Major Substation Building Design

SDI 510

Amendment No 7
December 2022

Endeavour Energy

Revision History

This standard replaces: SDI 510 am6 – Buildings

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Document Control

Documentation content coordinator: Engineering Delivery Manager

Documentation process coordinator: Standards Process Coordinator

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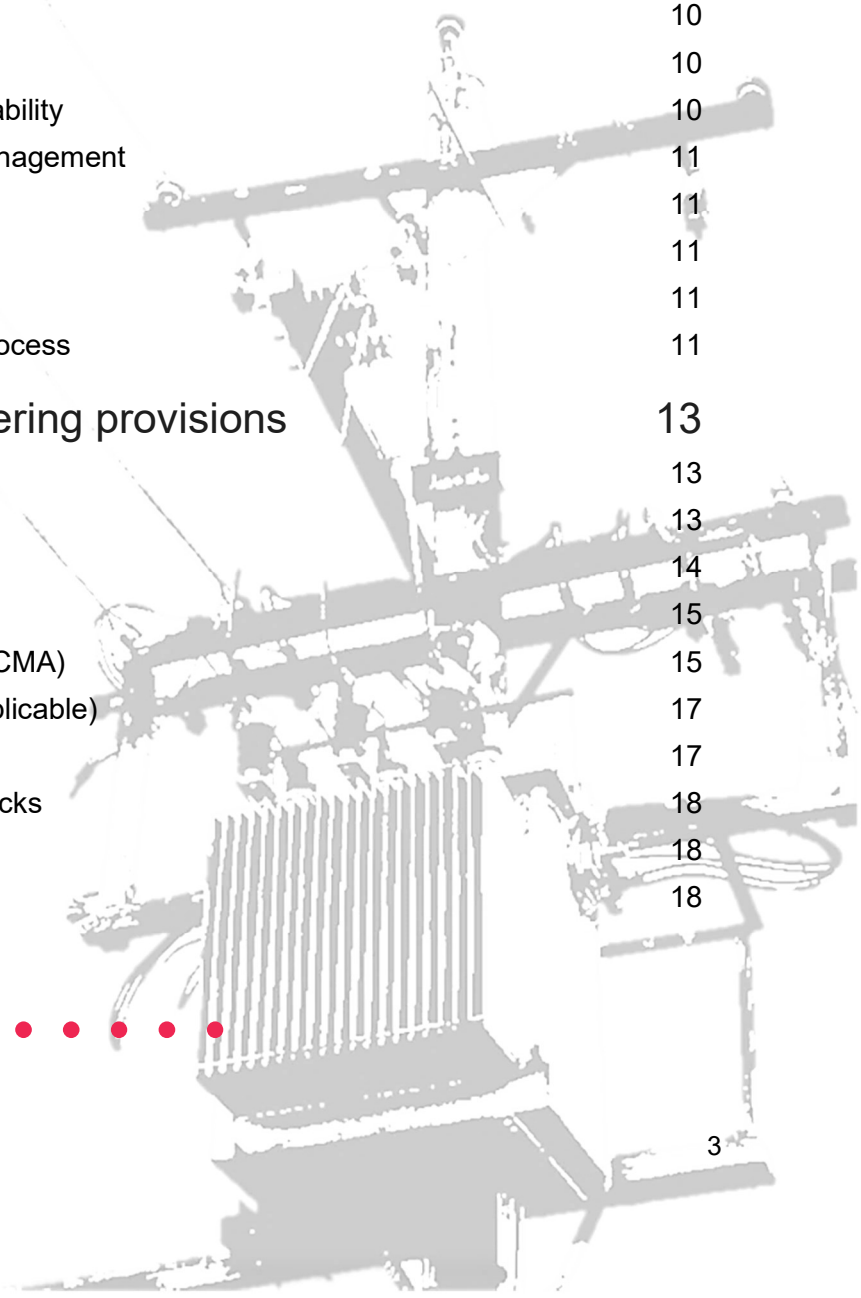
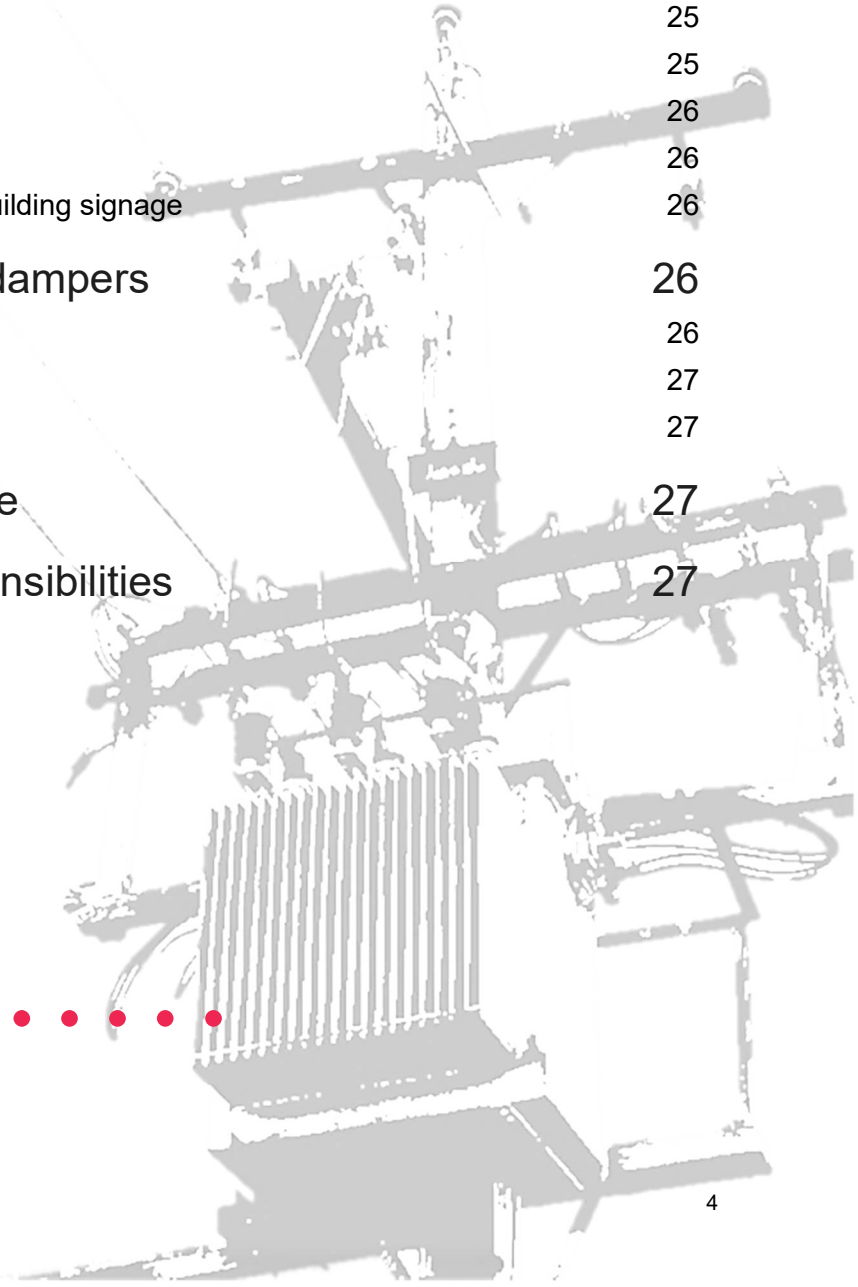




1 Scope

This standard sets out the performance and design criteria for architectural and structural design of buildings for major substations and switching stations in the Endeavour Energy network. It covers the design, finishing and furnishing of both permanent and prefabricated buildings.

This standard must be read in conjunction with SDI 505 and the various documents referenced within.

2 References

External Regulations
Electricity Supply Act 1995 (NSW)
Electricity Supply (Safety and Network Management) Regulation 2014
Environmental Planning & Assessment Act, 1979
Work Health and Safety Act 2011
Work Health and Safety Regulation 2017
State Environmental Planning Policy (Infrastructure) 2007

External Codes of Practice
SafeWork NSW First aid in the workplace – Code of Practice; July 2015

External Standards
Australian Building Code Board (ABCB) – National Construction Code (NCC), Building Code of Australia – Volume One (BCA)
ENA National Electricity Network Safety Code (Doc. 01-2008)
AS 1345:1995 - Identification of the contents of pipes, conduits and ducts
AS 1397:2011 - Continuous hot-dip metallic coated steel sheet and strip - Coatings of zinc and zinc alloyed with aluminium and magnesium
AS 1562.1:2018 - Design and installation of sheet roof and wall cladding: Metal
AS 1657:2018 - Fixed platforms, walkways, stairways and ladders - Design, construction and installation
AS 1670.1:2018 - Fire detection, warning, control and intercom systems - System design, installation and commissioning
AS/NZS 1170 - Structural design actions set
AS/NZS 1841.1:2007 - Portable fire extinguishers Part 1: General requirements
AS/NZS 1841.6:2007 - Portable fire extinguishers Part 6: Specific requirements for carbon dioxide type extinguishers
AS/NZS 1891.4:2009 - Industrial fall-arrest systems and devices Part 4: Selection, use and maintenance

External Standards
AS 1905.2:2005 - Components for the protection of openings in fire-resistant walls Part 2: Fire-resistant roller shutters
AS/NZS 2179.1:2014 - Specifications for rainwater goods, accessories and fasteners Part 1: Metal shape or sheet rainwater goods, and metal accessories and fasteners
AS 2444:2001 - Portable fire extinguishers and fire blankets - Selection and location
AS 2067:2016 - Substations and high voltage installations exceeding 1kV A.C.
AS 2865:2009 - Confined spaces
AS/NZS 3000:2018 - Australian/New Zealand standard electrical installations
AS 3011.2:2019 - Electrical installations - Secondary batteries installed in buildings - Sealed cells
AS/NZS 3500.3:2021 - Plumbing and drainage - Stormwater drainage
AS/NZS 3504:2006 - Fire blankets
AS/NZS 3666.1:2011 Air-handling and water systems of buildings – Microbial control. Design, installation and commissioning
AS/NZS 3823.1.1:2012 - Performance of electrical appliances - Air conditioners and heat pumps
AS/NZS 3835.1:2006 - Earth Potential Rise: Code of practice for the protection of persons and plant – Code of practice
AS 3959:2018 - Construction of buildings in bushfire-prone areas
AS 4145.2:2008 - Locksets and hardware for doors and windows - Mechanical locksets for doors and windows in buildings
AS/NZS 4536:1999 - Life cycle costing - An application guide
AS 60529 - Degrees of Protection Provided by Enclosures (IP Code)

Company Policies and Procedures
Company Policy 9.2.5 - Network Asset Design
Company Policy 9.9.1 - Network Asset Maintenance

Company Standards
Automation Design Instruction ADI 0006 - Substation communication systems
Earthing Design Instruction EDI 516 - Major substation earthing design, construct and commissioning
Equipment Technical Specification ETS 0018 Audio Frequency Injection Control Equipment
Mains Maintenance Instruction MMI 0013 - Clearances to be maintained between network assets and vegetation
Substation Design Instruction SDI 501 - Subtransmission Network and Zone Substation Configuration
Substation Design Instruction SDI 503 - Fire detection, control and suppression systems
Substation Design Instruction SDI 505 - Minimum design and construction requirements for transmission and zone substations and switching stations

Company Standards
Substation Design Instruction SDI 509 - Fire hydrants
Substation Design Instruction SDI 513 - Substation batteries and battery chargers
Substation Design Instruction SDI 522 - Deluge showers
Substation Design Instruction SDI 524 - Fencing and perimeter security at zone and transmission substations, and switching stations
Substation Design Instruction SDI 527 - Clearances
Substation Design Instruction SDI 528 - Substation signs and equipment labels
Substation Design Instruction SDI 529 - Light and power
Substation Design Instruction SDI 531 - Installation of conduits in transmission/zone substations and switching stations
Substation Design Instruction SDI 532 - Plumbing and drainage
Substation Design Instruction SDI 533 - Toilets in transmission and zone substations
Substation Design Instruction SDI 537 - Electronic security systems in transmission/zone substations and switching stations

3 Definitions and Abbreviations

Abbreviation	Meaning
AFIC	Audio Frequency Injection Cell
BCA	Building Code of Australia (the first two volumes of the NCC)
CMA	Cable Marshalling Area
DA	Development Application
FRL	Fire Resistance Level
EPA	Environmental Protection Agency
NCC	National Construction Code
SCADA	Supervisory Control and Data Acquisition
SDS	Safety Data Sheet
RFS	Rural Fire Service
NSWFB	New South Wales Fire Brigade
ZS	Zone Substation
TS	Transmission Substation

Term	Definition
Building(s)	Permanent or a prefabricated civil structure purposely designed and built to accommodate electrical items such as switchgear, control and protection equipment, telecommunications equipment, audio frequency injection equipment, auxiliary equipment, batteries and cables needed for the operation of an electrical substation; along with non- electrical items, such as washrooms.
Certifier	A corporation or individual who has a current *Certificate of Accreditation* issued by the NSW Building Professional's Board
IP54	Limited protection against dust ingress (no harmful deposit). Protected against splash water from any direction.
Major Substation	Endeavour Energy's Sub-Transmission Substations, Zone Substations or Switching Stations.

A full list of definitions is contained in SMI 100 and SMI 101

4 Functional and General Requirements

4.1 Design Standards Compliance

As a minimum, substation buildings must comply with the requirements of the National Construction Code (NCC)[1] where appropriate, mandatory requirements of AS 2067 and the requirements of this standard. Where compliance with the 'Deemed to Satisfy' provisions of the NCC is considered to be impracticable, 'Performance Solution' provisions of the NCC can be considered.

In addition to the above, specific local council requirements, the NSW Rural Fire Service and/or NSW Fire Brigade requirements and other statutory requirements may be applicable.

Particular considerations apply to requirements for substation buildings that are in excess of those specified in the above standards due to fire and blast risks that are required to be addressed. In particular the overpressure management and venting of substation buildings must be in accordance with this standard.

4.2 General

The substation building(s) must have a minimum IP54 rating to AS 60529 with a minimum thermal insulation of R2.5 in the walls and ceilings and must be designed to accommodate the following items of equipment where applicable:

- High voltage switchgear;
- Battery chargers, control, protection, metering, communications and SCADA equipment;
- Batteries;
- Auxiliary HV and LV equipment;
- Audio frequency injection equipment;
- Toilet facilities complete with hand basin and meal room facilities and hot and cold potable water supply;
- Storage facilities for spare equipment, drawings and manuals, trolleys, blanking plates, cover plates, signs, ladders, hanging racks etc
- An operators' desk;
- The design requirements for substation buildings must comply with the following:
- Provide adequate accommodation for, and protection of the enclosed electrical equipment;
- Provide a safe working environment for all users including:
  - having appropriate access for equipment installation, maintenance and replacement particularly with regards to live substation environment; make suitable allowance for safe access to routine operating and visual monitoring locations;
  - make suitable allowance for safe work at heights with adequate space provided to allow ladders, scaffolding, elevated work platforms and the like to be utilised where required;

[1]Note: AS 2067 and the National Construction Code (NCC) (Building Code of Australia (BCA)) specifies requirements for electrical substations and similar installations. The NCC classifies Electrical Substations buildings as Class 8. The NCC includes some exemptions for electricity network substations.

  - provide suitable access to emergency facilities such as eyewash, emergency shower and fire protection equipment in the event of an emergency;

- Meet the required design life criteria;
- Be cost effective when assessed on a life-cycle cost basis;
- Be designed and constructed cost-effectively and within required time constraints;
- Prevent unauthorised access and have appropriate levels of security based on a site-based risk assessment;
- Provide protection against intrusion from vermin and wildlife;
- Comply with the requirements of the NCC with regard to the risk of being affected by fire or fire spreading including fire protection of openings and penetrations to achieve fire risk minimisation;
- Minimise the risk of moisture ingress;
- Make suitable consideration to facilitate the future development of the substation; and
- Meet compliance requirements of the NCC and relevant Australian Standards.

4.3 Structural design loads

The structural components of Substation buildings, must be designed with an 'Importance Level 4' and an annual probability of exceedance for non-cyclonic wind of 1:2000 in accordance with the NCC and AS/NZS 1170 Structural design actions set for design loads.

The above loading includes prefabricated type and fixed type buildings.

4.3.1 Replacement considerations

Replacement of components of the substation building is allowed for accessible and replaceable non-structural elements. These may include, but is not limited to the following items:

- External roof and wall sheeting materials;
- Roof guttering and downpipes;
- External architectural elements;
- Exposed external metalwork such as handrails, ladders, louvres and the like;
- External doors and door frames; and
- Internal fitting and finishes such as doors, cornices, paintwork and the like.

Items identified for replacement should be subject to a lifecycle cost assessment in accordance with Section 4.4.

4.4 Lifecycle costing

The building design must be subject to a lifecycle assessment under AS/NZS 4536. The outcome of the lifecycle costing process, which may include community and environmental inputs, must be approved by the Manager Design prior to the final building design approval.

4.5 Safe access and maintainability

The building design must minimise future maintenance requirements and its construction must minimise the risk of damage from external sources, such as from bushfires or vandalism. Where applicable, the design of the external facades of buildings must avoid features that have a potential to assist unauthorised entry to a substation property.

The substation building and layout must be of sufficient space to allow safe access, operation and maintenance as detailed in Section 6. Rooms of the building must contain provision for safe egress. Where practicable, confined spaces must be avoided.

4.6 Fire and explosion risk management

The protection of buildings and personnel against fire must comply with the requirements of the NCC, this standard and SDI 503. Fire segregation, to limit the impact and spread of fire, must be in accordance with Section 7. The location of the building must take into account the potential for fire impact from other sources, including outdoor equipment, transformers, adjacent buildings and fire-source features in accordance with the NCC.

Equipment with pressure relief devices and arc contained switchgear must be arranged so that any emission from the device is directed away from the normal operating position.

The building must be able to withstand any build-up of internal pressure or have suitable pressure relief devices.

Fire alarm systems will monitor the condition of the building in accordance with SDI 503.

4.7 Emergency facilities

Emergency facilities, including eyewash, showers, fire extinguishers, fire blankets and spill kits must be located at key positions as detailed in this standard for the protection of personnel and the environment.

Emergency showers and eyewash systems must be in accordance with SDI 522.

4.8 Security risk management

Substation building design must incorporate measures for the safety of the public, operational personnel, and the electrical network. This includes the building design and location having due regard for site fencing requirements, the incorporation of electronic security systems, provisions for lighting and adequate locking and signage.

External fencing and security must be in accordance with SDI 524.

Electronic security provisions must be in accordance with SDI 537.

4.9 Ecological sustainability

The building design will minimise future maintenance requirements and its construction must minimise the risk of damage from external sources, such as from bushfires or vandalism.

4.10 Building development process

4.10.1 Development approval

Where a new substation project involves the construction of a new building, the demolition or modification of an existing building or the installation of a prefabricated building, Endeavour Energy will carry out an environmental assessment of the works and self-determine the proposed development under the State Environmental Planning Policy (Infrastructure) 2007.

Whilst no DA submission is required to be made to the local council, the design and environmental assessment of the project must go through a public consultation process, and wherever practical consider the requirements of the current local environmental plan (LEP) and development control plan (DCP) documents.

The local Council must be given written notice of the intention to carry out the proposed works and Endeavour Energy will consider any response received from the Council.

4.10.2 Architects and engineers

Substation Design will determine if an architect or principal consultant is be provided for a project that contains a building construction component. The architect must authorise all architectural drawings to comply with the requirements of this Standard.

The design of the project is to provide optimal costs and must fully comply with Endeavour Energy Standards. Any deviation from the Endeavour Energy Standards is required to be approved by the Head of Asset Planning & Performance.

Architects and engineers must have professional indemnity insurance of $10M and be registered in the state of NSW.

Substation Design will determine if a NCC certifier is to be engaged.

Substation Design will determine if the principal consultant is to engage sub-consultants such as structural/civil/mechanical/hydraulic engineers. Consultant engineers must be Chartered Professional Engineers and hold relevant indemnity insurance.

4.10.3 Certification

On completion of the substation building, the following certification evidence is required to be provided to Endeavour Energy:

- Where an architect has been engaged, a statement evidencing that the architect has inspected the works during construction and that it has all been satisfactorily completed in accordance with their documentation.
- A separate statement from the Structural, Civil, Hydraulics, Electrical, and Mechanical Ventilation Engineer evidencing that they have inspected the works during construction and that it has all been satisfactorily completed in accordance with their documentation including stormwater and sanitary drainage.
- A certificate from the contractor evidencing that all of the electrical light and power services, and the water supply and sewer drainage works have been inspected by the Regulatory Authority and are satisfactorily completed.
- A Construction Certificate issued by the certifier.

4.10.4 Inspection & Test Plan

An Inspection & Test Plan (ITP) must be prepared by Substation Design for all substation construction projects that have a construction activity, element of work or trade work.

An Inspection & Test Plan (ITP) must be prepared and completed for substation construction projects.

The Inspection and Test Plan will identify the items of materials and work to be inspected or tested, by whom and at what stage or frequency, as well as Hold and Witness Points, references to relevant sections of the specification and drawings and what records/reports are to be provided.

Inspection and Test Plans, when properly implemented, help ensure that, and verify whether, work has been undertaken safely in accordance with the contract specification and drawings.

Project Managers have the authority and responsibility for the implementation and completion of the Inspection and Test Plan.

5 Structural and engineering provisions

Substation buildings will be of prefabricated type or fixed type build. The typical requirements are as follows:

- Both prefabricated and fixed buildings will be erected on a suspended floor supported above the ground by concrete columns or steel columns as appropriate, to allow access for high voltage cables.
- The cable marshalling area below will be concrete slab (integrated with footings) designed to support high voltage cables, cable support stands, cable pulling points, cable ramps and to assist with cable arrangement and access.
- For fixed and prefabricated buildings, the suspended floor of the substation building must be of suitable reinforced concrete or steel construction and other approved materials.
- External walls will typically be steel stud framed with metal cladding with a Colorbond finish with internal walls dry-wall clad stud frame. Metal cladding with Colorbond finish or similar for the internal walls can be considered.
- The roof will typically be metal clad with a self-shed roof pitch and Colorbond finish, constructed with a steel structural frame. Internal ceilings will generally comprise of metal cladding with Colorbond finish or plasterboard lining with appropriate fire-rated materials as required.

5.1 Floors

The substation building switchroom floor must be suspended to allow for the installation of high voltage cables.

The suspended floor of the substation building must be of reinforced concrete construction or can be constructed from steel and other approved materials.

The finished floor surface in the high voltage switchroom must have a degree of finish, hardness and flatness that meets the requirements of the switchgear supplier. This may be aided by a granolithic topping for concrete floors. For floors of steel construction, this hardness and finished level can be achieved by using suitable materials such as compressed fibre cement flooring with a vinyl sheet covering.

The maximum allowable deflection of the floor must meet the requirements of the switchgear supplier, which typically is 1mm over a 1m distance and a maximum of 3mm of deflection across the length of the switchgear. For steel framed floors, any part of the switchboard support steel members, such as Unistrut channel or parallel flange channel must be constructed to the same tolerance.

Concrete floors must be finished with a dust proofer and surface sealer in light grey colour.

5.2 Walls

5.2.1 External walls

External walls will typically be steel stud framed with metal cladding with a Colorbond finish. Suitable vapour barriers (wall wrap) and flashing are to be provided to achieve assured protection of the building interior from the ingress of rainwater and solar radiation, whilst also preventing condensation.

External wall insulation materials must have a minimum rating of R2.5.

5.2.2 Internal walls

Walls of the auxiliary switch room and cell room shall be designed to withstand a blast impact of 3kPa.

Walls of switch rooms containing high voltage equipment shall be designed to withstand a blast impact of 1.5kPa unless arc contain switchgear is utilised.

Internal walls will typically be of steel stud frame construction. All plasterboard wall surfaces must be painted with a suitable sealer/undercoat and two (2) finish coats of good quality PVA paint (or similar) in a mid-range semi-gloss finish of a light colour.

Metal wall claddings with a Colorbond finish are also acceptable.

5.3 Roofing system

5.3.1 Roofing material

Roofing material will typically be of zincalume steel with a Colorbond finish of a light colour installed in compliance with the NCC and manufacturer's guidelines. The manufacturer's approved products including sealants, fasteners and flashing must be used. The roofing material must include a workmanship and product warranty of minimum of 20 years

All roofs must be constructed to prevent the entry of moisture under harsh weather conditions. A condensation barrier must be included in the roofing design.

Roof designs must have a roof pitch that self-sheds debris. As a general principle, no roof will have a pitch less than five (5) degrees.

Roof designs must integrate with the internal ventilation system so that incidental solar heat is not re-radiated into the building. Roof insulation materials must have a minimum rating of R2.5.

Roofing materials, their design and installation must comply with AS 1397 and AS 1562.1.

5.3.2 Roof structure

The roof structure must comprise of a system designed to resist collapse during a fire in the substation building. Accordingly, a structural steel system is preferred, and where fire rating is required it must be protected by a fire-rated ceiling.

5.3.3 Roof maintenance access

Roof support structures must be designed to support loadings from roof maintenance activities.

An appropriate system is to be provided for safe maintenance access onto the roof area. As a minimum, roofs must be capable of being fitted with sufficient fall arrest anchor points to comply with relevant SafeWork or other legislative requirements and AS/NZS 1891.4, including a ladder bracket system with signage.

The design and layout of the anchor system must be such that it can be used for appropriate fall restraint techniques with minimal fall distance and pendulum effects.

5.3.4 Rainwater roof plumbing

Roof guttering, downpipes and all associated accessories shall be of a type that is commercially easy to obtain and that requires nil-to-low maintenance.

In this regard a manufacturer's warranty shall be obtained for:

- corrosion to perforation of the base material, minimum 20 years.

- delamination due to natural weathering of the applied coating, minimum 20 years.

All roof plumbing materials shall be of zincalume steel with a Colorbond finish; installed in compliance with the NCC and the manufacturer's instructions. To maintain compatibility with the plumbing material, only the manufacturer's approved products, such as sealants, fasteners and flashings shall be used.

Colorbond coated zincalume steel eave type guttering and circular profile downpipe systems are preferred.

Box gutters must not be used.

The gutter must use a leaf guard system to prevent the accumulation of leaves and other debris that result in blockages. It is also preferred that leaf guard systems are separate from the guttering system so that the guttering can be easily maintained and replaced.

Guttering and downpipe systems must comply with AS 1397, AS/NZS 2179.1, and AS/NZS 3500.3.

All water from the guttering is to be piped to an approved drainage system in accordance with SDI 532.

5.4 Ceilings

Ceilings of the auxiliary switch room and cell room shall be designed to withstand a blast impact of 3kPa.

Ceilings of any other rooms containing high voltage switchgear shall be designed to withstand a blast impact of 1.5kPa unless arc contain switchgear is utilised.

Internal ceilings will generally comprise of metal clad or plasterboard lining. Where fire rating is required, a fire-rated system will be installed as indicated in clause 7.1, comprising of Fyrchek or equivalent fire rated cladding, screwed into the metal support framing. Control joints must be provided, and the lining must be installed in accordance with the manufacturer's recommendations.

Ceiling cornice detailing must be minimal; a Rondo P50 or equivalent type shadow trim is preferred.

As a general principle, the creation of a void in excess of 500mm between the ceiling lining and the roof sheeting is to be avoided to negate the need for a duplication of the smoke detection system and the provision of associated access panels.

Where a ceiling void in excess of 500mm cannot be avoided, the ceiling structure must be appropriately reinforced throughout so that it can fully support the weight of a person standing/laying upon it.

Exposed ceiling surfaces must be set and painted with a suitable sealer/undercoat and two (2) finish coats of good quality PVA paint (or similar) in a white semi-flat surface finish.

5.5 Cable Marshalling Areas (CMA)

Switchrooms will be elevated to allow for the entry H.V. cables under the building and shall be referred to as Cable Marshalling Areas (CMA). The clear ceiling height of the CMA should be a minimum of 2150mm and must comply with the NCC to allow a safe work area and egress of personnel.

In situations where plugin terminations are used or the cables are a large diameter (CSA > 1200mm^2), the CMA ceiling height may need to be higher than the minimum height to comply with the NCC.

The design of a CMA must incorporate the minimum cable bending radius, the length of the cable termination and adequate room to connect the cables into the HV switchgear.

The CMA should typically be installed at the finished ground level with natural drainage. In situations where the CMA is to be partially below ground level, the provisions of 5.5.3 will apply.

The floor of the CMA must have lightly reinforced concrete paving suitable to fix cables and cable supports and that provides for safe access. The space planning requirements of Section 6.1 will apply.

Provisions for cable pulling and positioning points must be provided in the building design, including the use of the building piers to allow cables to be positioned and pulled.

All CMA's that are situated at ground level will require emergency egress paths, which must be maintained unobstructed.

5.5.1 Cable entry into building

The switchgear cable access penetrations must be through floor slots located to suit the connection of the high voltage cables to the switchboard. The building structural support columns are to be located clear of the cables.

The number of cable supports must be limited to reduce trip hazards; however, the cable supports must still allow the cable to be fully supported.

Sharp edges and projections on steelwork and cable tray must be avoided, with all surfaces required to have a smooth finish.

Provisions to facilitate the installation of power cables must be included in the design of the CMA. They will be typically set opposite or above the conduit penetrations and in-line with the cable pulling anchors.

5.5.2 Cable entry into CMA

High voltage cables must enter the CMA via conduits. The conduits are to enter the CMA above the floor level.

Adequate protection must be provided for conduits that deviate from minimum buried depths.

Conduit support structures must be designed to withstand expected cable pulling loads.

5.5.3 Cable marshalling areas below ground level

In general, the CMA will be at the finished ground level unless specific site requirements dictate otherwise. Where economically justified, the CMA can be installed below the finished ground level.

Ventilation

Where the CMA is situated below the finished ground level, the ceiling of the CMA must be a minimum of 1000mm above the finished ground line to allow for natural cross-flow ventilation. Where natural flow ventilation is unable to be effectively provided, forced ventilation will be required as an alternative.

Drainage

Where possible, the CMA must be drained by natural falls, and dish drains must be provided around the perimeter of the CMA to keep water off the main floor area. The CMA floor surface must be finished with a minimum fall of 1% toward this perimeter dish drain.

Where the location of a building determines that drainage of the CMA and sub-soil water cannot be achieved by gravity, a pump system must be installed. The system will comprise of a sump or sumps within or externally adjacent to the CMA with dual sump pumps.

Sump grates within basements must be lightweight for handling ease. Sump pits must remain easily accessible and they must not be obstructed by any items such as cables or support structures. Sump depths must be kept to a minimum, while still allowing efficient removal of drain water.

All pumps must be easily removable for servicing without the need to enter the sump. Pump motors must be located a minimum of 600mm above the basement floor in accordance with typical drawing No. 351321. Pumps must be high-quality commercial/industrial grade with heavy-duty construction, to allow

them to move aggressive media such as liquids containing salt and fertilisers, abrasive material, chemicals and other ground contaminants. Pumps are to be self-priming.

A control panel must be located closely adjacent to the pump to facilitate ease of maintenance.

Location of the sump and pump arrangement must be carefully considered to avoid conflict with any on-floor cabling routes.

Access and Egress Requirements

If the CMA is required to be below finished ground level, the CMA must have emergency exit doors and a material access opening with double doors for receiving long material components.

The doors for the material access opening must open outward and be located in the basement wall under the loading dock. An arrangement where the door unit incorporates ventilation louvers is preferred. The minimum dimensions of the material access opening should be 550mm high and 1800mm wide. The door leaves must be secured in the same manner as an upper level door-set.

An egress path should be provided in the CMA for regular and emergency use. The layout of the CMA should aim to minimise hazards along the egress path. Access ramps should be considered in locations which are significantly obstructed.

5.6 Cable trenches (where applicable)

5.6.1 High voltage cables

Cable trenches must comprise of concrete bases and sides, with a smooth finish to avoid damage to cables during cable installation.

The depth of the cable trench must allow for the bending radius of the largest cable installed in the trench.

Trench covers must be metallic and corrosion resistant with a non-slip surface.

Trench covers must be hinged to facilitate opening and suitable measures must be provided to safely secure the hinged trench cover into the open position. Where hinged trench covers are not practical, the trench covers must have suitable lifting facilities.

To facilitate lifting and/or opening, trench covers must be limited to a maximum of 20kg.

The top of the cable trench and its cover must be flush with the finished floor level.

5.6.2 Control cables

As the preferred option, control cabling will typically be installed within the switch room/control room in cable trays suspended from the ceiling or wall above the switchgear and control panels.

Where this is not feasible or practicable, the control panel trenches are to be used where the control room floor level is at the finished ground level. These trenches will be located under the control panels and typically be as wide as the base access in the control panels. The trenches must also be deep enough to hold at least twice the maximum quantity of cables expected to be installed for the ultimate design. To allow maintenance, the depth must not exceed 500mm.

5.7 Provisions for earthing

Earthing must be provided to the building structural elements including, but not necessarily limited to:

- the steel building frame where applicable;

- reinforcement within concrete elements;
- water supply and plumbing services.

Earthing provisions must comply with EDI 516 and the final approved earthing design.

5.8 Stair flights and loading docks

External stair flights, landings and loading docks will be required to access the building. These must comply with the NCC.

5.8.1 Balustrading and handrails

Welded steel tube profile balustrading and handrails, in accordance with AS 1657, must be provided to stair flights and to loading docks. Where required, these must be removable.

Railings and their supports must be hot dip galvanised and be designed so that water cannot be trapped where the railings and their fittings meet or penetrate the concrete.

5.9 Lifting facilities

Lifting facilities shall be provided to allow the movement of equipment which is difficult to install, maintain or replace using manual methods utilising hand operated hydraulic mobile jacks, e.g. 132kV / 66kV GIS. Lifting facilities are not required where equipment can be jacked and skated without the need to dismantle the panel being moved.

The optimal lifting solution for each site should be determined by an economic evaluation and should be assessed via Safety in Design.

The lifting solution should allow the equipment to be lifted to and from the building landing.

The height of the room should allow the equipment to be comfortably lifted above adjacent units.

5.10 Doors and windows

5.10.1 Doors

Refer to Section 6.1.1. for safe egress requirements and location of doors. All door locks provided must comply with AS 4145.2.

All doorways must be of sufficient size to allow equipment in the room to be readily transported through the opening without the removal of building items or dismantling of equipment.

The external surface that is adjacent to the threshold of a doorway opening must be designed so that rainwater run-off that has the potential to be wind-blown or tracked into the building cannot accumulate. Exterior pavements that adjoin a substation building must be designed to fall away from the building at a minimum rate of 1% over a minimum distance of 1m, to shed water away from the building.

Escape doors in the basement, control room and rooms containing switchgear must open outwards and be fitted with panic bar exit devices. All door frames must be made of steel.

Non-exit doors, such as audio frequency injection rooms, meal rooms and toilets do not require panic bar exit devices, but must be fitted with an internal escape lever.

Toilet doors must be fitted with indicator bolts.

Audio frequency injection cell room doors must have a hasp and staple on the exterior to allow a padlock to be fitted.

All internal and external doors must be fitted with door closers without *hold open* features. External doors must also be fitted with a suitable mechanical latching device to hold the door fully open, with sufficient strength to retain the doors during strong winds (door closers with *hold open* features are not suitable for this purpose).

All external doors must be fitted with blocker plates.

Stainless steel butt hinges must be used on all hinged doors. All external doors must have three (3) fixed pins; internal doors must have three (3) loose pins.

All door hardware must be of *Lockwood Assa Abloy* manufacture of satin finish chrome on brass.

The broad door hardware requirements are as follows:

- Locksets and latch-sets – Lockwood 3572 SC mortice set with 570 series oval cylinders.
- Lever sets – Lockwood 1800 SC; with type 70 lever handles.
- Panic exit devices (single door leaves) – rim type for use with a mortice lock and external lever set.
- Panic exit devices (external double door leaves) – rim type to the active leaf, with non-panic vertical type bolts on the other leaf.
- Door closers – Lockwood – Arrow 7726DA series (7714DA for internal doors and 7726DA for external doors) – surface-mounted in a satin stainless steel finish (installed on the internal face of the door).
- Bolts – Lockwood 791 series, visible fix bolt type, provided top and bottom to the face of the door leaf. For leaves of nom. 2.1m height, the top bolt will be typically 300mm long: for those of 2.4m height, the bolt will be typically 600mm long. In all cases, the bottom bolt will be typically 300mm long.
- Toilet door (inside building) – Indicator bolt Lockwood 810 series surface mounted.
- Toilet door (external to building) - Indicator bolt and a mortice lock with an outside and inside handle.
- Hasp and staple fittings must be of galvanised steel comprising of a door plate of minimum 3mm thickness and approximately 50mm square, fixed by four (4) screws, with a staple arm having a sufficient eyelet to accommodate Endeavour Energy's standard security padlock.

5.10.2 Keying requirements

All locksets must be supplied either without the cylinders having been keyed; or with the cylinders keyed to the contractor's requirements to maintain site security.

Just prior to the building handover, all locks on substation access doors will be keyed by Endeavour Energy to allow authorised access.

5.10.3 External windows

New buildings must not have glass incorporated into any external openings except to amenities room / building provided the walling is not exposed to:

- Transformer enclosures within the limits defined in SDI 503 or;
- Within the limits of a fire source as defined by the NCC and SDI 503 or;
- A public space not protected by a security fence.

5.10.4 Internal windows

Internal windows are used for inspection of equipment such as frequency injection cells. Each door leaf used for access to a frequency injection cell room must have a 300mm minimum (vertical) x 200mm minimum (horizontal) size viewing window located above the lockset. The panel must be of heat-treated glass and must be integral with the fire-rated door system. Both the door and the viewing window must be rated to withstand a pressure of three (3) kPa.

5.11 Roller shutter doors

Roller shutter doors can be considered as an option to assist with equipment access.

Roller shutter doors must be made of industrial grade steel with solid internal guide channels (or similar) to provide, as a minimum, equal security to the other external door openings.

Roller shutter doors must be corrosion resistant, have a wind loading rating in accordance with the NCC and AS 1170.2 and fundamentally minimise dust and heat transfer.

Roller shutter doors must be manually hand chain operated; and they must operate smoothly with minimal maintenance.

Roller shutter slats must be powder-coat paint finished both sides; preferably in a light colour to avoid excessive solar radiation to the building interior.

Roller shutter doors must be located in a position that is not exposed to direct sunlight. Where this is not practical, appropriate measures must be used to minimise heat transfer.

Special attention must be made to prevent water entry into the room through the bottom and sides of the roller shutter door.

5.12 Building temperature management and ventilation

Buildings must maintain a reasonably constant humidity and air temperature.

For prefabricated buildings, the temperature should be a maximum of 25˚C which is regulated by air-conditioning. For fixed type buildings, the temperature should also be a maximum of 25°C regulated by air-conditioning in areas with electronic equipment. The temperature in all other areas within a fixed type building shall be maintained below 40°C.

Where a basement below ground cannot be naturally cross-ventilated it must be provided with a system of fan-forced ducted ventilation which operates upon entry to the basement. Where fan-forced ventilation is used, it must force air into the room (not extracted out), and it must be fitted with a filter that is easily removable and cleaned.

5.13 Overpressure

The substation building must be designed to withstand the overpressure that may result from fault and arcing activity.

Within HV switch rooms, facilities must be installed to vent arcing by-products away from all personnel access areas. The by-products of any arcing must be either fully contained or be vented outside in accordance with switchboard manufacturers recommendations.

Pressure relief panels shall be installed where switchgear is not provided with vent arcing. Where pressure relief panels are installed on external walls, the panels must be arranged so that in the event of an internal pressure increase, the panels will operate to relieve and limit the pressure increase in the enclosure to a maximum of 1.5 kPa. A pressure-relief unit must be designed to re-close immediately after operating (spring loaded or similar), to prevent excessive air flow occurring through the device which could fuel a fire

incident. Pressure-relief units must not be exposed to a fire source feature (as defined by the NCC), or directly exposed to any hazardous plant or combustible material.

Pressure relief and ventilation panels must be located in easily accessible locations.

Where there is no other alternative available other than locating the panels above the equipment, then to allow easy access to the panels appropriate distances from the equipment or other suitable means must be provided to facilitate access.

Under no circumstances are items such as pipework or cable trays to be located in a position that could restrict access to the pressure relief or ventilation panel or impede their operation.

The specific design requirement for ductile behaviour of building elements must be observed in accordance with the NCC.

5.14 Bushfire risk

Design and construction of buildings in bushfire prone areas must conform to AS 3959.

The floors of fixed buildings will be concrete and prefabricated buildings will be a non-combustible material.

Particular attention must be given to minimise the risk of both normal and abnormal operation or failure of the electrical equipment initiating a bushfire. Accordingly, vegetation around the substation must be cleared and maintained to the distances specified in MMI 0013.

5.15 Solar panels and Inverters

As per Endeavour Energy's requirements, a roof mounted solar PV generation system, complete with inverter rated to the system size shall be installed.

The design shall maximise the roof space, without protruding past the exterior wall line, and be designed to capture the maximum available solar energy, considering the location and orientation of the building.

The installation of the system shall not degrade the overall IP rating of the building, or provide excessive building deflection from increased wind loading and comply with AS/NZS 1170.

The installation of the system shall not divert stormwater runoff from the switchroom roof away from gutters or drains.

The inverter shall comply with AS 4777 and be registered with the Clean Energy Council of Australia. The inverter shall feed into the AC board in the building, in accordance with AS 3000 requirements. The inverter shall be located internal to the substation building.

The installation of the PV arrays shall comply to AS/NZS 5033.

6 Architectural design requirements

6.1 Space planning and layout

The following must be considered in the preparation of the substation layout:

- Specific room and accommodation requirements;
- Safe egress and adequate working space;
- Equipment handling plans;
- Cabling area requirement;

- General circulation and personnel access;
- Amenities;
- Emergency facilities;
- Security;
- Light & power;
- Data & communications;
- Earthing and lightning protection provisions;
- Coordination with services; and
- Consideration for future expansion

6.1.1 Egress and working spaces

Adequate working and circulation space must be provided around cables and electrical equipment so that all equipment operation and maintenance activities, cable connections and emergency escapes can be safely accessed. Working areas and egress paths must consider the following:

- Paths of travel to a required exit, from anywhere on the floor of the building, must be minimum 1m wide in accordance the NCC;
- Busbars through wall encroaching on minimum head clearances;
- Position of equipment during overhaul operations;
- Position of permanent electrical equipment, in particular switchgear and transformers;
- Positioning of cables particularly in cable basements, risers, marshalling and spreading areas;
- Positioning of cable trays;
- Positioning of other services within the building;
- Extent of emergency lighting provided;
- Positioning of doors;
- Fall arrest;
- Exposed conductors; and
- Section safety clearances (refer to SDI 527).

All rooms which contain high voltage switchgear must have at least two (2) exits. These exits are to be positioned diagonally opposite in the building, where possible, and must be spaced as far apart as practicable. The distances between doors must be in accordance with the NCC for Class 8 buildings.

Rooms with operating aisles not exceeding 10 metres in length, containing items such as protection and control equipment, frequency injection equipment, auxiliary switchgear, and batteries that do not impede access, can have one (1) access/exit point. However, in rooms where access is impeded by equipment or building fixtures then two (2) access/exit points must be provided.

Floor mounted door stops (or similar) must be installed to prevent doors and handles from causing crush injuries between the hand and the wall or wall fixtures when the door is opened.

6.1.2 Switchroom and control room access ways

Space must be made available on all sides of the switchgear in accordance with the manufacturer's recommendations to allow installation, cabling, maintenance and operation.

These access ways must be a minimum of 1000mm wide, to allow unobstructed egress from the switchroom. Where obstructions, such as removable parts or open doors, intrude into the path of travel to an exit, the unobstructed width of that path must be a minimum of 600mm. Where rackable switchgear is used, space must be provided in front of the switchgear when it is in the racked-out position to allow employee to pass unobstructed, or to allow the largest truck to be wheeled past if required. When retrofitting existing substations that have smaller aisles, it is acceptable to maintain the current aisle space as long as the space is not reduced.

A 1000mm clearance must be allowed between the back wall and rear of the switchboard or rear of control panels, unless they are front entry types.

All cabling and terminations must be easily accessible once the equipment has been installed.

6.1.3 Loading dock

A loading dock must be provided at an appropriate location to allow all equipment to be installed into the building or removed at any time. All loading docks must be provided with edge protection incorporating removable balustrading. Fall arrest anchor points to comply with relevant SafeWork or other legislative requirements and AS/NZS 1891.4 are to be provided for accessing the loading dock while the balustrading is removed.

6.1.4 Confined spaces

Where practicable, confined spaces must be avoided.

6.1.5 Battery accommodation

Batteries shall be installed in battery rooms or battery cabinets in accordance with AS 3011.2.

Adequate ventilation in accordance with AS 3011.2 shall be provided in the battery room or battery cabinet.

When the battery, battery charger or other equipment are not installed in a battery room, a suitable battery cabinet shall be used to house the equipment. Battery cabinets should be located adjacent to an external wall to allow for ventilation.

The ventilation shall be designed so that the batteries are not exposed to direct sunlight.

All station battery accommodation shall conform to AS 3011.2 and SDI 513.

6.1.6 AFIC accommodation

Where required, Audio Frequency Injection Control equipment must be located in suitable rooms within the building, in accordance with ETS 0018. The type of AFIC system will depend on the provisions detailed in SDI 501.

6.1.7 Data and communications

Provision must be made within the substation for the required data and communications installation works and for suitable access via communications conduits.

Provisions for cabinets, communication conduits and battery supply must be in accordance with ADI 0006.

6.1.8 Telephone and intercom

A telephone shall be installed in the substation control room. The telephone should typically be located near the control room desk and SCADA human-machine interface cubicle, so that a network operator can use the telephone and monitor the human-machine interface simultaneously.

All telecommunications brought into the substation shall be intrinsically isolated (for example, fibre optic) or through an approved telecommunications isolation device in accordance with EDI 516.

Power supply to the isolation equipment shall be from an AC supply. The internal batteries of the isolation equipment shall automatically power the unit when the normal supply fails.

Rubber mats shall be permanently placed on the floor for use during maintenance of isolation equipment.

Telephone circuits shall comply with AS/NZS 3835.1:2006. Refer also to ADI 0006, EDI 516, and SDI 531.

6.1.9 Amenities

These facilities may be part of the main building or a separate facility of fixed or demountable construction.

The meal room will be an area suitable to house a table and chairs to accommodate approximately 6 people, and shall be equipped with a sink having a cold-water tap and a waste bin. Lights and socket outlets must be provided in accordance with Section 6.4.

Toilets must be ventilated and have vermin proofing installed. A paper dispenser and a small, mirrored bathroom cabinet should be mounted on the wall near the sink. A 20mm cold-water hose tap must be fitted in the toilet area to assist in cleaning and maintenance.

Cleaning facilities shall include a tap that can be used to fill a bucket. For demountable amenities buildings a tap on the outside of the building must be provided to assist with cleaning.

Amenities are not required at sites housing a temporary mobile-type substation.

6.1.10 Control room furniture

The control room must include the following furniture as standard provisions:

- A desk
- A chair
- A document filing cabinet with 3-4 drawers to store equipment manuals
- A vertical file plan cabinet to store A1 drawings
- A wall mounted notice board in accordance with SDI 528
- A waste bin.

6.2 Emergency facilities

6.2.1 Eyewash

Eyewash facilities must be provided and located in accordance with SDI 522 Emergency showers and eyewash systems.

6.2.2 Emergency shower

Emergency shower facilities must be provided and located in accordance with SDI 522 Emergency showers and eyewash systems.

6.2.3 Fire extinguishers

Fire extinguishers must comply with AS/NZS 1841.1 and AS/NZS 1841.6.

Extinguishers must be installed in the substation in accordance with AS 2444; and be located beside every personnel doorway that leads to an exit.

Extinguishers must be suitable for flammable liquids in the presence of electrical hazards. Suitable extinguishers are the CO2 units, which allow easy clean up after their use. The typical sizes to be used are 5kg units.

6.2.4 Fire blankets

Fire blankets must be installed in the substation in accordance with AS 2444; and be located beside every personnel doorway that leads to an exit.

Both wet and dry blankets must be installed.

These blankets are suitable for different situations and they must be used in accordance with the Endeavour Energy Technical Training section's instructions.

Wet blankets

Wet blankets must be supplied by Water-Jel or approved equivalent. The typical size of the blankets will be 183cm x 152cm.

The wall mounting height will be approximately 700mm to the base of the supporting bracket to enable easy deployment. To further reduce the deployment time, the installation work will include the removal of two (2) of the four (4) clips that secure the lid.

Signs indicating that the blankets are not suitable for electrical fires (Warning - Not Suitable for Electrical Fires) must be placed in a prominent position adjacent to the blanket.

Dry blankets

Dry blankets must be provided alongside the wet blankets at approximately the same height as the top of the wet blanket container.

6.2.5 Oil spill kits

Every transmission and zone substation must be equipped with an oil spill kit. Spill kits must be stored in a dry location, easily accessible and clearly labelled.

Transmission substations must have a minimum of 2 x 240 litre hydrocarbon spill kits and zone substations must have 1 x 240 litre hydrocarbon spill kit.

6.3 Electronic security

Security provisions including electronic security systems must be in accordance with SDI 537.

6.4 Power and lighting

In addition to the normal AC and emergency DC lighting provided in accordance with SDI 529, self-contained battery back-up illuminated exit and directional signs, together with isolated emergency light fittings must be provided.

All lighting and power requirements for buildings must conform to the NCC, AS/NZS 3000, and SDI 529.

Electrical conduits must not be cast into the switch room or control room floor slabs. Where necessary, these conduits must be installed in a suitable manner, for example by surface mounting them in the basement.

6.5 Vermin proofing

All building elements must be animal and vermin proof. Animals and vermin include birds, possums, cats, rats, mice, snakes, foxes and termites. Where external ledges or potential bird roosting places cannot be eliminated, the need for 'bird-spikes' or similar systems to deter roosting must be considered.

6.6 Termite protection

The building should generally be designed to avoid the use of timber or cellulose based products that may be subject to termite attack.

6.7 Equipment labelling and building signage

Signage inside and outside the building must comply with SDI 528. Equipment labelling must comply with the minimum provisions of SDI 528.

7 Fire segregation and dampers

7.1 Fire segregation

Reference must be made to SDI 503 and SDI 509 to mitigate the risk of damage to substation assets and the environment in the event of a fire.

All fire rated materials must be long lasting, maintenance free and be suitable for the environment into which they are being fitted.

The use of an intumescent coating or fire-board linings (Promatect, Fyrchek or similar) to provide fire protection can be considered only where other more permanent methods of fire protection are not practical.

The technical provisions for the design and construction of all substation and switching station buildings within bushfire areas or containing equipment that could pose a fire risk (for example oil filled switchgear), must be in accordance with the following provided that they are as exacting as the FRL requirements in the NCC.

- Door sets: minimum FRL ---/120/30
- Roller shutter doors minimum FRL ---/120/30
- Walls: minimum FRL120/120/120
- Ceilings: minimum FRL 120/120/120

All other substation and switching station buildings where the fire risk is minimal must be designed and constructed in accordance with the FRL requirements in the NCC. For example, buildings that are not in bush fire areas or buildings that do not contain equipment that could pose a fire risk.

Where doors are exposed to a fire source feature (as defined by the NCC), or they come within the boundary distances as stated in the NCC for fire protection, then these doors must be identified as being fire doors by compliance tagging.

Signs in accordance with SDI 528 must be placed on each side of these doors indicating that they must be closed when leaving the area. Signs on roller shutter doors can be positioned alongside the door if necessary.

For fire segregation purposes in all substation and switching station buildings, high voltage power and control cables must not be installed in the same cable trench and they must not be laid on cable trays fixed to the same wall. Cables must be arranged so that a fire in a high voltage power cable does not affect the performance of the control cables. Power cables of different voltages must be laid in different cable trays.

7.2 Fire dampers

Fire dampers are generally not required on wall or floor ventilation openings as ventilation openings must not be directly exposed to any external hazardous plant, combustible material or to a fire source feature (as defined by the NCC). However, where fire dampers are required in exceptional circumstances, they will be typically of a type that comprises vertical drop type roll-formed steel blades with stainless steel retracting springs and a release mechanism controlled by a 71°C rated fusible link.

A fire-damper that is within a ceiling opening must be operated by a solenoid connected to the dedicated fire services control panel. The roof fire damper must have the facility for resetting during the testing of the fire system without the use of an elevated work platform or ladder.

7.3 Conduit sealing

Fire risk management associated with conduits between rooms and buildings must be in accordance with SDI 531.

8 Plumbing and drainage

All plumbing and drainage systems must be shown on the building drawings. Plumbing items, such as the fixtures described below, are typical requirements for installation in substation projects.

The water service connection and the provision of any on-site water storage must be in accordance with SDI 532.

The disposal of sewage from the property must be in accordance with SDI 533.

The provision of fire hydrant systems must be in accordance with SDI 509.

The provision of emergency deluge showers must be in accordance with SDI 522.

External water taps must be provided around the building in accordance with SDI 532.

Pipework must not be cast into the switch room or control room floor slabs. Pipework must be installed in a suitable manner – for example surface mounting the pipework in the cable marshalling area.

Cold and hot water pipework within a building must be copper and wherever practical, be installed within the cable marshalling area, upon the underside or around the perimeter of the floor slab above. Short lengths of branch risers will be taken to individual fittings.

Under no circumstances is pressurised water service pipe work to be installed upon a ceiling or within a roof-space that is above equipment such as switchgear and control equipment.

As a general principal, drainage that connects to external downpipes must be kept external to the basement.

All rainwater runoff from the building and all sub-soil drainage collected must be directed toward a single point of discharge from the substation property in accordance with SDI 532.

Plumbing works must include inspection and rodding points.

9 Authorities and Responsibilities

Chief Asset & Operating Officer has the authority and responsibility for approving this instruction.

Head of Asset Planning & Performance has the delegated authority and responsibility for approving this instruction for minor changes and making recommendations to Chief Asset & Operating Officer for major changes in respect to this instruction.

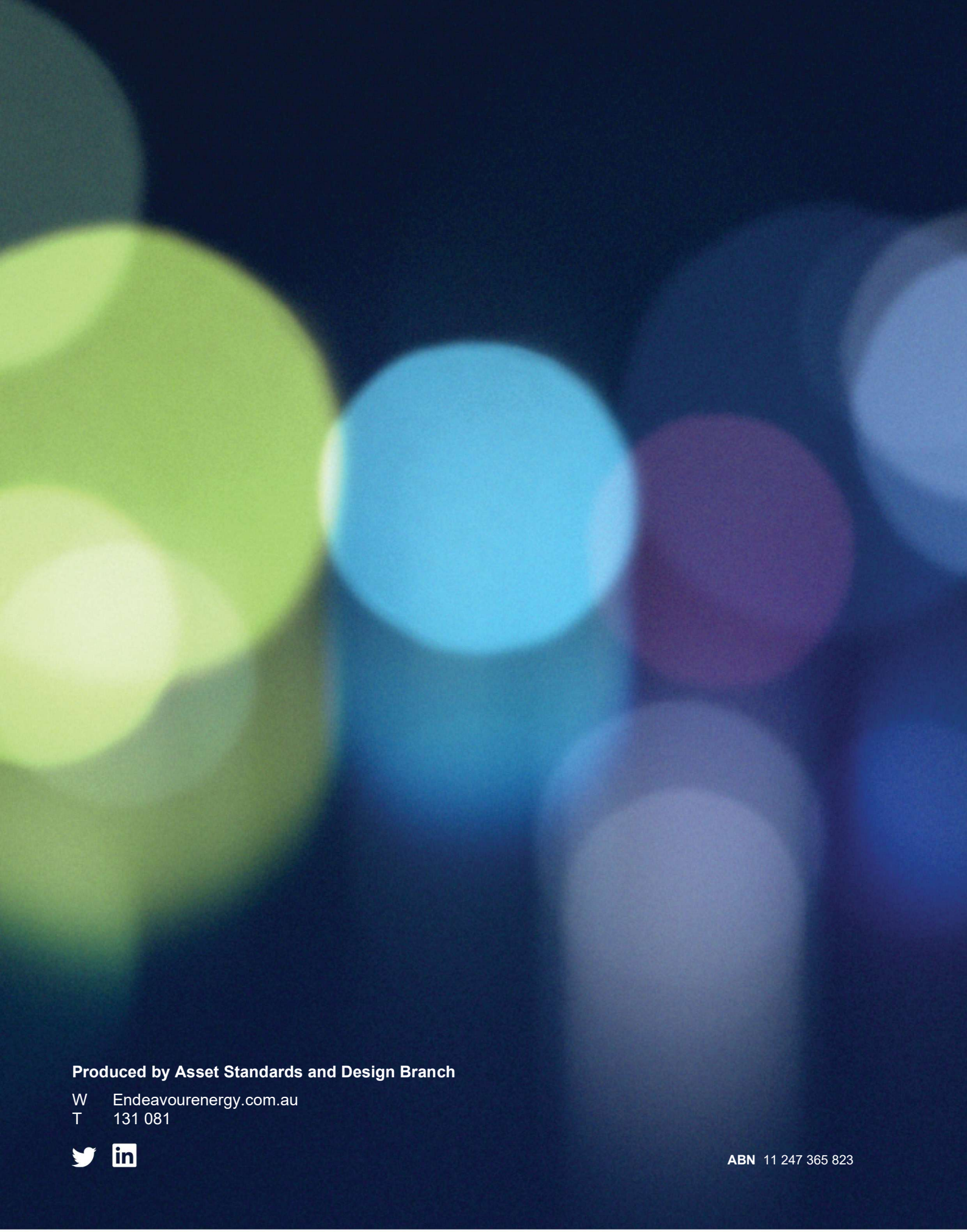
Engineering Delivery Manager has the authority and responsibility for keeping the contents of this instruction up to date.

Regional Transmission and Distribution Managers have the authority and responsibility for:

- engaging Endeavour Energy employees and/or contractors who have appropriate qualifications and are competent to carry out the work;
- entering the maintenance details into Endeavour Energy's asset management database;
- meeting the requirements of this instruction, SMI 100 and SMI 101;
- working in accordance with local and statutory requirements;
- upholding a high level of public safety; and
- encouraging employees to be conversant with and work in accordance with the principles of the Electrical Safety rules.

Maintenance employees have the authority and responsibility for:

- meeting the requirements of this instruction, SMI 100 and SMI 101;
- working in accordance with local and statutory requirements;
- upholding a high level of public safety;
- working in accordance with Endeavour Energy's Electrical Safety Rules; and
- communicating abnormalities found in the equipment to Regional Transmission/Distribution Managers and Engineering Delivery Manager.



Produced by Asset Standards and Design Branch

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