Network Standard

Document No.
NS185

Title:
Major Substations Building Design Standard

Approved Date	27/06/2025	Revision		4	
Lifecycle Stage	Design	Internal Use	☒	External Use	☒
Technical Approver		Authorised By			
Name	Joseph Metti	Name		Jacob Bayley	
Designation	Senior Engineer	Designation		Manager - Network Standards & Electrical Safety	

Revision

No	Date	Description	Technical Approver	Authorised By
4	27/06/2025	Update and conversion to the new template	Joseph Metti	Jacob Bayley

Table of Contents

Scope 3
Reference Documents 3
Ausgrid Documents 3
Other Standards and Documents 4
Acts and Regulations 4
1 General 6
2 Functional requirements 6
3 Site requirements 8
4 Materials in substations 9
5 National Construction Code requirements 9
6 Substation design requirements 10
7 Structural design requirements 13
8 Architectural design requirements 19
9 Equipment and personnel access 23
10 Future expansion provisions 25
11 Security requirements 25
12 Building power and lighting 26
13 Data and communications 27
14 Plant and equipment labelling 27
15 Building signage 28
16 Building design documentation 28

List of Annexures

Annexure A : Room Data Sheet Pro-forma A-1
Annexure B : Architectural Finishes B-1
Annexure C : Ecologically sustainable development C-1
Annexure D : Materials in substations D-1
Annexure E : Future expansion of control rooms E-1
Annexure F : Data and communications facilities F-3
Annexure G : Building signage G-1
Annexure H : Building design documentation H-1

Scope

This Network Standard details the requirements for the Architectural, Civil and Structural engineering design of buildings for major substations.

This standard provides the performance and design criteria for buildings in major substations with the voltages of 132kV, 66kV, 33kV and 11kV.

Refer to NS186 for details of the performance and design criteria for civil works associated with these major substations.

Refer to also the relevant network standard for building design requirements related to ventilation, substation overpressure, active and passive fire mitigation.

This document does not include detailed information for yard structures in substations, nor does it include provisions or information for distribution substations, kiosks or pole top equipment such as transformers, regulators or capacitors.

Reference Documents

All work covered in this document shall conform to all relevant Legislation, Standards, Codes of Practice and Network Standards.

Ausgrid Documents

NS001 Glossary of Terms

EG 320 Major Substation Environmental Sustainability Initiatives

NEG SM05 Site Assessment Process for Major Projects

NEG SM08 Noise Assessment

NEG TC28 Installation of Optical Fibre Infrastructure within Substations

NS158 Labelling of Mains and Apparatus

NS171 Fire Stopping in Substations

NS174 Environmental Procedures

NS184 Fences for Zone and Subtransmission Substations

NS186 Major Substations Civil Works Design Standard

NS187 Passive Fire Mitigation Design of Substations

NS188 Design for Substation Overpressure

NS189 Oil Containment for Major Substations

NS191 Batteries & Battery Chargers in Major Substations

NS200 Major Substations Ventilation Design Standard

NS203 Telecommunications Network: Master Policy Document

NS208 Series: Telecommunications Substations Communication Cabinet - Design Work Instructions

NS210 Documentation and Reference Design Guide for Major Substations

NS212 Integrated Support Requirements for Ausgrid Network Assets

T0007 NEG SM04.21 Light & Power

T0037 Network Access and Security – Locks and Keys

T0053 Design and Construction of Power Cable Conduits in Major Substations

T0059 NEG SM07 Active Fire Systems for Substations

Other Standards and Documents

ANZECC & ARMCANZ – Australian and New Zealand Guidelines for Fresh and Marine Water Quality, October 2000

AS/NZS 1170 Structural design actions (Set)

AS 1319 Safety signs for the occupational environment

AS 1530.4 Methods of fire tests on building materials, components and structures - Fire-resistance test of elements of construction

AS 1657 Fixed platforms, walkways, stairways and ladders – Design, construction and installation

AS/NZS 1680.1 Interior and workplace lighting - General principles and recommendations

AS/NZS 1680.2.4 Interior lighting - Industrial tasks and processes

AS/NZS 1680.5 Interior and workplace lighting - Outdoor workplace lighting

AS 2676.2 Guide to the installation, maintenance, testing and replacement of secondary batteries in buildings – Sealed cells

AS/NZS 2699 Built-in components for masonry construction (Set)

AS 2865 Confined spaces

AS 3600 Concrete structures

AS 3700 Masonry structures

AS 3745 Emergency control organisation and procedures for buildings - Planning for emergencies in facilities

AS 4100 Steel structures

AS 4282 Control of the obtrusive effects of outdoor lighting

AS 5100 Bridge Design (Set)

Department of Environment and Heritage – Coastal Risk Management Guide.

Department of Environment and Heritage – Flood Risk Management Guide

Department of Planning & Infrastructure – Hazardous Industry Planning Advisory Paper No 1 – Emergency Planning

Department of Climate Change, Energy, the Environment and Water – National Strategy for Ecologically Sustainable Development

ENA Doc 001 - 2019 National Electricity Network Safety Code

ENA Doc 015 - 2006 National Guideline for Prevention of Unauthorised Access to Electricity Infrastructure

ENA Guideline - Seismic Security of Power Systems ND/S/-01 (ESAA, ESC158 January 1994) (For Information only)

ENA Guideline - Substation Seismic Design Application Guide ND/S/-02 (ESAA, ESC156 September 1994) (For Information only)

Environment Protection Authority (EPA), NSW Noise Policy for Industry

Environment Protection Authority (EPA), Specification of Supply of Recycled Materials for Pavements, Earthworks and Drainage

IEC 60529 Degrees of protection provided by enclosures (IP Code)

National Construction Code Series (NCC)

Acts and Regulations

Electricity Supply (General) Regulation 2014 (NSW)

Electricity Supply (Safety and Network Management) Regulation 2014 (NSW)

Environmental Planning and Assessment (EP&A) Regulation 2000

Protection of the Environment Administration Act 1991 (NSW)

Protection of the Environment Operations Act 1997 (NSW)

Work Health and Safety Act 2011 (NSW)

Work Health and Safety Regulation 2017 (NSW)

Clause	Standard Requirements

1 General

1.1 All materials and equipment used for construction of Ausgrid's assets shall be free from Asbestos and/or Asbestos related products.

1.2 Refer to NS174 for Environmental Planning, licensing and/or approval requirements associated with major substation buildings.

2 Functional requirements

2.1 Design life

2.1.1 Design Life refers to the ability of the substation building to maintain functionality and operation in a safe, effective and cost-efficient manner. All substation buildings shall be designed to withstand the loads and other forces to ensure the building attains the required Design Life.

2.1.2 Ausgrid shall determine and advise the required Design Life for each substation, based on criteria related to calculated load, system reliability and criticality. Three classifications are used for the design of major substations:

- 100 year Design Life;
- 50 year Design Life;
- 20 year Design Life.

2.1.3 The applicable Design Life for each substation is project specific and shall be included in the Design Brief issued to the Designer by Ausgrid.

2.2 Design standards

Substation buildings shall be designed to comply with all relevant legislation, Australian Standards, Codes of Practice, the National Construction Code (NCC / BCA), relevant statutory and approving authorities and any other requirements as directed by Ausgrid.

2.3 Design life of components

2.3.1 General

The Design Life of all building components shall be assessed when designing the overall building to ensure compliance with, and achievement of, the specified Design Life.

2.3.2 100 year and 50 year design life

2.3.2.1 For major substations classified as 100 year or 50 year Design Life, the following requirements shall apply:

- The Architectural, Civil and Structural design shall ensure all structural components of the building are designed for the relevant Design Life, as applicable to the project;
- Replacement of nominated non-structural components during the Design Life is allowed. Refer to Clause 2.4; and
- Components which do not have the required design life, unless maintained, shall be included in the schedule of required maintenance works. Preliminary Maintenance Procedures and Operation Schedules (PMPO) shall be included in the Compliance Certificate (CC) submission and Tender documentation.

2.3.2.2 Where a Design Life of 100 years is required, the following additional requirements shall apply:

- The Designer shall provide details of measures used to achieve the extended Design Life to Ausgrid for approval, prior to the design proceeding; and
- The durability requirements in AS 5100:5 Bridge Design - Concrete shall be utilised in the designs.

2.3.3 20 year design life

For temporary substations, or equipment, required as a means of supplementing the Network, or required for emergency situations whilst other work is undertaken for a more permanent solution, the following requirement shall apply:

- The Architectural, Civil and Structural design shall ensure all structural components of the building are capable of a minimum Design Life of 20 years.

2.4 Replacement of components

2.4.1 For a Design Life of 100 years or 50 years, replacement of components is allowed for accessible and replaceable non-structural elements. These may include, but are 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 etc;
- External doors and door frames;
- External finishes;
- Internal fittings and finishes such as doors, amenities, paintwork etc.

2.4.2 All replacement of building components during the substation Design Life shall be subject to a Life Cycle Cost assessment in accordance with Clause 2.5.

2.5 Life cycle costing (LCC)

2.5.1 LCC assessment

2.5.1.1 LCC techniques shall be applied to projects as specified in the Design Brief documentation, or otherwise where requested in writing by Ausgrid.

2.5.1.2 LCC shall assess the capital and recurrent costs involved with the ownership and operation of the asset. Recurrent costs include, but are not limited to, maintenance, on-going operation, refurbishment and disposal.

2.5.1.3 The Designer shall provide information illustrating the use of LCC techniques in the selection of designs, construction options/activities, materials and finishes. This information shall form part of the design and options recommended to minimise overall LCC of the asset components and structure.

2.5.2 Mid-term refurbishment

2.5.2.1 All options for design of 100 year and 50 year Design Life substations shall take into account the re-equipping of switch rooms, control rooms and replacement of transformers in an operational substation.

2.5.2.2 The Design shall allow for the efficient and cost-effective replacement of identified building components and shall include a Life Cycle Cost assessment incorporating all replacement costs. Where applicable, the cost of any necessary power outages to enable replacement shall be factored into the Life Cycle Cost assessment.

2.5.2.3 The Life Cycle Costing shall include the cost of complying with all Ausgrid requirements for work undertaken in an operational substation.

2.6 Design statement and certification

Substation designs shall be accompanied by a Design Statement for the specified Design Life. Refer to Annexure H.

2.7 Preliminary maintenance procedures

As part of the design documentation, the Designer shall provide Preliminary Maintenance Procedures and Operation Schedules (PMPO) to Ausgrid. Refer to Annexure H.

2.8 Ecologically sustainable development

2.8.1 The design of the substation building shall take into account the principles of ecologically sustainable development (ESD).

2.8.2 Ecologically sustainable development can be achieved through the implementation of the principles and programs as outlined in Annexure C.

2.8.3 Refer to EG 320 for guidance on the initiatives that may be applicable in reducing embodied impacts associated with major substation projects.

3 Site requirements

3.1 Site investigation

3.1.1 The requirements for site inspection and investigation are described in NEG SM05. The site investigations are divided into two stages:

- Stage 1 – Preliminary Site Assessment (Property Acquisition). Ausgrid shall undertake the applicable activities during the site acquisition and concept design phase.
- Stage 2 – Detailed Site Assessment (Design Stage). The Designer shall undertake the applicable activities during the detail design phase.

3.1.2 Site investigation for the substation building shall assess site conditions including both the previous and proposed land use. Investigations shall be carried out to ensure compliance with all relevant standards and all project specific requirements.

3.2 Sites in flood prone areas

3.2.1 For all sites prone to flooding, the above-ground building floor levels shall be a minimum of 500mm above the 1 in 100 year (1% Annual Exceedance Probability) flood level.

3.2.2 For below-ground floor levels, all ventilation openings shall be a minimum 500mm above the 1 in 100 year flood level, unless otherwise approved in writing by Ausgrid. Depending on site conditions, an exception may apply for cable marshalling areas that do not contain electrical equipment other than cables.

3.2.3 For sites in low-lying areas near coastal locations, an allowance shall be made for potential future sea-level rise in accordance with the relevant NSW Government policies, guidelines and management programs.

3.2.4 Reference shall be made to the “CoastAdapt” datasets, developed by the National Climate Change Adaptation Research Facility (NCCARF) in conjunction with the CSIRO, which provide sea-level rise information for coastal councils.

3.2.5 The need for groundwater ingress management shall be assessed for low-lying substation building locations.

3.3 Structures below the groundwater table

3.3.1 Substation building areas shall be located above the groundwater table, where reasonably practicable, to minimise the potential entry of groundwater.

3.3.2 Where substation building elements are below the surrounding groundwater table, an assessment of groundwater ingress, water quality and other impacts shall be made. The affected building areas shall drain by gravity to a suitable discharge point or collection sump.

3.3.3 An appropriately designed groundwater drainage system, certified by a practising Civil or Hydraulic Engineer, shall be submitted by the Designer to satisfy the design requirements. All proposed groundwater drainage systems shall be subject to the review and approval of Ausgrid.

3.3.4 Any discharge to stormwater shall be in accordance with Section 120 of the Protection of the Environment Operations Act. In practice, this requires ensuring that all discharges are in accordance with the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC Guidelines).

3.3.5 Groundwater that is determined as not suitable under ANZECC Guidelines for discharge to stormwater shall require collection or on-site management.

3.3.6 Refer to NS186 for the requirements relating to discharge of groundwater or its collection and management on site.

4 Materials in substations

4.1 Key requirements

4.1.1 All materials shall be assessed with regard to their Design Life, Life Cycle Cost, strength and aesthetics.

4.1.2 All materials used in substation buildings shall be non-combustible, except with the written approval of Ausgrid.

4.1.3 Where required by the substation design, materials shall be designed to achieve the necessary fire resistance level (FRL).

4.1.4 Recycled materials may be utilised in the main substation building elements. The use of recycled materials shall comply with:

- the Protection of the Environment Operations Act,
- the recycled aggregate order 2014 and recycled aggregate exemption 2014;
- the excavated natural material order 2014 and excavated natural material exemption 2014; and
- the recovered fines order 2014 and the recovered fines exemption 2014.

4.1.5 The proposed use of any recycled materials shall be subject to an assessment of the relevant performance criteria and shall require the review and approval of Ausgrid.

4.2 Acceptable materials

4.2.1 The following materials are acceptable for substation buildings:

- Masonry, including brick work and reinforced blockwork, or reinforced concrete are suitable for the construction of substation building walls.
- Reinforced concrete is a suitable for substation floors and walls;
- Alternative lightweight materials for the walls, floors and roof that meet the functional building requirements are suitable, subject to the approval of Ausgrid. This includes steel framed construction, metal or precast concrete cladding, lightweight floors etc.

4.2.2 For lightweight metal claddings, the Designer shall assess the impacts on substation security where the cladding forms part of the intruder resistant barrier. Additional security measures may be required for accessible locations. Refer also to Section 11.

4.2.3 Other materials can be used for substations buildings, except where excluded by the requirements in this Network Standard, NS187, NS188 or the National Construction Code (NCC).

4.3 Material limitations

Refer to Annexure D for the limitations and restrictions on the use of specific materials in substation buildings.

4.4 Masonry

The design requirements for masonry construction shall be in accordance with Annexure D.

4.5 Finishes

The finishes for substation building elements shall be in accordance with Annexure B.

5 National Construction Code requirements

5.1 Building classification

5.1.1 Major substation buildings shall be classified under the National Construction Code (NCC) as Class 8 electricity network substation buildings.

5.1.2 All substation buildings shall comply with the relevant provisions of the NCC. Where compliance with the Deemed to Satisfy provisions of the NCC is inappropriate or not possible, approval shall be sought under the Alternative Solution provisions of the NCC.

5.2 Protection of openings

5.2.1 All openings for service installations in building elements that provide fire separation shall be protected with firestopping without exception, in accordance with the relevant NCC specification and NS171.

5.2.2 The design of openings to facilitate firestopping shall be reviewed and approved by Ausgrid prior to construction.

5.3 Room exits

5.3.1 Except where approved by Ausgrid, substation rooms which contain electrical power equipment shall have at least two exits, diagonally opposite where site conditions allow.

5.3.2 Basements that are used primarily as cable marshalling areas may be provided with only one exit provided that;

- The basement does not contain any other significant electrical power equipment, and
- The basement complies with the NCC with regard to maximum floor area, exit travel distances and any other requirements.

5.4 All designs which do not provide two exits from any compartment shall comply with the NCC, the relevant Australian Standards, and shall be approved by Ausgrid.

6 Substation design requirements

6.1 General

6.1.1 The substation building shall meet the following technical requirements:

- A minimum rating of IP55 to IEC 60529; and
- A minimum thermal insulation of R3.0 in the walls, floor and ceiling.

6.1.2 The substation building shall accommodate the following items of equipment:

- High voltage switchgear;
- Battery chargers, control, protection, metering, communications and SCADA equipment;
- DC batteries and chargers;
- Audio frequency load control equipment (where specified);
- Meal room facilities (where specified), complete with hot and cold potable water supply;
- Toilet facilities complete with hand basin;
- Storage facilities for spare equipment, circuit breaker trolleys, blanking plates, cover plates, signs, ladders, hanging rack for earth leads and operating sticks; and
- An ergonomically designed operator's desk, plan table, chair, filing cabinet, notice board and HMI complete with telephone.

6.1.3 The substation building shall meet the following design requirements:

- Comply with the Design Life requirements;
- Provide the required level of fire protection;
- Provide the required level of security against unauthorised entry;
- Provide ceiling heights to accommodate the plant and equipment, equipment handling requirements and arc fault venting as required;
- Provide the required access for equipment installation, maintenance and replacement;
- Provide for safe access to routine operating and visual monitoring locations;

- Provide for safe work at heights, including adequate space around equipment;
- Ensure that confined spaces are eliminated wherever possible;
- Comply with the NCC and relevant Australian Standards; and
- Facilitate the future development of the substation, where required.

6.1.4 Unless specified by Ausgrid, the building is not required to be sized or constructed to physically accommodate the ultimate development of the substation, but the design shall facilitate the expansion of the substation to its ultimate arrangement. Refer also to Section 10.

6.2 Durability

6.2.1 Materials and applied finishes for substation building elements shall be low maintenance. Applied finishes shall comply with the requirements in Annexure B.

6.2.2 Applied finishes that require re-application during the Design Life of the substation shall be subject to a Life Cycle Cost assessment in accordance with Clause 2.5. Where applicable, the cost of any necessary power outages shall be factored into the Life Cycle Cost assessment.

6.2.3 For near coastal locations, the exposure conditions of external cladding materials shall be assessed for their potential impacts upon durability. Metal cladding materials that are not regularly washed by rainfall (i.e. eaves soffits, adjacent wall claddings) may require increased future maintenance.

6.3 Noise and vibration

6.3.1 The design of substation buildings and equipment shall ensure all equipment which generates noise is orientated away from sensitive receivers.

6.3.2 Building location, orientation and local topography shall be used to minimise the line-of-sight exposure of noise sources to neighbouring properties.

6.3.3 A noise and vibration assessment shall be carried out during the design stage using realistic operating conditions and including maintenance activities. Refer to NEG SM08 for noise assessment requirements.

6.3.4 Operational noise levels shall comply with the EPA NSW Noise Policy for Industry. Refer to NS174.

6.3.5 Where the noise assessment shows that mitigation measures are required for realistic operating conditions, these measures shall be incorporated into the substation design.

6.3.6 Where the noise assessment shows that mitigation measures may be required for more severe (but less likely) operating conditions, suitable allowances shall be provided for the future installation of sound barriers, enclosures or other methods of mitigation.

6.3.7 Penetrations in walls such as air ducts, ventilators and grills shall be minimised in areas facing sensitive receivers. Openings in surfaces facing sensitive receivers may require appropriate acoustic louvres to baffle or redirect noise generated from the substation.

6.3.8 Where required, outdoor transformer enclosures shall be treated to minimise reverberant noise, consistent with fire rating requirements.

6.3.9 The use of acoustically rated walls for reduction of noise from transformers or equipment onto nearby sensitive receivers shall require prior acoustic testing of the area.

6.4 Overpressure

6.4.1 The substation building shall be designed to withstand the overpressures that may result from arcing by-products and from deflagrations, in accordance with the manufacturer's recommendations, NS188, the NCC and relevant Australian Standards.

6.4.2 Facilities shall be installed in the switch room(s) to vent arcing by-products away from all personnel access areas. The by-products of any arcing shall be either fully controlled or be vented outside the switch room(s) in accordance with the switchboard manufacturer's recommendations.

6.4.3 The design requirements for ductile behaviour of building elements shall be in accordance with the NCC and all relevant Australian Standards.

6.5 Fire resistance and stability

6.5.1 The substation building shall, as a minimum, comply with the NCC requirements for fire resistance, stability and occupant safety.

6.5.2 In addition, substation buildings shall maintain the operation of equipment for as long as reasonably practicable and allow safe re-entry into a structure after a credible fire has occurred.

6.5.3 Where required by the substation design, the building ceiling, roof, floor, internal walls, external walls and doors shall have an appropriate fire rating. The fire rating and fire protection of the substation building shall be in accordance with NS187 and T0059.

6.5.4 The substation building shall be provided with thermal / smoke detectors and fire extinguishers, except where otherwise specified by Ausgrid.

6.6 Ventilation, air quality and temperature control

6.6.1 The substation building design shall comply with the equipment manufacturer's recommendations relating to air quality and temperature control for equipment accommodation.

6.6.2 The design of the switch room / control room internal environment shall ensure a non-corrosive environment and minimise the entry of dust or any other air-borne contaminants.

6.6.3 The substation switch room / control room shall be fitted with a ventilation system that is sized to maintain a temperature within the range $+5^0$C to + 40^0C unless specific equipment requirements mandate otherwise.

6.6.4 The provision and extent of any internal temperature and humidity monitoring within the substation building shall be in accordance with the Design Brief issued by Ausgrid.

6.6.5 The design of the ventilation system and the requirements for a ventilation assessment for each building/room shall be in accordance with NS200. Refer also to Clause 6.7 for requirements relating to the thermal performance of the building.

6.6.6 Fire dampers, where provided, shall be of the multi-blade type in accordance with NS200.

6.6.7 Ventilation to all rooms and accessible locations within the building shall be sufficient to ensure that confined spaces are eliminated wherever possible.

6.6.8 Ventilation openings shall be provided with security in accordance with Section 11.

6.7 Thermal performance of building

6.7.1 Substation buildings shall provide an internal environment suitable for the continuous and safe operation of the equipment. The internal environment shall maintain the equipment to within the manufacturer's recommendations to ensure longevity and warranty requirements are maintained.

6.7.2 A thermal performance modelling assessment of the proposed building shall be prepared to support the substation building design, including the selection of building fabric materials, insulation levels and ventilation provisions.

6.7.3 The thermal performance modelling shall include a Life Cycle Cost assessment of the proposed building design in accordance with Clause 2.5.

6.8 Mine subsidence

6.8.1 Where the proposed substation building is within or near a mine subsidence area, the design shall comply with the guidelines and requirements of the Mine Subsidence Board and the Local Council or Approval Authority. Refer to NS174.

6.8.2 The Designer shall be responsible for obtaining approval of the design from the Mine Subsidence Board and the Local Council or Approval Authority.

6.9 Designer safety reports and CHAIR

6.9.1 The Designer shall prepare a Designer Safety Report in accordance with the WHS Regulation. The report shall comply with NS210 and shall be prepared at the completion of the design phase.

6.9.2 A Construction Hazard Assessment & Implementation Review (CHAIR) shall be undertaken in accordance with the WHS Regulation. A copy of the CHAIR review documentation shall be provided to Ausgrid for review and approval prior to completion of the design phase.

6.9.3 The Designer shall include sufficient resources and staff, across the range of design disciplines involved in the project, to coordinate advice and participate in the CHAIR process. The aim shall be to enable a full assessment of the building and the construction methodology.

7 Structural design requirements

7.1 Structural design criteria

Substation buildings shall be designed with an Importance Level of 4, in accordance with the NCC and relevant Australian Standards. The substation wind and earthquake design shall be based on this Importance Level.

7.2 Permanent and imposed loads

7.2.1 Permanent and imposed loads shall be in accordance with AS/NZS 1170.1 unless advised otherwise in writing by Ausgrid. Provision shall be made for any dynamic components, where applicable, and for equipment handling and installation loads.

7.2.2 For switch rooms and other areas containing significant items of heavy equipment, the imposed floor actions:

- shall be advised by Ausgrid; or
- shall comply with AS/NZS1170.1 under the type of activity E – “Areas around equipment in boiler rooms (weight of equipment to be determined)”.

7.2.3 For a roof/ceiling using a concrete slab structure, the imposed roof/ceiling actions shall be a minimum of 1.5kPa for serviceability design and 2.0kPa for strength design. Any superimposed permanent loads shall be additional to these values.

7.2.4 For all other roof structures, the permanent and imposed loads shall be in accordance with AS/NZS 1170.1.

7.2.5 Permanent loads shall be maximum foreseeable loads over the entire Design Life of the substation.

7.3 Wind loads

7.3.1 Wind loads applicable to the substation buildings shall be in accordance with AS/NZS 1170.2 and shall not be less than the value derived from Table 1.

Table 1: Wind loads applicable to substation buildings

Substation Category	Regional Wind Speed (m/s)
100 year	≥ V_{2500} (Note 1)
50 year	V_{2500}
20 year	V_{1000}

[1] Risk Analysis required. Refer to AS/NZS 1170.0 Annexure F – Annual Probability of Exceedance.

7.3.2 For structures covered by the NCC, AS/NZS 1170.0 requires the design loads to comply with the annual probability of exceedance as given in the NCC. For these structures the relevant requirements of the NCC shall apply where they are more severe than the values given in Table 1.

7.4 Earthquake loads

7.4.1 Earthquake loads shall be obtained from AS/NZS 1170.4.

7.4.2 The Designer shall reference ENA guidelines Seismic Security of Power Systems ND/S/-01 and Substation Seismic Design Application Guide ND/S/-02 for earthquake design.

7.4.3 The annual probability of exceedance and the probability factor (kp) for earthquake loading shall not be less than that shown in Table 2:

Table 2: Earthquake Loading Probability of Exceedance

Substation Category	Annual Probability of Exceedance	Probability Factor (kp)
Ultimate Loads		
100 year	≤ 1/2500	Risk Analysis (Note 1)
50 year	1/2500	1.8
20 year	1/1000	1.3
Serviceability Loads		
100 year	≤ 1/250	Risk Analysis (Note 1)
50 year	1/250	0.75
20 year	1/100	0.50

[1] Risk Analysis required. Refer to AS/NZS 1170.0 Annexure F – Annual Probability of Exceedance.

7.4.4 The serviceability load requirements in Table 2 are intended to ensure acceptable performance of the structure after a moderate earthquake. The building main structure shall not require significant repair after the serviceability limit state earthquake and shall remain in an acceptable condition for operational continuity.

7.4.5 For the serviceability limit state, the design requirements shall include the following:

- Probability Factor (kp) as per Table 2
- Structural Ductility Factor (μ) = 1.15, to reflect realistic damping for an elastic structure.
- Structural behaviour to remain within the elastic range (i.e. no yielding of reinforcement).
- Allowable lateral movement not to exceed 1.0% of height, to minimise damage to the non-structural components.

7.4.6 For the ultimate limit state, the structural design shall:

- use an appropriate Structural Ductility Factor (μ) in accordance with AS/NZS 1170.4;
- aim to reduce the risk of a complete structural collapse, where reasonably practicable; and
- for framed structures, any plastic hinges formed during a major earthquake shall occur preferentially in the beams, rather than the columns, to reduce the potential for collapse of the entire structure.

7.4.7 For structures covered by the NCC, AS/NZS 1170.0 requires the design loads to comply with the annual probability of exceedance as given in the NCC. For these structures the relevant requirements of the NCC shall apply where they are more severe than the values given in Table 2.

7.5 Vibration limits

7.5.1 Equipment installed in substations may have specific vibration profiles which affect the building and sensitive equipment within the building.

7.5.2 Where required, the building shall be designed to reduce the impacts involved with vibration of equipment.

7.5.3 Substation buildings which are proposed to be located near existing or identified future mine blasting activities shall be designed for the impacts of ground vibration and air blast overpressure as negotiated between Ausgrid and the mine/quarry operator.

7.5.4 Mine blasting activities may require additional protective measures to prevent flyrock from entering the substation site or damaging the associated overhead transmission lines.

7.6 Structural redundancy

Substation buildings shall be designed to prevent progressive collapse following a substation fire or an overpressure event. This requirement shall apply at the locations, and to the extent, that these events are required to be sustained by the building structure. Refer to Clauses 6.4 and 6.5.

7.7 Differential settlement

Differential settlement shall be limited or managed to prevent structural damage of the substation building and to limit detrimental impact on plant and equipment.

7.8 Foundation structures

The foundation structures used for substation buildings shall meet the requirements of NS186 relating to footing systems and piles as applicable.

7.9 Basement structures

7.9.1 Potential water ingress into the cable basement shall be minimised and a perimeter drain and sump shall be provided as outlined in Clause 7.11.2.

7.9.2 Where differential movement greater than 10 mm is expected between the cable basement and surrounding ground, the Designer shall ensure that any duct lines and cables which enter the cable basement do not suffer damage due to the resulting shear displacement. Refer to Drawing 177332 and to T0053 for details.

7.9.3 Cable conduits entering buildings shall comply with the following:

- All conduits which are not in use shall be capped;
- All conduits shall be graded away from the building, where site conditions allow, to minimise water ingress into the building;
- All bell mouths shall be installed in line with Ausgrid requirements. Refer to Drawing 177332; and
- All conduits shall be located to ensure cabling is not exposed to any sharp edges or misaligned conduit joints which may damage the cable.

7.10 Floors

7.10.1 General

7.10.1.1 The floor of the substation building shall be of concrete or other alternative construction (refer to Clause 4.2) and shall be surface treated in a manner approved by Ausgrid.

7.10.1.2 Post-tensioned or pre-stressed concrete floors shall only be used where approved by Ausgrid.

7.10.1.3 The locations of stressing tendons in post-tensioned concrete slabs shall be clearly marked on the soffit of the slab and on the adjacent wall above the slab to clearly indicate the tendon location.

7.10.1.4 Pre-cast concrete floor systems which incorporate thin topping slabs shall not be used in areas which are subject to concentrated floor loads, unless deflection compatibility between panels is appropriately designed and detailed.

7.10.1.5 The finished floor surface in the high voltage switch room shall have a degree of finish, hardness and flatness that meets the requirements of the switchgear supplier. Refer to the relevant Ausgrid standard drawings for switch room floor topping details and requirements.

7.10.2 Slabs in contact with the ground

7.10.2.1 The Designer shall ensure the durability of all concrete slabs in contact with the ground using measures such as limiting crack widths and non-absorptive concrete to achieve the required building Design Life.

7.10.2.2 For Acid Sulphate Soils (ASS), the use of non-absorptive concrete to prevent water ingress and/or control of the rate of concrete deterioration is acceptable.

7.10.2.3 The use of plastic moisture barriers may affect earthing characteristics of the structure and shall be subject to the approval of Ausgrid. The Designer shall ensure that all Ausgrid earthing requirements are maintained on all areas or buildings where plastic moisture barriers are utilised.

7.10.3 Floor loading drawing

7.10.3.1 The loads used in the design of various elements of the substation shall be clearly shown on a dedicated Floor Loading Drawing.

7.10.3.2 The Floor Loading Drawing shall depict the loading capability in each area using shading and shall include imposed loads, equipment loads and any superimposed permanent loads.

7.10.4 Floor deflections

Switch rooms shall be designed for the specific floor deflections and vibration limitations of the proposed equipment.

7.11 Walls

7.11.1 General

7.11.1.1 All internal walls and the internal skin of external walls shall be designed using materials that enable the fixing of wall anchors for support of equipment or cable trays.

7.11.1.2 Masonry or reinforced concrete walls shall be designed to minimise the extent of cracking and joints shall be provided as necessary to control cracking. For reinforced walls, horizontal reinforcing shall be proportioned to provide a high degree of crack control.

7.11.1.3 Lightweight steel-framed walls require specific detailing and shall be subject to the approval of Ausgrid.

7.11.2 Walls below ground

7.11.2.1 The use of precast concrete for walls below ground, and the treatment of associated joints, shall be subject to the review and approval of Ausgrid at the concept design stage.

7.11.2.2 The Designer shall ensure the durability of all walls in contact with the ground in accordance with the requirements of Clauses 7.10.2.1 and 7.10.2.2.

7.11.2.3 The Designer shall allow for hydrostatic pressures irrespective of the drainage system adopted for the wall below ground.

7.11.2.4 The installation of conduits in the perimeter walls of cable basements may result in seepage groundwater inflows. All seepage at external walls shall be collected by perimeter drains to a gravity draining stormwater or subsoil pit.

7.11.2.5 Pits which cannot provide gravity drainage shall be serviced by twin pumps installed to the appropriate Australian Standard and using an independent control system. The design and use of pumps shall be subject to Ausgrid approval.

7.11.2.6 The drainage and discharge of any seepage groundwater shall comply with the requirements of Clause 3.3.

7.11.2.7 Provision shall be made for differential movement between the building structure and conduits entering the building. Refer to Clause 7.9.2.

7.11.2.8 The use of plastic moisture barriers shall be in accordance with Clause 7.10.2.3.

7.12 Roofing system

7.12.1 General

7.12.1.1 In this standard, the roofing system consists of roof sheeting/cladding, roof drainage elements, roof space, ceilings (where required) and associated support structures.

7.12.1.2 The use of lightweight metal roof systems for substation buildings located on, or near, adjoining lot boundaries shall be subject to the review and approval of Ausgrid at the concept design stage.

7.12.1.3 The roofing system of the substation building shall provide the specified Design Life at a minimum Life Cycle Cost. Replacement is allowed for the outer or aesthetic roof components (e.g. roof sheeting, guttering, downpipes and architectural elements) at nominated intervals during the Design Life.

7.12.1.4 Replacement of roof components during the Design Life requires a Life Cycle Cost assessment in accordance with Clause 2.5 and shall be subject to approval by Ausgrid.

7.12.1.5 The area around the substation building, immediately under the roof eaves, shall be sloped away from the building to prevent water ingress. Refer to NS186 for details of personnel access paths and other areas external to the building.

7.12.2 Weather protection

7.12.2.1 To minimise the risk of water entering the building, penetrations through the roof cladding shall be avoided. Roofing systems which require the fasteners to perforate the roof sheeting/cladding shall be subject to review and approval by Ausgrid. Refer to Clause 7.12.3 for fastener requirements.

7.12.2.2 Penetrations shall also be avoided through any impervious membranes or continuous building elements (e.g. where ceilings are required) that sit below the main roof. Where penetrations are necessary, a suitable sealing system shall be proposed for review and approval by Ausgrid.

7.12.2.3 Architectural roof elements shall minimise dust entry into the building, as this may affect the operation of indoor switchgear and control equipment.

7.12.3 Roof sheeting/cladding

7.12.3.1 Roof sheeting shall have a minimum slope of 5 degrees, except where the design ensures that roof sheeting cannot permanently deform, or otherwise allow water ponding to occur, under the expected maintenance or construction loadings.

7.12.3.2 Roof coatings shall be of a light colour to reflect heat and decrease heat load on the building. All roof sheeting/cladding shall be specified to minimise reflectivity.

7.12.3.3 The use of composite sandwich-type panels for the roof sheeting shall be subject to the written approval of Ausgrid. Composite panels, consisting of two exterior metal faces bonded to a central core material, shall comply with the relevant Network Standards for strength, durability, fire resistance and other attributes.

7.12.3.4 The design of the roof sheeting and its fasteners shall meet or exceed the wind loading requirements of Clause 7.3. The design shall include for the effects of local wind pressure factors (e.g. suctions at roof edges and corners) in combination with any pressures exerted under the roof sheeting. The Designer shall:

- Provide design certification in accordance with Clause 16.4 which includes references to the design of the roof sheeting and its fasteners; and
- Indicate on the design drawings the actual roof sheeting design wind pressures adopted, including the localised high pressure areas around the edges and corners of the roof.

7.12.3.5 The design information provided by the Designer shall be subject to review and approval by Ausgrid.

7.12.3.6 Roof sheeting shall utilise concealed Cyclone fasteners which do not require the roof sheeting to be perforated. Alternative fastener types shall be subject to the approval of Ausgrid.

7.12.3.7 During construction, the on-site installation of concealed fasteners shall be fully inspected prior to attachment of the roof sheeting. For this purpose, a suitable inspection “HOLD” point shall be specified in the Designer documentation and included in the approved project program.

7.12.4 Roof drainage

7.12.4.1 The use of external roof gutters is optional and can be minimised, subject to the drainage requirements of the Local Council Authority.

7.12.4.2 Provision shall be made around the building perimeter to collect and divert any roof run-off and to provide suitable erosion control.

7.12.4.3 Where external roof gutters are omitted, each external doorway shall be provided with “waterfall” protection for diverting run-off from the roof.

7.12.4.4 Where external roof gutters are provided, they shall be of large, oversize, design to minimise blockages and reduce the need for access and maintenance.

7.12.4.5 The use of box gutters located inside the external perimeter of the building is not permitted, except with the written approval of Ausgrid.

7.12.4.6 Downpipes shall be oversized and provided with a gap at the base (minimum 75mm above ground level) to allow collected leaves and debris to be removed before entering the underground stormwater system. At ground level, the associated stormwater sumps and grates shall be sized and detailed to minimise roof water overflowing onto the adjoining ground or pavements.

7.12.4.7 The underground stormwater system shall be completely external to the substation building, unless otherwise approved in writing by Ausgrid.

7.12.5 Roof maintenance access

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

7.12.5.2 The Designer shall assess the requirements for safe maintenance access onto the roof area, noting that future access to the substation roof for inspection, repair or maintenance activities will require a risk assessment by the relevant Contractor, and subsequent approval by Ausgrid Safety Services.

7.12.5.3 Roof areas that are designed with minimal roof penetrations and have no significant roof services, no direct access, and a limited need for future maintenance activities do not require a permanent roof access system.

7.12.5.4 Minor roof items such as vent pipes, passive ventilation openings, lightning spires etc. are low maintenance and low risk items that do not require a permanent roof access system.

7.12.5.5 As a minimum, roofs shall be fitted with ladder brackets at suitable locations and shall be capable of sustaining loads from fall arrest anchor points complying with the relevant SafeWork NSW or other legislative requirements.

7.12.5.6 Where a permanent roof access system is deemed necessary, the design and layout of the anchor system shall ensure that it can be used for appropriate fall restraint techniques with minimal fall distances and pendulum effects.

7.12.5.7 A roof access system that relies on the roof sheeting for structural support shall be referred to Ausgrid for approval.

7.13 Doors, roller shutters and windows

7.13.1 All internal and external doors shall comply with the requirements of the NCC. Where necessary, doors shall be fire rated in accordance with NS187. Refer to Section 11 for the general design requirements for doors.

7.13.2 The design of external doors, including roller shutter doors, and their fixings shall meet or exceed the wind loading requirements of Clause 7.3. The roller shutter door slats, guides and locking components shall have sufficient strength to survive the design wind event with no major damage.

7.13.3 At least one entrance to the switch room shall be of sufficient size to accommodate the largest switchboard module.

7.14 Cranes and monorails

7.14.1 Provision shall be made for lifting and handling of equipment within substations. This may necessitate fixed lifting devices such as gantry cranes, monorail and other lifting and pulling points. Manoeuvring space shall be provided as necessary.

7.14.2 The lifting and handling requirements shall be identified in the Equipment Handling Plan. Refer to Clause 9.2.

7.15 Pulling points

The structural design of floors and walls shall allow for pulling points where required for the manoeuvring of equipment and for cable pulling. Refer to the Electrical Layout Plan and the Equipment Handling Plan.

8 Architectural design requirements

8.1 Electrical equipment layout

The following aspects shall be assessed in the preparation of the substation layout:

- Specific room and accommodation requirements;
- Cable marshalling area requirements;
- Amenities;
- Emergency facilities;
- Adequate working space and safe egress;
- Equipment Handling Plans;
- Equipment loading docks;
- General circulation and personnel access;
- Future expansion provisions;
- Security;
- Light and power;
- Data and communications;
- Earthing and lightning protection; and
- Coordination with other services.

8.2 Battery accommodation

8.2.1 Substation batteries shall be located in suitable metal cabinet-type accommodation within the control room / switch room. Separate battery rooms are not required except where requested and approved by Ausgrid.

8.2.2 The battery cabinet-type accommodation shall be either free-standing or wall mounted as required.

8.2.3 Where multiple battery groups are provided in a substation, the batteries shall be located with sufficient separation to enable maintenance or similar activities on one battery to not adversely affect operation of the other.

8.2.4 Battery enclosures shall be ventilated in accordance with the requirements of NS200.

8.2.5 Refer to NS191 for specific battery accommodation requirements.

8.3 AFLC accommodation

8.3.1 Audio Frequency Load Control (AFLC) equipment, where provided, shall be located in suitable accommodation within the substation. The type of AFLC accommodation adopted will depend on site location, substation layout, available space, equipment type and other factors.

8.3.2 The requirements for AFLC accommodation shall be as follows:

1) Outdoor Equipment – where the site allows, AFLC equipment shall be contained in outdoor kiosk type accommodation separate from the main substation buildings.
2) Indoor Equipment – Where outdoor equipment cannot be used, all AFLC indoor equipment shall be contained either inside one room within a substation building or in external separate enclosures (refer to Item 3 below).
3) External Separate Enclosures – Indoor AFLC equipment can be accommodated within one or more separate buildings / enclosures located away from the main substation building.
4) Alternative Use – The AFLC room within a building / enclosure shall be designed for an alternative future use (storeroom etc.) following removal of the AFLC equipment.
5) Overpressure – No provision for overpressure due to deflagration is required for the AFLC accommodation. Provision for arc fault overpressure may be required depending on design and equipment selection. An arc fault overpressure event shall not result in the failure of load bearing components within the building / enclosure.
6) Noise – Provision shall be made to mitigate the noise impacts on sensitive receivers due to AFLC equipment operation. Refer to Clause 6.3.
7) Ventilation – The AFLC accommodation shall be externally vented with suitable measures taken to address noise and contamination issues as required.
8) Design Life – The AFLC accommodation can be designed for a reduced 20 year design life in accordance with Clause 2.3.3. Prefabricated or modular type construction that satisfies the design requirements is acceptable for this purpose.

8.3.3 The Designer shall prepare proposed designs for the AFLC accommodation and submit to Ausgrid for review and approval.

8.4 Cabling marshalling area

8.4.1 General

8.4.1.1 The design of cabling marshalling areas (CMA) shall ensure these spaces are not classified as confined spaces. The CMA shall be ventilated in accordance with the requirements of NS200 and the design shall assess the use of natural ventilation with low level and high level openings.

8.4.1.2 The internal ceiling height of the CMA shall be the minimum required for safe installation and operation of equipment and for safe egress of personnel.

8.4.1.3 Adequate working and circulation space shall be provided in the CMA to ensure all maintenance activities, cable pulling and emergency escape and rescue activities can be safely undertaken.

8.4.1.4 CMA fit-out and clearance information relating to cable handling, installation and access shall be provided by the Designer to Ausgrid.

8.4.1.5 A CMA is not required under control room areas, except where specific approval has been granted by Ausgrid.

8.4.2 Safe egress paths

8.4.2.1 All personnel entering and working within cabling marshalling areas are:

- trained and inducted;
- aware of the CMA site-specific safety risks; and
- familiar with the location of emergency egress points.

8.4.2.2 Emergency egress paths shall be designed and maintained as unobstructed.

8.4.2.3 The CMA egress paths shall have a minimum height of 2.1 m, reducing to a minimum of 2.0 m for stairways, ramps, landings or the like.

8.4.2.4 The minimum height shall allow for overhead cable trays and other equipment or services supported from ceilings, beams or walls and for cables located at low level above the floor.

8.4.2.5 Cables that are located on the floor can be excluded from the minimum height calculation provided that:

- sufficient space is provided to step over (or between) the cables; and
- suitable emergency lighting is provided at, or near, each cable crossing of the defined egress paths.

8.4.3 Internal cable trenches

8.4.3.1 Internal cable trenches within the substation building shall allow for a suitable bending radius to be provided for cables and other services installed in the trench.

8.4.3.2 Where required, provision shall be made for the installation of fibre optic cables which may have larger bending radii than other services within the cable trench. Refer to Section 13.

8.4.3.3 The Designer shall ensure that internal cable trenches do not have exposed sharp edges or corners which may cause damage to cables during installation works.

8.5 Amenities

8.5.1 Minimum requirement

8.5.1.1 For substations which require amenities, as determined by Ausgrid, the minimum level of amenities shall comprise a unisex toilet, wash basin and wall mounted hose tap.

8.5.1.2 Where site conditions allow, access to the toilet shall be provided such that a lower level security key can be used to access the toilet without providing access to the general switchyard / control room area.

8.5.2 Additional amenities

8.5.2.1 Depending on the substation location and frequency of use, as determined by Ausgrid, further amenities may be specified as outlined in this Clause.

8.5.2.2 The provision and extent of any additional amenities at a substation shall be requested by Ausgrid and included in the Design Brief issued to the Designer.

8.5.2.3 Meal room / Plan layout room

Where specified by Ausgrid, a separate meal room / plan layout room shall be provided with the following:

- A non-opening window to allow natural light in accordance with the NCC;
- A table and chairs with sufficient capacity for 4 persons. Additional seating capacity, where required, shall be subject to approval by Ausgrid;
- A sink and cupboard unit connected to a domestic hot and cold water service. All taps shall be WELS minimum 5 star (maximum 7.5 L/min);
- An instantaneous boiling water unit over the sink with automatic cut-out when not in immediate use; and
- Two double power outlets for appliances.

8.5.2.4 Toilet/shower

Where specified by Ausgrid, a unisex toilet/shower area shall be provided containing the following:

- The cistern shall provide low water use and have full and half flush functions. The rating shall be WELS minimum 4 star (maximum 4.5/3 L/min);

- An enclosed shower tiled full height with attached change area including a bench seat and four clothes hanging hooks;
- The shower head shall be a water saving type which complies with Sydney Water requirements and guidelines;
- A large wash basin with moveable spout. All taps shall be WELS minimum 5 star (maximum 7.5 L/min);
- A wall mounted hose tap for the cleaner's use;
- All other water fixtures shall achieve a minimum 5 star WELS rating; and
- All amenities to be contained within one area with privacy locks on the entry door, the shower cubicle and the toilet.

8.5.3 Lighting

All lighting in staff amenities shall be motion activated to ensure the energy levels are kept to a minimum. Refer to Section 12 for specific lighting requirements.

8.6 Emergency facilities

8.6.1 One emergency eyewash and safety shower facility shall be provided for the substation to meet SafeWork NSW and Ausgrid requirements, except where exempted in Clause 8.6.2. Any additional emergency facilities shall be subject to the approval of Ausgrid.

8.6.2 A site-specific risk assessment shall be undertaken where substation emergency facilities are to be reduced, for example due to the lack of a potable water supply. The risk assessment shall be subject to the review and approval of Ausgrid.

8.6.3 The location of the emergency facility shall be external to the building where site conditions allow. All exposed pipework and/or storage tanks shall be shielded from direct radiant heat to reduce potential temperature rise.

8.6.4 The emergency facility shall be located near the area of highest personnel risk. This will be an external location that is as near as reasonably practicable to a switch room door.

8.6.5 Where site conditions allow, the emergency facility shall also be in the vicinity of the battery enclosure location, noting that the provision of emergency facilities or water supply is not required by AS 2676.2 for the sealed battery cells used by Ausgrid.

8.6.6 Where an emergency facility is required internally (e.g. a CBD substation) suitable measures shall be taken to ensure that the splash zone does not impact on electrical and other services such as power, lighting, switchboards, fire indicator panels etc.

8.6.7 Emergency facilities are used infrequently and, for external locations, specific drainage provisions for the discharge are not required. For internal locations, provision for drainage shall be included unless a specific path for the discharge is provided that avoids hazardous conditions arising within the building.

8.6.8 The use of a self-contained emergency facility without fixed plumbing shall be subject to compliance with SafeWork NSW requirements and relevant Australian Standards. A Life Cycle Cost assessment shall be provided for these types of facilities to balance the initial capital savings against future operation and maintenance costs.

8.7 Vermin proofing

8.7.1 All building elements shall be animal and vermin proof. Animals and vermin include birds, possums, cats, rats, mice, snakes, foxes and termites.

8.7.2 Where external ledges or potential bird roosting places cannot be eliminated, the Designer shall assess the need for 'bird-spikes' or similar systems to deter roosting.

8.8 Termite protection

8.8.1 At substations where the use of timber or cellulose based products is deemed to be necessary, the following precautions shall be adopted to detect and/or protect against termite attack:

- The buildings and surrounding areas shall be subject to an annual termite inspection to enable early detection and treatment;
- The buildings shall have design detailing of floors, walls and joints to deter termite entry and allow for visual detection of any termite activity; and
- Access for inspection, maintenance and durability assessment shall be provided as part of the design process.

8.8.2 Additional termite protection, including physical termite protection systems, shall be subject to the written approval of Ausgrid. Chemical systems for termite protection shall not be used.

8.8.3 Specifications for concrete work shall include provisions for the removal of all timber pegs used in concrete levelling and screeding activities. All holes shall be filled and compacted to avoid cracking which may allow the ingress of termites.

8.8.4 All conduits entering a building that may contain materials subject to termite attack shall be sealed to prevent the entry of termites via conduits or cracks at cable entry points.

9 Equipment and personnel access

9.1 Adequate working space and safe egress

9.1.1 Adequate working and circulation space shall be provided around electrical equipment to ensure all equipment operation and maintenance activities, cable connections and emergency escapes can safely take place. The provision of working areas and egress paths shall assess the following items:

- Exposed conductors;
- Busbars through walls encroaching on minimum head clearances;
- Position of equipment during overhaul operations;
- Position of permanent electrical equipment particularly transformers, switchgear etc.;
- 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;
- Egress paths shall not be near exposed live conductors including low voltage;
- Positioning of the doors;
- Fall arrest; and
- The retention of section safety clearances to Ausgrid and Australian Standards.

9.1.2 Sufficient space shall be provided in front of the switchgear to enable safe and effective operation of the equipment by an operator standing in front of the switchgear panel.

9.1.3 Refer to Clause 8.4.2 for safe egress path requirements for cable marshalling areas.

9.1.4 Access into any areas which are classified as “confined spaces” shall comply with the provisions of AS 2865.

9.2 Equipment handling plans

9.2.1 Equipment Handling Plans shall be prepared for each substation site in conjunction with the Electrical Layout Plan.

9.2.2 The Designer shall consult with key stakeholders during the design process regarding the equipping, operation, maintenance, replacement and ultimate decommissioning of the assets for each substation.

9.2.3 The Equipment Handling Plans shall take into account issues involving safety, timeframe, practicality and cost and shall include a schedule of unencumbered heights above and below the switchboards and control equipment.

9.2.4 Equipment Handling Plans shall be prepared by the Designer and approved by Ausgrid.

9.3 Equipment loading docks

9.3.1 The provision, location and size of any external equipment loading docks for the substation buildings shall be determined in conjunction with the Equipment Handling Plan.

9.3.2 Where an external equipment loading dock is deemed to be necessary, its size shall be minimised to the extent reasonably practicable.

9.3.3 Where the Equipment Handling Plan proposes an external loading dock that is smaller than the delivered equipment dimensions, or where the loading dock is deleted entirely, the Designer shall submit a detailed lift plan, risk assessment and proposed risk mitigation measures for review and approval by Ausgrid.

9.4 General circulation and personnel access

9.4.1 Corridors and passageways

9.4.1.1 Corridors and passageways shall meet the minimum NCC and AS 1657 requirements. In addition, provision shall be made for the site specific and ultimate equipment handling dimensions including equipment installation and maintenance requirements.

9.4.1.2 The Equipment Handling Plan shall be referenced to ensure all corridors and passageways are adequate for all equipment movement.

9.4.1.3 Door sizes shall meet the requirements of the NCC and the Equipment Handling Plan.

9.4.2 Lifts

9.4.2.1 Where lifts are provided for the substation, they shall be designed for the transport of personnel, equipment and ambulance or emergency stretchers required in an emergency.

9.4.2.2 Lifts shall satisfy the following requirements:

- Minimum internal lift car sizes are 2000 mm long x 1500 mm wide;
- Minimum clear lift door sizes are 2400 mm high x 1300 mm wide; and
- Minimum lifting capacity shall be 1200 kg.

9.4.2.3 The Equipment Handling Plan shall ensure sufficient space is provided to utilise lifts for the installation and replacement of equipment.

9.5 Telecommunication carriers

Provision shall be made within the substation for the required data and communication installation works and for suitable access via communications conduits. Refer to Section 13.

9.6 Access for people with disabilities

Substation buildings and outdoor yards containing live electrical equipment do not require disabled access.

10 Future expansion provisions

10.1 The Designer shall investigate the requirements for future expansion of the substation building where specified in the Design Brief or otherwise requested by Ausgrid. All provisions that are proposed for future expansion shall be assessed on a Life Cycle Cost basis and will be subject to approval by Ausgrid.

10.2 For control rooms, the Designer shall refer to Annexure E when determining the type and extent of future expansion provisions.

11 Security requirements

11.1 Design requirements

11.1.1 The perimeter of live substation switchyards and the substation building shall be secured to minimise the risk of unauthorised entry.

11.1.2 The live switchyard security fence enclosing live outdoor electrical equipment, and the substation building, shall be designed to be secure against opportunistic intruders without the aid of tools or keys.

11.1.3 The live switchyard security fence and the substation building shall be designed to be an intruder resistant and tamper-evident barrier. The barrier shall be resistant to covert attack.

11.1.4 For details of the live switchyard security fence, gates and boundary fences, refer to NS186.

11.1.5 The substation building security shall be designed in accordance with the requirements ENA Doc 15. The construction materials to be used for the roof, walls and other major building elements shall be based on the requirements of this standard. Refer to Section 4.

11.1.6 All doors and other substation building openings shall be adequately secured against forced entry. Windows and ventilation louvres shall be secured in accordance with Clause 11.4.

11.1.7 All entry/exit doors into the substation building shall swing outwards, unless opening directly onto a public footpath where this results in an unacceptable hazard to passing pedestrians.

11.1.8 Where a wall of a substation building faces a public space, there shall be no external recesses in the facade capable of offering a concealed place for individuals. Concealed spaces outside the live switchyard security fence shall be minimised where reasonably practicable.

11.1.9 No storage rooms or areas, other than those required for approved substation equipment, shall be provided within substations.

11.2 External doors

11.2.1 The minimum requirements for external doors shall be in accordance with the Design Brief issued by Ausgrid.

11.2.2 Where necessary, external doorsets and hardware shall be fire rated, tagged and certified. Doors that are required to be fire-rated shall comply with NCC or Ausgrid's requirements, whichever is the more severe.

11.2.3 Unless specified otherwise by Ausgrid, external doors shall be a metal clad 0.55 BMT, 45mm external grade solid core blockboard door, or a solid core fire rated door, both with a 1.6mm metal frame, grout filled.

11.2.4 The use of Zincanneal for corrosion protection is not permitted for external door frames or claddings.

11.2.5 All door hardware shall be continuously sealed to prevent water ingress. Isolation tape shall be used to provide a barrier between any dissimilar metals.

11.3 Internal doors

11.3.1 The minimum requirements for internal doors shall be in accordance with the Design Brief issued by Ausgrid.

11.3.2 Where necessary, internal doorsets and hardware shall be fire rated, tagged and certified. Doors that are required to be fire-rated shall comply with NCC or Ausgrid's requirements, whichever is the more severe.

11.3.3 Unless specified otherwise by Ausgrid, internal doors shall be a painted 45mm external grade solid core blockboard door, or a solid core fire rated door, both with 1.6mm metal door frame.

11.3.4 All internal doors shall comply with the egress provisions of the NCC. Keyed locks for internal doors may be required for specific locations, as indicated in the Design Brief.

11.3.5 Internal doors do not require hinge bolts or strike shields. Where required, door plates with oval cylinders shall be provided to suit Ausgrid locks.

11.4 External windows and louvres

11.4.1 Intruder resistant security shall be provided to all window and louvre openings in external substation walls where the sill heights are below 2.4m.

11.4.2 Intruder resistant security shall also be provided for any opening where the surrounding climb aids would assist in unauthorised access for sill heights greater than 2.4m.

11.4.3 The level of security shall be equivalent to SL81 mesh installed with steel frame and security fixings. Each bar of the security mesh shall be secured to prevent unauthorised access.

11.4.4 Windows and ventilation louvres shall be secured by the security grille fixed on the inside of the window or louvre.

11.5 External roller shutters

11.5.1 The minimum requirements for external roller shutters shall be in accordance with the Design Brief issued by Ausgrid.

11.5.2 Unless otherwise specified by Ausgrid, external roller shutters shall be constructed of unperforated galvanised steel. The steel slats shall be a minimum thickness of 0.8mm.

11.5.3 The roller shutter guides shall be a minimum of 75mm deep by 3mm thick to provide adequate embedment and retention of the roller slats. For roller shutters exceeding 3m wide, additional measures shall be used to provide a positive resistance to lateral removal of the door curtain from the guides.

11.5.4 For non-motorised external roller shutters, a lockable slide bolt shall be installed to each side of the roller shutter bottom rail. All mechanical locking shall be fitted to the secure side of the roller shutter. Where a motorised system is installed, the gearing shall ensure that the roller shutter cannot be lifted from outside the substation building.

11.6 Doors, locks and keys

11.6.1 Refer to T0037 for lock system requirements.

11.6.2 Doors shall meet the requirements of ENA Doc 015.

11.6.3 All external doors, and any internal doors opening from areas accessible by non-authorised personnel, shall be fitted with Ausgrid lock barrels in accordance with T0037.

11.6.4 Keys to all Ausgrid yards and buildings shall be issued only by Ausgrid Security Services.

11.6.5 Keys shall not to be issued to any person unless authority in writing is received from Ausgrid.

11.7 Monitoring and alarms

11.7.1 Thermal / smoke alarms, meeting the requirements of T0059, shall be installed throughout the substation building and connected to the Ausgrid SCADA system and to the local fire authority fire detection system.

11.7.2 Intruder alarms and motion detectors are optional for the substation building and shall be specified by Ausgrid as required.

12 Building power and lighting

12.1 General

12.1.1 The substation building shall be fitted with AC lighting, GPO’s and thermal / smoke detectors. Additional wiring for mechanical ventilation and other building services may be required in some substations as specified by Ausgrid.

12.1.2 All electrical installation work shall be carried out in accordance with T0007.

12.1.3 Refer to T0059 for thermal / smoke detector requirements.

12.2 Emergency lighting

12.2.1 Self-contained emergency exit lights and emergency egress lighting shall be installed. The emergency exit and egress lighting system shall be checked and maintained in accordance with NCC requirements.

12.2.2 A separate battery and emergency DC lighting is not required.

12.3 Task lighting

12.3.1 Task lighting shall be based on the type of equipment and the work to be carried out in the compartment. The use of portable lighting to supplement task specific work shall be assessed where adequate permanent lighting is impracticable or not cost effective.

12.3.2 Task lighting shall be in accordance with T0007, AS/NZS 1680.1, AS/NZS 1680.2.4 and AS/NZS 1680.5.

12.4 External lighting

The type and layout of fittings shall conform to T0007. Refer to the intrusive lighting provisions of AS 4282 and the general lighting provisions of AS/NZS 1680.5.

12.5 General power outlets

General power outlets shall be as required by T0007.

12.6 Location of switches, cables and lights

12.6.1 All light switches shall be located inside the compartment immediately adjacent to the entry door on the latch side.

12.6.2 All light fittings shall be positioned to facilitate ease of maintenance and replacement of luminaires without the need for equipment outages and access permits. All cabling shall be installed in conduits.

13 Data and communications

13.1 Standards

All data and communication installation work shall be carried out in accordance with Ausgrid requirements, the NCC, Australian Standards and Network Standards. Refer to NS203 and NS208 series for further details.

13.2 Telecommunications brief

A Telecommunications Brief indicating the specific project requirements shall be issued by Ausgrid for all major substation projects. The Brief will detail communications related work at the substation and also other works required to ensure the site is integrated into the communications network.

13.3 Design and installation

The design and installation of communications facilities shall be in accordance with Annexure F.

14 Plant and equipment labelling

All plant and equipment within the switch room/control room shall be fitted with identification nameplates and labelled in accordance with the requirements shown in NS158.

15 Building signage

15.1 Statutory building signage shall be provided to ensure compliance with the relevant legislation, Australian Standards, ENA Guidelines, the NCC or other statutory authority requirements. Refer to ENA Doc 015 for information on building signage.

15.2 Building signage, including emergency information diagrams, shall be in accordance with Annexure G.

16 Building design documentation

16.1 Drawings and specifications

Electronic copies of design drawings and specifications shall be provided by the Designer in an Ausgrid compatible format. “As built” drawings shall be provided within 4 weeks of completion of construction in the same format.

16.2 Room data sheet proforma

The Designer shall provide Room Data Sheets to the format in Annexure A for the substation building. The required finishes shall be as specified in Annexure B.

16.3 Maintenance procedures and operating manuals

The Preliminary and Final Maintenance Procedures and Operating Manuals shall be prepared and provided to Ausgrid in accordance with Annexure H.

16.4 Design and construction certification

16.4.1 A Certification or Design Statement as per Annexure H shall be provided stating the project has been designed by appropriately qualified personnel in accordance with the Ausgrid Design Brief, all relevant Network Standards, the relevant Australian Standards and accepted standards of practice prior to approval or acceptance of the design.

16.4.2 A Certification or Design Statement of the as-constructed works shall be provided in accordance with the Ausgrid design documentation and shall be provided to Ausgrid as part of the Final Occupation Certificate process.

Annexure A: Room Data Sheet Pro-forma

Level No.	Space Name		
Min. Floor Dimensions	Min. Height Clearances		
Access Notes	Equipment	Fixtures	Furniture

Roof		
	Type	
	Finish/colour	
	Thermal Rating	
	Design Life	
	Slope	
	Fasteners	
	Guttering	
	Downpipes	
	Anchor Points	
Floor		
	Type	
	Finish	
	Traffic	
	Loadings / Point Loading	
	Tolerances	
	Inserts / Penetrations	
	Min. Fire Rating	
	Overpressure	
Wall		
	Type (Internal/External)	
	Acoustic rating	
	Finishes (Internal/External)	
	Viewing Panels	
	Fixtures (Internal/External)	
	Min. Fire Rating	
	Overpressure	
	Venting type and area	

Doors		
	Min. Clear Opening	
	Hob height.	
	Type / Min. Fire Rating	
	Electronic Security	
	Keying	
	Min Fire rating	
	Overpressure	
Ceiling/slab soffit		
	Type	
	Finish	
	Acoustic Rating	
	Min. Fire Rating	
	Overpressure	
	Venting	
Mechanical Ventilation/Air Conditioning (min. volume / RH / Temp.)		
Natural Ventilation (min. volume / free area)		
Hydraulic Services		
Lighting		
Power		
Data / Communications		
Fire Services		
Special Hazards		

Annexure B: Architectural Finishes

B1 Internal and external finishes

Internal finishes to the different areas of the substation shall comply with the requirements of Table B1.

The required internal finishes in Table B1 may vary for ceilings, walls and floors that use alternative types of substrate materials.

External finishes shall comply with this Network Standard and the specific urban design requirements for the locality of the substation.

All paints shall meet the low volatile organic compounds (VOC) requirements, unless approved otherwise in writing by Ausgrid.

For specific details on the paint systems and colours, refer to Table B3.

Table B1: Internal Finishes

Room/Area	Ceiling	Walls	Floors
11 and 33kV Switch room	Unpainted unless otherwise specified – P1	Unpainted unless otherwise specified – P2	For Steel Trowel Monolithic Slabs; Concrete Sealer – P8 Within switchgear zone; 65 mm set-down topped with reinforced screed Concrete Sealer – P8
132kV Switch room	Unpainted unless otherwise specified – P1	Unpainted unless otherwise specified – P2	For Steel Trowel Monolithic Slabs; Concrete Sealer – P8 Within switchgear zone; 65 mm set-down topped with reinforced screed Concrete Sealer – P8
Control room	Unpainted unless otherwise specified – P1	Unpainted unless otherwise specified – P2	For Steel Trowel Monolithic Slabs; Concrete Sealer – P8 Within control panel zone; Concrete Sealer – P8 or Computer floor finished with low maintenance flooring
Cable basements, marshalling galleries, jointing and other areas where mass cables are found	Unpainted	Unpainted	For Steel Trowel Monolithic Slabs; Concrete Sealer – P8
Battery Rooms (where provided)	Unpainted unless otherwise specified – P1	Unpainted unless otherwise specified – P2	For Steel Trowel Monolithic Slabs; Concrete Sealer – P8
Communications Room	Unpainted unless otherwise specified – P1	Unpainted unless otherwise specified – P2	For Steel Trowel Monolithic Slabs; Concrete Sealer – P8
Sprinkler Valve and Pump Room	Unpainted unless otherwise specified – P1	Unpainted unless otherwise specified – P2	For Steel Trowel Monolithic Slabs; Concrete Sealer – P8

Room/Area	Ceiling	Walls	Floors
AFLC Rooms	Unpainted unless otherwise specified – P1	Unpainted unless otherwise specified – P2	For Steel Trowel Monolithic Slabs; Epoxy paint – P6
Meal Room / Plan Layout Room	Painted – P1.	Painted – P2	For Steel Trowel Monolithic Slabs; Vinyl sheet welded with coved skirting, or Epoxy paint – P6
Toilets / Showers	Painted – P1.	Painted – P2 Ceramic tiles to wet areas	Ceramic tiles, or Epoxy paint (toilets only) – P6
Capacitor Rooms	Unpainted unless otherwise specified – P1	Unpainted unless otherwise specified – P2	For Steel Trowel Monolithic Slabs; Concrete Sealer – P8
Stairs	Unpainted unless otherwise specified – P1	Unpainted unless otherwise specified – P2	For Steel Trowel Monolithic Slabs; Concrete Sealer – P8 Non-slip nosing to treads (colour: safety yellow)
Cable risers	Unpainted	Unpainted	For Steel Trowel Monolithic Slabs; Concrete Sealer – P8
Lifts	Fire rated plastic laminate on high density fibreboard	Finished stainless steel (Rigidtex 5WL Patterned SS)	Fire rated vinyl (Armstrong Nylex or equal)
Transformer Bays (Internal)	Unpainted	Unpainted off-form concrete or masonry.	For Steel Trowel Monolithic Slabs; Concrete Sealer – P8
Transformer Roadway (Internal)	Unpainted	Unpainted	For Steel Trowel Monolithic Slabs; Concrete Sealer – P8
Loading Docks	Unpainted unless otherwise specified – P1	Unpainted unless otherwise specified – P2	For Steel Trowel Monolithic Slabs; Concrete Sealer – P8
Entry Foyers and general circulation areas	Unpainted unless otherwise specified – P1	Unpainted unless otherwise specified – P2	For Steel Trowel Monolithic Slabs Concrete Sealer – P8

B2 Off-form concrete finishes

The off-form concrete finishes shown in Table B2 shall be specified for substation buildings.

Table B2: Off-form Concrete Finishes

Type	Internal Finish	External Finish
Exposed off-form concrete	Class 2	Class 2
Non-exposed off-form concrete	Class 3	Class 4

B3 Painting

The paint systems and colours shown in Table B3 shall be provided at the locations specified by Ausgrid. Proposed alternative paint systems and colours shall require the written approval of Ausgrid.

All painting shall comprise a sealer coat, primer coat and two finish coats of paint system as specified in Table B3.

The required paint finishes for ceilings, walls and floors that use alternative substrate materials shall be subject to review and approval by Ausgrid.

Table B3: Paint Finishes

Code	Surface	Typical Substrate	Paint system	Colour reference	Colour name
P1	Ceilings	Concrete or Fyrechek	Low gloss Latex		White
P2	Internal Walls	Concrete or masonry with render	Low gloss latex	Wattyl 25A-3P	'Antique Ivory'
P3	Internal Handrails, Balustrades	Metal	Semi-gloss solvent borne	Dulux 70BB 08/064	Dark Grey
P4	Doors, Door Frames		Semi-gloss solvent borne	Wattyl 12C-4D	Dark Grey
P5	Floor	Concrete	Oil resistant, concrete sealant	Clear	Clear
P6	Floors and Walls	Concrete, concrete block	Alkaline resistant epoxy coating system Full height	Durafloor N (Novolac)	Clear
P7	External Walls	Concrete, Masonry and ceramic tiles	Non-Sacrificial Teflon Graffiti Barrier	Clear	Clear
P8	Floors	Concrete	Concrete sealer to prevent dusting	Clear or Light Grey	Clear or Light Grey
P9	Roofs	Metal	Manufacturer's Standard	As Specified	As Specified

Annexure C: Ecologically sustainable development

C1 Key principles

C1.1 Ecologically sustainable development (ESD) can be achieved through the implementation of the following principles and programs:

- The precautionary principle - if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.
- In the application of the precautionary principle, public and private decisions should be guided by:
  - careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment; and
  - an assessment of the risk-weighted consequences of various options.
- Inter-generational equity - the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations.
- Conservation of biological diversity and ecological integrity - conservation of biological diversity and ecological integrity should be a fundamental consideration.
- Improved valuation, pricing and incentive mechanisms - environmental factors should be included in the valuation of assets and services, such as:
  - Polluter pays - that is, those who generate pollution and waste should bear the cost of containment, avoidance or abatement.
  - The users of goods and services should pay prices based on the full life cycle of costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste.
  - Environmental goals, having been established, should be pursued in the most cost-effective way, by establishing incentive structures, including market mechanisms, that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems.

C1.2 For additional guidance on ESD refer to the Department of Climate Change, Energy, the Environment and Water website shown below:

https://www.dcceew.gov.au/environment/epbc/publications/criteria-determining-esd-relevance

C1.3 The National Strategy for Ecologically Sustainable Development provides the broad strategic directions and framework for governments to direct policy and decision-making.

Annexure D: Materials in substations

D1 Material limitations

D1.1 General

The following materials are not permitted in substation building construction:

- Rubber;
- Mud brick and other unfired masonry;
- Asbestos containing materials;
- Products containing inhalable Man-Made Mineral Fibre (MMMF); and
- Plastics and resins without fire resistance

D1.2 Timber

Timber building materials shall not be used in the construction of the substation, except with the written approval of Ausgrid.

In locations such as amenities areas, pilot isolation rooms, piles or landscaping the limited use of timber may be acceptable where suitable alternatives are not available. Any wood composites shall be specified as low formaldehyde or no formaldehyde.

Timber piles and timber landscaping shall be in accordance with the requirements of NS186.

D1.3 Aluminium

Aluminium shall not be used for structural members or external cladding in substation buildings. Aluminium may be used for trench covers except where adversely impacted by radiant heat from transformer oil pool fires.

D1.4 Compressed fibrous concrete sheeting

Compressed fibrous concrete (CFC) sheeting shall not be used in areas of high point or impact loads or where it is exposed to the weather.

D1.5 Autoclave aerated concrete (AAC)

AAC products shall not be used where ductile performance is required.

D1.6 Calcium Silicate bricks

Calcium Silicate (Calsil) bricks shall be used only in strict compliance with the manufacturer's requirements. Calsil bricks shall be laid at the correct dampness to ensure bond strength. On site testing may be required to verify the bond strength achieved.

D2 Masonry

D2.1 General

Except where approved by Ausgrid, unreinforced masonry shall not be used in substation buildings due to the need to allow for the effects of ductile failure.

D2.2 Durability

The durability requirements for masonry construction shall be in accordance with AS 3700 and AS/NZS 2699, together with the following additional requirements:

- Exterior unprotected concrete blocks shall have a salt attack resistance at "Exposure" grade, when used on sites within 2 km of a surf coast or within 1 km of a non-surf coast;
- Wall ties and built-in components (other than lintels) shall satisfy the requirements of durability class R4 for all locations. Grade 316 stainless steel shall be used for all wall ties;
- Lintels shall satisfy the requirements of durability class R3 for all locations. As a minimum, all lintels shall be hot-dip galvanised steel with a minimum coating mass of 600 g/m2; and

- The reinforcement for concrete block walls shall be galvanised for situations where it may be continually wet or in exposed locations. This requirement applies to retaining walls and exposed walls in coastal or industrial areas.

D2.3 Brick growth

All clay bricks shall have a low representative expansion coefficient for the brick.

D2.4 Bed joint reinforcing

Stainless steel bed joint reinforcement to the requirements of AS 3700 shall be used at locations where it is necessary to increase masonry strength and improve resistance to cracking. Wall sections which are vulnerable to stress concentrations shall have additional bed joint reinforcing installed.

D2.5 Control joints

Walls shall have control joints of sufficient size and spacing to provide for expansion due to temperature change and brick growth. Control joints shall also allow for contraction and articulation caused by expansive soils, ground movement, mine subsidence or specific site conditions.

Filler materials and sealants shall have proven long term characteristics for softness, plasticity and flexibility to ensure the wall has sufficient space for movement and/or cracking.

Filler materials shall have a fire resistance commensurate with the fire resistance level required for the associated walls.

D3 Alternative materials

The use of non-conventional alternative materials shall be subject to approval in writing by Ausgrid.

Alternative materials shall have a well-established track record and codification by Standards Australia to confirm the performance of the material. Independent test results on the performance of the alternative material shall be assessed.

Alternative materials shall perform at least as well as conventional materials and satisfy the requirements of this standard.

Annexure E: Future expansion of control rooms

E1 Design approach

E1.1 For control rooms, the Designer shall assess the following aspects when determining the type and extent of future expansion provisions:

1) Design Life – allow for the equipment and technology changes that may reasonably occur during the Design Life of the substation.
2) Ultimate Capacity – allow for the expected future feeder bays, transformers and equipment which will form the ultimate design capacity of the substation.
3) Refurbishment – provide for the space requirements of mid-term refurbishment as outlined in Clause 2.5.2.
4) Future Flexibility – enable future flexibility by providing a shared common space designed for alternative applications using common panels wherever possible.
5) Potential Reductions – assess potential reductions in future space requirements (i.e. control and protection) that may offset increases elsewhere over a similar timeframe.
6) New Technologies – assess new applications which are on the horizon and expected to develop over the Design Life.
7) Future Contingency – assess additional, well supported, space allowances for unforeseen developments, energy strategies and technologies that may develop.
8) Integration – combine all functions within one room wherever possible unless separate rooms are nominated by Ausgrid for specific equipment.
9) Building Design – investigate a building layout and design that enables the control room to be readily extended within an operational substation.
10) Special Requirements – allow for the specific requirements that may arise at unique locations within the network (i.e. tunnel communications, UPS, GRN etc.).

E1.2 The design requirements that shall be applied to future expansion provisions for control rooms include, but are not limited to, the following:

- Restrict panel dimensions (width and depth) to within a nominated range for improved layout efficiency;
- Distribute spare panel space appropriately throughout the room and amongst each of the various functional groupings;
- Eliminate or minimise separation between functional groupings unless required by technical or risk determinations;
- Provide ventilation, air quality and temperature control to current standards and procure any future equipment accordingly;
- Ensure cabling provisions (sub-floor, trenches) have sufficient size and capacity to accommodate current and future panel installations;
- Make the necessary allowances for segregation and redundant paths for future cables where appropriate;
- Ensure that all allocations of future panel space are controlled and coordinated solely by the Designer and that variations are approved by Ausgrid; and
- Ensure that the future expansion provisions are clearly indicated on the design drawings together with the approved nominal allocations.

E1.3 For most major substation control rooms, it is recognised that:

- the Designer will allow for some spare panel space within the total allocated space to cater for known or reasonably expected future additions and for panel upgrades and replacement;
- this provision may increase where there is a level of uncertainty regarding future requirements; and

- the amount of space provided for future expansion will vary from site to site and as new technologies emerge.

E1.4 Substations in CBD locations have specific requirements and may require additional technical provisions to those that are indicated this Annexure.

Annexure F: Data and communications facilities

F1 Communications cabinets

Communications cabinets shall be designed, supplied and installed in accordance with NS208 series. The NS208 series provides details dealing with, but not limited to, the following aspects:

- Number of enclosures allocated for communications purposes in substations of various types;
- Placement of communications enclosures; and
- Arrangement of equipment inside communications enclosures.

F2 Communication installation works

The communications/data technician shall coordinate the installation of the following services:

- connection of substation phones;
- connection of fire brigade line;
- connection of SCADA;
- security system(s); and
- any other project specific communication needs to the telecommunications network.

All external copper telephone lines shall be run to the Telephone Isolation Cabinet and shall be isolated from the building and any non-approved termination equipment.

F3 External communications conduits

Conduits that run from internal pits or buildings to outside the major substation boundary are classified as external communications conduits.

The following are the minimum number of external communications conduits required:

- One white 50mm conduit shall run from the Telephone Isolation Cabinet (TIC) to outside of the substation boundary. Where the conduit transits via the cable marshalling area, provision shall be made to enable the conduit to be earth isolated from other cables.
  The placement of the communications pit outside the substation boundary shall be such that it minimises the civil works required by the incumbent National carrier (Telstra).
- One white 50mm conduit shall be provided to a communications pit outside the boundary of the substation. The placement of the pit outside the substation boundary shall be such that it minimises the civil works by a competitive National carrier (non-Telstra).
- One orange 50mm conduit shall be run with each 11kV bank of conduits to the cable marshalling area. Conduits shall be capped outside of the substation boundary, unless otherwise specified in the Telecommunications Brief.
- A minimum of one orange 63mm conduit for Protection Fibre shall be run with each 33kV or higher voltage bank of conduits to the vicinity of the nearest joint bay. These conduits shall NOT to enter the joint bay, but rather enter an adjacent communications specific pit.
- A minimum of one orange 50mm conduit for Distributed Temperature Sensing (DTS) shall be run with each 33kV or higher voltage bank of conduits to the nearest joint bay. These conduits shall enter the joint bay. Refer to the Telecommunications Brief and the Transmission Mains Underground design for the bank of conduits.

F4 Internal communications conduits

Conduits that run between buildings within the major substation are classified as internal communications conduits.

Where the substation consists of multiple buildings the communications conduits shall be run between the buildings in a manner to securely and reliably provide connectivity. This shall also facilitate a structured cabling system to be installed if required.

To ensure that secure and reliable connectivity is provided, the following minimum number and arrangement of conduits is required:

- Conduit depths shall align with NEG TC28 to ensure minimum disruption to the conduits due to normal substation works; and
- A minimum of two orange 80mm diverse conduit routes shall be provided between all buildings. This may be facilitated in a “ladder” or “ring” arrangement. Refer to Ausgrid for advice on route planning.

For substations where a bank of control and protection conduits is constructed between buildings, the required internal communication conduits can be run together with these conduits.

F5 Cable trenches and trays

Both external and internal communications cables for the substation shall be run to a designated end-point, such as a telecommunications cabinet.

For external switchyards, the communications cables can transition between buried conduits to conduits located within the cable trenches. Upon entry into the building cable marshalling area, the communications cables can remain within conduits and run on the existing internal cable trays.

Precautions shall be taken when designing all communication cable routes to:

- Maintain minimum bend requirements. For fibre optic cables the minimum bend radius for cables is 21 times the outer diameter of the cable. This translates to approximately a 300mm minimum bend radius.
- Ensure all cables are contained in conduits, whether on cable trays or in cable trenches. This will minimise exposure and the risk of mechanical damage when run within a substation area.
- Saddle the cable conduits to the side wall of any cable trenches when running conduits through an external switchyard.
- Minimise the risk of outage to redundant diverse cables by not using common cable paths or common mechanical fixings where possible (i.e. booker rod supporting dual cable trays).
- Maintain cable diversity as required by the Telecommunications Brief and as advised by Ausgrid.
- Label all conduits with the cable number at all substation transition (entry/exits) points. Where the conduit run is significant, label also every 10 metres of conduit.

Annexure G: Building signage

G1 General

External building identification signs shall be made of stainless steel, engraved, colour filled and fixed to the requirements of Ausgrid Drawing 167191.

Additional signage details, including layout and specification, shall be provided by Ausgrid.

G2 Compartment / room names

Identification signs shall be provided in accordance with Ausgrid Drawing 167191.

Earth lead storage rooms shall not be labelled when the access doors are on the external walls or are visible from outside the switchyard.

G3 Standard Ausgrid operational signs

Ausgrid shall supply the following signs where appropriate:

- Electrical equipment operating safety signs.

G4 Emergency information diagrams

Emergency information diagrams shall comply with the Department of Planning & Infrastructure – Hazardous Industry Planning Advisory Paper No 1 – Emergency Planning, AS 3745 and relevant sections of AS 1319.

Emergency information diagrams, including emergency drainage diagrams, shall be prepared for the entire substation area including the completed substation building. They shall be prepared and installed prior to commissioning of the substation.

All emergency information diagrams shall be updated when any modifications are undertaken.

Emergency information diagrams shall be inspected for relevancy and accuracy annually during routine substation inspections. Any deficiency in the emergency diagrams shall be reported to Ausgrid.

Emergency information diagrams shall be posted adjacent to substation phones (typically in the control room) and additional copies shall be posted at the substation entrance door and other main exits.

Additional diagram locations may be required to facilitate emergency response at substations.

All emergency information diagrams, including emergency drainage diagrams, shall be available on Ausgrid's Technical Document Management System (TDMS).

The emergency information diagrams shall incorporate locations of emergency exits, emergency equipment, hazards, telephones and procedures to be employed in case of accidents or emergencies in the substation and any other relevant information regarding local emergency facilities and resources.

G5 Emergency drainage diagrams

Emergency drainage diagrams shall be prepared for the completed stormwater and oil containment systems for the entire substation site. The diagrams shall include the building, outdoor areas and locations immediately adjacent to the boundary where site runoff may be critical.

The emergency drainage diagrams shall be updated when any modifications to the drainage systems are made. Emergency drainage diagrams shall be posted adjacent to, and together with, each emergency information diagram.

Annexure H: Building design documentation

H1 Design statement and certification

Substation designs shall be accompanied by a Design Statement for the specified Design Life and adequacy, prepared by the appointed Architects, Structural Engineers and Civil Engineers prior to acceptance of the design drawings for review by Ausgrid.

The Design Statement shall detail the standards, codes, practices or other literature and information which supports the recommendation of materials, products or finishes utilised to achieve the required Design Life.

The certification of the building being designed for the required Design Life shall be referenced in the Design Certificates required from the Designer as part of the Compliance Certificate process.

The Design Certificates shall specifically:

- Refer to the Design Life of the substation building;
- Include full referencing to the standards utilised for the design;
- State the design has assessed and is in accordance with relevant codes and standards to achieve the Design Life specified by Ausgrid;
- Be approved by Ausgrid prior to submission of the Compliance Certificate documentation to the Local Approval Authority; and
- Contain approved Preliminary Maintenance Procedures and Operation Schedules (PMPO).

H2 Preliminary maintenance procedures

As part of the design documentation, the Designer shall provide Preliminary Maintenance Procedures and Operation Schedules (PMPO) to Ausgrid.

The PMPO Schedules shall include expected time frames and procedures to enable maintenance to be planned in compliance with the manufacturer's and Designer's requirements, and any recommendations to achieve the required Design Life.

The PMPO Schedules shall include information on the suitability of all components to achieve Design Life including finishes, maintenance procedures and inspection regimes.

The PMPO Schedules shall accompany the documents submitted for project approval.

H3 Maintenance procedures and operating manuals

The Designer documentation shall specify that the Maintenance Procedures and Operating Manuals shall:

- Be prepared based on information contained in the Preliminary Maintenance Procedures and Operation Schedules provided by the Designer;
- Be submitted to Ausgrid for review and approval prior to an application being submitted for Practical Completion;
- Include recommended procedures for all maintenance and operation activities;
- Ensure the specified Design Life to comply with Life Cycle Costing requirements;
- Include information regarding operation and replacement instructions for items which have been amended during construction;
- Include all items added to the project due to revised construction, design, security or organisational issues encountered in the design and construction phases;
- Comply with the relevant requirements of NS210 and NS212; and
- Be in a format and structure that is suitable for uploading into the Ausgrid record management system (HPRM).

The Designer documentation shall also specify that:

- within four weeks of Practical Completion of the construction of the substation, the Final Maintenance Procedures and Operating Manuals detailing all the inspection, maintenance and operational requirements shall be provided; and
- where the Final Maintenance Procedures and Operating Manuals are not provided within four weeks, Ausgrid may arrange to prepare these documents at the Contractor's cost which shall be deducted from the retention monies.