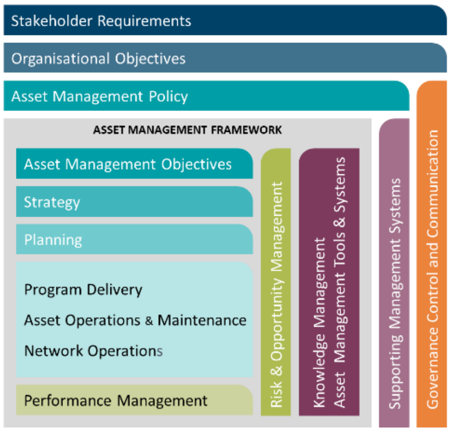
# Western Power's
# Asset Management System




## Distribution Substation Plant Manual

## Chapter 11
## Chamber Substation Standards

**Supplement to DSPM layouts for below ground substations**

Original Issue: January 2026

Content Owner/Custodian: Distribution Design and Standards

This Revision: September 2026

Date for Next Review: September 2029



Volt ID ID05-1343104688-602312

## Document control

### Endorsement approvals

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### Record of revisions

| Revision No. | Date | Version | Compiled by | Description |
|---|---|---|---|---|
| 0 | January 2026 | - | Mark Montemayor | Original Issue |
| 1 | 11/09/2026 | Volt 2 | Mark Montemayor | Standards Forum Circulation |

### Key documents providing direction and influencing this document

| Doc | Title of document |
|---|---|
| Volt ID ID-005-dc7f342fed83eb7f008777ff0463b876 | Asset Management System |
| Volt ID ID87-1104746466-152109 | Safety in Design Guidelines |
| Volt ID ID-005-5fc14a0c0a2236566dc182c37ccca458 | DSPM Governance and Technical Documents Register |

### This document gives direction to and influences the following documents.

| Doc | Title of document |
|---|---|
| Various DQM documents | Distribution Substation Design Projects |

**Stakeholders** (people that were consulted when document was updated)

| Business Unit / Function |
|---|
| Asset Management - Asset Performance |
| Asset Management – Safety Environment Quality and Training |
| Asset Management - Grid Transformation |
| Asset Operations – Network Operations |
| Asset Operations – Operational Services |
| Asset Operations – Customer Connection Services |
| Business and Customer Service – Customer Service |

**Notification list** (people to be notified when document is updated)

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## Document classification and hierarchy

A key requirement of the Western Power Asset Management Policy (AMP) is to develop and maintain an Asset Management System (AMS). This Distribution Substation Plant Manual is defined as a technical document within the AMS document classification and structure and sits within the planning and Program Delivery components of the AMS.

The AMS and the interrelationships between the collection of documents, tools and systems that are used for asset management are described in the AMS document AMS document Volt ID

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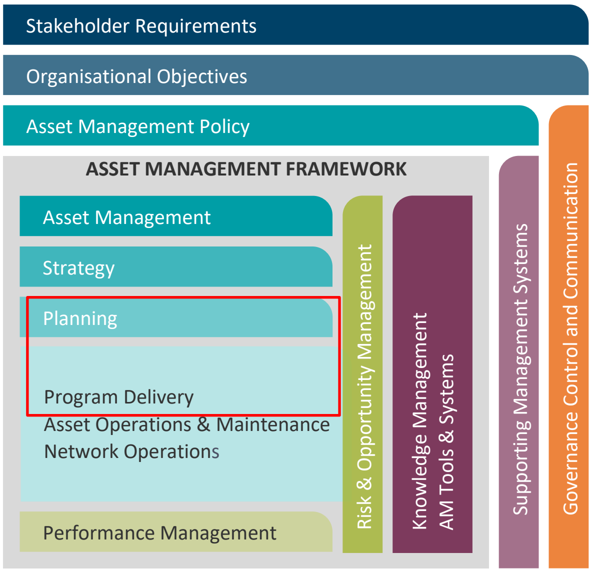

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# 1. Scope and Objective

This document describes the minimum design and to some extent, construction considerations for all new ‘Chamber Substations’ in Western Power’s distribution network. The requirements stipulated herein may apply to upgrade and modification works where possible for existing chamber substations. Where the points in this standard cannot be achieved, a dispensation to this standard shall be discussed and approved by Western Power. The customer is required to explain all deviations and submit proof showing that they still satisfy the minimum requirements, at an equal or higher level than the standard provided.

A Chamber Substation is a substation containing electrical equipment receiving a Primary Voltage (11kV, 22kV or 33kV) and provides a supply to the premises and/or adjacent LV network. A chamber substation is one where the location is below the footpath or roadway level or more commonly known as below ground substations. Typical locations are in loading bays, carparks, and/or part of a basement.

The purpose of this report is to define the technical requirements, responsibilities, safety compliance obligations, and design guidelines governing the engineering, and acceptance of a chamber-type substation. These requirements ensure that all works are executed in accordance with applicable engineering standards, regulatory safety frameworks, and organisational risk-management practices.

This network standard:

- Applies to nominal 11kV / 22kV / 33kV primary voltage systems
- Applies to nominal 415 / 240 Volt distribution systems
- Applies to supply of high voltage customer connections (primary metered)
- Does not apply to SPUD systems
- Does not apply to zone or sub-transmission substations
- Does not apply to voltage regulators or auto transformers

Substation civil design and construction are not covered in this Standard. The requirements of all relevant Australian Standards, the Building Code of Australia and all statutory bodies are regarded as minimum requirements for the establishment or refurbishment of a Chamber Substation. Where the requirements of this document exceed those of the referenced standards or regulatory obligations, the provisions herein shall constitute the minimum acceptable standard for Western Power.

# 2. References

| Document Number | Document Title |
|---|---|
| AS 2067 | Substations and High Voltage Installations Exceeding 1 KV A.C. |
| AS 2239 | Galvanic (sacrificial) anodes for Cathodic Protection |
| AS 2344 | Limits of electromagnetic interference from overhead A.C. power lines and high voltage equipment installation |
| AS/NZS 4325.1 | Compression and mechanical connectors for power cables with copper or aluminium conductors |
| AS/ NZS 3000 | Electrical Installations |
| AS/NZS 4026 | Electric Cables – For underground residential distribution systems |
| AS 60038 | Standard Voltages - 2012 |
| ISO ACOUSTICS Vol 1 | Acoustics - General Aspects of Acoustics; Methods of Noise Measurement In General |
| ENA EG1-2006 | Substation Earthing Guide |
| AS 1768 | Lightning Protection |
| AS 1905 | Components in Fire Rated Walls |
| AS/NZS 1682.1 | Fire, smoke and air dampers - Specification |
| AS/NZS 1682.2 | Fire, smoke and air dampers - Installation |

# 3. Definitions and Abbreviations

| Abbreviations | Meaning |
|---|---|
| **AC** | Alternating Current |
| **ABE** | Dry Chemical Fire Extinguisher Type ABE |
| **AS** | Australian Standard |
| **AS/NZS** | Australian/New Zealand Standard |
| **ASD** | Aspirating Smoke Detection |
| **BCA** | Building Code of Australia |
| **CO2** | Carbon Dioxide |
| **COM** | Constructability, Operability and Maintainability |
| **DBA** | Direct Brigade Alarm (DFES) |
| **DFES** | Department of Fire and Emergency Services |
| **DSPM** | Distribution Substation & Plant Manual |
| **FRL** | Fire Resistance Level |
| **GPO** | General-Purpose Outlet |
| **HV** | High Voltage |
| **IPXX** | Ingress Protection Rating (generic placeholder level) |
| **ISO** | International Organization for Standardization |
| **kPa** | kiloPascal |
| **kV** | kiloVolt |
| **LV** | Low Voltage |

| Abbreviations | Meaning |
|---|---|
| **MEN** | Multiple Earthed Neutral |
| **NCC** | National Construction Code |
| **PVC** | Polyvinyl Chloride |
| **PBDB / FEB** | Performance-Based Design Brief / Fire Engineering Brief |
| **RMU** | Ring Main Unit |
| **RTU** | Remote Terminal Unit |
| **SCADA** | Supervisory Control and Data Acquisition |
| **SMSB** | Site Main Switchboard (Customer's MSB) |
| **SPUD** | Single Phase Underground Distribution system |
| **SFAIRP** | So Far As Is Reasonably Practicable |
| **WHS** | Work Health and Safety |

# 4. General Information and Requirements

## 4.1 Safety in Design

Designs shall maximise the utilisation of standardised and readily available plant, materials, and equipment to ensure compatibility with established construction and maintenance methodologies. This includes provision for live-line work practices where operationally feasible and compliant with authorised work procedures. The design shall also incorporate assessment and mitigation of fire risks associated with the installation of electrical assets in proximity to building structures.

Designs shall be developed in accordance with Western Power's approved safety work practices and engineering procedures. All design outputs shall comply with the requirements of the Electricity Act 1945, Electricity Industry Act 2004, Energy Operators Powers Act 1979, the WA Work Health and Safety Act 2020, all regulatory requirements and Western Power's corporate risk-management framework.

## 4.2 Design Life of and Maintenance for Substations

Western Power's substation is to have a targeted design life of 50 years for greenfield developments. This applies to equipment and material selection, and workmanship. The structural and external maintenance of the substation chamber remains the responsibility of the building owner. A registered encumbrance, either a combination of an "Easement" or/and "Restrictive Covenant" shall be applied to the property title advising subsequent owners of the building around responsibilities on maintenance and caveats associated with the substation.

## 4.3 Chamber Substation Standards vs Existing Chamber Substations

When alterations or refurbishments are planned for existing substations, all reasonably practicable economic and technical opportunities should be taken to upgrade the substations to meet current Network Standard requirements. If this is not achievable, a risk assessment must be performed to identify any residual risks and determine their implications for Western Power's decision-making. Refer to the Brownfield Standard[1] Appendix H for a sample of a risk assessment.

## 4.4 Compliance with this Standard

The Network Designer shall use the Standard Design principles published within this Manual unless it is impractical or unsafe to do so. It is then the Network Designer's responsibility, in conjunction with the customer or their architect, to prepare an alternative arrangement design that shall meet Western Power's requirements.

Where project designs vary from Western Power's Standard Design Principles a detailed report is required to be submitted to Western Power for approval detailing the variations and shall include a record of information as described below:

- the reason for derogations on clauses of this standard
- the alternative provision that which satisfies safety risks are SFAIRP
- an explanation of how the proposed substation design is fit for purpose and will facilitate installation of "standardised Western Power distribution equipment".

[1] Brownfield Standard

Any derogation must be approved by a Team Leader and a Senior Engineer. The design shall be recorded in the register[2] with the accompanying report.

[2] Chamber Substation – derogation list

# 5. Site Selection

The following considerations shall be investigated when choosing a site for a chamber substation:

1.) The structure of the substation or chamber is to be designed to have a design life no less than 50 years matching the building structure.

2.) All other services must not pass through or infringe into the substation site area including accompanying access, ventilation ducts, cable risers and trays.

3.) Electromagnetic Field (EMF) impacts to the surround on the substation shall be considered when choosing a site. A strong focus should be given to sensitive equipment such as operating theatres. Shielding can be considered; however, the installation shall not be allowed inside the substation.

4.) Building columns, beams, footings shall not encroach on the clearances referred to in this document. This applies to accompanying access, as well as the space required for the ventilation ducts.

5.) The selected site/location shall be clear of all obstructions which could interfere with the installation of the substation earthing system. Due to the high resistivity of soil in WA, the depth of the earthing system/rods could extend beyond 15m.

6.) No more than two (2) transformers in the same enclosure / room, with transformer pairs fire segregated

7.) Cable route selection be deemed as a factor for site selection such that all associated cable pulling methodology shall not exceed the maximum pulling tension and maximum cable radius during and after installation.

8.) Transformer, switchgear and kiosk access and installation methodology to be considered

9.) The selected site/location shall consider installation access requirements & restrictions that will impact the construction/replacement of assets as part of future fault/maintenance works.

## 5.1 Prohibited Locations or Areas

Substation and associated access route shall not be within any of the locations listed below:

1.) Hazardous or wet area as per AS3000

2.) Confined space as per WHS safety regulations

3.) Locations where fire and or explosion is exacerbated such as but not limited to storage rooms of combustible materials as per AS/NZS 60079.10.1 – Explosive gas atmospheres

4.) within 10m from any fire hydrant as per AS 2419.1 – Fire hydrant installations

## 5.2 Acoustic Noise Levels

AS2067 requires substation to consider community requirements being met which includes having a minimal noise impact. Designers need to consider the requirements of the relevant environmental protection agencies, or development approval conditions stipulated by government authority or local government regulations. The acoustic noise level shall be as low as reasonably practicable and shall not be more than 85dB (A) for working in the substation. Similarly, external noise due to the substation operation shall be as low as reasonably practicable.

## 5.3 Building below potential water table or 1 in 100-year flood level

### 5.3.1 General Requirements

Where a chamber substation or any associated chamber, pit, or conduit is installed below the level to which the surrounding groundwater may rise under any foreseeable condition, provisions shall be made to ensure that wall cavities and sub-floor areas are adequately drained. Drainage shall be directed by gravity to an approved discharge location or to a dedicated collection sump.

### 5.3.2 Design Certification

A drainage system designed and documented by a practising Civil Engineer or Hydraulic Engineer and demonstrating compliance with the performance requirements of this section, may be accepted by Western Power as meeting the intent of the standard.

### 5.3.3 Pump System Requirements

All drainage components, including any sump and pump equipment, shall be located external to the substation and related chambers.

An automatic pumping system shall be provided, designed and installed in accordance with the relevant Australian Standards, including applicable electrical, hydraulic, and mechanical requirements.

The electrical supply and control systems for the pumps shall be independent of the substation's electrical installation.

### 5.3.4 Redundancy

To ensure continuity of operation in the event of equipment failure, the pumping arrangement shall incorporate not fewer than two pumps configured to provide operational redundancy. The accountability of repair or replacement of failed pump(s) sit with the building owner.

A durable and clearly visible label shall be installed within the substation, identifying the presence of the pump system and specifying the source of electrical supply to the pumps.

### 5.3.5 Structural and Waterproofing Provisions

The substation floor and associated structures shall be designed to withstand hydrostatic pressures that may occur should the pumping system become inoperative.

Waterproofing systems, membranes, and construction detailing shall be selected and installed to prevent groundwater ingress in accordance with relevant Australian Standards and good engineering practice.

### 5.3.6 Post-Commissioning Requirements

If groundwater ingress or flooding occurs at any stage during the operational life of the chamber substation, the building owner shall be responsible, at their expense, for supplying and installing a compliant dual-pump system and any additional groundwater-control measures deemed necessary by Western Power.

## 5.4 Layout

Where possible, DSPM Section 3 and the appropriate indoor substation layout is to be used. Where the site is constrained and requires modification, the following rationale should be accounted for when producing the substation layout:

- Complies to all requirements in AS/NZS 2067
- Equipment (Transformer, RMU and LV Kiosk) dimensions can be found in DSPM – Chapter 4 for 22kV equipment and Chapter 10 for 33kV equipment
- Minimum separation of transformer door to any wall shall be 1000mm when doors are opened. This is for combined egress and operational requirement.
- Minimum separation of a transformer (non-opening side) to a wall shall be of minimum 1000mm. This is for combined egress and future proofing the clearances for future transformer upgrades (i.e. larger dimensions).
- Minimum separation between two transformers is 1000mm. Where transformer doors are opposite each other, additional 600mm will be required to achieve egress clearance whilst both doors are open.
- 200mm minimum separation up to a maximum of 400mm from the back of the HV RMU to the nearest wall. HV switchgear presently used in Western Power have rear mounted arc fault discharge vents. It is essential that the area behind the HV switchgear is kept clear of objects that can interfere with the proper operation of the arc fault discharge vents. Personnel presence or thoroughfare behind this switchgear is not allowed when the substation is energised.
- Minimum head clearance of 2.5m. All other roofing fixtures such as lighting, ducts are to be above the minimum head clearance.
- A constructability, operability and maintainability (COM) review workshop needs to be completed with relevant Western power representatives (Customer Connections Solutions, Engineering and Design, Asset Performance and Operational Maintenance).

## 5.5 Fire and Blast Rating

### 5.5.1 General Requirements

The separating wall between any access way or corridor and the substation chamber(s) shall provide fire and blast resistance equal to that required for the substation chamber.

Unless otherwise specified and approved in writing by Western Power, the minimum structural fire resistance level (FRL) for substations containing combustible insulating liquid-filled equipment shall be not less than FRL 120/120/120, with a minimum blast resistance of 2 kPa.

Customer-owned Energy Storage Systems (ESS) shall be located such that they do not obstruct, encroach upon, or adversely affect access to substation entrances, exits, emergency egress paths, or fire escape routes.

### 5.5.2 Construction Requirements for Fire-Rated Access Corridors

All components forming a fire-rated access corridor shall be constructed from reinforced concrete or reinforced masonry (reinforced blockwork).  The fire resistance performance of the access corridor construction shall match the fire rating required for the associated substation chamber. An example but not limited to, is the cable access route needing protection from a fire that could originate in the basement (outside of the chamber).

### 5.5.3 Structural Integration Requirements

All walls forming the substation chamber and associated access ways shall be structurally connected (tied) at both the floor and the ceiling to ensure structural integrity during fire or blast events.

## 5.6 Lightning Protection

Lightning protection for the substation chamber is inherently included in the lightning protection system of the building where the chamber is housed. A lightning risk assessment shall be carried out for free standing chamber substations and measures taken to manage identified risks in accordance with AS/NZS 1768 “Lightning Protection”.

The lightning protection earthing system shall be electrically isolated from the chamber substation earthing system. Bonding between the two earthing systems is permissible only where the interconnection satisfies all performance, safety, and installation requirements stipulated in AS 1768.

# 6. Access

Access, without notice, by Western Power personnel to all Western Power chamber substations shall be unimpeded and unrestricted and maintained 24 hours, 7 days a week.

Under the Energy Operators (Powers) Act 1979, the energy operator, in this case Western Power shall be taken to have a right to access or carry out activities necessary for the operation and for the purposes of the performance of the asset functions.

No public or occupant access must be through the Western Power dedicated access ways.

## 6.1 Vehicle Access (below ground chamber)

A minimum of 3-metre-wide area or driveway to the substation chamber is provided.

Common methods of heavy equipment delivery are as follows:

| Method | Loading Requirement | Turning Radius |
|---|---|---|
| Articulated Crane (Franna) | 25 tonnes | 8.0m |
| Mobile crane and truck | 21 tonnes | 9.0m |
| Self-loading truck (Hiab or Palfinger) | 21 tonnes | 14.0m |
| Permanent Cranes and lifting devices | Monorail and Trolley shall comply to AS1418 | N/A |
| Heavy-duty forklift | 12.5 tonnes | 6.0m |

Access route slope shall not exceed a 1:10 and shall have a minimum headroom of 5.5m metres. The area outside the entrance to the substation shall have a minimum clear height of 6m, where a dedicated access way is utilised.

Where minimum clear height cannot be met along the vehicle access way, the order of preference is as follows:

### 6.1.1 Heavy-duty Forklift

Where a heavy-duty forklift is used to transport the transformer from the loading bay into the chamber substation room, the following points shall be considered:

- Able to accommodate transformer weight of 5 tonne (1MVA) derated to accommodate reduced capacity on slopes. (typical 10-25% buffer on capacity)
- A minimum of 3m headroom along the access way
- Capable of auto-levelling fork technology or fork tilt-indication system to ensure fork stays perfectly level on incline/declines maintaining the transformer’s centre of gravity within the stability triangle.
- Usage of spotters and banksman due to limited visibility with transformers

### 6.1.2 Franner Crane and Skates

Straight ramps are treated using a Franner Crane and skates under the transformer to lower it into the basement. This requires 2.5m clear height. Ramps with transition or are curved requires the installation of pulling eyes. These are used in conjunction with Tirfor hand-winch associated with snatch block to continue the descent to the required level. Pulling eyes shall be engineered for the required line-pull loads generated during the descent of the transformer. Pulling-eyes shall be rated to the calculated maximum line pull (with a minimum safety factor of 4:1) and installed at regular intervals determined by the installation engineer (typically 2–3 m spacing along the descent path). Final size, rating, and spacing shall be certified by a structural engineer prior to installation.

## 6.2 Personnel Access

Personnel access hatchways are not permitted, and access is strictly via personnel entry doors. This requirement is extended for chamber substations. Personnel access via stairways, for below ground are to be fitted with handrails and to be of minimum 1200mm between the handrails. A minimum stairway headroom of 2200mm is required. Access doors shall be self-closing/locking doors that are openable from the inside without a key and is fitted with panic release bars. It also requires fitment of Network Operator labels as per AS/NZS 1905.

Personnel access doors shall be located diagonally opposite where possible or located on alternative walls to facilitate rapid escape in the event of emergency such as fire and explosion. Fire-rated doors including all associated hardware are to have a fire resistance level of X/120/120 and shall swing in the direction of exit and are not to open directly onto driveways or roadways or to another electrical room. For back-to-back chamber rooms, where an access door is fitted between the two rooms, the swing doors are to be bi-directional. Where this is not feasible, the underpinning principle for placement of access doors is to determine the optimal location that minimises egress time, overcrowding and away from line of fire from any hazard.

## 6.3 Equipment Access

The transformer access area shall be sized to provide adequate space for manoeuvring the transformer during initial delivery and any future replacement activities. To support safe and efficient movement of the transformer, the access area may be fitted with pulling rings, which may be either permanent fixtures or removable components. The same rule applies for HV metering customers i.e. RMU and HV Metering unit manoeuvrability and access requirements.

Equipment doors to have a clear opening of 2340mm x 1720mm.

All equipment doors are to be outward swinging fitted with hinges that allows a swing/opening of 180 degrees to allow for maximum manoeuvring space in front of the substation entry. Metal hinges are to be of heavy-duty non-corroding material and are to be of the same fire withstand of the door.
All fire rated doors are to be supplied and tagged with the fire rating.

Sliding and rolling doors are not permitted.

### 6.3.1 Specification for Fire Doors and Solid Core Doors

Required fire doors must comply with AS 1905.1, which is the construction Standard for fire doors. This Standard in turn requires that fire doors be tested in accordance with AS 1530.4.

If there is any glazing in the door, the door must not fail by radiation through that glazing within the period specified in the door's FRL criterion of integrity.

Western Power requires a fire door to have an FRL of –/120/30. Where a fire door is located in a firewall, a higher FRL is required. The first criterion of zero minutes is a reference to the structural adequacy of the door. AS 1905.1 does not require a fire door to be tested for structural adequacy. The final criterion of 30 minutes is a reference to the insulation the door must provide. It is difficult for a fire door to achieve a higher insulation criterion when tested in accordance with AS 1530.4. The fire door has to have a minimum of 100mm-thick reinforced concrete structure or a 150mm non-reinforced structure as specified in AS2067 6.7.1.5.

Any glass panel in a fire door must not fail through heat radiation during a fire, as measured by the AS 1530.4 test, before the door fails the integrity criterion. If the glass panel fails by radiation, spread of fire could occur due to radiant heat igniting combustible materials.

Louvered Doors are not to be used for below ground chamber substations.

### 6.3.2 Hatchways (case by case)

The preferred equipment access is via a dedicated access way. Refer to section 6.1 for further details. Where this is not practical or where site is constrained, such is the case in CBD areas, equipment access via hatchways is accepted on case-to-case basis provided the below requirements are met

- Transformer hatches can be permitted at Western Power's discretion provided that it is not located on tenanted areas or other areas normally occupied by persons.
- The location of the hatchway does not directly lead onto the substation room as meeting the fire rating requirements would require bespoke engineering and products and, on some cases, water penetrates into the hatchway cover directly into the substation room. Therefore, a landing area outside the chamber substation room shall be provided to ensure safe access and maintain compliance with fire and operational requirements.
- Where a hatchway is the preferred method, the hatch location shall be approved by Western Power prior to commencing of the network design.

Accessing the hatchway can only be done via two methods:

- Mobile crane lifting arrangements where this requires a headroom of 6 metres, access roadways suitable for heavy duty vehicles or
- A permanent lifting device (to eliminate personnel working under suspended load) suitable to lift the transformer (nominal weight of the transformer is 5 tonnes) from the unloading area to the transformer hatch. All lifting devices shall have its Safe Working Load (SWL) stamp visible for the crews. Refer to DSPM Chapter 6 for permanent lifting devices.

The access side of the hatch is to have sufficient clearance for vehicle access (frannah or flatbed). Refer to Section 6.1 for the vehicle dimensions and further information. The remaining sides two (2) sides of the hatch shall have a minimum of 600mm clearance against any obstruction. The third side (apart from the access side) may need greater clearance for when immediate/adjacent storage of the hatch lids.

Access chamber and access ways are to have adequate clearance to enable future maintenance i.e. equipment replacements or upgrades and allowing equipment to be moved into place without restrictions from walls or other equipment within the chamber substation including but not limited to other cable accessories such as frames and ladders.

The hatch cover shall be designed and installed to accommodate all required surface finishing materials and waterproofing systems. Detailing of the surface finish and waterproofing for both the hatch cover and the surrounding area must ensure that the hatch cover can be removed and replaced without causing damage to either the hatch cover finish or adjacent finishes.

The hatch lifting points are to be stamped with Safe Working Load (SWL) visible for the crews.

The perimeter of the hatch cover shall be clearly defined within the surrounding surface finish. After final installation of equipment, the hatch cover must be properly sealed in place and re-sealed whenever the hatch is accessed.

A nearby on-site area shall be provided for the temporary storage of the hatch cover, allowing it to be placed flat and kept clear of streets and pedestrian pathways.

## 6.4 Cable Access

Cables coming from and to the road reserve requires a dedicated easement. The width of the easement may vary depending on the number of cables and conduits (future provisions) but shall be no less than 1m. No structures nor finished approved levels can be altered within the easement and requires approval from Western Power. For chamber substation further down below the basements, a 3D easement shall apply for the vertical alignment of the cable, typically in the cable risers, cable ladders and the likes.

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

### 6.4.1 Cable section between road reserve and building

Cable routes between the substation trench and the road reserve shall be installed as straight as practicable. Where a straight alignment cannot be achieved, surface treatments such as cable turning pit that allow easy access for cable bending must be provided. If the cable bend occurs within a trafficable area, the turning pit lid must be designed to withstand the expected vehicle load conditions.

The size and depth of the turning area or turning pit must account for the number of conduits and the minimum cable bending radius. Refer to Table 1 - Cable Data for design consideration for applicable cable data.

As the cable approaches the building cable entry, the maximum depth of the cable shall be between 750mm up to 1200mm to avoid shoring or temporary retaining of the trench when the cable requires replacement.

All cables shall be installed inside an appropriately sized conduit with a provision for a spare conduit for each cable going in and out of the substation.

### 6.4.2 Trenches, Ducts and Other Penetrations

Duct type, size, locations are as per DSPM requirements. Additional ducts may be required as per WP designer due to location and ancillary services, such communication and remote earth applications.

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

Trench dimensions are to be designed as per DSPM requirements. Retrofitting of existing trenches are not encouraged due to difference in latest switchgear and cables. Changes to trench dimension from DSPM requirement will require WP design engineer approval prior to construction. The following principles applies to all trench design, ease of access and egress for cables, jointing and termination and any other design solutions. Use of a small permanently fixed ladder or rebated foot-wells in the side or end of the trench shall be provided.

The cable trench also acts as an oil containment in case of catastrophic tank failure as such trench surfaces and enclosure floors are to be painted with an appropriate sealant. Trenches are to have 50mm wide x 38mm deep rebate to allow for trench cover.

Trench covers are to be either a FRP mesh cover or FRP slab and are to be fitted flush to the floor. The trench covers shall be:

- Supplied and installed in removable sections.
- Fire resistant so as to not increase the fuel loading within the substation.
- Resistant to the effects of fauna and environmental conditions.
- 35mm thick and are to be 26 kg/m2 where it is an FRP Slab and 38mm thick and are to be 18.2 kg/m2 where it is an FRP Mesh Grating
- Structurally supported by brackets and fixtures throughout, that do not hinder cable installation, entry into equipment or access
- Are fixed in place to prevent movement under foot but allow for removal and replacement when required for maintenance and cable installation

### 6.4.3 Cable Risers, Ladders, and Trays

Where cable entries are laid using cable risers and trays, the cleating of the high voltage and earthing cables shall be verified by the designer using the TE supplied Cable Cleats Force Calculator and Product Selector Tool[3] and details for the Cable Cleat types and the spacing will be provided part of the design drawing. Cable ties, particularly for HV and LV cable use, is strictly prohibited.

All cable trays and support brackets are to be able to support the final cable weight during and after the installations. The width maybe splayed to allow for sufficient space for the cable bending radii, ensuring the cable does not rest on sharp edges of the trays.

All cable trays, ladders, support brackets must be earthed by a minimum of 35 $mm^2$ copper cable and shall be terminated to the substation main earth bar.

Where the cable riser is outside of the substation room, it must be located so that personnel can access it without obstruction from plant or equipment. It must not be installed within any area classified as hazardous under AS/NZS 3000: Australian/New Zealand Wiring Rules and must not be considered a confined space under applicable Confined Spaces Regulations.

Continuous and unobstructed access to all cables within the riser is required. To support this, the riser is to be fitted with access openings that span the full width and height necessary to allow maintenance and cable installation activities. The access openings may be divided into multiple

[3] Cable Cleats Force Calculator and Product Selector Tool

panels, provided the required Fire Resistance Level (FRL) is maintained and any framing does not restrict cable access. All access panels are to provide a minimum FRL of -/180/30 and allow full access when opened.

Where multiple panels or leaves are used, they must be capable of being securely fastened in both open and closed positions using appropriate, durable hardware suitable for the building environment and use case. Hinges, fasteners, and related components must be heavy-duty and corrosion-resistant.

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

A clear zone of at least one metre must be maintained directly in front of the cable riser access points at all times. This is inherent due to the cable bending radius for the HV conductor.

| Type of Cable | Voltage (kV) | No of Cores | Cable Size (mm$^2$) | Conductor Material | Reel Length (m) | Nominal Overall Cable Diameter (mm) | Maximum Pulling Tension (with sock on cable as described in No. of cores column) (kN) | Minimum Bending Radii (Bundle/One Cable) | | Stock Code | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Installing (mm) | Installed (mm) | Standard cable | Termicide treated |
| Transformer Cable | 33 | 3x1 | 50 | Al | 250 | 81.4 | 7.5 | 1220/945 | 815/565 | EE2003 | EC1336 |
| Transformer Cable | 33 | 1 | 50 | Al | 1000 | 37.8 | 2.5 | 945 | 565 | EE2004 | NA |
| HV Feeder Cable | 33 | 3x1 | 185 | Al | 250 | 98.4 | 11.8 | 1475/1140 | 985/685 | NA | EE2551 |
| HV Feeder Cable (labelled Core 1) | 33 | 1 | 185 | Al | 1250 | 45.6 | 5.5 | 1140 | 685 | NA | EE2171 |
| HV Feeder Cable (labelled Core 2) | 33 | 1 | 185 | Al | 1250 | 45.6 | 5.5 | 1140 | 685 | NA | EE2172 |
| HV Feeder Cable (labelled Core 3) | 33 | 1 | 185 | Al | 1250 | 45.6 | 5.5 | 1140 | 685 | NA | EE2173 |
| Transformer Cable | 22 | 3x1 | 35 | Al | 250 | 66 | 5.3 | 990/765 | 660/460 | EE2101 | EE2558 |
| Transformer Cable | 12.7 | 1 | 35 | Al | 500 | 30.6 | 1.75 | 765 | 460 | EE2141 | NA |
| HV Feeder Cable | 22 | 3x1 | 95 | Al | 250 | 78 | 9.4 | 1170/905 | 780/545 | EE2151 | NA |
| HV Feeder Cable | 22 | 3x1 | 185 | Al | 250 | 87.6 | 10.5 | 1315/1015 | 875/610 | EE2163 | EE2557 |
| HV Feeder Cable (labelled Core 1) | 22 | 1 | 185 | Al | 1250 | 40.6 | 4.9 | 1015 | 610 | NA | EE2175 |
| HV Feeder Cable (labelled Core 2) | 22 | 1 | 185 | Al | 1250 | 40.6 | 4.9 | 1015 | 610 | NA | EE2176 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| HV Feeder Cable (labelled Core 3) | 22 | 1 | 185 | Al | 1250 | 40.6 | 4.9 | 1015 | 610 | NA | EE2177 |
| HV Feeder Cable | 22 | 3x1 | 240 | Cu | 250 | 92.5 | 11.1 | 1390/1075 | 925/645 | EE2165 | EE2164 |
| HV Feeder Cable | 22 | 3x1 | 400 | Al | 250 | 105.4 | 12.7 | 1580/1225 | 1055/735 | EE2168 | EE2169 |
| HV Feeder Cable (labelled Core 1) | 22 | 3x1 | 400 | Al | 1250 | 48.9 | 5.9 | 1225 | 735 | NA | EE2181 |
| HV Feeder Cable (labelled Core 2) | 22 | 3x1 | 400 | Al | 1250 | 48.9 | 5.9 | 1225 | 735 | NA | EE2182 |
| HV Feeder Cable (labelled Core 3) | 22 | 3x1 | 400 | Al | 1250 | 48.9 | 5.9 | 1225 | 735 | NA | EE2183 |
| LV Feeder Cable | 415 | 1x3 | 120 | Al | 250 | 37.7 | 4.5 | 680 | 450 | EC1100 | NA |
| LV Feeder Cable | 415 | 1x3 | 240 | Al | 250/ 750 | 50.9 | 6.1 | 915 | 610 | EC1102 | - |
| | | | | | | 53.9 | 6.5 | 1350 | 810 | - | EC1337 |
| Service | 415 | 1x3 | 25 | Cu | 250/ 1000 | 25.5 | 2.3 | 460 | 305 | EE1425 | NA |
| Street Lighting | 415 | 1 | 16 | Cu | 1000 | 14.1 | 0.7 | 255 | 170 | EE1421 | NA |

**Table 1 - Cable Data for design consideration**

Where the riser extends above a suspended or false ceiling, access to this upper section must be provided through appropriately fire-rated and lockable access openings consistent with the requirements above. A removable ceiling section must be available to permit entry, and a one-metre clear space, measured from the exterior of the access opening, must be maintained. No building services are to be installed within this clearance zone.

## 6.5 Loading Area (Hardstand)

A 2.5m wide loading area (hardstand) along the full face of the chamber containing the equipment access doors. It is preferred that the loading area is not located in a driveway requiring traffic management. The ground outside the substation should be at the same height as the substation floor. From there, it should slope gently away from the substation at a ratio of 1:100. The slope must not run sideways across the front of the substation. The loading area (hardstand) shall be designed and is fit for purpose for equipment and its weight requirements.

Pulling eyes are required at various turning points together with appropriate landing area. Similar requirements at Section 6.1.2 will apply for the pulling eyes.

# 7. Substation Earthing

All earthing and bonding connections are to be clearly labelled for testing and maintenance purposes.


## 7.1 Earth Grid

The earth grid is to be designed and constructed in accordance with the relevant DSPM or where the layout is bespoke shall be part of the detailed design. The design shall implement the standards and guidelines of AS/NZS 2067 and EG-0.

## 7.2 Earth Electrodes

The earth electrodes shall satisfy the design requirement to achieve a functional requirement or as so far as is reasonably practical stipulated in the Distribution Design Earthing Standard and Guideline.

The earth electrode system including the equipotential bonding interconnections shall be installed prior to the placement of any waterproofing membranes and before construction of the covering floor slab. Electrodes shall be positioned at a minimum separation distance equal to not less than their full vertical length unless permitted in the design. Cable identification markers shall be provided on the completed surface directly above the installed earth grid conductors.

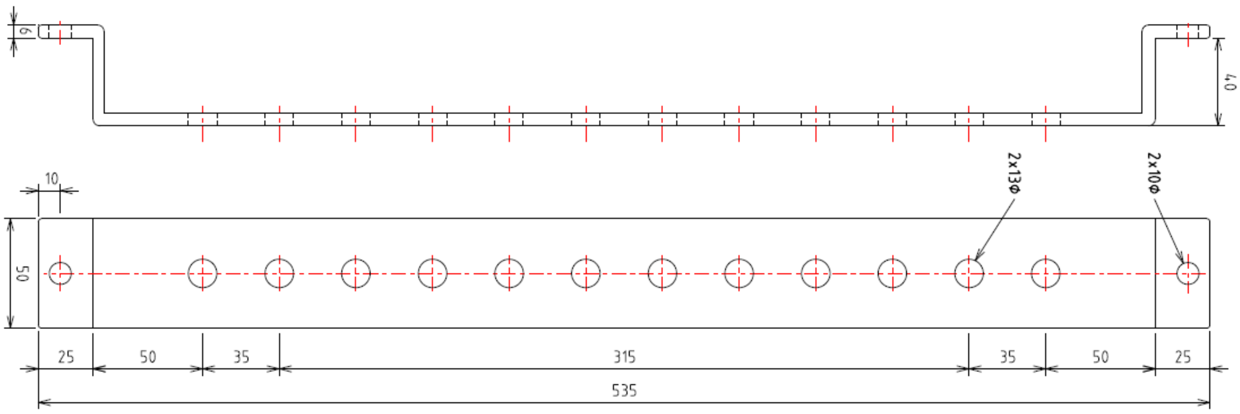
Where the substation is constructed on a suspended floor slab, i.e. multilevel basements, the earthing electrodes are to be installed at the lowest level of building excavation directly below the substation footprint and is interconnected via an earthing cable back to the substation room's grading ring. For design and construction timing and discrepancies, each substation electrode is to have a minimum reading of 10 ohms and are to be completed by the customer. Where design deems that a lower impedance is required for the overall site to address transfer voltages and to meet SFAIRP principles in earthing, a remote earth location within the customer lot suitable for deep earth installation will be required. Deep earth going into the road reserve is the least preferred method due to congestion with other utilities and other metallic objects increasing the risk of voltage transfers.

All earth electrodes will require future testing and maintenance, as such the location of the earth electrodes are to be clearly marked and labelled on site and on the drawing.

Similar to the requirements on waterproofing provisions, appropriate sealing is required for when earth rod installation/penetration has occurred.

## 7.3 Substation Earth Bar

A substation earth bar (CE0010) shall be mounted 300mm above the substation floor at the end of the HV trench. Cable connections to the substation earth bar shall be installed using bolts, washers, and nuts in accordance with the sizes specified in the drawing below. All conductive frameworks, low-voltage (LV) board earths, and equipment earthing points shall be bonded to the earth bar.




The substation earth bar has been designed to provide a clearance from the wall of 45mm to enable the cable lug bolts to be inserted and removed from either side of the bar. Where additional connections are required, adjacent earth bars may be daisy-chained together. The substation earth bar must not be located where it would impede access to the trench and must not be located where it could cause a hazard to personnel.

## 7.4 Equipment Earthing

A 70 mm² copper conductor with single-insulated yellow/green PVC earthing cable shall be used to individually connect each item requiring earthing to the substation earth bar, with additional conductors provided where specified.

The following, but not limited to, shall be connected to the substation earth bar:

- Transformer tank
- All equipment cabinets/frames
- Low Voltage Neutral (where PENDA is utilised)
- Grading ring
- Door frame
- Ventilation Ducting
- Louvres
- Cable Ladder

## 7.5 Structure Earthing

Two copper earth earthing tails are to be exothermally welded onto the substation floor reinforcing, preferably close to the location of the HV earth bar. These earthing tails shall enter the cable trench at 300mm below the floor level and shall be terminated by Western Power to the substation earth bar.

## 7.6 Bonding Metallic Structures

A minimum of $35mm^2$ Copper conductor is to be used as bonding conductor and is to be completed by the customer and shown to Western Power part of the handover.

Metallic structures in and around the chamber substation are to be bonded to reduce earth resistance as well as to meet the requirement for achieving equipotential and addressing touch voltages. The following shall be bonded to the earthing system:

- Metallic structures such as handrails or barriers
- Steel door frames
- Ventilation grilles and ducting
- Cable trays and Risers
- The risks of transfer potential to a remote earth via bonding and the long run of cable supports or ducts (as an example) needs to be assessed and mitigated as part of the earthing design process. Similarly, LV MEN transfers should be addressed as such is the case for substation light and power earthing where supply originates from the customer main switchboard.

## 7.7 Customer Earthing

If applicable, AS/NZS 3000 Clause 5.3.6 requires the customer to have a dedicated earthing electrode and MEN connection for their electrical installations requiring meeting the earth fault-loop impedances.

# 8. Ventilation

For indoor substations in Western Power, the preferred ventilation method is natural airflow achieved through louvered openings installed on the external walls of the substation. When designed and constructed in accordance with the requirements outlined in this document, this approach generally provides sufficient cooling under normal operating conditions.

Where site-specific factors demand additional cooling—such as high ambient temperatures, restricted airflow, or concerns for personnel comfort—a mechanical (forced) ventilation system must be implemented. Forced ventilation is also mandatory in locations where louvered doors or openings are not permitted, including below-ground substations or more commonly known as chamber substations.

The forced ventilation system must be designed to:

- Maintain positive internal pressure to prevent the ingress of dust and other contaminants.
- Effectively dissipate heat generated by transformers during normal operation.

Although peak cooling demand typically occurs during periods of high load or elevated temperatures, a continuous positive airflow is always required to ensure contaminant control and maintain safe operating conditions. A minimum of continuous airflow is 0.5m$^3$ /second flowrate shall be maintained inside the substation room.

Ventilation ducts shall not be located where their openings may become obstructed, partially blocked, or otherwise rendered ineffective by foreseeable future developments or external environmental factors.

Louvred door or panel-type ventilation is not permitted in below-ground substations or locations subject to heavy pedestrian traffic, such as shopping centres, bus stops, or central business districts. In such cases, ducted ventilation to a suitable remote venting location is required.

The ventilation system shall be designed to prevent rainwater, spray, or moisture ingress into the substation chamber.

The building owner is responsible for the ongoing maintenance and reliable operation of the substation ventilation system. All inlet and outlet vent filters, including associated grilles, shall be routinely inspected, cleaned, and replaced as required to maintain the airflow necessary for effective cooling and contaminant control.

All ventilation fans shall be regularly inspected to verify correct operation. Any failed fan shall be replaced at the earliest opportunity, and suitable temporary measures shall be implemented to ensure the required ventilation rate is maintained until full system functionality is restored. Where fans are located within the room, the building owner or their representative shall arrange access with Western Power to facilitate inspection and maintenance activities.

Designs shall incorporate adequate access provisions to allow safe and efficient performance of all maintenance activities.

Maintenance activities that may reduce airflow to the substation room shall not be scheduled between 11:00 am and 7:00 pm during the summer period due to elevated thermal loading.

## 8.1 Air quality

The air source for incoming air is to be fresh, outside air and external inlet vents are to be located away from potential heat sources. Similarly, external outlet vents are open to fresh air and the only exemption is when vented to indoor areas where sufficient airflow is available to remove hot and potentially smokefilled air (an example of which is a carpark). The outlet vent shall not terminate in areas where heat or smoke could be exacerbated or subject to fire risk. In addition, heavy pedestrian presence such as foyers, lobbies are to be avoided. Where a direct vent outlet from the substation room is impractical, ducting must be used to redirect heat/smoke to a suitable location. Refer to section 8.3.1 for further details.

Where incoming air source may contain foreign substance such as salt deposits, fumes, and cement dust, the usage of air filter is required.

## 8.2 Natural ventilation

Natural ventilation operates on fundamental buoyancy principles driven by temperature-induced changes in air density. When heat-generating equipment—such as transformers—releases thermal energy into the surrounding air, the air temperature increases. As air warms, its density decreases proportionally, causing it to become lighter than the surrounding cooler air.

This reduction in air density creates a vertical pressure differential between the warmer air inside the room and the cooler ambient air at the inlet openings. The resulting stack effect drives the upward movement of warm air toward high-level vents while simultaneously drawing in cooler outside air through low-level openings.

The sustained heat emission from the transformer therefore establishes a continuous natural convection flow path. This airflow:

- Removes accumulated heat from the equipment enclosure,
- Helps maintain internal temperatures within allowable equipment limits, and
- Ensures ongoing air exchange without the need for mechanical systems, provided that openings are correctly sized and positioned.

In essence, the transformer’s heat gain initiates and maintains the natural ventilation cycle by creating the pressure difference required to move air through the space.

Inlet(s) to be positioned on the windward side and the exhaust to be on the leeward side. Ventilation shall be of minimum wind-resistance design in the events that louvre or grilles are used.

Roof outlet ventilators are acceptable for free standing indoor substation on a case-by-case basis and shall comply with AS60529 at IP2X degree of protection. If this is used, the roof ventilator shall not be directly above any electrical equipment and positioning shall still comply with the intent of cross flow ventilation rationale.

In addition, roof ventilators are to be treated to the same fire risk zone as the louvre ventilation.

The height difference of the outlet opening (located at a higher level) and the inlet opening shall be positioned at least 1.2m.

## 8.3 Forced Ventilation

Where possible, Western Power’s preference is a dedicated inlet should be provided for each transformer such that air will be blown across the transformer. However, where this is not possible, shared ventilation maybe acceptable as long as vanes / guide plates are installed avoiding dead zones and allowing redirection of airflow so that each transformer receives the needed amount of cooling air. For back-to-back chamber substations, series temperature loading of the air is not permitted.

Mechanical ventilation is to be designed and approved by a qualified practicing mechanical engineer and the certification is to be provided to Western Power.

The fans required for forced ventilation shall be designed considering a single point of failure where it shall include redundant fans to ensure safety and equipment reliability. In addition, as the fans are generally located inside the substation where access to the customer is restricted, an availability check (e.g. Building Management System or a circuit supervision) shall be made available.

### 8.3.1 Ductwork

Where ventilation ducts are needed, a minimum of 2.5m clearance is to be maintained from the bottom of the ducts to the floor of the substation.

Duct shall be of minimum practical length not exceeding 10m in length, and the number of bends shall be minimised. No changes in the cross-sectional area of the ducts are permitted. Conditional approvals maybe issued, subject to specific design and modifications to the building design.

Detailed ventilation duct routing drawings showing complete duct paths, dimensions, equipment and penetrations shall be submitted to Western Power for review and approval.

All unfiltered external vents and duct terminations shall be weatherproof louvres fitted with vermin-proof screening. External inlet and outlet ducts or vents should be located on different sides of the building wherever practicable.

The bottom edge of any duct opening shall be located at a height of not less than 3m above areas where pedestrian activity may occur. Where this is not possible, the minimum height can be reduced provided that upward-deflecting guide vanes are fitted externally on the weatherproof louvres.

Substation ventilation ducts shall not contain any other building services, shall not provide access to any other part of the building, and shall not form part of any other ventilation system.

Where a concrete plenum forms part of the ventilation system, all internal concrete surfaces shall be sealed with an appropriate concrete sealer. The plenum design shall ensure that water is diverted away from the area at all times, preventing pooling, dampness, or ingress into the substation.

The ductworks as per Section 7.6 shall be bonded, more importantly at the remote ends of the ductwork where transfer voltage is at its worst. As a minimum, remote ends of the ducts shall be bonded to the building reinforcement to address remote transfer voltage.

#### *Inlet Ventilation*

The ventilation ducting system shall be installed on the exterior of the substation room where practicable. Where external installation is not feasible, ventilation ducting may be installed within the substation room, provided that the resulting configuration complies with all spatial, access and electrical clearances requirements specified in this standard.

If internal ducting reduces available space or interferes with mandatory clearances, the substation room dimensions shall be increased accordingly to ensure full compliance with the requirements of this manual.

Transformers shall be positioned as close as reasonably practicable to the ventilation louvres or air inlets to ensure effective cooling airflow and optimal thermal performance.

Notwithstanding the above, a minimum clearance of 1250mm shall be maintained between all transformer surfaces and surrounding structures, including walls, ducting and other fixed obstructions.

The required 1250mm clearance shall take precedence over proximity to ventilation inlets where conflicts occur, unless otherwise approved through documented engineering justification.

#### *Outlet Ventilation*

For substations utilising forced ventilation, outlet airflow shall be discharged through purpose-designed outlet vents or ductwork sized to accommodate the required mechanically driven exhaust volume.

Outlet vents shall be positioned as high as practicable on the substation wall to support efficient removal of heated air and to optimise the performance of mechanical extraction systems.

Outlet ventilation openings shall be located on the wall opposite the inlet vents to establish a clear, unobstructed airflow path through the substation, noting that site or structural limitations may restrict exact alignment.

The minimum cross-sectional area of any outlet duct shall be equal to or greater than the internal outlet vent area, ensuring the duct does not restrict fan-driven airflow. The external outlet vent shall have a cross-sectional area at least equal to the internal outlet vent to avoid static pressure build-up within the duct.

The external termination point of the outlet duct shall be located as high as possible.

Where duct geometry, building constraints, or vent location inhibit adequate forced airflow, mechanical extraction fans shall be installed to ensure the required ventilation rate is achieved.

### 8.3.2 Fire Isolation Dampers

A fire isolation damper shall be installed at every inlet and outlet duct penetration at the substation end, except where the outlet damper is an integral component of the fan assembly. Dampers shall be designed to not operate due to normal conditions such as transformer overload.

Fire dampers shall be provided in accordance with AS 1682.1 (Fire, smoke and air dampers—Specification) and AS 1682.2 (Installation). The damper assembly shall incorporate a mechanically operated release mechanism that maintains the blades in the fully open position during normal operation. The release mechanism shall activate automatically upon detection of fire within the substation chamber, consistent with the activation and thermal-linkage requirements defined in AS 1682.1. The damper and its mounting arrangement shall be designed and installed in accordance with AS 1668.1 to ensure that, upon release, no moving components can fall, drop, or otherwise come into contact with live electrical equipment.

Where the fire dampers protrude into the chamber, protective guards shall be fitted to prevent personnel injury. On the flipside, where the damper is not within the substation room and is elsewhere along the ductworks, the ductwork section between the damper and the room shall meet the fire-rating requirement specified under Section 5.5.

### 8.3.3 Temperature sensor

Each transformer is to be fitted with temperature sensor maintaining 50 degree's setting to operate the fan controls for the transformer. The sensors are to be fitted directly above each transformer.

A manual override switch shall be installed outside the chamber substation room to enable Western Power personnel to operate the ventilation system to cool down the room and safely enter the substation for inspection or maintenance activities, particularly during high ambient temperatures in summer.

### 8.3.4 Wiring

The forced ventilation system must be fed from the Fire Essential Section of the Main Switch Board to ensure that power to the fan system is continually available from the building's essential services. The circuit to the fans shall allow for electrical isolation from the Main Switch Board to allow for maintenance of the fans and filters without disabling other essential electrical systems.

# 9. Fire Protection

## 9.1 Building Code of Australia

Fire protection design for a chamber substation must comply fully with the National Construction Code (NCC) – Building Code of Australia (BCA). Substation rooms located below ground level require construction that achieves the required Fire Resistance Level (FRL), with walls, floors, ceilings, and all service penetrations designed to prevent fire spread between compartments. Transformer rooms, HV and LV switchgear rooms, control rooms, and cable basements must be treated as individual fire-rated compartments, with fire-resistant doors, sealed penetrations, and appropriate fire-stopping systems installed in accordance with the NCC. Due to the challenges associated with underground installations, egress routes must be designed to ensure safe evacuation, and firefighter access must meet BCA requirements, including protected access paths and smoke-controlled escape routes. Mechanical ventilation systems for basements must incorporate smoke and heat control measures consistent with AS 1668 to provide adequate life-safety protection and support firefighting operations.

## 9.2 Fire Extinguishers

Portable fire extinguishers for a chamber substation must be selected and installed in accordance with AS 2444. Electrical equipment rooms typically require $CO_2$ extinguishers because they provide effective suppression without leaving conductive residue, making them suitable for HV and LV switchgear rooms. ABE dry chemical extinguishers should be positioned strategically at access points to provide general-purpose fire protection while avoiding placement within high-risk energised zones. All extinguishers must be positioned so they can be accessed without entering hazardous areas, installed at designated mounting heights, and labelled with compliant signage to ensure clear visibility. Travel distance limitations must be observed to ensure that personnel can reach an extinguisher within the allowable distance specified by the standard.

## 9.3 Fire Detection

Where a fire detection system is used in chamber substations, it must comply with AS 1670.1 and be tailored to the functional characteristics of each room. Heat detectors, either fixed-temperature or rate-of-rise, are better suited to transformer rooms, cable basements, and switchgear areas where airborne dust, ventilation airflow, or electrical equipment could cause smoke detector false alarms. For large cable basements, tunnels, or critical rooms, aspirating smoke detection (ASD) may be implemented to provide enhanced sensitivity and early warning capability. The fire detection system must be integrated to the customers Building Management System (BMS), enabling fire alarms/status, ventilation shutdown controls, and any gaseous fire suppression systems be available for Western Power crews going in and out of the substation.

## 9.4 CO2 Fire Suppression System (if required)

$CO_2$ fire suppression may be used in select basement substation rooms where electrical equipment makes traditional water-based systems unsuitable. Design of $CO_2$ systems must comply with AS 4214, ensuring the protected space can achieve and maintain the gas concentration required to suppress a fire. Because $CO_2$ presents a significant asphyxiation hazard, protected rooms must include pre-discharge alarms, mandatory time delays, and manual abort switches located at the entry points. Rooms must also be fitted with warning signage and post-discharge ventilation systems to safely clear $CO_2$ after an activation.

## 9.5 DFES Requirements

The Department of Fire and Emergency Services (DFES) imposes additional requirements for below-ground substations to ensure safe firefighter access and operational effectiveness. Access to basement levels must be provided through fire-rated stairwells or protected pathways that allow personnel to reach the substation without exposure to smoke or hazardous equipment. Hydrant systems must be designed in accordance with AS 2419.1, with DFES often requiring additional hydrants or hose reels due to the depth and complexity of basement spaces. Mechanical smoke exhaust and ventilation systems must support safe entry during firefighting and accelerate smoke removal following a fire or $CO_2$ discharge. DFES also requires fire indicator panels and firefighting information—such as substation layout diagrams, equipment locations, and hazard data—to be located at building entry points where crews can quickly access them during an emergency.

Fire Engineered Performance Solutions: If a substation chamber does not meet standard National Construction Code requirements, a Performance-Based Design Brief (PBDB/FEB) must be prepared in consultation with stakeholders, including the Built Environment Branch (BEB) of DFES.

Site Planning and Access: Substation sites must allow for fire appliance access (if applicable). This includes providing mountable kerbs (no higher than 100mm) at entrances/exits and ensuring access ways are free from obstructions at all times.

Security and Access: If the substation is secured by fencing or gates, they must have mechanical overrides or fail-safes to allow DFES access during an emergency.

Fire Detection and Monitoring: Substation fire alarm systems, particularly those with Direct Brigade Alarms (DBA), must adhere to the DFES DBA Connection Code.

Maintenance of Systems: Installed fire safety systems (e.g., detection, suppression) within the chamber must be maintained to the standards required at the time of installation, with AS 1851 recommended for routine service.

## 9.6 Fire rated certification

A network operator may request from the consumer/owner certification that the completed installation complies with the relevant sections of the WASIR, this document, National Construction Code and applicable industry standards to ensure substation fire rated requirements are achieved.

# 10. Substation Lighting and General Power

## 10.1 Lighting

Indoor substations are to be provided with lighting with adequate illumination level, preferably comprising of LED lights batten fitting with a minimum 2-way switch positioned on the door strike side of the access doors and are to be fitted with neon indicators.

Adequate lighting is to be provided to ensure people can operate equipment and work comfortably at all times of the day and night without straining their eyes.

One of the lights must have an integrated battery back-up unless the lighting circuit and the installations has provision for an alternative supply (e.g. customer owned backup generators).

The minimum lighting level required is of minimum 200 lux throughout the horizontal plane one metre above the floor level as depicted in AS 1680 series.

Light fitting placements should be given consideration and directly above HV switches, transformers, LV switchboard, cable trays and or ventilation ducts should be avoided as it is at risk of damage, block/reduce the lighting levels and could impede future replacement of assets.

## 10.2 Emergency Lighting

Emergency lighting shall be installed in all chamber substations, switching stations, and associated access ways. The design, installation, and performance of the emergency-lighting system shall comply with the requirements of the Building Code of Australia and AS 2293.

Emergency luminaires shall be configured to operate either concurrently with the normal lighting system—energising and de-energising with the primary lighting supply—or via approved motion-detection controls to ensure activation when personnel are present within the substation. This operational requirement is not applicable to shared access ways that form part of routine building operations.

The emergency-lighting system shall provide a minimum operating duration of 1.5 hours following loss of supply. All emergency-services wiring shall be segregated from other electrical wiring and equipment and shall be connected to a single normal-lighting circuit within the same room to ensure automatic activation upon primary-lighting failure. Test facilities shall be incorporated within the substation distribution board to enable periodic verification of correct emergency-lighting operation.

## 10.3 Power Outlets

A minimum of one single-phase, double, 10-amp, 240-volt general-purpose outlet shall be provided. This outlet is to be installed on the Customer's Service Board unless it is already included as part of the standard LV board design, and it must be supplied from a dedicated circuit. Depending on the equipment requirements within the substation, an additional three-phase outlet may also be necessary.

All GPOs must be protected by an RCD. Similar to ventilation maintenance, where the building owner or its representative requires access into the substation for RCD testing and maintenance, Western Power shall be notified for access/entry into the substation.

## 10.4 Remote Terminal Unit (RTU) Supply

Where the substation room has a Western Power owned LV Switchboard, the RTU supply shall be fed from the said switchboard unless all slots in the LV switchboard is required by the customer. The alternative is, including sole-use customers and HV metered customers, the RTU LV supply is to be fed from the customer's Essential/ High reliability circuit of the Main Switch Board via a captive GPO so as to prevent inadvertent removal of the RTU supply plug.


**Figure 10.1 - Captive GPO**

## 10.5 Light and Power circuits

All electrical wiring relevant to lighting, general power and ventilation shall be installed in accordance with AS3000 and Electricity (Licensing) Regulations 1991.

PVC conduits shall be used when single insulated cable is selected for the wiring of the light and power circuits. Where double insulated cable is used, it shall be installed on cable trays or PVC duct with cover.

Where requested a copy of both the "completion notice" and "electrical safety certificate" shall be provided to the network operator on completion of this work.

# 11. HV Supply / Switch Room

Where the installation follows DCCR 1-07-3, DCCR 1-07-4, DCCR 1-07-5 and DSPM 3-22 series for ground mounted equipment, wherein the customer is fed via HV Metering, sections of this document will still apply with the following considerations added:

- Typical arrangement in a HV metering shall be from left to right, however where it is not suitable due to site constraints and cable entry limitations, the metering polarity shall be reversed, and a note has to be added in the design.
- RM6 explosion vent for HV supply arrangement vents downwards into the trench. The acceptable setback for the RM6 to the nearest wall shall be of maximum 400mm as per DSPM 3-22; no less than 200mm for installation purposes. The back of the RM6 shall not be accessible to any personnel when the RM6 is in service/operation.
- Where the equipment access is on the short side of the room, a minimum of 1800mm is required between the equipment access door and the edge of the trench to allow for landing and manoeuvrability of the equipment. This also serves as a buffer for personnel safety when maintenance is on-going whilst the trench covers are removed.
- Where customer's protection panel is required, a free-standing cabinet shall be located opposite of the customer switchgear mounted against a wall. A 600mm egress clearance is to be maintained when both panel doors are open.
- Where SCADA/RTU panel is required, the preference is to have the panel placed to the nearest wall along the trench. Where this is not possible, i.e. access doors are on the short side of the room, the panel is to be placed opposite the metering unit. A 600mm egress clearance is to be maintained when the panel doors are open whilst the metering unit is pulled out. Appropriately sized conduit to be placed between the trench the panel for secondary wiring and terminations.
- RTU LV supply is to be fed from the customer's Essential/ High reliability circuit of the Main Switch Board
- Though transformers are not present for the HV Supply/Switch room, presence of SF6 in addition to heat build-up requires forced ventilation to maintain positive air pressure.
- Both switch rooms (Western Power and Customer) are to be fitted with separate earth bars to fully comply with the technical rules regarding no reliance between the two earthing system.
- Where combustible insulating liquid-filled equipment is present (e.g., customer CTs) instead of dry-type equipment, the HV Switch Room must meet the required fire rating in accordance with Section 5.5.1. This requirement applies because earlier Western Power switchgear used combustible insulating liquid insulation. For non-combustible insulation mediums such as $SF_6$, or when dry-type equipment is used, the fire-rating requirement may be waived provided that:
    - The HV submission documents clearly state that Western Power will not approve or permit any future replacement of equipment with oil-insulated types
    - Fire risks associated with combustible cable sheaths are addressed as part of the fire risk assessment.
    - The Switch Room is free-standing or away from other building