Distribution Network Standard

Standard for Site Selection and Construction Requirements for Chamber Substations

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Abstract: This Standard provides minimum site selection, building design and construction requirements for the establishment of new Chamber Substations with ratings up to and including 22kV. This Standard applies to Surface, Elevated, Upper Level and Basement Chamber Substations, Switching Station Chambers and Chambers for High Voltage Customer Connections.

Keywords: Chamber Substation, Substation, Indoor

Standard for Site Selection and Construction Requirements for Chamber Substations

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Standard for Site Selection and Construction Requirements for Chamber Substations

1 Overview

1.1 Purpose

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

The design and construction requirements specified in this Standard are intended to satisfy Ergon Energy performance and economic requirements to meet statutory obligation. The substations specified utilise readily available components which have demonstrated reliability.

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

1.2 Scope

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

This Standard:

- applies to nominal 11 & 22 kV primary voltage systems.
- applies to nominal 415 / 240 volt supply systems.
- applies to chambers used for Switching Stations.
- applies to chambers utilised for control of supply to High Voltage Customer (HVC) connections.
- does not apply to SWER systems.
- does not apply to nominal primary voltage systems higher than 22 kV.
- does not apply to Zone or Bulk Supply Substations, 11 kV regulators or auto transformers.
- does not apply to padmounted substations.

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

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 Ergon Energy.

2 References

2.1 Ergon Energy controlled documents

ES000904R104	EMF Guidelines for New Electrical Infrastructure (Reference)
ES000904R105	EMF Assessment Protocol for Existing Electrical Infrastructure (Reference)
STNW3389	Electrical Design and Construction Standards for Chamber Type Substations

2.2 Other documents

Nil.

3 Legislation, regulations, rules, and codes

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

Legislation, regulations, rules, and codes
Building Code of Australia (BCA)
AS 1074:1989 - Steel tubes and tubulars for ordinary service
AS 1418.1:2002 - Cranes, hoists and winches (Series)
AS 1657:2013 - Fixed platforms, walkways, stairways and ladders - Design, construction and installation
AS 1668.2:2012 - The use of ventilation and air-conditioning in buildings - Mechanical ventilation in buildings
AS 2067:2008 – Substations and high voltage installations exceeding 1 kV a.c.
AS 3600:2009 – Concrete Structures
AS 3735:2001 - Concrete structures retaining liquids
AS/NZS 2053.2:2001 - Conduits and fittings for electrical installations - General requirements
AS/NZS 3000:2007 - Electrical Installations (known as the Australian/New Zealand Wiring Rules)
AS/NZS 3003:2011 - Electrical installations - Patient areas
Electrical Safety Act 2002
Work Health and Safety Act 2011 (QLD)
Work Health and Safety Regulation 2011 (QLD)
Confined Spaces Code of Practice 2011

4 Definitions, acronyms, and abbreviations

4.1 Definitions

For the purposes of this standard, the following definitions apply:

Term	Definition
Access / Access Way requirements	Requirements for entry, exit and escape access as described and required by the BCA, Ergon Energy Electrical Safety Rules and referenced Ergon Energy 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 Ergon Energy. Such written consent may contain authorised specific departures from this Network Standard.
Building Coordinator – External Substations	The Building Coordinator is the person who inspects the project on behalf of Ergon Energy for compliance with Ergon Energy's requirements.
Chamber Substation	A Chamber Substation is a building of part of a building that contains electrical equipment which receives a Primary Voltage and provides 415/240V supply.
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 anything, other than the substation chamber. A dedicated access way must only allow access by Ergon Energy personnel or personnel specifically authorised by Ergon Energy. 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, ladders, passages, chambers and corridors.
Equipping	Installation of substation equipment, including but not limited to cables, busbars, switching and control equipment and transformers.
Fire stopping	Measures that are adopted to prevent the spread of fire, smoke and acid residues from one compartment to another.
High voltage	A voltage above 1,000 volts AC RMS or 1,500V ripple free DC. As specified in the Electrical Safety Act
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.

Term	Definition
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.
Prudent Avoidance	Refer to the Electricity Supply Association of Australia (ESAA).
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.

4.2 Acronyms and abbreviations

The following abbreviations and acronyms appear in this standard.

Term, Abbreviation or Acronym	Definition
BCA	Building Code of Australia
CT	Current Transformer
DFL	Defined Flood Level
EMF	Electronic & Magnetic Fields
EMI	Electromagnetic Interference
FRL	Fire Resistance Level
HV	High Voltage
HVC	High Voltage Customer
LV	Low Voltage
ROW	Right of way
VT	Voltage Transformer
WHS	Workplace Health & Safety

5 General Information and Requirement

5.1 Chamber Substations

This 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 or three transformers. Chamber Substations referred to in this 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
- Switching Station Chambers associated with Upper Level Chamber Substations

In general the construction of Chamber Substations (including access chambers, Switching Station 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. The substation is to be located above the Q100 level to prevent ingress of flood water and shall not be subject to tidal inundation, storm tide or flooding (1:100 year return period risk).

5.2 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 WHS Legislation as ‘confined spaces’ will not be approved for use or connection of power by Ergon Energy.

5.3 High Voltage Customer (HVC) Connections and Switching Station Chambers

This Standard includes requirements for the establishment of chambers for control of supply to High Voltage Customer (HVC) connections and Switching Station Chambers. Unless indicated otherwise, the requirements for HVC chambers and Switching Station Chambers shall be the same as requirements for Chamber Substations.

5.4 Equipment

The following Chamber Substation equipment shall be installed in accordance with the requirements of Distribution Standard for Electrical Design and Construction of Chamber Substations:

- HV Switchgear,
- Transformers,
- LV Switchgear,

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

In particular, Distribution Standard for Electrical Design and Construction of Chamber Substations details the necessary allowances for equipment sizes, clearances, etc. that are essential for determining the overall size of chambers.

5.5 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 Distribution Standard for Electrical Design and Construction of Chamber Substations.

6 Types of Chamber Substations

6.1 General

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

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.

6.2 Surface Chamber Substations

Surface Chamber Substations are located at or above ground level and is the preferred installation. For a Surface Chamber Substation the highest point of the floor of the substation chamber shall be not more than 2000mm above the lowest finished surface level of the roadway or footpath from the point where personnel and equipment access is gained.

6.3 Elevated Chamber Substations

Where there are no technically viable alternatives, Elevated Chamber Substations may be permitted.

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

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 Switching Station.

Lifting requirements and personnel access must be in accordance with Clause 8.

6.4 Upper Level Chamber Substations

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

Lifting requirements and personnel access must be in accordance with Clause 8.

Upper Level Chamber Substations must have a Switching Station at street level or at a level one floor above or below street level (i.e. may be a Surface, Elevated or Basement Switching Station Chamber).

6.5 Basement Chamber Substations

Where there are no technically viable alternatives, Basement Chamber Substations may be permitted.

All Chamber substations below footpath or roadway level where access is gained shall be for the purposes of this Standard treated as a Basement Chamber Substation. Refer to Clause 8 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, provided the room is above the Q100 level or higher as prescribed by Local Authority with the floor of the substations a minimum of 100mm above the DFL.

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.

6.6 Chambers for Control of High Voltage (HVC) Connections

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

Ergon Energy'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 Switching Station Chambers as detailed in this Network Standard.

6.7 Switching Stations

A Switching Station is required when a Chamber Substation is considered by Ergon Energy to be remote from direct unimpeded personnel access from the street, such as Upper Level Chamber Substations. A Switching Station does not contain any transformers; it only houses high voltage switchgear and other ancillary equipment. The associated transformers can be located in the same building, closer to the load centres in other substations rooms.

Typical examples include:

- High rise buildings – switching stastion on lower / street level, transformers located on upper floors
- Large factories – Switching Station on street frontage, transformers near LV switchboards.

Where Ergon Energy provides supply to an Upper Level Chamber Substation a Switching Station 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 Switching Station 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 Switching Station.

Switching Stations must comply with the same requirements of Surface, Elevated or Basement Substations as appropriate.

7 Site Selection

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 be located in areas which are free of any other building, structure or services excluding services or conduits directly related and, required for the Chamber Substation.
- The selected site is required to be geotechnically stable and RPEQ 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 RPEQ certified, as being designed at least by a practicing RPEQ Structural Engineer to Australian Standards prior to supply being made available to the Substation.
- The structure of the substation is to be designed to have a design life matching that of the building structure but shall be no less than 50 years.

- The selected site/location shall be clear of all obstructions which may interfere with the installation of any part of the substation earthing system.

Caution
Electrodes for the earthing system may extend some 10 metres into the ground below the substations and / or ground level near the substations. Refer to Clause 10 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 Ergon Energy, 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.
- Care should be considered to locate services sensitive to high voltage and strong electromagnetic fields with sufficient seperation to the chamber substation. This is to ensure that they are not be affected adversley by the installation of the Chamber substation. Ie. Separation of gas/metallic pipelines from the earthing installation. Separation of electronics/computer systems from the LV bus magnetic fields.
- 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.

7.1 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 or wet area as defined in AS/NZS 3000, or
- deemed to be a Confined Space according to WHS 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 the fire risk zone as specified in AS 2067 Appendix C 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 where the substation contains oil-filled equipment or 120/120/120 where there is no oil-filled equipment,and a blast resistance of 2kPa. Refer to Clause 9.5.8. Refer also to Clause 8.1.2.

8 Access Requirements

8.1 Common Access Requirements

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

8.1.1 General

Compliance with the following conditions is necessary:

- Unimpeded access to all Ergon Energy substations must be maintained 24 hour access seven days a week.
- Substations must be provided with direct street access or be accessible using permanent all weather routes.
- Access to Ergon Energy substations shall be through one dedicated access way and one shared access way to a secured chamber.
- Access points must be located where they will not be obstructed by vehicles, equipment, site usage or any other impediments. Access through areas that are deemed dangerous to personnel (such as areas patrolled by guard dogs) is unacceptable.
- Access ways must be at least 1200mm wide. Doorways must be 1200mm wide when the door is in the open position.
- Dedicated Ergon Energy access ways shall not allow any public or occupant access. This includes periods of emergency evacuation when Ergon Energy 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. I.e temporary boxes, plant protruding into walkway space.

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 Building Code of Australia (BCA) egress and ingress requirements. The exception is for Upper Level Chamber Substations which require the registration of a Right of Way (ROW) through common areas (Refer to Clause 8.2.4).

8.1.2 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 8.2.4).

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.

8.1.3 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.

8.1.4 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 Clause 8.4.

All access ways or roadways servicing access points must be capable of withstanding construction and service loadings and loads applied by vehicles and plant transporting or moving equipment/plant to and from the substation and ensure clear access at all times. See Clause 8.4.

8.1.5 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 Ergon Energy in writing the minimum structural component ratings are FRL 180/180/180 where the substation contains oil-filled equipment or 120/120/120 where there is no oil-filled equipment, and 2kPa blast rating.

All substation chambers and access way walls are to be structurally tied at the floor and the ceiling. Refer to Clause 11.4.

8.1.6 Personnel Access Doors

All Chamber Substation personnel access doors must provide a minimum clear opening of 2400mm high and 1200mm wide when the door is in the fully open position.

For Surface Chamber Substations and Switching Stations in the City or Town 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 City or Town 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 or alternatively a louvered personnel door or combined transformer and personnel louvered door may be used provided the use of such doors in the particular application complies with all other Ergon Energy requirements and the BCA.

Louvered doors must be meshed to repel insects.

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.

All external doors shall be weatherproof.

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

8.1.7 Transformer Access Doors

Each transformer access door is to provide an opening which is full height (i.e. minimum clear height of 3100mm high) and minimum clear width of 2400mm, with the door in the fully open position.

Louvered doors must be meshed to repel insects.

For Elevated and Upper Level Chamber Substations, transformer access doors may be utilised for substation ventilation utilising louvers provided the use of such doors in the particular application complies with all other Ergon Energy requirements, AS 2067 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.

All external doors shall be weatherproof.

For Surface Chamber Substations and Switching Stations in City or Town CBDs, 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 Switching Stations outside City or Town CBD, external transformer access doors shall be louvered doors provided the use of such doors in the particular application complies with all other Ergon Energy 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. Also the following requirements apply:

- outward swinging doors may need to be fitted with hinges to allow a swing of 180 degrees to provide sufficient manoeuvring space in front of the substation entry,
- 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 600mm. Refer clause 8.4.3.4 for transformer handling area requirements.

For multi transformer or single transformer chambers containing more than 1000 litres of oil, the inside or substation chamber side of each transformer access is to have facilities to contain an oil spill. Refer to Clause 12.

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 8.4.4 for requirements of access to basement chambers.

8.1.8 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 98 series plain lever handle or similar on the inside. Panic bars shall be fitted on all outward opening doors used for emergency egress from Chamber Substations. The latch shall be fitted such that there is no less than 10mm engagement of the latch bolt into the striker plate when the door is in the closed position. The latch shall have no less than 65mm back set. With the exception of louvered doors, each door is also to be fitted with a 200mm ‘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 200mm ‘D’ handle is to be provided on the access chamber or access passageway side. No locks are to be fitted to these doors.

Upon Ergon Energy's acceptance of a Chamber Substation, Switching Station or cable riser, lock cylinders will be changed to the Ergon Energy series, by Ergon Energy.

Transformer only 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 25mm penetration into the sockets, and shots are to be machined to allow easy socketing.

8.2 Personnel Access Requirements

8.2.1 General

Unimpeded access to all Ergon Energy substations must be maintained 24 hours, 7 days a week. Personnel access doorways are used for normal entry and exit from substations. All substations must be provided with two separate personnel access doorways; one dedicated access way and one shared access way to a secured chamber. The second personnel access doorway may not be required if the equipment access door is suitably located with the provision of personnel access, at the discretion of Ergon Energy.

At each substation both access doors 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 (such as a shopping centre exit road), that is acceptable to Ergon Energy 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, and
- the front of any equipment mounted on a protection panel, where installed, and the battery charger, where installed.
- equipment nameplates.

8.2.2 Surface Chamber Substations

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

For Surface Chamber Substations outside the CBD of a City or Town, 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 Ergon Energy 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 Ergon Energy and in compliance with the BCA. There is no need for a door between the substation and the dedicated access passageway.
- a combined transformer and personnel louvered door , however only one such access way is permitted per substation.

For Surface Chamber Substations in the CBD of a City or Town, 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 Ergon Energy 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.

8.2.3 Elevated Chamber Substations

Elevated Chamber Substations must comply with all relevant requirements contained within this Standard 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 Ergon Energy.

Option A

Each access way 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 Clause 8.3 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.

8.2.4 Upper Level Chamber Substations

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

8.2.4.1 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 days a week access by Ergon Energy personnel is required for Upper Level Chamber Substations.

8.2.4.2 Right of Way (ROW)

A permanent registered Right of Way (ROW) in favour of Ergon Energy 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.

The ROW must enable Ergon Energy access at all times 24 hours a day, 7 days a week. Refer to Clause 8.3.

8.2.4.3 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 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 8.2.4.5.

8.2.4.4 Doors to Upper Level Chamber Substations and Access Chambers

Personnel doors must achieve a fire resistance level (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 Clause 14.

8.2.4.5 Access Chambers

Upper Level Chamber Substations located within buildings must have a dedicated access chamber outside each substation chamber access door.

The access chamber must comply with and be of the same construction and 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.

8.2.5 Basement Chamber Substations

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

8.2.5.1 General

Generally personnel access to Basement Chamber Substations must:

- Provide two separate dedicated means of access from an access roadway.
- Be located in areas which provide unimpeded 24 hour seven day a week access by Ergon Energy 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.

8.2.5.2 Dedicated Access Ways

The dedicated access ways must be approved in writing by Ergon Energy. Access ways can only be one of the options described below.

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

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.

Note
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. Refer Clause 8.3 for further details.

All doors, access chambers and stairways are to be fire and blast rated to the same level as the Basement Chamber Substation chamber.

8.2.6 Switching Station Chambers and Chambers for Control of Supply to High Voltage (HVC) Connections

Unless specified otherwise in this Network Standard, the requirements for Switching Station 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 Ergon Energy approval.

8.3 Personnel Access Ways for Chamber Substations

8.3.1 General

All personnel access doors that are also used for small equipment access must provide a clear opening of not less than 2400mm high by 1200mm 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 cannot provide level access from a public roadway, will be subject to review and approval from Ergon Energy before design is finalised or construction commences.

All doors, access chambers and stairways are to be fire and blast rated to the same FRL 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.

8.3.1.1 Doorways between External Areas and Substation Chambers or Access Chambers or Switching Station Chambers

For each doorway leading from an external area into a substation, access chamber, or Switching Station, the following shall apply:

- If a step is required it shall have a 120mm minimum, 190mm 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 Switching Station and include an appropriate handrail.
- have the threshold of each step up finished with an angle nosing as shown on Drawing 1056964-04.
- Bollards are to be 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. Individual circumstances will dictate bollard design.
- be positioned such that their use does not create a personnel hazard.
- be fitted with doors that;
  - are positioned so that suitable clearances are maintained from any internal stairways when the doors are in the fully open position,
  - have a danger sign fixed to it,
  - are fire resistant,
  - are weatherproof if leading from an outdoor area,
  - are fitted with fire rated hydraulic door closers.

8.3.2 Stairways

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.

8.3.3 Doorways between Access Chambers and Substation Chambers

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

- 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 where possible.
- 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 200mm 'D' handle is required on the access chamber side,
- swing on their frame with heavy-duty non-corroding metal hinges.

8.3.4 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 the following:

- 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.
- Ergon Energy 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 1600mm x 900mm.
- 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 stairway.

The door into the substation chamber from the access chamber must provide a clear opening of not less than 2400mm high by 1200mm 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 1200mm 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.

8.3.5 Personnel Only Stairway Access Way Requirements

This access way is for personnel access only.

The access chamber at street level must have a door with a clear opening not less than 2400mm high and 1200mm 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 1200mm 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.

8.3.6 Personnel Access via Access Chamber and Ladder

This access way is for personnel and small equipment access.

The upper access chamber must incorporate the following:

- 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. Ergon Energy 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 1200mm 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 1200mm 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.

8.3.7 Personnel Access via Hatchway

This access way is for personnel and small equipment access.

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.

- 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 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 Ergon Energy requirements.

- A pull-out guard railing to Ergon Energy 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 Ergon Energy specifications.
- Ladders must be constructed in accordance with AS 1657 and other relevant Australian Standards and Building Codes.

8.4 Equipment Access and Handling

8.4.1 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 Clauses 8.4.4 & 8.1.7 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 which may be 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.

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

8.4.2 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 Clauses 8.2 and 8.3.

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.

8.4.3 Heavy Equipment

8.4.3.1 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 Ergon Energy. However in some situations such as Upper Level Substations, the building owner or occupant must supply a suitable crane or lifting device, approved by Ergon Energy and at no cost to Ergon Energy, 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 Switching Station 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.

8.4.3.2 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 Ergon Energy prior to equipment delivery.

8.4.3.3 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 Standard.

There are various methods of heavy equipment delivery. The 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.

Common methods of heavy equipment delivery are as follows:

1. **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 rear axle, with 4 tyres on each axle.

2. **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.

3. **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.

4. **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.

5. **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 (4) and (5) above will normally need to be considered in conjunction with method (1), (2) or (3).

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 Ergon Energy.

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 25 metres 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.

8.4.3.4 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 600mm.

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 Distribution Standard for Electrical Design and Construction of Chamber Substations. Refer to Clause 8.4.4 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 Ergon Energy and be of the same FRL as the Chamber Substation. Refer to Clause 8.4.5 for further details.

8.4.4 Transformer Hatches and Access Chambers

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 Ergon Energy.

The transformer hatch location must be in an unenclosed area accessible from the street with 24 hour seven day a week access for Ergon Energy personnel. It is preferable for the hatch to be located in an area clear of any overhead building or structure.

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 Clause 12 unless approved in writing by Ergon Energy.

Note: Ergon Energy 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.

Hatch cover must be designed to support design loadings of surrounding area.

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 Ergon Energy and be of the same FRL as the Chamber Substation.

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. 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 or the access chamber provided appropriate door handles are fitted.

8.4.5 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 Ergon Energy equipment or cables associated with the Chamber Substation, Switching Station or Chamber for Control of HVC Connections.

The easements must be a minimum 2 metres in width for 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 Ergon Energy. Other services may cross an easement provided Ergon Energy is satisfied the mains will not be affected.

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

All mains between a Switching Station 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 Switching Station to the substation or, in the case of an upper level substation, via an approved fire rated cable riser. The riser must be of the same FRL as the Chamber Substation.

8.4.6 Equipment Handling Within the Substation Chamber

Equipment must be manoeuvred into position within the substation chamber using appropriate handling methods.

Clearances around permanent equipment shall ensure the equipment is readily accessible at all times and does not obstruct the passage of other equipment in the event that replacement is required.

To facilitate cable pulls; pulling rings must be installed at the top and bottom of cable risers and at the end of conduit runs as shown on drawing 1056469-06. Refer clause 11.4.2 & 3 for details.

8.5 Adjacent Substations and Switching Station Chambers

8.5.1 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 Standard.

8.5.2 Adjacent Substations and Switching Stations

8.5.2.1 Personnel

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

Option A

Requires separate accesses to be constructed for each Substation and Switching Station chamber.

Option B

This option requires one external access to the Substation chamber, one separate external access to the Switching Station chamber and a separate access chamber between the Switching Station chamber and the substation chamber. This option requires the access chamber to form an air lock between the Chamber Substation and the Switching Station. 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 Switching Station 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 1056964-04.
- not be positioned behind substation or Switching Station 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 Switching Station side of each door, and a 200mm '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 switching Station. The access into the Switching Station from the external access should be diagonally opposite to the access into the Switching Station from the passageway from the substation.

8.5.2.2 Equipment

Equipment handling for the Substation Chamber is as per Clauses 8.4 and 8.1.7.

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

8.6 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 within an area which is classified as hazardous in Clause 7.7 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. These cable risers will be Ergon Energy dedicated only. 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 -/180/30, 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 10mm engagement of the latch bolt into the striker plate when the door is in the closed position. The latch shall have no less than 65mm backset.

If the width of the riser is covered by 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 10mm engagement of the latch bolt into the striker plate when the door is in the closed position. The latch shall have no less than 65mm backset. The other door leaf 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.

HV danger signage is to be places on all cable riser access doors.

9 Ventilation Requirements

9.1 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.

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. All unfiltered external vents are to be fitted with louvers, which are to be covered with vermin-proof screens.

Ventilation must be sufficient to maintain a maximum temperature rise within the substations room of 5°C above the average ambient temperature for the location.

Ventilation Design is to allow for 12kW Heat of Rejection per 1000kVA transformer capacity.

9.2 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.

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.

Louvered 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 a city / Town. In these situations, ventilation of the substation chamber must be effected by ventilation ducts as detailed for Basement Chamber Substations (see Clause 9.4).

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 but personnel doors shall not be used as the sole source of ventilation.

Refer to Clause 8.1.7 for the minimum size of transformer access doors.

9.3 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 as per ventilation design requirements. 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.

9.4 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 Clauses 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.

9.4.1 Switching Stations and Chambers for the Control of High Voltage Customer (HVC) Connections

Even though the equipment installed in a Switching Stations 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 Clauses 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 Clauses 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 9.5.2 and 9.5.3).

When mechanically vented, each of the dedicated ducts are required to have 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/s against a static pressure of 38 Pa.

9.5 Ventilation Requirements

9.5.1 Duct Design

The aspect ratio of all ventilation ducts, inlets and outlets shall be kept as close as possible to 1:1 and shall 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 Ergon Energy. 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 (m^3/s).

The full length and area of the ventilation ducts from the substation chamber or Switching Station 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 Ergon Energy, 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.

9.5.2 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 2.4 metres providing upward deflecting guide vanes are fitted to the outside of the weatherproof louvres.

9.5.3 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.

9.5.4 Construction

Ventilation ducts are to be constructed 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, and resist a 2kPa blast from the remainder of the building.

If a portion of the ventilation duct for a substation or Switching Station is located inside that substation or Switching Station chamber, that portion may be constructed of sheet metal, subject to the fire damper being placed where the duct enters/exits the chamber.

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 Standards.

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.

9.5.5 Drainage

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

9.5.6 Fire Dampers

A multi-blade fire damper 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

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.

9.5.7 Ventilation Fan

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.

Power for the fan is to be provided from the Substation Services Board. The fan is to be mounted in a mounting plate 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.

Where vertically mounted (ceiling) fans are intended, a lifting bar must be provided within the duct as per 1056964-06.

9.5.8 Separation between Ventilation Openings

The substation ventilation openings, including substation duct openings and louvered panels, as described in this 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, Ergon Energy requires the substation ventilation openings, including duct openings and louvered panels, as described in this 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 Ergon Energy 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 Ergon Energy and approval must be obtained before design proceeds.

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

Refer to Clause 14 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.

9.5.9 Maintenance

Maintenance of the ventilation system remains the responsibility of the building owner.

Filters to inlets and outlet vents and grills must be periodically be cleaned, and access requirements should be considered during the design. Fans should regularly be inspected to ensure operation and shall be replaced as soon as possible if found to have failed, and suitable alternative measure/s put in place until the fan/s have been replaced and are operational. Any maintenance work that will result in a reduction of airflow to the substation room shall not be planned between the hours of 11.00am and 4.00pm during summer months.

Where air filtering is required, it is the responsibility of the building owner that the filters be regularly checked, so as to ensure that adequate airflow can be maintained and where necessary, filters be replaced.

9.5.10 Earthing or insulating Ventilation Ducts

Metal ventilation ducts are generally connected to the building earth via the chassis of attached fan motors and as such are a potential remote earth. Any conductive part of the ventilation system that enters the substation must be electrically disconnected and insulted from the remaining part of the ventilation system that is outside the substations (and is remotely earthed). Alternatively, conductive surfaces must be covered and insulated such that personnel inside the substations could not come into contact with a conductive surface. This approach would involve insulating ventilation droppers to a height of at least 2.4 metres.

10 Earthing

10.1 General

10.1.1 Installation Requirements

Refer to Distribution Standard for Electrical Design and Construction of Chamber Substations for installation requirements of earth electrodes and connections between earth electrodes.

10.1.2 Footprint

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

- If a Switching Station 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 Switching Station Chamber.

- If a Chamber Substation is located near its Switching Station Chamber, the electrode earthing system for both the Switching Station and the substation should be installed under the footprint of the Chamber Substation.
- Where the Switching Station 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 Switching Station Chamber.
- If there are exceptional site conditions, Ergon Energy may permit, or may require, alternative locations for the electrodes.

Refer to Electrical Design and Construction Standards for Chamber Type Substations for connection requirements for cables from earth electrode groups, and for installation and connection requirements for interconnecting chamber earth cables.

10.1.3 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 Ergon Energy.

10.1.4 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.

10.2 Earthing Electrode System

The Chamber Substation (including any Switching Stations), must be located in an area which is free of other building services except those directly related to the Chamber Substation. (Refer to Clause 7 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 chamber or switching station.

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

If the Chamber Substation or Switching Station 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 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 10.3.2.

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. 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 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 Ergon Energy.

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

10.3 Earthing Cables and Conduits

Conduits must be installed within floor slab of Chamber Substation (including any Switching Stations) for the earth cables from substation and Switching Station equipment to the earth bars. The minimum diameter for these conduits is 40mm, and the conduits must comply with Clause 11.8. Any bends used must be sweep bends. Elbows are not permitted.

10.3.1 Earthing Cables between Chambers

The earth cables between an Upper Level Substation and its Switching Station 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 suitable provision must be made. Provision must include conduits within the chambers as indicated in Clause 11.8, and cable risers and / or conduits between chambers.

10.3.2 Installation of Earthing Cables between Electrode Groups and Chambers

If the substation is located on natural ground, the two cables are to enter the substation from a group of electrodes connected to the earth grid.

If the substation is constructed on a suspended floor slab, the two cables from the earth grid are to be brought up through the building structure along separate routes to the earth ring in the substation.

The two earthing cables are to run through two 40mm PVC conduits encased within a structural column. Outer steel pipe or steel hat section are to be used if conduits are surface mounted. The earth cable route is to be marked with cable identification markers along the route.

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 305mm. 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 are to be fitted with a cover not less than 300mm long. Covers are to be formed from a minimum 1.6mm thick galvanised steel sheet. Covers must be readily accessible at all times.

11 Construction

11.1 General

In general the construction of Chamber Substations (including access chambers, Switching Stations 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 Ergon Energy 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 that specified in AS3600.

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 standard. 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.

Switching Stations, 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.

11.2 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 50mm.

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 Ergon Energy.

11.3 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 RPEQ certified Civil or Hydraulic Engineer may be considered by Ergon Energy 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 Ergon Energy.

11.4 Walls

11.4.1 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.

Preferred wall finish is bare/painted concrete or block. Alternative surface linings must be submitted for approval to Ergon Energy.

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

11.4.2 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 that specified in AS 3600.
- All wall structures must be certified by an RPEQ certified structural engineer for and structural integrity to support expected loads, and for FRL of 180/180/180 where the substation contains oil-filled equipment, or 120/120/120 where there is no oil-filled equipment.
- All walls must be designed to withstand a short term blast 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 50mm.
- 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 50mm is to be formed on the outside of the substation wall.
- An alternative membrane or drainage system which has been designed and certified by an RPEQ certified Civil or Hydraulic Engineer and approved by Ergon Energy 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 shall preferably be positioned such that it is flush with the interior of the substation wall, and finished to the same standard as the walls.If a column is unable to be finished flush with the face of the wall these columns are permitted to encroach the room space however all wall clearances will be taken to the nearest point on the wall which will include any encroaching column faces.
- 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 Ergon Energy requirements. Pulling rings used for pulling cables can be subjected to a maximum applied load of 50kN whilst the applied load of 35kN 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.

11.5 Floor

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

- designed and certified by a practising RPEQ certified 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 that specified in AS 3600.

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 Clauses 8 and 12.

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 Clause 8 for all access requirements and Clause 12.1 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.

In Elevated and Upper Level Camber Substations with suspended slab floor construction, preference will be to support HV and LV cables in cable trays supported by the inside chamber roof. In situations where cable trays are not able to be utilised and acceptable alternative will be to provide a floor chase to run the HV and LV cables in. This will need to be provided in the suspended slab floor and designed and certified by an RPEQ structural engineer, see clause 11.5.1 and 11.5.2 for more details.

11.5.1 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.

Note: Chase widths shall be designed to meet individual requirements.

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 drawing 1056964-04.

11.5.2 Pit and Floor Chase Cover Plates

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

Floor plate covers are to be a minimum 6mm thick but must be increased to 10mm 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 1000mm in length. Each section must contain a lifting eye at each end. For more detail refer to drawing 1056964-06.

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.

11.5.3 Earthing

Refer to Clause 10 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.

11.6 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.

In all cases the concrete cover to the reinforcing of the ceiling sections must not be less than as specified in AS 3600.

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.

Switching Stations which meet all other requirements of this 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 600mm.

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.

11.7 Doors

Door construction requirements are detailed in Clauses 8.1.6 and 8.1.7.

11.8 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 "HD"). Conduit joints shall be socketed and solvent welded.

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 shall be used. The radius of any bends shall be sufficient to accommodate the intended cable.

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 are to enter at an angle which is perpendicular to the internal face of the substation chamber wall and shall have their edges pencil rounded to minimise damage to the cables. Alternatively conduit bushes can be used for the conduit entering pits or the substation chamber.

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

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

11.9 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 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. Ergon Energy's liaison officer will examine the water service position for acceptability.

11.10 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 non-galvanised 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 drawings 1056964-07 & 10 for further details.

12 Oil Filled Equipment Requirements

12.1 Surface Chamber Substations

Where a Chamber Substation, with equipment containing oil is located within a building the following requirements apply in addition to the BCA and other requirements within this 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 Clause 9.1 regarding ventilation requirements for Surface Chamber Substations for separation of substation ventilation openings from building ventilation openings.

Refer also to Clause 14.1 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, with the exception of single transformer chambers.. 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 300mm and the ramp length is to extend 1000mm from this flat area. The top of the ramp is to be between 70mm and 80mm above the finished substation floor level. In situations where personnel doors are adjacent to an equipment door, a single ramp can be used.

12.2 Elevated and Upper Level Chamber Substations

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

Refer also to Clause 14.1 regarding fire rating of buildings near substation ventilation openings.

13 Environment

13.1 Asbestos

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

Suppliers are expected to comply with the Work Health and Safety Act (QLD) and Work Health and Safety Regulation (QLD) and confirm in writing all products supplied to Ergon Energy contain no Asbestos related materials.

13.2 Oil Containment

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

Drainage is allowed as specified in Clause 9.5.5 where drainage is provided for safety reasons within personnel hatchway/ladder access chambers only.

Clause 11.3 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 Clause 14.5 regarding fire barrier sealing and fire stopping requirements.

Oil containment volume shall be as per design requirements.

Refer to Electrical Design and Construction Standards for Chamber Type Substations for further information.

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

Ergon Energy exercises "Prudent Avoidance" when locating electrical substations, refer ES000904R104.

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 conduit 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.

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

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.

13.4 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.

13.5 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.

Venting of Liquid Storage areas must be kept away from substation ventilation openings as indicated in Clause 9.5.8.

14 Fire Protection

Ergon substations are designed to contain any products of a fire within the enclosure. Self containment has the added advantage of also being self smothering and this ensures that there is no spread of fire to other parts of the building. Fire Protection shall be designed in accordance with the Building Code of Australia and all relevant Australian Standards.

14.1 Fire Rating of Substation Construction Materials

All construction materials used in the substation room including walls, ceilings and floors, doors and vents must be constructed from noncombustible materials. Any wall, ceiling or floor shared with or adjoining another part of the building must be treated as a fire wall as defined in the Building Code of Australia with a FRL of not less than 180/180/180 as stated in Clauses 12.1 & 12.2.

14.2 Fire Rating of Buildings Near Substation Ventilation Openings

In addition to the requirements of Clauses 12.1 and 12.2, exterior parts of buildings within 3 metres in any direction from substation ventilation openings, including duct openings and louvered panels, must have a fire rating level (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.

14.3 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.. Fire dampers shall be of the multi-blade type and be positioned to provide testing, ready maintenance and inspection from within the Chamber Substation.

Ergon does not have a requirement to fit fire detection or alarm systems within the substation. The owner is advised that where the installation of fire detection or alarm systems is required, consideration must be given to the need for continued access for inspection and maintenance of the system. Depending on the location of the fire detection / alarm system it may be necessary to have a shutdown of the substation for maintenance or inspection. Such needs shall incur an ongoing charge for providing access to the substation and any shutdown required.

Fire damper trip wires are to be 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.

Refer to Clauses 9.5.6 and 9.5.7 for further details.

14.4 Switching Stations and Chambers for the Control of HVC Connections

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

14.5 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 FRL equivalent to the substation walls (FRL 180/180/180 where the substation contains oil-filled equipment).

If cable penetrations or provision for cable penetrations or spare conduits, are less than 100mm 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.

14.6 Cable Risers

Cable risers must provide a FRL of 180/180/180 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 Ergon Energy 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.

14.7 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 FRL 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 RPEQ Structural Engineer.
- Prior to construction an Engineer's Certificate must be provided to Ergon Energy certifying the design of the works complies with Ergon Energy, all Local Authority and BCA requirements.

- All foundations are to be approved in writing by an RPEQ certified practicing Structural Engineer.
- The barriers must have a minimum FRL 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 Ergon Energy as part of the Design certification prior to approval for construction from Ergon Energy.

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

14.8 Separation Between Adjacent Transformers

Where transformers are arranged in banks, they shall be separated by the minimum distances specified in AS2067 CL 6.7.2, table 6.1. If these distances are me there are no requirement to have a fire/blast barrier between transformers.

For other arrangements contact Ergon Energy.