attach a lifting device to the trolley when required. The attachment point on the trolley is to be between 3000mm and 3200mm above the upper access chamber landing. The shaft must be not less than 1600 mm x 900 mm. Self-closing, self-latching gates must be fitted between the landing and the shaft. The gates must swing over the landing. The monorail, trolley, gates and their installation must be in accordance with relevant Australian Standards, and must be labelled as required in those Standards.

The lower access chamber must be not less than 1600 mm x 1600 mm wide to facilitate moving and turning of equipment. The headroom must be suitable for the lifting facilities as specified for the upper chamber, and must otherwise have minimum headroom of 2500 mm. The lower access chamber must be located beside the equipment shaft. The floor of the shaft must be level with the floor of the lower access chamber.

Personnel access between the upper and lower access chambers must be provided via a stairway.

The door into the substation chamber from the access chamber must provide a clear opening of not less than 2400 mm high by 1000 mm wide, when the door is in the fully open position.

The door to the street level access chamber must be located in a position where a truck with a hoist can stand and deliver tool boxes and small items of equipment. The door to this access chamber must provide a clear opening of not less than 2400 mm high and 1000 mm wide, when the door is in the fully open position. A suitable clearance is to be provided in front of the door to facilitate handling of equipment.

7.3.3 Personnel Only Stairway Access Way Requirements

This access way is for personnel access only.

The access chamber a street level must have a door with a clear opening not less than 2400mm high and 1000mm wide, when the door is in the fully open position. This chamber must have a minimum headroom of 2500mm and a minimum width of 1200mm.

The doorway into the substation chamber from this access chamber is to provide a clear opening of not less than 2400mm high by 1000mm wide, when the door is in the fully open position. The access chamber associated with this door must have a minimum headroom of 2500mm and a minimum width of 1200mm.

7.3.4 Personnel Access via Access Chamber and Ladder

This access way is for personnel and small equipment access.

The upper access chamber must incorporate a landing of not less than 1600mm x 1600mm, to facilitate moving and turning of equipment. A shaft from the upper access chamber to the lower access chamber must be located beside the upper access chamber landing. A one tonne monorail and trolley, suitable for attaching a lifting device for lifting and lowering tool boxes and small items of equipment from the upper access chamber to the lower access chamber, must be located over the centre lines of the shaft and the upper access chamber landing. It is also preferable to have the centre line of the door align with shaft centre line. Ausgrid personnel will attach a lifting device to the trolley when required. The attachment point on the trolley is to be between 3000mm and 3200mm above the upper access chamber landing. The shaft must allow 1600mm x 900mm clear vertical access. Self-closing, self-latching gates must be fitted between the landing and the shaft. The gates must swing over the landing. The monorail, trolley gates and their installation must be in accordance with relevant Australian Standards, and must be labelled as required in those Standards.

The lower access chamber must be not less than 1600mm x 1600mm wide to facilitate moving and turning of equipment. The headroom must be suitable for the lifting facilities as specified for the upper chamber, and must otherwise have minimum headroom of 2500mm. The lower access chamber must be located beside the equipment shaft. The floor of the shaft must be level with the floor of the lower access chamber.

Personnel access between the upper and lower access chambers must be provided via a permanent ladder, installed in the shaft and complying AS 1657 Part 1.

The door into the substation chamber from the access chamber must provide a clear opening of not less than 2400mm high by 1000mm wide, when the door is in the fully open position.

The door to the street level access chamber must be located in a position where a truck with a hoist can stand and deliver tool boxes and small items of equipment. The door to this access chamber must provide a clear opening of not less than 2400mm high and 1000mm wide, when the door is in the fully open position. A suitable clearance is to be provided in front of the door to facilitate handling of equipment.

7.3.5 Personnel Access via Hatchway

This access option is for Basement Chamber Substations only. It provides for one stairway access and one hatchway or ladder access, the following requirements apply.

This access way is for personnel and small equipment access.

- The lower access chamber shall be 3500mm x 1600mm minimum
- Any shaft between the access chamber and hatchway must have a minimum opening of 1410mm x 880mm.
- The lower access chamber floor shall fall 20mm along its length and 20mm across its width towards the corner of the chamber adjacent to the foot of the ladder and away from the doorway. At this point a 300mm x 300mm x 300mm deep sump with a removable galvanised iron grating cover is to be constructed. The sump must be drained to a point free of surcharge. It may drain to a stormwater system, but not via the cavity of any adjacent wall.
- The hatch cover is to be located at road level, within the customer's premises where vehicles cannot drive over it. The hatch cover should not be located near a main building entrance or in front of an emergency exit.
- The installation must not allow ponding of water on the hatch cover. The hatch cover must not be located in a position where stormwater or water from street cleaning could engulf the hatch cover.
- The pavement must slope up to the hatch cover on all sides in a manner that does not create a trip hazard and the hatch cover top surface level must be 25mm above the surrounding footpath level on all sides.

- The installation of the hatch cover must comply with Ausgrid Drawing 28949.
- The hatchway is to be located in a position where a truck with a hoist can stand and deliver tool boxes or small items of equipment. Hatch covers must have unimpeded 24 hour access seven days a week vehicle access available, without roller shutters, gates, doors, etc. in the access way. The minimum clear head clearance required above hatch covers is 3.2 metres.
- Hatch covers are to be positioned so that there is no less than 1000mm clearance behind the direction of entry, to any wall or other part of the building. Clearance of at least 300mm must be provided on at least one other side of the hatch cover.
- Access from the hatch opening to the substation personnel access chamber must be gained via a permanent ladder. This ladder is not to exceed 4.3 metres in length and must comply with Ausgrid requirements.
- A pull-out guard railing to Ausgrid requirements is to be provided at road level to protect the opening when the hatch is in use.
- The hatchway installation must be in accordance with Ausgrid specifications.
- Ausgrid Drawing 38630 shows a typical installation of a personnel hatch cover guard and ladder.
- Ladders must be fitted with appropriate handrails, and a self-closing gate must be fitted at the top of each ladder. The self-closing gate must swing away from the ladder.
- Ladders must be constructed in accordance with AS 1657 and other relevant Australian Standards and Building Codes.
- A separate transformer hatchway must also be provided.

7.4 Equipment Access and Handling

7.4.1 General

Access for all substation equipment must be through approved access doors in the external wall of the Chamber Substation, or through hatches in the ceiling of the Chamber Substation. Access for transformers shall be through dedicated transformer hatches or access doors as discussed in Sections 7.4.4 & 7.1.7 respectively. Access for other heavy equipment such as HV or LV switchgear may be through the transformer access doors or through the designated combined personnel and equipment access way.

The Chamber Substation access doors and hatches must be accessible at all times for lifting equipment required to replace or service the equipment within the Chamber Substation.

Equipment handling also requires a suitable access way or road with turning circles, safety clearances, parking areas and roadway load capacity requirements as set out in Section 10.

Where direct unimpeded access is not possible, switchgear access and handling arrangements must be included in the initial substation design and be approved by Ausgrid prior to the construction commencing.

7.4.2 Small Equipment

The access for small items of equipment weighing less than 70kgs is to be through an approved personnel access hatch or door as discussed in Sections 7.2 and 7.3.

For Upper Level Substations, access for small items of equipment weighing less than 70kgs can generally be obtained by utilising a goods or passenger lift, which services the same level as the Chamber Substation. Access must be on the same level and not require any lifting of the equipment or access through tenanted or occupied areas.

7.4.3 Heavy Equipment

7.4.3.1 Movement of Heavy Equipment

Equipment weighing more than 70kgs but less than one tonne (e.g. HV & LV switchgear) (not including transformers) is classified as HEAVY and must be lifted by an appropriate crane or lifting mechanism.

Generally, the crane or lifting mechanism will be provided by Ausgrid. However in some situations such as Upper Level Substations, the building owner or occupant must supply a suitable crane or lifting device, approved by Ausgrid and at no cost to Ausgrid, whenever it is required.

Access into the Chamber Substation for heavy equipment can be via the transformer access doors or hatches, or via the designated combined personnel and equipment access way.

Since the majority of equipment in a Control Point Chamber or Chamber for the Control of a High Voltage Customer consists of high voltage switchgear which weighs less than one tonne and so can be delivered via the designated combined personnel and equipment access way, dedicated equipment access doors or hatches are not necessarily required.

7.4.3.2 Movement of Transformers and Large Equipment

Large pieces of equipment such as transformers require a mobile crane and a low loader or truck for movement to and from the substation. A heavy duty access roadway and plan for lifting and movement of equipment and associated transformer landing area must be provided and approved by Ausgrid prior to equipment delivery.

7.4.3.3 Heavy-duty Access Roadway

The heavy-duty access roadway and associated transformer landing area must be suitable for use under all weather conditions. The access roadway must be constructed to withstand all loads likely to occur from the installation of transformers and shall comply with or exceed the requirements of this Network Standard.

There are various methods of heavy equipment delivery. The Service Provider (Designer) must select the method of delivery which is most appropriate for the site and nominate the chosen method on the architectural lock-in drawing (as required by NS149).

Common methods of heavy equipment delivery are as follows:

(a) Articulated crane (eg. Franna).

This is the most common method of transformer delivery. For a 20 tonne Franna crane lifting a 5 tonne transformer, the roadway must be suitable for a front-axle loading of 15 tonnes. The rear-axle loading should not exceed 12 tonnes and the overall loading of the crane with transformer would be 25 tonnes spread across the two axles.

Note: A 20 tonne Franna crane has one front and one rear axle, with 4 tyres on each axle.

(b) Mobile crane and truck.

The surface of the Right of Way (ROW) from the street to the transformer delivery point must be capable of withstanding a rear-axle loading of 21 tonnes.

Where the crane with outrigger pads extended, lifts the transformer from the truck in the manoeuvring area adjacent to the substation, the surface of the ROW must be capable of withstanding a rear-axle group or outrigger loading of 21 tonnes. The loading on any one pad may be up to 15 tonnes with a total loading on any two pads of 21 tonnes.

This loading must be provided for in the design of any paving or suspended slab within 1.9 metres of the roadway kerb in those cases where the position to which the transformer has to be lifted is more than 4 metres from the kerb.

In this regard, 5.2 metres from kerb to transformer centre line at the landing position is the maximum reach with a 1500 kVA transformer unless approved in writing by Ausgrid.

(c) Self-loading truck.

(eg. Heavy table-top truck with boom-lift crane, eg. Hiab or Palfinger.)

This method is generally only suitable in cases where the truck can park immediately adjacent to the transformer landing area in front of the substation louvres. This is because the boom-lift crane can only set the transformer down immediately adjacent to the truck. From this point it is necessary to winch the transformer into the substation. The surface of the ROW should be capable of withstanding a rear-axle group or outrigger loading of 21 tonnes, with the loading on any one pad being up to 15 tonnes.

(d) Permanent monorail and trolley.

This is the usual method for Upper Level Chamber Substations. A site-specific design is required. The monorail and trolley must comply with the requirements of AS 1418.

(e) Temporary outrigger landing platform.

This method may be suitable for some Upper Level Chamber Substations.

A site-specific design and safe work method statement is required.

Note: Permanent on-site storage for the platform is required.

For Upper Level Chamber Substations, methods (d) and (e) above will normally need to be considered in conjunction with method (a), (b) or (c).

In each case, the height and width of the access way must be a minimum 4 metres for reasonably straight routes, with increased width at bends and in the manoeuvring area adjacent to the substation, where lifting operations will be carried out. The surface grade along the ROW should not exceed 1:8 and in the transformer handling area should not exceed 1:20.

Headroom of not less than 4 metres (clear), for structures on a level access route, is required along the route to be taken by vehicles to and from the transformer handling and vehicle manoeuvring areas, to ensure operation of the crane is not impeded.

Where the access route for the crane is on sloping ground or where there are humps or dips in the access route, the headroom for structures must be increased above 4 metres as necessary to compensate for the position of the crane boom at any point along the access route. Each case will need to be determined to the satisfaction of Ausgrid.

The clearance requirements indicated above must be achieved following completion of all building treatments including cladding of overhead structures, and paving of the access route.

If the substation is above 25metres from the lifting point, or the crane lift would include a significant horizontal component, or significant crane set-up time, then a permanent lifting device or devices must be installed. Permanent lifting devices may include suitably strengthened building maintenance cranes, dedicated plant room lifting devices or dedicated substation lifting devices.

Any reinstatement which may be necessary, in the event of damage to the paved surface or walls of a Right-of-Way, is the responsibility of the owner of the premises.

7.4.3.4 Transformer Handling Area

A transformer handling area with sufficient space for vehicle manoeuvring must be included adjacent to the substation. The transformer and equipment handling area shall be of a size which will allow all of the substation transformers to be stored within the area at any time. The floor grade of the transformer handling area should not exceed 1:20.

For Surface Chamber Substations a raised transformer handling area is to be provided outside the transformer access doors where the rise up from outside the chamber would otherwise be greater than 600 mm.

For Basement Chamber Substations, the access for large items of equipment such as transformers must be through a dedicated hatch, generally referred to as a transformer hatch. The design of the transformer hatch, hatch cover and framing is to comply with Ausgrid Drawing 50740. Refer to Clause 7.4.4 for the required clearance of structures above the transformer hatch.

For Basement Chamber Substations the transformer hatch and the transformer and equipment handling area should generally be directly above the substation chamber. However, where the location of the substation chamber is such that a transformer hatch and transformer and equipment handling area cannot be directly above, due to relative location or horizontal distance requirements, a basement transformer/heavy equipment access chamber may be constructed. The use of any such access chamber must be approved by Ausgrid and be of the same FRL as the Substation Chamber. Refer to Clause 7.4.5 for further details.

7.4.4 Transformer Hatches and Access Chambers

7.4.4.1 General

Transformer hatches must be located in common areas. Transformer hatches must not be located in tenanted areas or other areas normally occupied by persons. In all cases, the hatch location must be approved by Ausgrid.

The transformer hatch location must be in an unenclosed area accessible from the street with 24 hour seven day a week access for Ausgrid personnel. It is preferable for the hatch to be located in an area clear of any overhead building or structure. If any part of the hatch is located below any part of a building, Ausgrid may specify the substation must not contain oil filled equipment.

The centre of the transformer hatch is to be within 5.2 metres (see Note below) of an all-weather access roadway which is suitable for heavy-duty vehicles. The access roadway must comply with the requirements in Section 12 unless approved in writing by Ausgrid.

Note: Ausgrid may permit this limit to be slightly increased, where satisfied that future mobile crane lifting arrangements will be satisfactory.

If this requirement cannot be met, a permanent lifting device with a suitable capacity is to be provided for transportation of heavy equipment from the truck unloading area to the transformer hatch. The nominal weight of a transformer is 5 tonnes.

The access side of the hatch is to have sufficient clearance for crane access. The other 3 (three) sides of the hatch must be provided with a minimum clearance of 600mm.

In the Basement substation chamber, or Basement equipment access chamber, the hatch is to be positioned to achieve a clearance of not less than 300mm to any wall, equipment or other obstruction without the need to move any equipment, cables or cable ladders to gain full accessibility for any piece of heavy equipment.

Adequate clearance must be provided within the access chamber and access way to enable replacement equipment to be moved into place without interference from walls or pieces of equipment, cables frames or ladders.

The hatch cover must be designed and installed to allow for any surface finishing material and waterproofing. Surface finish and waterproofing of the hatch cover and surrounding area shall be detailed to ensure removal and/or replacement of the hatch cover does not result in damage to either the surface finish of the hatch cover or surrounding areas.

The hatch cover outlines must be clearly delineated in the surrounding surface finish. The hatch cover must be sealed in place after the final installation of equipment and resealed at any time the hatch is required to be used.

An adjacent on-site space must be provided for the temporary storage of the hatch cover in a flat position clear of the street and pedestrian thoroughfares.

Due to relative location or horizontal distance requirements the use of vertical heavy equipment access hatches may not achieve full access into some Basement Chamber Substations. Such basement substations may gain acceptable access by the installation of a basement access chamber which must be approved by Ausgrid and be of the same FRL as the Substation Chamber.

The size of transformer access chamber must be sufficient to allow for manoeuvring of the transformer during initial delivery and any subsequent replacement. To facilitate movement, the chamber is to be equipped with pulling rings, either permanent or removable as shown on Ausgrid Drawings 48008, 27298 and 63678. The minimum headroom of this access chamber can be 2800mm and care must be taken to ensure that the chamber cannot be assessed as a confined space. The access chamber is to be separated from the substation chamber by double three hour fire rated doors which provide a clear opening of not less than 2800mm high x 1700mm wide when they are in the fully opened position. The doors can swing into either the substation of the access chamber provided appropriate door handles are fitted. Refer to Section 7.1.7 for further door information.

7.4.4.2 Additional Requirements for Dry Type Transformers

Where dry type transformers are to be installed in areas where moisture may be present, a water drip barrier acceptable to Ausgrid must be installed under the transformer hatch, to reduce the likelihood of water leakage onto the transformers.

In such circumstances, the area inside the substation and directly under a transformer hatch (including the surrounding water drip barrier), must not be any part of an allocated transformer space.

A water drip barrier may consist of 50mm x 50mm galvanised angle installed on the substation ceiling completely around the perimeter of each transformer hatch, approximately 100mm from the edge of the hatch.

Appropriate membranes and barriers must be provided to ensure no moisture enters the transformer area. All waterproofing proposals must be provided to Ausgrid for consideration and approval prior to construction. Approval must be given by Ausgrid prior to the installation of any transformer.

7.4.5 Access for Cabling and Conduits

Dedicated easements are required for the entry of cables to the approved site. The easements must be clear of all construction except as required for the installation or future maintenance of Ausgrid equipment or cables associated with the Chamber Substation, Control Point or Chamber for Control of HVC Connections.

The easements must be a minimum 2 metres in width for direct laid cables.

Where a pit and conduit system is utilised the width of the easement shall be the width of pit and conduit system.

Depending on the number of cables and conduits to be accommodated, easement widths may vary and multiple easements may be required.

No structure may be erected or levels altered within an easement without permission from Ausgrid. Other services may cross an easement provided Ausgrid is satisfied the mains will not be affected.

Where any surface finish over direct laid cables may involve future excavation, the conduits from the substation must be extended to a position where excavation does not affect cables or to a cable pit. Instructions and approval in writing is required from Ausgrid with regard to this matter.

Where cables are installed beneath a paved area or in a building, permanent surface markings acceptable to Ausgrid must be installed by the building owner at 3 metre intervals to indicate location, depth and presence of cables.

All mains between a control point and a substation are to be installed in a conduit system, due to the remote location of the substation chamber. This system is to run directly from the control point to the substation or, in the case of an upper level substation, via an approved fire rated cable riser. The riser must have a fire resistance level at the same as the Chamber Substation.

Where any substation conduit passes through a customer's property it must be encased in a minimum of 150mm of concrete.

7.4.6 Equipment Handling Within the Substation Chamber

Equipment must be manoeuvred into position within the substation chamber using methods acceptable to WorkCover and all other the appropriate authorities. Pulling rings are to be incorporated into the substation structure to assist this process.

Pulling rings located in walls, ceilings or pit floors can be permanent, as shown on Ausgrid Drawing 63678. Pulling rings located in the substation floor must be removable, as shown on Ausgrid drawings 48008 and 27298.

The positioning of any pulling rings is to provide straight pulls, clear of any pieces of equipment which do not obstruct doorways or hatches.

Clearances around permanent equipment shall ensure the equipment is readily accessible at all times. Incorporation of pulling rings or eyes into the substation structure must not impair fire rating, waterproofing or structural integrity of the surrounding structure.

To facilitate cable pulls; pulling rings must be installed at the top and bottom of cable risers and at the end of conduit runs.

Ausgrid can provide advice on a case by case basis.

7.5 Adjacent Substations and Control Point Chambers

7.5.1 Adjacent Substations

Where two or more substations are located adjacent to each other, it is not acceptable for any access door, hatch or passageway to be shared between substations. Each substation chamber must be separate and each chamber must have separate access arrangements as described in this Network Standard.

7.5.2 Adjacent Substations and Control Points

7.5.2.1 Personnel

Where a Chamber Substation and a Control Point are located adjacent to each other, there are two options.

Option A

Requires separate accesses to be constructed for each Substation and Control Point chamber.

Option B

This option requires one external access to the Substation chamber, one separate external access to the Control Point chamber and a separate access chamber between the Control Point chamber and the substation chamber. This option requires the access chamber to form an air lock between the Chamber Substation and the Control Point. The air lock doors must not be lockable. Each door to the air lock must provide a clear opening of not less than 2400mm high and 1000mm wide when the doors are in the open position.

Each air lock doorway is to:

- have a step of 120mm from the substation or control point chamber up to the air lock chamber level at the threshold of the doorway.
- have the threshold of the 120mm step finished with angle nosing as shown on Ausgrid Drawing 48008.
- not be positioned behind substation or control point equipment.
- provide a non-tortuous path for personnel and equipment entry and exit.
- be located on opposite sides of the chamber in diagonally opposite corners.
- be fitted with doors that;
    - are positioned to ensure the minimum clearances around equipment are maintained when the door is being opened or is in the fully open position.
    - swing into the air lock.
    - are 3 hour fire resistant.
    - are fitted with fire rated hydraulic door closers.
    - are fitted with a push plate on the substation and control point side of each door, and a 200 mm ‘D’ handle is required on the air lock side.
    - swing on their frame with heavy-duty non-corroding metal hinges.

The access into the substation chamber from the external access way should be diagonally opposite to the access into the substation from the air lock from the control point. The access into the control point from the external access should be diagonally opposite to the access into the control point from the passageway from the substation.

7.5.2.2 Equipment

Equipment handling for the Substation Chamber is as per Sections 7.4 and 7.1.7.

Equipment access to the control point is obtained from the external access way of the control point. Equipment delivery is not to be undertaken via the substation.

7.6 Cable Risers

The position of a cable riser should be such that personnel access is not impeded by the need to remove plant and equipment or be located in within an area which is classified as *hazardous* in Section 9 of AS/NZS 3000 and is not to be deemed to be a *Confined Space* according to Confined Spaces Regulations.

Full access to cables is to be provided at all times. To achieve this, the cable riser is to be provided with full width doors that extend the full height of the riser. The height of the cable riser can be divided into multiple door panels provided the Fire Resistance Level (FRL) is not reduced where panels join, and any frames between panels do not impede access to cables. The doors are to provide a FRL of at least 180/180/180, and should be arranged to provide full access when they are fully opened. It is preferable to have 180 degrees swing on these doors.

If the width of the riser is covered by a single door it is to be provided with Lockwood 3572 series latch bolt or similar with oval cylinder operated by key from the outside. The latch shall be fitted such that there is no less than 10 mm engagement of the latch bolt into the striker plate when the door is in the closed position. The latch shall have no less than 65 mm backset.

If the width of the riser is covered by a double doors one door leaf is to be provided with Lockwood 3572 series latch bolt or similar with oval cylinder operated by key from the outside. The latch shall be fitted such that there is no less than 10 mm engagement of the latch bolt into the striker plate when the door is in the closed position. The latch shall have no less than 65 mm backset. The other door leaf can be is to be secured in position with a skeleton bolt at the top and bottom of the panel. The top bolt is to have its shoot extended such that it is capable of operation without the use of a ladder. Both bolts are to achieve a minimum of 25mm penetration into the sockets and shoots are to be machined to allow easy socket entry. Skeleton bolts are to be of heavy duty non-corroding metal.

Each door leaf is to be swung on its frame using heavy duty non-corroding metal hinges.

A hob of 150mm is to be constructed across the bottom of each door opening of a cable riser.

A clear area of at least one metre is required in front of the cable riser doors.

When the cable riser extends above a false ceiling access to this area is to be achieved by locked fire rated doors as described above. A section of the false ceiling is to be readily removable to allow access and a clear space of one metre, measured from the outside of the doors, is to be available. Building services are not to be run in this clear one metre zone.

8 VENTILATION REQUIREMENTS

8.1 General

Adequate ventilation must be provided to dissipate heat generated by the substation equipment during normal operation. All areas nominated for the purpose of ventilating the substation are to terminate on an external face, to free open air. Vents must not terminate in areas where heat or smoke dissipation will cause inconvenience or are subject to fire risk. Areas such as those under awnings, under car park ramps or adjacent to the entry to buildings, foyers, lobbies and car parks are to be avoided.

The efficiency of any louvre used must not cause a reduction in the free area by more than 35%. If this figure is exceeded the louvered panel must be increased in size to achieve the required effective free area.

Ausgrid Drawing 53680 provides a guide to various acceptable louvre opening sizes.

All louvres are to be to the details shown on Ausgrid Drawings 43140 and 48009. Louvres can be finished in colours to suit the building decor, however if they are to be left in natural aluminium they must be finished with a grade A coating of clear anodising followed by a coat of clear methacrylate lacquer or equivalent.

8.2 Surface Chamber Substations

Transformer access doors are generally to be used for ventilating surface chamber substations and as such are to be constructed as weatherproof aluminium louvres as shown on Ausgrid Drawing 43140.

If it is not possible to use the transformer access doors as ventilation louvres, louvered panels equivalent in size to the transformer access doors must be provided elsewhere in the substation. These panels must not be placed behind equipment, doors or cables. Under these circumstances the transformer access doors are to be fire rated to the equivalent of the substation chamber. Locking of these transformer access doors remains the same as their equivalent louvered doors.

Louvred door or panel type ventilation is not acceptable in situations where heavy pedestrian traffic occurs such as in shopping centres, at bus stops or in the CBD of Sydney. In these situations, ventilation of the substation chamber must be effected by ventilation ducts as detailed for Basement Chamber Substations.

Transformers must be located as close as possible to the ventilation louvres after taking into account allowance for appropriate clearances. In addition, personnel access doors can be louvered as shown on Ausgrid Drawing 43140 but personnel doors shall not be used as the sole source of ventilation.

Refer to Section 7.1.7 for the minimum size of transformer access doors.

8.3 Elevated and Upper Level Chamber Substations

Elevated and Upper Level Chamber Substations are generally located on the outside face of the building due to ease of heavy equipment access. The outside wall is to be fully louvered. However it is recognised that building constraints may mean that the chamber is not located on an outside face. If this is the case ventilation ducts generally as per a Basement Chamber Substations are to be provided.

However non-oil filled transformers as used in Elevated and Upper level Chamber Substations require larger ventilation duct sizes, details of which can be obtained from Ausgrid.

8.4 Basement Chamber Substations

Basement Chamber Substations (and Surface, Elevated and Upper Level Substations where the use of normal louvered doors or panels is not appropriate as indicated in Sections 8.1 and 8.2) require dedicated inlet and outlet ventilation ducts, each entering the substation chamber in a specified location and each terminating on the outside of the building.

8.4.1 Basement Chamber Substations - Outside Sydney CBD

For substations outside of Sydney CBD a fan is not to be used.

For transformer ratings up to 1000 kVA each duct is to have the following minimum cross sectional area:

- Single 1000 kVA transformer substation: 1 square metre
- Two 1000 kVA transformer substation: 1.4 square metres
- Three 1000 kVA transformer substation: 2 square metres

Note: Where there is any reasonable likelihood that the 1000 kVA transformer substation could require uprating to accommodate one or more 1500 kVA transformers, the cross sectional area of the ventilation ducts should be made suitable for 1500 kVA transformers in the original installation. Space should be allocated in the substation design for the protection panels, battery and other relevant ancillaries required for 1500 kVA transformers.

For transformer ratings up to 1500 kVA each duct is to have the following minimum cross sectional area:

- Single 1500 kVA transformer substation: 2 square metres
- Two 1500 kVA transformer substation: 2 square metres
- Three 1500 kVA transformer substation: 2.8 square metres

Refer to Section 8.6 regarding duct design details.

Note: The ventilation duct sizes indicated above for 1000 and 1500 kVA transformers are based on substations which are “Firm Rated”. For substations which are ‘non-firm rated’ the suitable ventilation duct sizes are to be calculated and submitted to Ausgrid for approval.

8.4.2 Basement Chamber Substations in the CBD of Sydney

For CBD located substations, a fan is to be fitted into the substation end of the outlet ventilation duct. Both the inlet and outlet ducts are to have a minimum cross sectional area of 1.3 square metres for transformers each with a rating of up to 1500 kVA. Refer to Clause 8.6.7 for fan details. Refer to Section 8.6 regarding duct design details.

8.5 Control Point Chambers and Chambers for the Control of High Voltage Customer (HVC) Connections

Even though the equipment installed in a Control Point Chamber or a Chamber for the control of HVC Connections generates minimal heat, adequate ventilation must be provided for personnel. For Surface or Elevated Chambers ventilation can be via louvered panels or doors as per a Surface or Elevated Chamber Substations (Refer to Sections 8.1 and 8.2 for further details). For Basement Chambers or where the use of normal louvered doors or panels is not appropriate (as indicated in Sections 8.1 and 8.2) a mechanically ventilated system is required with dedicated inlet and outlet ventilation ducts, each entering the chamber in a specified location and each terminating on the outside of the building (Refer to Clauses 8.6.2 and 8.6.3).

When mechanically vented, each of the dedicated ducts are required to be of 0.5 square metres cross sectional area, with openings at both the chamber and building

face ends of the ducts located in accordance with the requirements for ducts serving Basement Chamber Substations. Ventilation ducts must achieve a FRL of 180/180/180. The design of both ducts should be such that overall impedance to air flow is minimised.

The dampers and ventilation fan arrangement is to be similar to a Basement Chamber Substation, with fan control being from the lighting circuit so the fan activates when the lights are switched on. The ventilation fan shall be direct driven by a single phase, 240V AC motor, and capable of delivering 250 L/sec against a static pressure of 38 Pa.

8.6 Ventilation Duct Requirements

8.6.1 Duct Design

The aspect ratio of ventilation ducts is not to exceed 4:1. Duct lengths must not exceed 10 metres, excepting where approval for longer duct lengths has been given in writing by Ausgrid. Approval for lengths exceeding 10 metres may include conditions, such as the duct layout being predominantly vertical, with minimal changes in direction, and the cross-sectional area being increased. Duct design shall be such that the overall impedance to air flow is minimised. For substations, overall impedance to air flow must not exceed 250 Pa with a flow rate of 3.3 cubic metres per second.

The full length and area of the ventilation ducts from the substation chamber or control point chamber or chamber for the control of HVC connections to the outside of the building, including any parts of the ducts constructed outside the building, are to be included in the lease documentation for the chamber.

Where the ducts do not open directly to a public roadway or easement for access to the substation, an area of appropriate dimensions between the duct openings and a public roadway or other open area acceptable to Ausgrid, may be required to be registered as part of the easement requirements for substation access, if there is a reasonable possibility that the duct openings could be blocked or partly blocked or otherwise rendered unsuitable or ineffective by future development.

8.6.2 External Duct Inlet/Outlet Openings

Termination of the ducts shall be to the open air and preferably in different faces of the building. The distance between any part of the termination openings for inlet and outlet ducts is to be not less than 6 metres, measured in a direct line in free air or around wall faces. The level of the bottom of the outlet opening is to be at least 1.2 metres above the top of the inlet opening.

The bottom edge of any duct opening is to be no less than 3 metres above any area where pedestrian traffic can be anticipated. If this is not practicable, the height of the bottom of the opening can be reduced to 2.3 metres providing upward deflecting guide vanes are fitted to the outside of the weatherproof louvres. Ausgrid Drawing 48009 shows acceptable weatherproof louvres.

8.6.3 Internal Duct Inlet/Outlet Openings

The bottom of one of the ducts is to terminate 120mm to 190mm above finished chamber floor level. This duct is considered to be the inlet opening. The outlet duct can terminate high on a wall or in the ceiling of the chamber. The openings must not terminate behind equipment, doors or cables, or above any piece of equipment. The openings should be approximately diagonally opposite and must be positioned so that the transformers are located in cross-flow ventilation between the openings.

8.6.4 Construction

Ventilation ducts are to be constructed from reinforced concrete or equivalent strength reinforced core-filled concrete blockwork, and must achieve a FRL of 180/180/180

where the substation contains oil-filled equipment or 120/120/120 where there is no oil-filled equipment, and resist a 2 kPa blast from the remainder of the building. Under no circumstances may plasterboard be used for ventilation duct construction.

If a portion of the ventilation duct for a substation or control point is located inside that substation or control point chamber, that portion may be constructed of sheet metal, subject to the fire damper being placed against the end of the concrete / concrete block section.

Any sheet metal portion of the duct must be secured to the ceiling, but must not be located over any equipment or reduce the available headroom below the minimum levels set out in the relevant Network Standards.

Ventilation ducts located in personnel or equipment access chambers and passageways must be constructed only from reinforced concrete or equivalent strength reinforced core-filled concrete blockwork. Under no circumstances may plasterboard be used for ventilation duct construction.

Substation ventilation ducts must not contain any other services, give access to any other portions of the building or form part of the ventilation system for any other part of the building.

8.6.5 Drainage

All ventilation ducts are to be drained to a point free of surcharge, external to the substation chamber.

8.6.6 Fire Dampers

A multi-blade fire damper, as shown in Ausgrid Drawing 48849, is to be fitted to all inlet duct openings at the substation end and to the outlet duct opening in the case of suburban type substations. In the case of CBD of Sydney located substations the outlet damper is to be part of the fan unit as shown on Ausgrid Drawing 117632.

Dampers shall be positioned to provide testing, ready maintenance and inspection from within the substation chamber. Where dampers project into the substation chamber they shall be provided with guards sufficient to provide protection from personnel injury. Such guards shall not impair the operation of the damper.

Dampers shall be connected to a mechanically operated tripping system that holds them open against gravity or a spring during normal operation. The tripping mechanism shall be activated by fire in the substation chamber and be arranged so moving or discarded parts do not fall onto live equipment as shown on Ausgrid Drawings 117634 and 117635.

8.6.7 Ventilation Fan

The ventilation fan to be used in CBD of Sydney located substations (Refer to NS112 Appendix B and NS114), is to be a 760 mm diameter vane axial exhaust type capable of delivering 3280 litres per second against a static pressure of 250 Pa. It is to be direct driven at not more than 1450 rpm by a three phase 415 Volt, 50 Hz, AC motor.

Access to the motor terminals is to be by a removable cover. The fan is to be fitted with a wire guard and a bell mouth on the inlet, and with an exhaust cone on the outlet. The sound pressure level of the complete unit is not to exceed 75 dB(A) at a distance of 3 metres from the inlet. The fan unit is to be fitted with a fire damper (as shown on Ausgrid Drawing 117633).

Power for the fan is to be provided from the Substation Services Board. The fan is to be mounted in a mounting plate as shown on Ausgrid Drawing 42416 and the door of the mounting plate is to be placed in such a position as to allow easy access via a ladder. The fan must not be mounted over equipment or where a ladder must be placed over equipment to access the fan.

The outlet ventilation duct is to be designed to allow for the fitting of the fan mounting plate inside the substation chamber end of the duct. The first two metres of the duct, behind the fan mounting plate, must be straight and formed to suit the size of the mounting plate.

At the fan end of the duct, there must be sufficient clearance from the ceiling for a ceiling mounted lifting eyebolt and chain block to be used to fit the fan into the mounting plate. This arrangement must not reduce the available headroom below the minimum levels set out in the Network Standards. Refer to Ausgrid Drawing 48008 for further details of the duct, fan lifting and fan mounting plate.

The ventilation fan is to be installed in conjunction with the control system shown in Ausgrid Drawing 64599.

8.7 Separation Between Ventilation Openings

The substation ventilation openings, including substation duct openings and louvered panels, as described in this Network Standard, must be separated from building air intake and exhaust openings, natural ventilation openings and boundaries of adjacent allotments, by separation distances which meet the requirements of all relevant authorities, building regulations, BCA and Australian Standards including AS 1668.2.

In addition to above, Ausgrid requires the substation ventilation openings, including duct openings and louvered panels, as described in this Network Standard, to be separated from building ventilation system air intake and exhaust openings, including those on buildings on adjacent allotments, by not less than 6 metres.

Note: 6 metres is measured by the shortest string line between substation ventilation openings and building ventilation system air intake and exhaust openings. This separation requirement by Ausgrid applies irrespective of whether the building or substation ventilation is mechanical or natural and irrespective of whether or not dampers are installed in the building and/or substation ventilation systems.

Where the dimensions of the allotment make the 6 metre separation from ventilation system openings on an adjacent allotment impossible to achieve, the proposal must be submitted to the Manager - Distribution Services and approval must be obtained before design proceeds.

Note: For the purposes of this Section, Ausgrid does not regard openable windows, that provide natural ventilation to one building compartment only, as a building ventilation system opening.

Refer to Section 13 for the fire rating of buildings near substation ventilation openings.

Upper Level Chamber Substations, substation chamber openings and building ventilation openings in the vicinity of substation openings must comply with BCA fire resistant construction requirements and fire segregation requirements.

9 EARTHING

9.1 General

9.1.1 Installation Requirements

Refer to NS116 *Design Standards for Chamber Earthing* for installation requirements of earth electrodes and connections between earth electrodes.

9.1.2 Footprint

An electrode type earthing system must be installed directly under the footprint of each Chamber Substation (this includes any Control Point Chamber), unless the following exceptions apply:

- If a Control Point Chamber is associated with an Upper Level Chamber Substation, the electrode earthing system for both is to be combined and is laid under the footprint of the Control Point Chamber.
- If a Chamber Substation is located near its Control Point Chamber, the electrode earthing system for both the control point and the substation should be installed under the footprint of the Chamber Substation.
- Where the Control Point Chamber is at a lower level than the Chamber Substation the earthing system for both is to be combined and is laid under the footprint of the Control Point Chamber.
- If there are exceptional site conditions, Ausgrid may permit, or may require, alternative locations for the electrodes.

Refer to NS114 for connection requirements for cables from earth electrode groups, and for installation and connection requirements for interconnecting chamber earth cables.

9.1.3 Special arrangements

Special earth cable connection arrangements may be required for the Chamber substations supplying electric traction installations, or in the vicinity of electric traction installations.

Note: Any special arrangements must be agreed on a case by case basis with Ausgrid.

9.1.4 Easement and Lease

The easement or areas required for earth cables from the earthing electrode installation to the Chamber Substation and the earthing electrode installation area, are to be included in the lease and easement documentation for the Chamber Substation.

9.2 Earthing Electrode System

The Chamber Substation (including any Control Point Chamber), must be located in an area which is free of other building services except those directly related to the Chamber Substation. (Refer to Section 6 for site selection details).

The selected site is required to be stable and clear of any obstructions that could interfere with the installation of any part of the earthing system including the electrodes.

Earthing system electrodes may extend 10 metres or more into the ground below the substation or control point chamber.

If the Chamber Substation chamber or control point chamber is located on natural ground, the earthing system is to be installed directly under the chamber floor slab.

If the Chamber Substation or control point chamber is constructed on a suspended floor slab, the earthing system is to be installed at the lowest level of building excavation directly below the chamber footprint. In this case, the two cables from the A group and B group earth grid electrodes are to be brought up through the building structure to the position of the earth bar in the chamber, in the manner specified in Clause 9.3.2.

The earthing electrode system and cables connecting the electrodes are to be installed before any waterproof membranes are laid and before the covering floor slab is constructed.

Earthing electrodes shall be installed and connected in accordance with Ausgrid Drawing 25121, which also shows how penetrations through any waterproof membrane are to be sealed.

Earth electrodes are to be installed at no less than 3 metres apart and they shall be connected into A group and B group using a cable type earth grid. The earthing system must be protected from damage during construction. Failure to do so will require damage to be repaired to the satisfaction of Ausgrid.

The earthing electrode system:

- must be a stand-alone type not connected to building reinforcement bars or grading rings,
- must be well clear of building lightning protection systems, and
- should not be connected to the earth bar of any switchboard other than the earth bar inside the Chamber Substation as specified in NS114.

9.3 Earthing Cables and Conduits

Conduits must be installed within floor slab of Chamber Substation (including any Control Point Chamber) for the earth cables from substation and control point equipment to the earth bars, as specified in NS114. The minimum diameter for these conduits is 50mm, and the conduits must comply with Clause 10.8. Any bends used must be sweep bends. Elbows are not permitted.

Refer to Appendix A - Schedule of Conduits.

9.3.1 Earthing Cables Between Chambers

The earth cables between an Upper Level Substation and its control point are to be run via the cable riser which links the two chambers.

In other cases where earth cables are required to be installed between chambers, in accordance with NS114, suitable provision must be made. Provision must include conduits within the chambers as indicated in Clause 10.8, and cable risers and / or conduits between chambers.

9.3.2 Installation of Earthing Cables Between Electrode Groups and Chambers

If the Chamber Substation is located on natural ground, the arrangement for the two cables to enter from the A group and the B group electrodes is shown in Ausgrid Drawing 25121.

If the chamber is constructed on a suspended floor slab, the two cables from the A group and B group earth electrodes are to be brought up through the building structure to the position of the earth bar in the chamber, using one of the following methods:

Method (a) (Preferred method)

Installation of earthing cables is through two 38mm galvanised pipes. These pipes must start 300mm above the floor slab under which the earthing system is installed and must terminate 100mm above the finished level of the chamber floor slab. Draw wires are to be installed in both conduits.

The pipes must be surface run for their entire length and can change direction provided a suitable galvanised draw-in box is installed at each change of direction.

Any draw-in box is to be installed in a position which is readily accessible at all times. Both pipes are to be installed with draw wires.

After installation of earthing cables, the initial 300mm of the run is to be suitably covered. This cover is to be readily accessible at all times. Ausgrid Drawing 25121 indicates the required arrangement for the cover.

A suitable cover is described in Method (c). Each cover is to be suitably capped to prevent the entry of foreign material.

Method (b)

Installation of earthing cables is through two 50mm PVC conduits encased within a structural column.

Note: This method is not permissible where the maximum run length for a conduit encased within a structural column would exceed 10 metres.

At the lower end, the conduits are to emerge from the column 300mm above the floor slab under which the earthing system is installed. At the upper end, the conduits are to emerge from the column 100mm above the finished level of the chamber floor slab. The conduits must be straight, except for each end where bends are to be installed for the sections emerging from the columns. The radius of the bends is to be 300mm.

Draw wires are to be installed in both conduits. All conduits and fittings must be joined with solvent cement in accordance with manufacturer's instructions.

Conduits and bends must be adequately tied to reinforcing steel in the columns to prevent separation of the joints during pouring of concrete. After installation of earthing cables in the conduits and connection to the earthing cables from under the lowest floor slab, the section of exposed earthing cables is to be fitted with a cover not less than 300mm long. This cover is to be readily accessible at all times. Ausgrid Drawing 25121 indicates the required arrangement. A suitable cover is described under Method (c). Each cover is to be suitably capped to prevent the entry of foreign material.

Note: Method (a) or Method (c) will have to be used instead of Method (b) if for any reason the earthing cables cannot be installed in the conduits encased in a structural column.

Method (c)

Earthing cables are attached to a column and covered with removable covers.

Note: This method is not permissible where Ausgrid considers the covers would be liable to mechanical damage. This may include plant rooms, areas used for car parking, equipment and material handling and storage areas, etc.)

Earthing cables may be attached to a column with suitable commercial saddles and fully enclosed under removable covers meeting the following design requirements:

- Covers are to be formed from minimum 3mm thick galvanised steel sheet metal.
- The section of cover approximately 300mm long which covers the cable joints immediately above the lowest floor slab, is to be separately removable. Refer to Ausgrid Drawing 25121.
- Builders must provide holes not less than 38mm diameter through intermediate floors to allow for the cables to pass through.

- The installation of cables and covers on each floor must be vertical.
- Cables must be totally enclosed under the cable covers without jamming or pinching of the cable insulation.
- The cross sectional dimensions and fixing arrangements for the cover(s) are to be subject to approval in writing from Ausgrid.

10 CONSTRUCTION

10.1 General

NS114 details the electrical design and construction standards for Chamber Substations.

In general the construction of Chamber Substations (including access chambers, Control Point Chambers and chambers for the control of HVC connections) shall provide a chamber which is dry and completely isolated from the remainder of the building with walls, floor, ceiling and doors providing a minimum FRL of 180/180/180 where the substation contains oil-filled equipment, or 120/120/120 where there is no oil-filled equipment.

Before acceptance for equipping the Chamber Substation and any associated chambers shall be:

- Vermin and bird proof.
- Watertight.
- Secure from all persons other than Ausgrid authorised personnel.

Walls, floor and ceiling of chambers shall be designed to adequately support any loads likely to be superimposed on the area or member.

In all cases the concrete cover to the reinforcing of the walls, ceilings and floor sections must not be less than 60 mm.

Services for the building such as drains, sewers, water services, electrical and communications cables etc, must not pass through the substation chamber or its associated access passageways and ventilation ducts.

Attention is to be given to the encroachment of any column, beam or ventilation duct into the substation chamber or its associated access passageways. Such encroachment may affect clearances outlined in this document and NS114. These clearances are not to be reduced.

Attention should also be given to the encroachment of any column, beam or ventilation duct in the area under the floor which may conflict with the location of substation conduits. Because large bending radii are required in most conduits to suit cable characteristics, the conduits may have to penetrate through encroachments.

Control Point Chambers, Chambers for the Control of HVC Connections and Cable Risers are to be constructed to the same requirements as Surface, Elevated or Basement Chamber Substations as appropriate.

10.2 Waterproofing

The effectiveness of the waterproofing and fire rating of the chambers shall not be impaired by drilling holes for the fixing of expansion bolts.

Walls, ceiling and floors which depend on their thickness and/or the incorporation of an admixture for waterproofing are not acceptable.

To effect waterproofing to an acceptable standard, walls must be provided with a drained cavity of at least 50 mm.

If the ceiling slab is exposed to the weather a water proofing membranes is to be applied to the outside of the ceiling slab. Water proofing membranes will also be needed if the ceiling slab is in a location which forms part of the building which may be subject to the occasional passage of water.

Floors and ceilings must have an appropriate membrane applied to effect waterproofing to a standard acceptable to Ausgrid.

10.3 Building Below Potential Water Table

In situations where the Chamber Substation or any associated chamber, pit or conduit are below the level to which the surrounding water table may rise under any condition, the wall cavity and the under floor area of the substation and any associated chamber must be gravity drained to a suitable discharge point or to a collection well.

An appropriately designed system certified by a practising Civil or Hydraulic Engineer may be considered by Ausgrid to satisfy this requirement.

All drainage must be external to the substation and associated chamber and have a reliable automatic discharge pumping system. The pumping system must be installed to the appropriate Australian Standard and the wiring and control system is to be independent of the substation.

To comply with this section, two pumps must be provided to ensure back up in the event of failure of the first pump. An appropriate label is to be fixed to a substation wall indicating the presence of the pumping system and the source of the power to the pumps.

The substation floor must be designed to withstand any hydrostatic pressure to which it may be subject if the pumping system may fail. Particular attention must be paid to the incorporation of waterproofing membranes.

If at any stage in the life of the Chamber Substation it is found that flooding is occurring, the building owner will have to supply and fit, at the building owner's cost, a pump system comprising 2 pumps and any other water stopping features deemed necessary by Ausgrid.

10.4 Walls

10.4.1 Material

The walls of the substation and associated chambers shall be constructed of either:

- Class 2 finish, reinforced cast in-situ concrete with the reinforcing structurally tied-to the reinforcing in the floor, ceiling, and adjoining walls, or
- core filled reinforced concrete blockwork with the reinforcing structurally tied into the floor, ceiling and adjoining walls.

Note: Walls must be core filled or solid to allow for drilling holes for the fixing of expansion bolts.

Walls for cable Risers are to be constructed to the same standard as a Substation Chamber.

10.4.2 Construction

The following must be taken into consideration when constructing the walls of the substation and associated chambers:

- In all cases the concrete cover to the reinforcing of the wall sections must not be less than 60 mm.
- All wall structures must be certified by a practicing structural engineer for FRL of 180/180/180 where the substation contains oil-filled equipment, or 120/120/120 where there is no oil-filled equipment, and structural integrity to support expected loads.
- All walls must be designed to withstand a live loading from the substation side of not less than 2kPa uniformly distributed.
- Where the walls of the substation and associated chambers form the external wall of a building or where these walls are exposed to the elements, the substation walls are to be separated from an outer wall by a drained cavity of not less than 50 mm.

- All substation walls below ground level built against natural excavation or where a retaining wall is used to retain natural excavation, a drained cavity of not less than 50 mm is to be formed on the outside of the substation wall.
- An alternative membrane or drainage system which has been designed and certified by a Civil or Hydraulic Engineer and approved by Ausgrid may be accepted in lieu of a drained cavity.
- Any cavity constructed in conjunction with a substation or associated chamber is to extend below the level of the lowest pit in the substation chamber and be drained to a point free of surcharge.
- Walls are to be so designed that they withstand any loads imposed on them by the substation and/or the building structure.
- Any penetration in the walls is to be sealed to prevent the ingress of water and to maintain FRL of 180/180/180 where the substation contains oil-filled equipment, or 120/120/120 where there is no oil-filled equipment.
- Reinforced concrete columns are permitted in the substation chamber, however any column incorporated into the walls is to be positioned such that it is flush with the interior of the substation wall, and finished to the same standard as the walls.
- The joints where walls abut a column are to be of the same structural strength, fire rating and waterproofing as the wall structure.
- The area surrounding any pulling rings which may be attached to a substation or pit wall is to be suitably reinforced to ensure the use of the pulling ring does not cause damage to the wall. Such rings are to be structurally certified to Ausgrid requirements. Pulling rings used for pulling cables can be subjected to a working load of 50kN whilst the working load of 5kN can be exerted on pulling rings used for transformer manoeuvring.
- Where expansion or control joints are incorporated in any substation wall, these features must have a fire rating and waterproofing equivalent to the substation chamber.

10.5 Floor

The floor of the Chamber Substation and any associated chamber is to be:

- Designed and certified by a practising structural engineer.
- Capable of carry the loads of substation equipment.
- Capable of supporting loads imposed by the building, plus a superimposed live loading of not less than 2kPa uniformly distributed.

The floor is to have a Class 2 steel trowel finish.

In all cases the concrete cover to the reinforcing of the floor sections must not be less than 60 mm.

If the substation floor is laid on natural or filled ground an appropriate waterproofing membrane is to be placed between the underside of the substation floor and the ground.

Differences in floor levels between the substation chamber, associated chambers and the outside access areas shall be as outlined in Sections 7 and 11.

All ramps at access doors are to be poured integrally with the floor slab. Ramp edges are to be rounded to prevent trip hazards. Refer to Section 7 for all access requirements and Section 11.1 for oil containment ramps.

Provision is to be incorporated in the floor slab for any pulling rings or pulling ring recesses.

Floor slab construction must take into account the depths of pits and floor chases to ensure the headroom of the substation chamber is not decreased below 3.2 metres.

The construction method for the floor slab must provide for a minimum concrete encasement of 150 mm for any conduit which is located in any void between the finished substation floor slab and structural slab or, in the case of a suspended floor slab, is located under the substation floor slab and is therefore within the building.

The cables indicated in Appendix A should generally be installed in conduits, however where the design of the particular substation makes the use of conduits impracticable the cables may be installed in floor chases. All other cables should be installed in pits & floor chases; these cables include the LV transformer tails.

10.5.1 Pits and Floor Chases

Pits and floor chases may be constructed in a continuous structural floor slab, formed in a topping slab over the structural floor slab or may be constructed with core filled or solid concrete block walls over the structural slab. Walls of pit and floor chases must be core filled or solid to allow for drilling holes for the fixing of expansion bolts.

Pits and floor chases can be at various depths providing sufficient depth has been allowed for the bending radius of any cable. However the depth of pits should be minimised as much as practicable since ladders may need to be provided to access pits of depth greater than 0.45m. For pits of depth equal to, or greater than, 1.0m these ladders will need to be permanent and compliant with AS 1657. Permanent ladders shall be fitted with extendable or removable handrails to ensure safe access to, and egress from, the top of the ladder.

If pits or floor chases of various depths are linked, the floor or base structure must allow smooth transition of cabling by providing ramps in the floor of the pit or chase.

The inside surfaces of all pits and floor chases are to be smooth and free of protrusions. All corners or angles shall be well rounded and smooth.

Pits and floor chases are to be provided with cover plates which do not protrude above the floor and become a trip hazard. The cover plates shall be supported in accordance with the requirements of drawings no.s 48008 for floor chases, 178229 for LV switchboard pits, or 191085 for HV pits as appropriate.

The cables indicated in Appendix A shall be installed in the conduits as shown, however where the design of the particular substation locates the Substation Earth Bar, Service Board, Protection Panels and Protection Battery on a common wall it is permissible to install the cables in a common 300mm wide floor chase. The LV and HV Pits can be connected to the common floor chase by extending the floor chase or by a number of 100mm conduits. At least one conduit is required for each cable group function, eg Protection, LV Board earthing, Service Board power and earthing.

10.5.2 Pit and Floor Chase Cover Plates

Any pit inside the substation or associated chambers is to be covered in patterned steel floor plate, except under switchgear or the switchboard.

Floor plate covers are to be a minimum 6 mm thick but must be increased to 10 mm thickness if there is any possibility of equipment, such as transformers being transported over such plates.

All floor plate covers shall be set so that they do not protrude above the floor and become a trip hazard. They shall be divided into sections, each weighing not more than 20 kg, or exceeding 1000 mm in length. Each section must contain a lifting eye at each end. For more detail refer to drawings no. 48008 for floor chases, 178229 for LV switchboard pits, or 191085 for HV pits as appropriate.

All floor plate covers are to be free of burrs and sharp edges. The surface of all covers is to be a non-slip finish. Covers can be either finished with inorganic zinc paint or an approved epoxy two coat and metal primer finish. To prevent warping, floor plates should not be galvanised.

Floor plate covers with cut-outs or dividers, placed around single core low voltage cables, must not form closed paths, either individually or with supporting steelwork. Such configurations which may enable eddy currents to occur must utilise insulated pads or other approved arrangements to remove possible eddy current paths.

10.5.3 Earthing

Refer to Section 9 in regard to floor slabs since a buried electrode system is required to be installed in the ground directly under the substation floor; or in the case of suspended floor slab, at the lowest level of excavation directly below the footprint of the substation.

10.6 Ceiling

Ceilings shall have a FRL of not less than 180/180/180 where the substation contains oil-filled equipment, or 120/120/120 where there is no oil-filled equipment, and shall incorporate any required waterproofing membrane. The use of plasterboard or fibreboard to achieve fire rating is not permitted.

Ceilings shall have a FRL of not less than 180/180/180 where the substation contains oil-filled equipment, or 120/120/120 where there is no oil-filled equipment, and shall incorporate any required waterproofing membrane. The use of plasterboard or fibreboard to achieve fire rating is not permitted.

In all cases the concrete cover to the reinforcing of the ceiling sections must not be less than 60 mm.

The concrete formwork finish shall be Class 2 or better.

If the ceiling is supported or formed by permanent ribbed steel formwork or exposed steel beams, the exposed steelwork must be coated or enclosed to achieve a FRL of 180/180/180 where the substation contains oil-filled equipment, or 120/120/120 where there is no oil-filled equipment.

When the slab forming the ceiling is of pre-stressed or post-tensioned construction, then the wire strands forming the tensioning and any anchor mechanism must be fully encased to achieve a minimum FRL of 180/180/180 where the substation contains oil-filled equipment or 120/120/120 where there is no oil-filled equipment.

In the substation chamber, the ceiling slab must be positioned to provide headroom of not less than 3.2 metres. The position of any beams in the ceiling should ensure the 3.2 metre headroom is maintained.

Control point chambers which meet all other requirements of this Network Standard, but cannot reasonably achieve a ceiling height of 3.2 metres, may have the ceiling height reduced to not less than 2.8 metres, provided the clearance over the top of high voltage switchgear is not less than 600 mm.

The relative levels of the personnel access chamber floors and ceilings shall provide clear headroom of 2.5 metres. Clear head room dimensions are to be measured under the lowest point of any ceiling beams or ceiling structure.

10.7 Doors

Door construction requirements are detailed in Clause 7.1.6 and 7.1.7.

10.8 Conduits

Any conduit used in conjunction with the Chamber Substation, whether for mains entry into the substation chamber or cable reticulation within the chamber, is to be of a suitable diameter and is to conform to AS/NZS 2053.2 (colour Orange, minimum conduit classification “LD”). Conduit joints shall be socketed and solvent welded.

All conduit installations must conform to NS130 *Specification for UG Cable Laying* regarding the installation of Underground Cables up to 22kV.

Note: Smooth bore profiled wall (‘Corflo’) type conduits or equivalents, including ‘sandwich construction’ conduits, are not to be used in substation chambers or for mains entry to substation chambers.

Where conduits change direction, bends complying with NS130 Appendix E must be used.

Elbows must not be used and under no circumstances are conduits to be bent to achieve the bending radius.

Conduits entering pits or the substation chamber shall have their edges pencil rounded to minimise damage to the cables.

Conduits for mains entry and exit to the substation shall project 150 mm past the boundary line of the building and are to be socket ended. These conduits are to terminate at a depth set by Ausgrid.

All conduits associated with the substation, which pass through a building or structure, are to be encased in a minimum of 150 mm of concrete.

Where conduits are laid in any void under the substation floor, whether the void is inside or outside the substation chamber, the conduits must be encased in a minimum of 150 mm of reinforced concrete for the entire length.

All conduits for high voltage or low voltage network cables installed in any void within the boundaries of a building must be encased in a minimum of 150 mm of reinforced concrete for the entire length. This includes conduits to the substation chamber, and conduits to any control point, cable riser or cable joining or turning area.

Refer to Appendix A for details of typical conduit allocations and sizes.

10.9 Water Service

In all Basement Chamber Substations a water service is to be installed on a wall in a position away from switchgear and the switchboard. The water service is to consist of a 20mm OD copper pipe, with wall thickness of 1.4mm, using brazed fittings. An accessible control valve must be installed in the substation chamber and only a short length of pipe is to be exposed in the substation chamber. The water service is to be installed in accordance with Ausgrid Drawing 48008 and the appropriate Australian Standards.

In Surface and Upper Level Substations a water service is to be installed in a similar manner to Basement Substations. However if a water service is adjacent to a Surface or Upper Level Substation chamber it may be acceptable to use this water service and eliminate that of the substation chamber. Ausgrid's liaison officer will examine the water service position for acceptability.

10.10 Painting

All ceilings and walls of the Chamber Substation and associated chambers are to be painted. The first coat shall comprise an acrylic based filler/sealer followed by two full surface coats of white low sheen wash and wear acrylic based paint.

All exposed ungalvanised metal shall be primed with an appropriate etch primer and finished with two full surface coats of grey paint, either enamel of acrylic based.

External doors may be finished in colours to suit the building decor, while all internal doors are to be undercoated and finished in two coats of grey paint, either enamel of acrylic based.

Louvres may be finished in colours to suit the building decor, however if they are to be left in natural aluminium they must be finished with a Grade A coating of clear anodising followed by a coat of clear methacrylate lacquer or equivalent. Refer to Ausgrid Drawings 43140 and 48009 for further details.

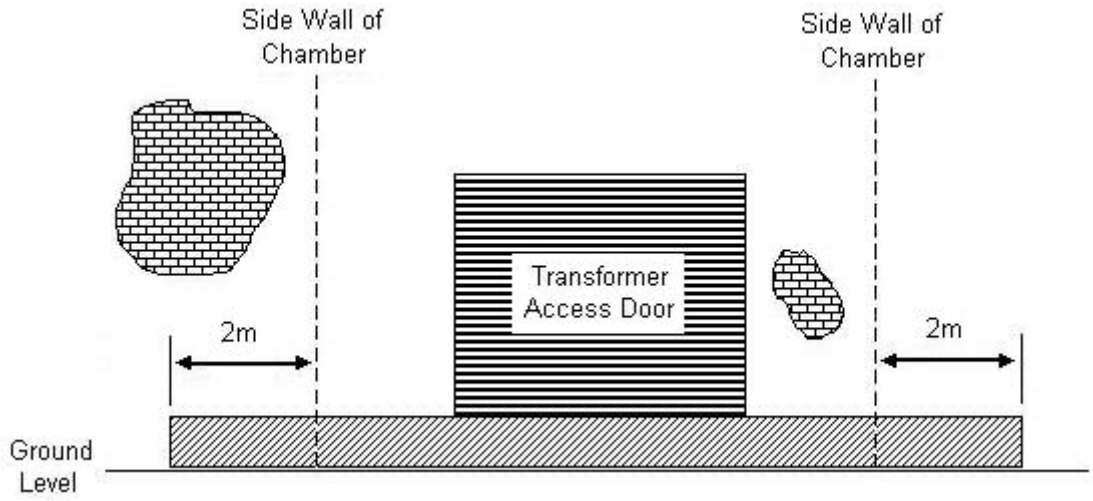
11 OIL FILLED EQUIPMENT REQUIREMENTS

11.1 Surface Chamber Substations

Where a Surface Chamber Substation, Surface Control Point or Surface Chamber for Control of HVC Connection with equipment containing oil is located within a building the following requirements apply in addition to the BCA and other requirements within this Network Standard.

The section of the external face of the substation wall, from ground level up to the base of any transformer access doors, and extending horizontally to 2m beyond the side walls of the chamber (the hatched area as shown in the diagram below):

- must be of solid brickwork, reinforced concrete blockwork or cast in-situ concrete, with a FRL of not less than 180/180/180, and
- must have no openings, windows, fixed glass, glass bricks or similar.



Refer to Section 8.1 regarding ventilation requirements for Surface Chamber Substations and Section 8.7 requirements for separation of substation ventilation openings from building ventilation openings.

Refer also to Section 13.1 regarding fire rating of buildings near substation ventilation openings.

The inside or substation chamber side of each of these doors is to have facilities to contain any oil spill. This should take the form of a ramp down to the finished substation floor level. The top of the ramp is to be preceded by a flat area of at least 300 mm and the ramp length is to extend 1000 mm from this flat area. The top of the ramp is to be between 70 mm and 80 mm above the finished substation floor level. In situations where personnel doors are adjacent to an equipment door, a single ramp can be used.

11.2 Elevated and Upper Level Chamber Substations

Elevated and Upper Level Chamber Substations (including elevated control points and elevated chambers for control of HVC connections) must not have equipment containing oil.

Refer also to Section 13.1 regarding fire rating of buildings near substation ventilation openings.

12 ENVIRONMENT

12.1 Asbestos

All materials and equipment used in the construction of Ausgrid's assets are to be free from Asbestos and or Asbestos related products.

Suppliers are expected to comply with the Occupational Health and Safety Act 2000 (NSW) and Occupational Health and Safety Regulation 2001 (NSW) and confirm in writing all products supplied to Ausgrid contain no Asbestos related materials.

12.2 Oil Containment

It is not permissible to run drainage lines from Chamber Substations Control Points or Chambers for Control of HVC Connection.

Drainage is allowed as specified in Clause 8.6.5 where drainage is provided for safety reasons within personnel hatchway/ladder access chambers only.

Section 10.3 provides drainage information for buildings below the water table.

All external conduits terminating in substations or chambers are to be sealed, after cable installation, against the ingress and subsequent spread of oil. Refer to Section 13.5 regarding fire barrier sealing and fire stopping requirements.

Refer to NS114 for further information.

12.3 Electric and Magnetic Fields (EMF) and Electromagnetic Interference (EMI)

Ausgrid exercises "Prudent Avoidance" when locating electrical substations, refer NUS174 Environmental Procedures.

Substations shall be located, constructed and equipment layout optimised so as to minimise magnetic fields within and external to the substation chamber consistent with prudent avoidance.

The selection of the site for a Chamber Substation should take into account the possible effects of Electric and Magnetic Fields (EMF) and Electromagnetic Interference (EMI) on adjacent sensitive receptors such as residential or childcare areas or sensitive medical equipment.

Areas of particular relevance include hospitals, particularly operating theatres (Refer to AS/NZS 3003), computer rooms, laboratories, general offices and apartments.

The adjacent, current and expected building and land uses and locations of duct lines and cables leading to and from the substation should be evaluated in the design.

An EMF report may be appropriate where adjacent sensitive receptors have been identified.

Refer to NS114 for additional requirements and guidance.

Note: Installation of EMI screening is not permitted inside any Chamber Substation, at any HVC connection, or associated chambers and cable risers. The addition of EMI screening must not interfere with access to, maintenance of, air circulation or the efficient operation of the substation equipment or cables.

12.4 Noise

As transformers emit a constant low-pitched hum, special precautions must be made when selecting a Chamber Substation site. The requirements of local councils and all other relevant authority must be taken into account.

The addition of noise attenuating devices is acceptable providing such devices do not interfere with access to, maintenance of, air circulation or the efficient operation of the substation equipment or cables.

12.5 Pools and Liquid Storages

Substations must not be located below or near swimming pools, water features or storage facilities or similar locations; where possible leakage, seepage or splashing of liquid could result in wet areas on, at or inside the substation.

Substations in the vicinity of swimming pools require special earthing designs. Refer to NS116.

Venting of Liquid Storage areas must be kept away from substation ventilation openings as indicated in Section 8.7.

13 FIRE PROTECTION

13.1 Fire Rating of Buildings Near Substation Ventilation Openings

In addition to the requirements of Sections 11.1 and 11.2, exterior parts of buildings within 3 metres in any direction from substation ventilation openings, including duct openings and louvered panels, must have a FRL of not less than 180/180/180 where the substation contains oil-filled equipment or 120/120/120 where there is no oil-filled equipment.

13.2 Fire Dampers

For substations and chambers with ventilation ducts (eg. basement substations) a fire damper is required to be fitted to the opening of each ventilation duct at the substation or chamber end, as shown in Ausgrid Drawing 48849. Fire dampers shall be of the multi-blade type and be positioned to provide testing, ready maintenance and inspection from within the Chamber Substation.

Fire damper trip wires are to be installed 50mm above the level of the CO_2 delivery pipe (see below), and kept clear of transformer hatch openings. Fusible links shall yield at 70^{o}C and shall be located over, or in close proximity to, transformers and HV switchgear. An example of a trip wire installation is shown on Ausgrid Drawing 184970.

Refer to Clauses 8.6.6 and 8.6.7 for further details.

13.3 Basement Chamber Substation CO_2 System

Substations and chambers with ventilation ducts (e.g. basement substations & surface chambers in the Sydney CBD) require the injection of carbon dioxide (CO_2) by the fire brigade. To facilitate this, a connection box as shown on Ausgrid Drawing 56197 is to be installed on an outside face of an outside wall of the building, where it is visible and directly accessible from the street and both of the substation entrances. The bottom of the box is to be 1000 mm above the surrounding footpath surface finishes.

The connection box must not be placed:

- on the non-street side of columns or behind vegetation,
- beside any door, where opening of the door would restrict access to the box, or
- where persons accessing the box would have to stand in an accessway, including an accessway to the substation, or an accessway to a fire door or fire stairs.

For CO_2 delivery, a DN25 mm heavy duty galvanised pipe in accordance with AS 1074 is to be run from the connection box into the Basement Chamber Substation. It is to terminate 300 mm below the substation ceiling and project 300 mm into the chamber. This pipe is to be surface run for its entire length at a height above the substation floor of 2700mm minimum, 2900mm maximum. The pipe shall be mechanically protected if there is a danger of it being damaged. If the pipe needs to change direction bends are to be fitted, elbows must not be used. Any bend is to be pressure tested to 7 MPa.

The pipe between the connection box and the substation should not pass through other tenancies within the building, however if this is not practicable the pipe must be mechanically protected e.g. bricked-in and must be covered by a suitable lease/easement for it's entire length between connection box and substation.

The CO_2 gas is distributed around the Basement Chamber Substation by a ringed pipe and nozzle system. Reference should be made to Ausgrid Drawings 184970 and 117634 which show a typical CO_2 system and associated components.

For effective use of the Fire Brigade's CO_2 Tender, the empty volume of the Basement Chamber Substation should not normally exceed 336 cubic metres. If the chamber exceeds this figure, appropriate localised reductions should be made. Reductions should not reduce clearances or create hazardous locations within the Basement Chamber Substation. The CO_2 nozzles should be arranged to concentrate the amount of CO_2 delivered to critical areas (eg. around oil-filled transformers).

13.4 Control Points and Chambers for the Control of HVC Connections

Fire protection for Control Point Chambers and Chambers for the Control of HVC Connections is to be as per Basement Chamber Substations described above.

13.5 Firestopping

All cable and busbar penetration openings into the substation chamber are to be sealed after installation of the conductors so the completed installation has a fire rating equivalent to the substation walls (FRL 180/180/180 where the substation contains oil-filled equipment or 120/120/120 where there is no oil-filled equipment).

If cable penetrations or provision for cable penetrations or spare conduits, are less than 100 mm above floor level (e.g. in a pit), the sealant must also prevent the spread of any oil spillage.

The sealant used must be suitable for this application, including oil resistance and fire rating. The sealant and its installation must comply with NS171 *Fire Stopping in Substations*.

13.6 Cable Risers

Cable risers must provide 180/180/180 fire rating to the cables.

Following the installation of cables in cable risers, the Building Owner or Customer is to fit fire barrier sealing, rated to match the construction of the cable riser. The fire barriers must be installed and approved by Ausgrid prior to supply being made available.

An Engineering Certification must accompany all applications for service supply involving cable risers.

The fire barrier sealing is to be installed:

- at a maximum of every fifth floor through which the cable riser passes.
- at the floor and ceiling levels of floors through which the cable riser passes, where those floors house strategic installations, such as substations, switch rooms, machinery rooms, lift rooms and computer rooms.
- at additional floor levels where required by the building owner or developer for increased fire protection or to comply with the BCA.

The fire barriers are to be readily removable and any supporting framework should not interfere with cables or decrease floor-opening sizes.

13.7 Non-ignitable and Blast Resisting Barriers

Any portion of an area which may be utilised for storage of combustible materials which is within 3 metres of any ventilation opening from a Chamber Substation must be sheltered by a non-ignitable blast resisting barrier.

Any meter, regulator or exposed pipe work associated with the reticulation of gas, which is within 3 metres in any direction from any ventilation opening from a Chamber

Substation and which does not have a Fire Resistance Level of 120/120/120, must be sheltered by a non-ignitable blast-resisting barrier

Non-ignitable and blast resisting barriers constructed of openable or fixed windows or glass blockwork or similar, irrespective of fire rating, do not comply with this requirement unless such items are sheltered by an approved non-ignitable and blast resisting barrier.

Non-ignitable and blast resisting barriers must comply with the following:

- The barriers and associated footings must be external to the substation operational building and site area.
- Is not to interfere with or impede cable, personnel or equipment access to the substation.
- Shall be constructed of non-perishable material such as concrete or masonry.
- Provide access for concrete encasement to conduits into or out of the substation.
- Not interfere with the substation ventilation or release of heat from the substation.
- Be constructed to comply with Local Council and Building Code of Australia
- Be certified by an independent Structural Engineer.
- Prior to construction an Engineer's Certificate must be provided to Ausgrid certifying the design of the works complies with Ausgrid, all Authority and BCA requirements.
- All foundations are to be approved in writing by a certified practicing Structural Engineer.
- The barriers must have a minimum fire resistance level of 120/120/120 and be designed to withstand a live loading from the substation side of not less than 2 kPa uniformly distributed.

The location and construction of all blast resisting barriers must be approved by Ausgrid's as part of the Design certification prior to approval for construction from Ausgrid.

Ongoing maintenance of the blast resisting barrier is the responsibility of the building owner/occupant.

Appendix A – Schedule of Conduits

TYPICAL CONDUIT ALLOCATION PER SUBSTATION

Note: Additional and/or larger size conduits may be required in some substation designs.

FUNCTION	ORIGIN	DESTINATION	SIZE	NUMBER OFF
HV Feeders	Street	HV Switchgear Pit/s	125 mm	4 Suburban (a) / 8 City CBD.
HV Transformer Tails	HV Switchgear Pit/s	Transformer (HV side)	100 mm	1 per Transformer.
LV Network Cables	LV Board Pit	Street	125 mm	1 per 400 amps. Minimum 6 conduits (b).
Customer Supply / Supplies	LV Board Pit	Customer's Switchboard		To suit customer's requirements.
SCADA Signals (c)	HV Switchgear Pit/s	SCADA Signals Marshalling Box (l)	100 mm	1 per HV Switchgear Pit.
SCADA Signals (c) (k)	Transformer/s	SCADA Signals Marshalling Box (l)	100 mm	1 per Transformer.
SCADA Signals (c)	SCADA Pit (m)	SCADA Signals Marshalling Box (l)	100 mm	1
Protection (d)	HV Switchgear Pit/s	Protection Panels	100 mm	1 per HV Switchgear Pit.
Protection (d)	Transformer/s	Protection Panels	100 mm	1 per Transformer.
Protection	LV Board Pit	Protection Panels	100 mm	1
Protection	HV Switchgear Pit/s	LV Board Pit	100 mm	1 per HV Switchgear Pit.
Substation Light & Power	LV Board Pit	Service Panel	100 mm	1
Protection Battery AC Power	Service Panel	Protection Battery	50 mm	1
Protection DC Supply (e)	Protection Battery	Protection Panel	50 mm	1
Fan Control	Substation Service Panel	Substation Ventilation Fan	50 mm	1 where Fan is present.
Fan Signals	Signal Marshalling Box	Substation Ventilation Fan	50 mm	1 where Fan is present.
Transformer Tank Earth	Transformer Tank	Substation Earth Bar	100 mm	1 per Transformer (h).
HV Switchgear Earth	HV Switchgear Pit/s	Substation Earth Bar	50 mm	1 per HV Switchgear Pit (i).
Earth Rod Connections (f) (g)	Earth Rod Location	Substation Earth Bar	38 mm GI	2 where suspended floor slab.
Electrolysis Bond (j)	Bond Connection	Substation Earth Bar	50 mm	1
LV Switchgear Earth (o)	LV switchgear Pit	Substation Earth Bar	100 mm	1
Service Board earth (o)	Service Board	Substation Earth Bar	50 mm	1
Protection panel earths (o	Protection Panels	Substation Earth Bar	50 mm	1 per group of panels
Alternative/additional requirements for Upper Level Substations where cable riser does not directly enter substation and/or control point				
HV Transformer Tails	HV Switchgear Pit/s	Cable Riser - lower end	125 mm	1 per Transformer.
HV Transformer Tails	Cable Riser – upper end	Transformer (HV side)	125 mm	1 per Transformer.
SCADA Signals (c) (k)	SCADA Signals Marshalling Box in Control Point	Cable Riser - lower end	100 mm	1
SCADA Signals (c) (k)	Cable Riser – upper end	SCADA Signals Marshalling Box in Substation (l)	100 mm	1
Protection (n)	Protection Panels	Cable Riser - lower end	100 mm	1
Protection (n)	Cable Riser – upper end	LV Switchboard Pit	100 mm	1
Earth Rod Connections (f) (g)	Earth Rod Location	Control Point Earth Bar	38 mm GI	2 where suspended floor slab.

FUNCTION	ORIGIN	DESTINATION	SIZE	NUMBER OFF
Earthing Connections	Control Point Earth Bar	Cable Riser - lower end	100mm	
Earthing Connections	Cable Riser – upper end	Substation Earth Bar	100mm	
Control Point Light & Power	Service Panel in Upper level substation	Cable Riser – upper end	100 mm	1
Control Point Light & Power	Cable Riser - lower end	Service Panel in Control Point	100 mm	1

(a) Unless specified otherwise by Ausgrid's Regional Planning Officer.	(b) Minimum of 6 conduits if the substation is adjacent to the street. If the substation is remote from the street, the number of conduits is to be determined by Ausgrid's Regional Planning Officer.	
(c) Where SCADA is required.	(d) Depending where HV CTs are located.	(e) To closest protection panel or protection pit.
(f) Not required if floor is not suspended.	(g) Can be 2 x 50 mm UPVC if located inside columns.	(h) Alternative, 2 x 50 mm conduits per transformer.
(i) Suitable for 2 x 70 mm^2 cables to earth bar. Install 1 x 50 mm conduit per switch if switches are to be individually earthed to earth bar.		
(j) Only where electrolysis bond is required.	(k) Conduit not required if SCADA signals cables are installed in the transformer protection cables conduit.	
(l) Conduits for SCADA signals marshalling box destination may terminate in low voltage pit if protection panels and SCADA signals marshalling box are located on low voltage board extension.		(m) Located in personnel access chamber.
(n) For Upper Level substations, differential HV CTs are to be mounted at the transformer. Protection panels are to be mounted in the Substation chamber.		
(o) Where the design of the particular substation locates the Substation Earth Bar, Service Board, Protection Panels and Protection Battery on a common wall it is permissible to install the cables in a common 300mm wide floor chase. The LV and HV Pits can be connected to the common floor chase by extending the floor chase or by a number of 100mm conduits. At least one conduit is required for each cable group function, eg Protection, LV Board earthing, Service Board power and earthing.		

Appendix B – List of Drawings

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

Number	Title
18894	Sydney CBD Type Substations & Control Points Emergency Pull-Out Gear Operating Equipment Typical Arrangement
25121	Substation Earthing Typical Installation of Earthing Electrodes
27298	Basement & Chamber Substations Removable Transformer Pulling Insert to Suit Floor Recess Arrangement & Details
28949	Personnel and Equipment Hatch Installation
38630	Underground Substation Personnel Access Ladder Mk4 Arrangement
42416	Basement Substation Fan Mounting Plate (*Sydney CBD Substation only)
43140	Details of Louvred Doors
48008	Miscellaneous Construction Details
48009	Weatherproof Louvre Details
48849	Multi-blade Fire Damper Details
50740	Transformer Hatchcover and Rebate
53680	Standard substation Design Basement Substation Chamber Louvre Selection table
56197	Wall Mounted CO_2 Connection Box
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