Network Standard

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NW000-S0057 NS185 MAJOR SUBSTATIONS BUILDING DESIGN STANDARD

ISSUE

For issue to all Ausgrid and Accredited Service Providers' staff involved with the design of major substations, and is for reference by field, technical and engineering staff.

Ausgrid maintains a copy of this and other Network Standards together with updates and amendments on www.ausgrid.com.au.

Where this standard is issued as a controlled document replacing an earlier edition, remove and destroy the superseded document.

DISCLAIMER

As Ausgrid's standards are subject to ongoing review, the information contained in this document may be amended by Ausgrid at any time. It is possible that conflict may exist between standard documents. In this event, the most recent standard shall prevail.

This document has been developed using information available from field and other sources and is suitable for most situations encountered in Ausgrid. Particular conditions, projects or localities may require special or different practices. It is the responsibility of the local manager, supervisor, assured quality contractor and the individuals involved to make sure that a safe system of work is employed and that statutory requirements are met.

Ausgrid disclaims any and all liability to any person or persons for any procedure, process or any other thing done or not done, as a result of this Standard.

All design work, and the associated supply of materials and equipment, must be undertaken in accordance with and consideration of relevant legislative and regulatory requirements, latest revision of Ausgrid's Network Standards and specifications and Australian Standards. Designs submitted shall be declared as fit for purpose. Where the designer wishes to include a variation to a network standard or an alternative material or equipment to that currently approved the designer must obtain authorisation from the Network Standard owner before incorporating a variation to a Network Standard in a design.

External designers including those authorised as Accredited Service Providers will seek approval through the approved process as outlined in NS181 Approval of Materials and Equipment and Network Standard Variations. Seeking approval will ensure Network Standards are appropriately updated and that a consistent interpretation of the legislative framework is employed.

Notes: 1. Compliance with this Network Standard does not automatically satisfy the requirements of a Designer Safety Report. The designer must comply with the provisions of the Workplace Health and Safety Regulation 2011 (NSW - Part 6.2 Duties of designer of structure and person who commissions construction work) which requires the designer to provide a written safety report to the person who commissioned the design. This report must be provided to Ausgrid in all instances, including where the design was commissioned by or on behalf of a person who proposes to connect premises to Ausgrid's network, and will form part of the Designer Safety Report which must also be presented to Ausgrid. Further information is provided in Network Standard (NS) 212 Integrated Support Requirements for Ausgrid Network Assets.

2. Where the procedural requirements of this document conflict with contestable project procedures, the contestable project procedures shall take precedent for the whole project or part thereof which is classified as contestable. Any external contact with Ausgrid for contestable works projects is to be made via the Ausgrid officer responsible for facilitating the contestable project. The Contestable Ausgrid officer will liaise with Ausgrid internal departments and specialists as necessary to fulfil the requirements of this standard. All other technical aspects of this document which are not procedural in nature shall apply to contestable works projects.

INTERPRETATION

In the event that any user of this Standard considers that any of its provisions is uncertain, ambiguous or otherwise in need of interpretation, the user should request Ausgrid to clarify the provision. Ausgrid's interpretation shall then apply as though it was included in the Standard, and is final and binding. No correspondence will be entered into with any person disputing the meaning of the provision published in the Standard or the accuracy of Ausgrid's interpretation.

KEYPOINTS

This standard has a summary of content labelled "KEYPOINTS FOR THIS STANDARD". The inclusion or omission of items in this summary does not signify any specific importance or criticality to the items described. It is meant to simply provide the reader with a quick assessment of some of the major issues addressed by the standard. To fully appreciate the content and the requirements of the standard it must be read in its entirety.

AMENDMENTS TO THIS STANDARD

Where there are changes to this standard from the previously approved version, any previous shading is removed and the newly affected paragraphs are shaded with a grey background. Where the document changes exceed 25% of the document content, any grey background in the document is to be removed and the following words should be shown below the title block on the right hand side of the page in bold and italic, for example, Supersedes – document details (for example, "Supersedes Document Type (Category) Document No. Amendment No.").

KEY POINTS OF THIS STANDARD

Scope and Risks Addressed

This standard details the general requirements for various Architectural, Civil and Structural engineering aspects to be considered and included into the design of buildings for Major Substations. It is limited to the scope identified below and provides controls for associated risks as listed below:

- ☐ Major Substations with primary voltages of 132kV, 66kV and 33kV.
- ☐ The design of all Ausgrid major substations will comply with this standard.
- ☐ The standard does not apply to distribution substations, kiosks or pole top equipment.
- ☐ NS186 Major Substation Civil Works Design standard details the performance and design criteria for the civil works.
- ☐ Ausgrid may have some site specific requirements that apply in addition to those in this standard.
- ☐ This standard does not include detailed information for yard structures.

Where to for more information?

Section 1, 2

Functional Requirements

The standard includes the following functional, general and material requirements:

- ☐ All material and equipment used will be free of asbestos
- ☐ Substation design life of 100, 50 or 20-years will apply as determined by Ausgrid.
- ☐ Substation buildings will comply with all relevant Legislation, Australian Standards, Codes of Practice and the Building Code of Australia (BCA).
- ☐ Maintenance schedules of required maintenance works will be prepared for components of the design that do not meet the Ausgrid required Design Life.
- ☐ Replacement of components is allowed for accessible and replaceable non-structural elements where a design life of 100 or 50-years has been determined.
- ☐ Preliminary maintenance procedures and operations schedules will be supplied to Ausgrid with the design documentation.
- ☐ Where requested by Ausgrid, Life Cycle Costing shall be used to determine the most suitable components.
- ☐ All options for 50 and 100-year design life substations shall take into account mid-term re-equipping needs for the substation plant.

Where to for more information?

Section 5, 6

Tools and Forms

Annexure C – Ecologically sustainable development

General and Materials Requirements

The general design and material requirements include the following requirements:

- ☐ General requirements concerning building accommodation, aesthetics, safety, durability, suitability for purpose, etc.
- ☐ The need for Designer Safety Reports, a design risk assessment (CHAIR), and site investigations.
- ☐ Requirements in relation to ventilation, air quality, temperature control, noise and vibration.
- ☐ Consideration of flood prone areas, the level of the ground water table and the general collection and management of groundwater.
- ☐ Limitations on the use of specific materials in the building.
- ☐ Recommendations as to acceptable materials and their desirable properties.
- ☐ Requirements for architectural finishes are provided in Annexure B.
- ☐ Use of non-conventional alternative materials shall be subject to approval in writing by Ausgrid.
- ☐ All substations shall comply with the relevant provisions of the BCA as required.

Where to for more information?

Section 7, 8, 9

Tools and Forms

Annexure B – Architectural Finishes

Engineering, Structural and Architectural Requirements

The engineering, structural and architectural requirements include the following:

- ☐ The building design must withstand overpressures as required. Refer NS188 Design for Substation Overpressure.
- ☐ Locations subject to mine subsidence to comply with the requirements stated.
- ☐ General fire resistance and fire rating is to comply with NS187 Passive fire Mitigation Design of Substations.
- ☐ Structural requirements in relation to floors, walls, ceilings, roofs, doors, windows.
- ☐ Loading considerations for permanent and imposed loads and due to wind/earthquakes.
- ☐ Special consideration is given to structural redundancy, vibration, basements and cranes.
- ☐ Architectural requirements include provisions for vermin proofing, termite protection, access and egress and provision for specific equipment requirements.
- ☐ Provision of general amenities, emergency facilities, security provisions and data communications requirements.
- ☐ Provision for power and lighting.
- ☐ Provision of equipment labelling and building signage
- ☐ Provision for future expansion and upgrades.
- ☐ Documentation requirements

Where to for more information?

Section 10, 11, 12

Tools and Forms

Annexure A – Room data sheet proforma
Annexure D – Sample compliance checksheet

Network Standard
NS185
Major Substations Building Design Standard

Contents

1.0 PURPOSE

Network Standard NS185 details the general requirements for various Architectural, Civil and Structural engineering aspects to be considered and included into the design of buildings for Major Substations.

2.0 SCOPE

This Standard details the performance and design criteria for the architectural and structural design of buildings for Major Substations with the voltages of 132kV, 66kV, 33kV and 11kV.

The design of all Ausgrid Major Substations shall comply with this Standard.

An associated Network Standard, NS186 Major Substations Civil Works Design Standard, details the performance and design criteria for the civil works design of Major Substations.

This standard should be read in conjunction with other Ausgrid standards relevant to the requirements for ventilation, substation overpressure, active and passive fire mitigation. Refer to Section 3.0 References for specific details.

Ausgrid may have some site specific design requirements which apply in addition to those in this Standard. This Standard draws attention to the unique requirements of substations to meet the Ausgrid performance expectations of the asset.

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.

3.0 REFERENCES

All work covered in this document shall conform to all relevant Legislation, Standards, Codes of Practice and Network Standards. All work covered in this document shall conform to all relevant Legislation, Standards, Codes of Practice and Network Standards. Current Network Standards are available on Ausgrid's Internet site at www.ausgrid.com.au.

3.1 Ausgrid documents

- Bush Fire Risk Management Plan
- Company Form (Governance) - Network Technical Document Endorsement and Approval
- Company Procedure (Governance) - Network Technical Document Endorsement and Approval
- Company Procedure (Network) – Network Standards Compliance
- Company Procedure (Network) - Production / Review of Engineering Technical Documents within BMS
- Customer Installation Safety Plan
- Division Workplace Instruction (Network) – Production/review of Network Standards
- Electrical Safety Rules
- Electricity Network Safety Management System Manual
- Be Safe Hazard Guideline 01: Asbestos
- EG 320 Major Substation Embodied Impacts
- NEG EP07 Network Access and Security – Locks and Keys
- T0057 NEG EP09 Intruder Resistant Fences for Zone & Subtransmission Substations
- T0007 NEG SM04.21 Light & Power
- T0053 NEG SM04.27 Power Cable Conduits
- NEG SM05 Site Assessment Process for Major Projects
- T0059 NEG SM07 Active Fire Systems for Substations
- NEG SM08 Noise Assessment
- T0083 NEG SM22 Blasting Near Ausgrid Substations and Power Lines
- NEG TC28 Installation of Optical Fibre Infrastructure within Substations
- NS158 Labelling of Mains and Apparatus
- NS171 Fire Stopping in Substations

- NS174 Environmental Procedures
- NS178 Secondary System Requirements for Major Substations
- NS181 Approval of Materials and Equipment and Network Standard Variations
- 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
- Public Electrical Safety Awareness Plan
- Public Lighting Management Plan
- Section 170 Register
- Tree Safety Management Plan

3.2 Other standards and documents

- ANZECC & ARMCANZ – Australian and New Zealand Guidelines for Fresh and Marine Water Quality, October 2000
- AS/NZS ISO 14040:1 Environmental management - Life cycle assessment - Principles and framework.
- AS/NZS 1158 Lighting for roads and public spaces (Set)
- AS/NZS 1170.0 Structural design actions – General principles
- AS/NZS 1170.1 Structural design actions – Permanent, imposed and other actions
- AS/NZS 1170.2 Structural design actions – Wind actions
- AS/NZS 1170.4 Structural design actions – Earthquake actions in Australia
- 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 1940 The storage and handling of flammable and combustible liquids
- AS 2159 Piling – Design and installation
- AS 2187.2 Use of Explosives
- AS 2293.1 Emergency escape lighting and exit signs for buildings - System design, installation and operation
- AS/NZS 2312 Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings
- AS 2484.1 Fire – Glossary of terms – Fire tests
- 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 2870 Residential slabs and footings
- AS/NZS 2890.1 Parking facilities – Off-street car parking
- AS/NZS 3000 Electric installations (Australian/New Zealand Wiring Rules)
- AS 3011.1 Electrical installations – Secondary batteries installed in buildings – Vented cells
- AS/NZS 3500 National Plumbing and Drainage (Set)
- AS 3600 Concrete structures
- AS 3700 Masonry structures

- AS 3745 Emergency control organisation and procedures for buildings Planning for emergencies in facilities
- AS 4072.1 Components for the protection of openings in fire-resistant separating elements – Service penetration and control joints
- AS 4100 Steel structures
- AS 4282 Control of the obtrusive effects of outdoor lighting
- AS/NZS 4536: Life cycle costing – An application guide
- AS 4678 Earth-retaining structures
- AS 5100 Bridge Design (Set)
- Australian Rainfall and Runoff A Guide to Flood Estimation
- Austroads Framework for Specifying Asphalt, Austroads 2002 (AP-T18-02)
- 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 January 2011
- Department of Sustainability, Environment, Water, Population and Communities – National Strategy for Ecologically Sustainable Development
- Electricity Supply Act (NSW)
- ENA Standards/Guidelines (www.energynetworks.com.au/industry-guidelines)
- ENA Doc 001 - 2008 National Electricity Network Safety Code
- ENA Doc 015 - 2006 National Guideline for Prevention of Unauthorised Access to Electricity Infrastructure
- ENA EMF Management Handbook 2016
- EPA: Environment Protection Authority (EPA), NSW Industrial Noise Policy, January 2000
- EPA: Environment Protection Authority (EPA), NSW Environment & Heritage – Assessing Vibration: a technical guideline, February 2006
- EPA: Environment Protection Authority (EPA), Specification of Supply of Recycled Materials for Pavements, Earthworks and Drainage, June 2003
- ESAA D(b)36-1990 Guide for Design of Substations in Cyclone and Other High Wind Areas (For Information only)
- IEC 60529 Ed. 2.1 Degrees of protection provided by enclosures (IP Code)
- National Construction Code Series (NCC)
- Pavement Design: A Guide to the Structural Design of Road Pavements (Austroads)
- RTA 45070666E Heavy Vehicle Mass, Loading and Access
- Seismic Security of Power Systems ND/S/-01 (ESAA, ESC158 January 1994) (For Information only)
- Substation Seismic Design Application Guide ND/S/-02 (ESAA, ESC156 September 1994) (For Information only)

3.3 Acts and regulations

- All Relevant SafeWork NSW documentation
- Electricity Supply (General) Regulation 2014 (NSW)
- Electricity Supply (Safety and Network Management) Regulation 2014
- 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 and Regulation 2011

4.0 DEFINITIONS

Active System	A system that has moving parts or relies on mechanical, chemical or electrical controls in order to function. Examples of active systems include fire protection systems such as sprinklers and smoke detection systems.
Access requirements	Requirements for openings, loading docks corridors and passages and for supporting the weight of all equipment and personnel.
Approved	Requires written consent from Ausgrid. Such written approval may contain authorised specific departures from the Standard.
Accredited Service Provider (ASP)	An individual or entity accredited by the NSW Department of Industry, Division of Resources and Energy, in accordance with the Electricity Supply (Safety and Network Management) Regulation 2014 (NSW).
Business Management System (BMS)	An Ausgrid internal integrated policy and procedure framework that contains the approved version of documents.
BCA	The Building Code of Australia (BCA) is Volume One and Volume Two of the National Construction Code Series (NCC).
Cage	As defined in Ausgrid's Electrical Safety Rules.
Design	The substation design that is to be provided by the Designer in compliance with Ausgrid requirements.
Designer	The Designer is the nominated party responsible for the layout and design of the project under the overall direction of Ausgrid. The Designer may be an internal group within Ausgrid, or an external party appointed for the project.
Design Life	The timeframe in which the building can operate efficiently and be fit for purpose without breakdown of the building fabric or structure.
Dolly	A device used to split the load from the transformer float to the prime mover.
Document control	Ausgrid employees who work with printed copies of document must check the BMS regularly to monitor version control. Documents are considered "UNCONTROLLED IF PRINTED", as indicated in the footer.
Electrical Layout Plan	A concept plan showing the spatial arrangement of equipment and the minimum dimensions of the substation building and yard. Electrical Layout Plans are provided for specific projects by Ausgrid.
ENA	The Energy Networks Australia (ENA) is the peak national body representing gas and electricity distribution businesses throughout Australia. See ENA Industry Guidelines (www.energynetworks.com.au/industry-guidelines).
Equipment Handling Plan	A plan that clearly illustrates and shows consideration for the movement of plant for equipping, replacement and maintenance/operation.
Equipping	Installation of substation equipment, including but not limited to cables, busbars, switching and control equipment and transformers.
Fire stopping	Measures that are adopted to prevent the spread of fire, smoke and acid residues from one compartment to another.
GIS	Gas Insulated Switchgear.
High voltage	A voltage above 1,000 volts alternating current or 1,500 volts direct current.
Impact Resistance	Offers resistance to accidental impact from ordinary day to day operations without suffering mechanical damage sufficient to adversely affect the fire rating performance.

Layout Drawings	Drawings to scale showing the dimensions and relative locations of substation equipment and infrastructure.
Light weight ceiling construction	Ceiling construction consisting of plaster board type materials such as Fyrechek or Gyprock products.
Low maintenance	Low required return period for inspection and maintenance.
Major Substation	Zone and sub-transmission substations with primary voltages of 132, 66 or 33 kV.
Network Standard	A document, including Network Planning Standards, that describes the Company's minimum requirements for planning, design, construction, maintenance, technical specification, environmental, property and metering activities on the distribution and transmission network. These documents are stored in the Network Category of the BMS repository.
Overpressure	A rapid rise in the enclosure pressure caused by high voltage electrical equipment failing in an enclosed compartment.
Passive System	Describes a system of fire protection with no moving parts which does not rely on other external controls in order to function as intended. Examples of passive systems are: fire rated building elements such as fire barrier walls, fire doors in the closed position etc.
Review date	The review date displayed in the header of the document is the future date for review of a document. The default period is three years from the date of approval however a review may be mandated at any time where a need is identified. Potential needs for a review include changes in legislation, organisational changes, restructures, occurrence of an incident or changes in technology or work practice and/or identification of efficiency improvements.
Self-cleaning	Uses natural weather conditions to remove dust, debris and other airborne materials.
STS	Sub-transmission substation. Normally 132/33 kV or 132/66 kV.
Substation	In this Standard, the term substation refers only to Zone or Sub-transmission substations. This includes substations with 132/11 kV, 66/11 kV, 33/11 kV, 132/66 kV and 132/33 kV. This may include temporary STS or Zone substations as defined below.
Switch building	Building housing electrical switchgear and equipment.
Switch room	A room for housing switchgear, also known as switchgear room.
Switchgear	Equipment for controlling the distribution of electrical energy or for controlling or protecting circuits, machines, transformers, or other equipment.
Switching equipment	Switchgear, circuit breakers, fuse switches, ring main switches and isolators.
Switchyard	Outdoor yard containing high voltage electrical substation equipment.
Temporary	Relates to substations with a design life of 20 years. Refer to Clause 6.3 for a further explanation on the various substations.
Transformer	A static piece of apparatus with one or more windings which, by electromagnetic induction, transforms a system of alternating voltage and current into another system of voltage and current usually of different values but with the same frequency, for the purpose of transmitting electrical power .

Transformer float	A transformer transport trailer towed by a prime mover with or without a dolly.
Turning circle	The area required for access by a transformer float to allow the replacement of a transformer.
WELS	Water Efficiency Labelling and Standards

5.0 ASBESTOS

All materials and equipment used for construction of Ausgrid's assets are to be free from Asbestos and or Asbestos related products. Suppliers are expected to comply with the Work Health Safety Act 2011 (NSW) together with the Work Health Safety Regulation 2011 (NSW) and confirm in writing that all products supplied to Ausgrid contain no Asbestos related materials.

If any asbestos is encountered during construction or maintenance activities then safe work method statements and appropriate practices must be implemented. Materials containing asbestos must be handled by a licensed contractor. This material should be disposed of offsite to an appropriately licensed landfill.

All work must be in accordance with Ausgrid's Be Safe Hazard Guideline 01: Asbestos.

6.0 FUNCTIONAL REQUIREMENTS

6.1 General

Substations are classified by the required Design Life which is based on issues relevant to calculated load, system reliability and criticality as determined by Ausgrid. Three classifications are used in the design for Major Substations:

- 100 year Design Life,
- 50 year Design Life, and
- 20 year Design Life.

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

6.2 Design standards

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

Ausgrid requirements are described in this Network Standard, other Network Standards and/or Network Engineering Guidelines (NEG).

6.3 Design life of structural components

6.3.1 General

Design Life in this Network Standard 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 all loads and other forces to ensure the building and the structure attains, as a minimum, the required Design Life.

Ausgrid shall determine and advise the required Design Life for each substation. The Design Life of all components shall be assessed and taken into account when designing the overall building to ensure compliance with, and achievement of, the specified Design Life.

6.3.2 100 year design life

Architectural, Civil and Structural design shall ensure all structural components of the building are designed for a Design Life of 100 years.

Replacement of nominated non-structural components during the Design Life is allowed. Refer to Clause 6.3.5.

Components which do not have a 100 year 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.

6.3.3 50 year design life

Architectural, Civil and Structural design shall ensure all structural components of the building are capable of a Design Life of 50 years.

Replacement of nominated non-structural components during the Design Life is allowed. Refer to Clause6.3.5.

Components which do not have a 50 year 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.

6.3.4 20 year design life

Temporary substations are generally required as a means of supplementing the Network, or for emergency situations whilst other work is undertaken for a more permanent solution.

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

6.3.5 Replacement of components

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.

Any proposal for replacement of components during the substation Design Life shall be subject to a Life Cycle Cost assessment in accordance with Clause 6.6. Where applicable, the cost of any necessary power outages to enable replacement shall be factored into the Life Cycle Cost assessment.

6.4 Design of the components for design life

The current Australian Building Standards are based on a Design Life of 50 years. Where an extended Design Life is required by Clause 6.3, details of measures to achieve this required Design Life shall be provided by the Designer to Ausgrid for approval for use prior to design.

The durability requirements in AS 5100:5 Bridge Design - Concrete shall be utilised in designs requiring a 100 year Design Life.

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.

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 considered 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.
- Contain approved Preliminary Maintenance Procedures and Operation Schedules (PMPO).

6.5 Preliminary maintenance procedures and operation schedules

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

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

6.6 Life cycle costing (LCC)

6.6.1 Definition

Life Cycle Costing is defined in AS/NZS 4536 Life cycle costing – An application guide as the "sum of acquisition cost and ownership cost of a product over its life cycle".

Where requested by Ausgrid, designs shall be assessed on Life Cycle Costing (LCC) to determine the most suitable components. Calculations shall be based on the Design Life period allowing for the varying design lives of components. The LCC should also assess alternative options and include a sensitivity analysis.

6.6.2 LCC assessment and report

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

To ensure the most cost efficient design is selected, LCC techniques shall be utilised, where requested, in the selection of all options for design and material selection.

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

The Designer shall provide to Ausgrid all of the relevant 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.

All LCC assessments shall comply with AS/NZS 4536 and AS/NZS ISO 14040:1 Environmental management - Life cycle assessment - Principles and framework.

6.6.3 Mid-term refurbishment requirements and activities

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

The Design shall allow for the efficient and cost effective replacement of components. The Design shall include assessment and consideration for a whole of life costing including replacement costs undertaken in an operational substation.

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

6.7 Ecologically sustainable development

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

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

As part of the ESD process, EG 320 Major Substation Embodied Impacts provides some guidance on the initiatives that may be applicable for reducing embodied impacts associated with Major Substation projects.

7.0 GENERAL SUBSTATION DESIGN REQUIREMENTS

7.1 General

The substation building shall be of a low profile design where practicable. The proposed external and internal colours and finishes shall be submitted to the Ausgrid Representative for approval. The ceiling height shall accommodate all plant and equipment, including the necessary equipment handling requirements and provision for arc fault venting as required.

Substation buildings with a 50 year and 20 year Design Life may be prefabricated or of a modular type construction.

The building shall have minimum rating of IP55 to IEC 60529, with a minimum thermal insulation of R2.5 in the walls, floor and ceiling and 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; and
- Storage facilities for spare equipment, circuit breaker trolleys, blanking plates, cover plates, signs, ladders, hanging rack for earth leads and operating sticks.

An ergonomically designed operator's desk, plan table, chair, filing cabinet, notice board and HMI complete with telephone shall be installed.

The design of all substations shall address the issues of aesthetics, the environment, resource minimisation, energy usage and legal requirements. All developments should be of appropriate quality to meet the Ausgrid design requirements and shall comply with the following:

- Adequately accommodate and protect the associated electrical equipment.
- Provide a safe and comfortable working environment for all users.
- Meet the Design Life requirements.
- Be cost effective when assessed on a life cycle cost basis.
- Have an appropriate level of security.
- Be capable of being constructed cost efficiently and within time constraints.
- Have appropriate access for equipment installation, maintenance and replacement particularly with regard to live substations.
- Make suitable provision for safe access to routine operating and visual monitoring locations.

- Make suitable allowance for safe work at heights with adequate space provided around equipment to ensure that ladders, scaffolding, elevated work platforms etc. can be utilised when required.
- Meet the requirements of the Building Code of Australia (BCA) where appropriate and relevant Australian Standards.
- Be acceptable to the local community and Local Approval Authorities.
- Provide durability and performance of the intended function.
- Provide security against vermin, wildlife, unauthorised entry and fire.
- Facilitate the future development of the substation without unplanned disruption to supply from the substation.
- Enable access from ground level into the building for all major plant such as circuit breaker trucks in accordance with the Work Health and Safety Regulation 2011 (NSW).

Unless otherwise specified, it is not required that the building 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.

7.2 Designer safety reports

For structures, including buildings, the Work Health and Safety Regulation 2011 (NSW) requires a written safety report to be provided by the designer of a structure, or any part of a structure, to the person who commissioned the design.

The Designer Safety Report shall comply with the requirements of NS 210 Documentation and Reference Design Guide for Major Substations and shall be prepared at the completion of the design development process.

7.3 Design risk assessment

Substation buildings shall be designed to particular performance requirements of Ausgrid and inherent site conditions.

A Construction Hazard Assessment & Implementation Review (CHAIR) shall be undertaken in accordance with the Work Health and Safety Regulation 2011 (NSW). A copy of the CHAIR review documentation shall be forwarded to Ausgrid / Development Services, for review and approval prior to completion of the Design phase.

The Designer shall include sufficient resources and staff to coordinate advice and participate in the CHAIR process to enable full assessment of the building and the construction methodology to gain compliance with all SafeWork NSW requirements.

7.4 Durability

Low maintenance materials are preferred, with any applied finishes not required to be frequently retouched or re-coated during the life of the system. Where applied finishes are required such finishes shall comply with the requirements in Annexure B and Clause 6.3.

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 6.6. Where applicable, the cost of any necessary power outages to enable re-application shall be factored into the Life Cycle Cost assessment.

All external finishes and fittings are to be self-cleaning where possible.

For near coastal locations, the exposure conditions of external cladding materials should be assessed for their potential impacts upon durability. Metal cladding materials that are not regularly washed by rainfall (i.e. eaves soffits and adjacent wall claddings) may require increased future maintenance to achieve the warranted durability. Any alternative materials or designs proposed should be assessed on a Life Cycle Cost basis in accordance with Clause 6.6.

Refer to NS187 Passive Fire Mitigation Design of Substations for material limitations with respect to fire performance.

7.5 Noise and vibration

The design of substation buildings and equipment shall ensure all equipment which generates noise is orientated in a manner that ensures noise is transmitted away from all sensitive receivers. Building location, orientation and local topography should be used to minimise the line of sight exposure of noise sources to neighbouring properties.

Sensitive receivers include residential properties, land on which residential dwellings can be constructed without rezoning, health facilities, motels, aged care facilities, schools, child care facilities and any other receivers which may be considered sensitive due to operational issues. Consideration should also be given to wetlands of high ecological value, national parks and habitat of any endangered or threatened species.

A noise and vibration assessment shall be carried out as early as practicable in the design stage and should consider realistic operating conditions including maintenance activities. Refer to NEG SM08 Noise Assessment for noise assessment requirements.

Operational noise levels shall comply with the EPA NSW Industrial Noise Policy. Refer to NS174 Environmental Procedures and NEG SM08.

Where the assessment shows that mitigation measures are required for realistic operating conditions, suitable allowances for measures shall be incorporated into the substation design. These measures shall enable compliance with the maximum allowable noise levels, as defined in the appropriate legislation/regulation.

Where the assessment shows that mitigation measures may be required for more severe (but less likely) operating conditions, suitable allowances should be provided for the future installation of sound barriers, enclosures or other methods of mitigation. These mitigation measures may then be implemented if, and when, deemed to be necessary.

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

Outdoor transformer enclosures should be treated to minimise reverberant noise, consistent with fire rating requirements.

The use of acoustically rated walls shall only be considered appropriate for reduction of noise from transformers or equipment onto nearby sensitive receivers following acoustic testing of the area.

7.6 Ventilation, air quality and temperature control

The equipment manufacturer's recommendations relating to air quality and temperature control for equipment accommodation **shall always be considered and adopted**.

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

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.

The design of the ventilation system and the requirements for a ventilation assessment for each building/room shall be in accordance with NS200 Major Substations Ventilation Design Standard. Refer also to Clause 10.4 for requirements relating to the thermal performance of the building.

Fire dampers, where provided, shall be of the multi-blade type in accordance with NS 200.

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

Ventilation openings shall be provided with security in accordance with Clause 12.6.

7.7 Site investigation

7.7.1 General

The requirements for site inspection and investigation are described in NEG SM05 Site Assessment Process for Major Projects. The site investigations required are divided into the following two stages:

- Stage 1 – Preliminary Site Assessment (Property Acquisition)
- Stage 2 – Detailed Site Assessment (Design Stage)

7.7.2 Site investigation

NEG SM05 shall form the basis of the required site inspection and investigation requirements.

Ausgrid shall undertake the applicable Stage 1 – Preliminary Site Assessment activities during the site acquisition and concept design phase.

The Designer shall undertake the applicable Stage 2 – Detailed Site Assessment activities during the detail design phase.

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

Site investigations could include, but are not limited to, electric and magnetic fields, noise and vibration, hydrology, geology, contamination, ecological, bush fire threat, Aboriginal heritage, non-Aboriginal heritage, visual and aesthetics, and traffic and access.

7.8 Sites in flood prone areas

On all sites prone to flooding, the above-ground building floor levels shall be at least 500mm above the 1 in 100 year flood level.

For below-ground floor levels, all ventilation openings shall be at least 500mm above the 1 in 100 year flood level, unless otherwise approved in writing by Ausgrid. The intent is to facilitate the provision of ventilation openings to natural air without any possibility of water ingress. Depending on site conditions, exceptions may be considered for cable marshalling areas that do not contain electrical equipment other than cables.

For sites in low-lying areas near coastal locations, suitable provisions shall be made for potential future sea-level rise in accordance with the relevant NSW Government policies, guidelines and management programs. Refer to the national ”CoastAdapt” datasets, developed by the National Climate Change Adaptation Research Facility (NCCARF) in conjunction with the CSIRO, which are intended to provide sea-level rise information for coastal councils.

The projections for NSW sea-level rise are indicative and will vary based on a number of factors. Typical estimates for Sydney and Newcastle (mid 2019) are an increase above the 1986 to 2005 average sea-level of up to 30cm by 2050, and up to 65cm by 2090 (High greenhouse gas scenario - RCP6.0).

Groundwater ingress management may also be required for low-lying substation building locations.

7.9 Structures below the groundwater table

Where possible, substation building areas should be located above the groundwater table to minimise the potential entry of groundwater.

In situations where substation building elements are below the surrounding groundwater table, consideration 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.

An appropriately designed groundwater drainage system certified by a practising Civil or Hydraulic Engineer may 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.

Any discharge to stormwater must be in accordance with Section 120 of the Protection of the Environment Operations Act 1997. In practice this means ensuring all discharges are in accordance with the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC Guidelines).

The ANZECC Guidelines provide water quality “trigger values” that, if exceeded, indicate a potential environmental impact and so trigger further investigation to determine whether or not the discharge water would pose a risk of harm to the receiving water body.

The investigation and water quality assessment will determine if the water is suitable to be discharged to local stormwater, or requires collection or on-site management.

7.9.1 Discharge of groundwater

Discharge of groundwater to local Council or Water Authority stormwater infrastructure shall only occur where a water quality assessment against the ANZECC Guidelines has been completed. The assessment shall confirm the discharge water would not pose a risk of harm to the receiving water body.

All approved groundwater discharges shall be external to the substation building using gravity drainage or an automatic pumping system, as required. Pumping systems shall be installed in accordance with Clause 11.3.2.

7.9.2 Collection and management of groundwater

Where a water quality assessment has determined that groundwater is not suitable for discharge to stormwater, an investigation of alternative options shall be undertaken.

Alternative options may include (but are not limited to):

- Options for re-use on-site
- Infiltration structure (i.e. absorption trench/zone)
- Discharged to an unsealed area (i.e. grassed area, garden bed)
- Collection and treatment on-site
- Collection via tanker for off-site management

8.0 MATERIALS IN SUBSTATION STRUCTURES

8.1 Key material requirements

The application or use of construction materials in substations shall be governed by fire resistance, substation overpressure, Design Life, Life Cycle Costing and aesthetics, as specified by Ausgrid and the Local Approval Authority.

All materials shall be assessed with regard to their whole of life cost.

All materials used in substation construction shall be non-combustible.

Where reasonably practicable, recycled materials should be utilised in construction of the main substation building elements. The use of recycled materials shall comply with Protection of the Environment Operations Act, the recycled aggregate exemption 2010, the excavated natural material exemption 2010 and the recovered fines exemption 2010.

The proposed use of any recycled materials shall be subject to a review of the relevant performance criteria, and will require the review and approval of Ausgrid.

8.2 Acceptable materials

Masonry, including brick work and reinforced blockwork, or reinforced concrete are suitable materials for the construction of substation building walls. These materials should only be designed as fire rated where necessary.

Reinforced concrete is a suitable material for substation floors, and should only be designed as fire rated where necessary.

The use of alternative lightweight materials, and lightweight construction methods, for the walls, floors and roof that meets the functional building requirements may also be acceptable subject to the approval of Ausgrid. This approach could include a steel framed construction, with suitable metal or precast concrete cladding, lightweight floors, and an appropriate fire rated lining where required.

For lightweight metal claddings, the Designer shall consider the impacts on substation security where the cladding forms part of the intruder resistant barrier. Additional security measures may be required for metal claddings that are located less than 2.4m above an accessible level. Refer also to Clause 12.6.

Other materials can be used except as detailed in the requirements in this Network Standard, NS187 Passive Fire Mitigation Design of Substations, NS188 Design for Substation Overpressure and the Building Code Australia (BCA).

8.3 Finishes

All finishes for substation building elements are included in Annexure B.

8.4 Material limitations

Due to the performance requirements of substations, some standard construction industry materials may not be permitted.

8.4.1 Timber

Due to the risk of ignition during a fire or substation overpressure, timber building materials are generally not to be used in the construction of the substation. 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, subject to the approval in writing of Ausgrid. 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 Major Substations Civil Works Design Standard.

8.4.2 Rubber

Rubber shall not be used in the substation building construction. Rubber is adversely affected by ozone which may sometimes be present in substations.

8.4.3 Aluminium

Aluminium shall not be used for structural members in substations. Aluminium may be used for trench covers, and cable coating adopted where required by NS 171 Firestopping in Substations to mitigate the risk of fire spread and the extent of damage to the cables.

8.4.4 Compressed fibrous concrete sheeting

The use of compressed fibrous concrete (FC) sheeting shall be avoided in areas of high point or impact loads or where it is exposed to the weather. Deterioration due to weather can reduce the material life expectancy and cause Work Health and Safety issues.

8.4.5 Autoclave aerated concrete (AAC)

The use of AAC products shall be avoided where ductile performance is required.

8.4.6 Calsil bricks

Calcium Silicate (Calsil) bricks may be used only in strict compliance with the manufacturer's requirements for laying. 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.

8.4.7 Mud brick and other unfired masonry

Mud brick and other unfired masonry shall not be used.

8.4.8 Asbestos based products

All materials and equipment used for construction of Ausgrid's assets are to be free from Asbestos and or Asbestos related products. Refer to Section 5 for more information.

8.4.9 Other materials

Products containing inhalable Man-Made Mineral Fibre (MMMF) shall not be used. This includes some sandwich panels, insulation batts, and some types of fire stopping products.

Plastics and resins which are not fire resistant shall not be used in the construction of any building.

8.5 Masonry

The use of unreinforced masonry shall be avoided due to the need to allow for the effects of ductile failure. All masonry work shall comply with the following clauses.

8.5.1 Durability

The durability requirements for masonry construction shall be in accordance with AS 3700 Masonry structures and AS/NZS 2699 Built-in components for masonry construction with the following additional requirements:

- Wall ties and built-in components (other than lintels) shall satisfy the requirements of durability class R4 for all locations. Use Grade 316 stainless steel for all wall ties.
- Lintels shall satisfy the requirements of durability class R3 for all locations. As a minimum Ausgrid requires all lintels to be hot-dip galvanised steel with a minimum coating mass of 600 g/m^2.
- The reinforcement for concrete block walls shall be galvanised if it is in a situation where it may be continually wet or in exposed locations. This requirement applies to retaining walls and exposed walls in coastal or industrial areas.

8.5.2 Brick growth

When selecting clay bricks the representative expansion coefficient of the brick shall be considered. Products with low expansion are preferred.

8.5.3 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 considered vulnerable to stress concentrations may have additional bed joint reinforcing installed as required.

8.5.4 Control joints

Walls shall have 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 also have a fire resistance commensurate with the fire resistance level required for the associated walls.

8.5.5 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 may also be considered.

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

9.0 BCA PROVISIONS

9.1 Building classification

Substation buildings do not fit a particular class of building under the Building Code of Australia (BCA) but are generally considered as Class 8 buildings.

All substations shall comply with the relevant provisions of the BCA noting that the BCA may contain some provisions that are inappropriate for electricity substations. Where compliance with the Deemed to Satisfy provisions of the BCA is considered to be inappropriate or not possible, approval should be sought under the Alternative Solution provisions of the BCA.

9.2 Protection of openings (firestopping)

All openings for service installations in the building elements providing fire separation shall be protected without exception in accordance with BCA Specification C3.15 and NS171 Firestopping in Substations.

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

9.3 Egress

Ausgrid generally requires all rooms which contain electrical power equipment to have at least two exits, diagonally opposite where possible.

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 BCA with regard to maximum floor area, exit travel distances and any other requirements.

All designs which do not provide two exits from any compartment shall comply with the BCA, the relevant Australian Standards AND be approved by Ausgrid prior to submission to the Local Approving Authority.

10.0 SPECIFIC ENGINEERING REQUIREMENTS

10.1 Overpressure

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 Design for Substation Overpressure, the BCA and relevant Australian Standards.

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.

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

10.2 Mine subsidence

If 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.

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

10.3 Fire resistance and stability

The BCA requires buildings to be designed, constructed and maintained to ensure the building can withstand the effects of a fire in order to:

- protect the user's health and safety,
- minimise hazards to fire brigade personnel fighting the fire, and
- prevent fire from spreading to adjoining buildings or adjoining fire compartments within the building.

Additionally, Ausgrid requires substation buildings to maintain the operation of equipment for as long as possible and allow safe re-entry into a structure after a credible fire has occurred.

Where required, the substation ceiling, roof, floor, internal walls, external walls and all doors shall have an appropriate fire rating. The fire rating and fire protection of the substation building shall be in accordance with NS187 Passive Fire Mitigation Design of Substations and NEG SM07 Active Fire Systems for Substations.

The substation building shall be provided with fire extinguishers only, unless otherwise specified by Ausgrid.

10.4 Thermal performance of building

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.

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.

The thermal performance modelling shall include a Life Cycle Cost assessment of the proposed building design in accordance with Clause 6.6.

11.0 STRUCTURAL DESIGN REQUIREMENTS

11.1 Structural design philosophy and criteria

Substation buildings shall be designed with an Importance Level of 4, in accordance with the Building Code of Australia (BCA) and all relevant Australian Standards. The return period applicable for the substation Design Life will affect the wind and earthquake loads only. Such return periods do not have an impact on imposed and permanent loads.

All designs shall comply with the Design Brief issued to the Designer by Ausgrid / Development Services.

11.2 Floors

11.2.1 General

The floor of the substation building shall be of suitable concrete or other alternative construction (refer to Clause 8.2) and shall be treated in a manner approved by Ausgrid.

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

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

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.

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.

Sufficient space should 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.

11.2.2 Slabs in contact with the ground

Measures shall be taken to ensure the durability of all concrete slabs in contact with the ground. Consideration shall be given to limiting crack width and the use of non-absorptive concrete to achieve the required building Design Life.

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

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

11.2.3 Floor loading drawing

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

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

11.2.4 Deflections

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

11.3 Walls

11.3.1 Architectural detailing

All internal walls and the internal skin of external walls shall be of suitable material to enable the fixing of wall anchors for support of equipment or cable trays.

Masonry or reinforced concrete walls shall be designed to minimise the extent of all cracking. 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.

Lightweight steel-framed walls may be acceptable and shall be subject to the approval of Ausgrid.

11.3.2 Walls below ground

Measures shall be taken to ensure the durability of all walls in contact with the ground. Consideration shall be given to limiting crack width and the use of non-absorptive concrete to achieve the required building Design Life.

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

Allowance shall be made for hydrostatic pressures irrespective of the drainage system adopted for the wall below ground.

Due to the installation of conduits in perimeter walls of the cable basements, such areas may collect seepage groundwater. All seepage at external walls shall be collected by perimeter drains to a gravity draining stormwater or subsoil pit. 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 use of pumps shall only be allowed with specific Ausgrid approval.

The drainage and discharge of any seepage groundwater shall comply with the requirements of Clause 7.9.

Provision shall be made for the possibility of differential movement between the building structure and conduits entering the building.

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

11.4 Roofing system

11.4.1 General

The roofing system consists of roof sheeting/cladding, roof drainage elements, roof space, ceilings (where required) and associated support structures.

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. Replacement during the Design Life requires a Life Cycle Cost assessment in accordance with Clause 6.6 and shall be subject to approval by Ausgrid.

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 Major Substations Civil Works Design Standard for details of personnel access paths and other areas external to the building.

11.4.2 Weather protection

To minimise the risk of water entering the building no penetrations are permitted through the roof cladding. Roofing systems which require the fasteners to perforate the roof sheeting/cladding shall be subject to review and approval by Ausgrid.

In addition, no penetrations (other than approved fixings) are permitted through any impervious membranes or continuous building elements (e.g. where ceilings are required) that sit below the

main roof. Where penetrations are not avoidable, a suitable sealing system shall be proposed for review and approval by Ausgrid.

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

11.4.3 Roof sheeting/cladding

Roof sheeting shall have a minimum slope of 5 degrees unless the design ensures the roof sheeting cannot permanently deform, or otherwise allow water ponding to occur, under the expected maintenance or construction loading. All roof sheeting/cladding shall be specified to minimise reflectivity.

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.

The design of the roof sheeting and its fixings shall meet or exceed the wind loading requirements of Clause 11.7. 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. In order to ensure that these effects have been properly and fully considered, the Designer shall;

- Provide a structural design certificate which includes references to the design of the roof sheeting and its fixings, and
- Indicate the 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.

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

Unless approved, all roof sheeting shall utilise concealed fasteners which do not require the roof sheeting to be perforated. Cyclone fasteners are preferred and should be used for all types of roof sheeting. Alternative fastener types shall be subject to the approval of Ausgrid and, in all cases, shall meet or exceed the wind loading requirements of Clause 11.7.

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 included in the approved project program.

Roof coatings shall be of a light colour to reflect heat and decrease heat load on the building wherever possible.

11.4.4 Roof drainage

The use of external roof gutters is to be minimised subject to the drainage requirements of the Local Council Authority. The use of box gutters located inside the external perimeter of the building is not permitted, unless approved in writing by Ausgrid.

Each external doorway shall be provided with “waterfall” protection where this is required for diverting run-off from the roof. In addition, suitable provisions should be made around the building perimeter to collect and divert any roof run-off and to provide suitable erosion control.

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

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 appropriately sized and detailed so as to minimise roof water overflowing onto the adjoining ground or pavements.

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

11.4.5 Roof maintenance access

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

The Designer shall consider the requirements for safe maintenance access onto the roof area. Generally, access to the roof for inspection, repair or maintenance activities will require a risk assessment to be undertaken by the relevant Contractor, and a subsequent approval by Ausgrid / Safety Services.

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.

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

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.

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.

A roof access system that relies on the roof sheeting for structural support is not preferred and shall be referred to Ausgrid for approval.

11.5 Doors and windows

All internal and external doors are to comply with the requirements of the BCA. Where necessary, doors shall be fire rated in accordance with NS187. Refer to Clause 12.6 for the general design requirements for doors.

The design of external doors, including roller shutter doors, and their fixings shall meet or exceed the wind loading requirements of Clause 11.7. In particular, the roller shutter door slats, guides and locking components shall have sufficient strength to survive the design wind event with no major damage.

All doors and windows shall be provided with security in accordance with Clause 12.6.

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

All external doors, and any internal doors opening from areas accessible by non-authorised personnel, shall be fitted with Ausgrid "standard" lock barrels in accordance with NEG EP07 Network Access and Security – Locks and Keys.

11.6 Permanent and imposed loads

Permanent and imposed loads shall be in accordance with AS/NZS 1170.0 Structural design actions – General principles and AS/NZS 1170.1 Structural design actions – Permanent, imposed and other actions unless advised otherwise in writing by Ausgrid. Suitable provisions shall be made for any dynamic components, where applicable, and for equipment handling and installation loads.

For switch rooms and other areas containing significant items of heavy equipment, the imposed floor actions shall be advised by Ausgrid or otherwise shall comply with Table 3.1 Reference Values of Imposed Floor Actions in AS/NZS1170.1 (2002) under the type of activity E – “Areas around equipment in boiler rooms (weight of equipment to be determined)”.

Where a concrete slab is used as the roof/ceiling 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. For all other roof structure types the permanent and imposed loads shall be in accordance with AS/NZS 1170.0 and AS/NZS 1170.1.

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

11.7 Wind loads

Wind Loads applicable to the substation buildings shall be in accordance with AS/NZS 1170.2 Structural design actions – Wind actions, and shall not be less than the value derived from the following:

Table 1: Wind loads applicable to substation buildings

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

Note: Risk Analysis required. Refer to AS/NZS 1170.0 - 2002, Annexure F – Annual Probability of Exceedance.

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

11.8 Earthquake loads

Earthquake loads shall be obtained from AS/NZS 1170.4 Structural design actions – Earthquake actions in Australia and AS/NZS 1170.0.

The ENA guidelines Seismic Security of Power Systems ND/S/-01 (ESAA, ESC158 January 1994) and Substation Seismic Design Application Guide ND/S/-02 (ESAA, ESC156 September 1994) should also be referenced for information purposes.

The annual probability of exceedance and the probability factor (k_p) 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 (See Note)
50 year	1/2500	1.8
20 year	1/1000	1.3
Serviceability Loads		
100 year	≤ 1/250	Risk Analysis (See Note)
50 year	1/250	0.75
20 year	1/100	0.50

Note: **Risk analysis required.** Refer to AS/NZS 1170.0 – 2002, Annexure F – Annual Probability of Exceedance.

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

For the serviceability limit state, the design requirements shall include the following;

- Probability Factor (k_p) 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.

For the ultimate limit state, the structural design should aim to reduce the risk of a complete structural collapse, where reasonably practicable. For framed structures, any plastic hinges formed during a major earthquake should occur preferentially in the beams, rather than the columns, to reduce the potential for collapse of the entire structure.

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

11.9 Structural redundancy

Substation buildings shall be designed to prevent progressive collapse following a substation fire or an overpressure event. This requirement shall apply only at the locations, and to the extent, that these events are required to be sustained by the building structure. Refer to Clauses 10.1 and 10.3.

11.10 Differential settlement

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

11.11 Foundation structures

The foundation structures used for substation buildings shall meet the relevant requirements of NS186 Major Substations Civil Works Design Standard relating to footing systems and piles as applicable.

11.12 Vibration limits

Some equipment installed in substations has specific vibration profiles which may affect the natural frequency of the building.

Measures shall be taken to address the issues involved with vibration.

Vibration levels shall be within the levels described by EPA NSW Environment & Heritage – Assessing Vibration: a technical guideline, February 2006.

Substation buildings which may be affected by existing or potential mine blasting activities shall consider the impacts of ground vibration and air blast overpressure. The requirements and limitations of T0083 NEG SM22 (T0083) Blasting Near Ausgrid Substations and Power Lines, and also AS 2187.2 Use of Explosives should be considered. However, it should be noted that sensitive electrical equipment may require much more stringent vibration limits.

The blasting induced Peak Particle Velocity (PPV) and air blast overpressure within a substation boundary should not exceed the limits given in T0083 NEG SM22, unless approved by Ausgrid. Blasting activities may also require protective measures to prevent flyrock from entering the site and/or damaging associated overhead transmission lines.

11.13 Basement structures

Substations may have basement areas, referred to as Cable Marshalling Areas (CMA) which may require construction below surface or ground level.

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. A CMA should not be provided under control room areas unless specific approval has been granted by Ausgrid.

Refer to Clause 12.3.7 for detailed CMA design requirements.

Potential water ingress into the CMA should be minimised and a perimeter drain and sump should be provided as outlined in Clause 11.3.2.

11.13.1 Cable entry points into building

Where there is potential for differential movement greater than 10 mm between the cable basement of a building and the surrounding ground, care shall be taken to ensure that duct lines and cables which enter the cable basement do not suffer damage due to the resulting shear displacement. Refer to Ausgrid Drawing No. 177332 and T0053 NEG SM04.27 Power Cable Conduits for details.

Cable conduits entering buildings shall comply with the following:

- All conduits which are not in use are to be capped.
- All conduits should be graded away from the building, where possible, to minimise water ingress into the building.
- All bell mouths are to be installed in line with Ausgrid requirements. See Ausgrid Drawing No. 177332.
- All conduits shall be located to ensure cabling is not exposed to any sharp edges or misaligned joints which may damage the cable.

11.14 Cranes and monorails

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 should be provided as necessary.

The requirements shall be identified in the Equipment Handling Plan. Refer to Clause 12.3.5.

11.15 Pulling eyes and stanchions

Fixed stanchions or pulling eyes may be required for the manoeuvring of equipment and for cable pulling. Refer to requirements of the Electrical Layout Plan and Equipment Handling Plans (Refer to Clause 12.3.5).

12.0 ARCHITECTURAL DESIGN REQUIREMENTS

12.1 Vermin proofing

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

12.2 Termite protection

12.2.1 Specifications

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

At locations where the use of timber or cellulose based products are deemed to be necessary, suitable precautions as indicated below 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 of any potential termite attack.
- The buildings shall have suitable design detailing of floors, walls and joints to deter termite entry and allow for visual detection of any termite activity.
- Suitable access for inspection, maintenance and durability assessment should be considered as part of the design process.

By limiting the use of materials that are subject to termite attack and adopting the precautions as indicated above, the further installation of physical termite protection systems within a substation will generally not be required.

Where additional termite protection, including physical termite protection, is proposed at a specific location, it shall be subject to the written approval of Ausgrid. Chemical systems for termite protection are not acceptable and will not be approved.

Specifications for concrete work are to include provisions regarding the use of pegs in concrete and screeding activities. All pegs used for activities such as, but not limited to, height levelling of slabs or indicators of wet areas for screeding at a lower level are to be removed and all holes properly filled and compacted to avoid cracking or holes which may allow the ingress of termites.

12.2.2 Conduits or cabling requirements

All conduits entering Ausgrid buildings that may contain materials that are subject to termite attack are to be sealed. The aim is to prevent the entry of termites into buildings via conduits or any cracks which could occur near or at cable entry points.

12.3 Space planning and layout

12.3.1 Electrical equipment layout

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

- Specific room and accommodation requirements
- Safe egress and adequate working space
- Equipment Handling Plans
- Cabling area requirements
- General circulation and personnel access
- Amenities
- Emergency facilities
- Security
- Light and power
- Data and communications
- Earthing and lightning protection

- Coordination with other services
- Future expansion provisions

12.3.2 Battery accommodation

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

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

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.

Battery enclosures shall be ventilated in accordance with the requirements of NS 200 Major Substations Ventilation Design Standard.

Refer also to NS191 Batteries & Battery Chargers in Major Substations for specific battery accommodation requirements.

12.3.3 AFLC accommodation

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.

The requirements for AFLC accommodation shall be as follows:

1. Outdoor Equipment – The first preference, where the site allows, is for an 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 separate external enclosures as indicated below.
3. 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.
6. Noise – Suitable provisions shall be made to mitigate the noise impacts on sensitive receivers due to AFLC equipment operation. Refer to Clause 7.5.
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 20 year design life in accordance with Clause 6.3.4 where appropriate. Prefabricated or modular type construction that satisfies the design requirements may be acceptable for this purpose.

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

12.3.4 Safe egress and adequate working space

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. Working areas and egress paths shall consider but not be limited to the following:

- 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
- Section safety clearances shall be provided to Ausgrid and Australian Standards.

Access into substations which contain areas which may be classified as 'confined spaces' shall comply with the provisions of AS 2865 Confined spaces and the Work Health and Safety Regulation, 2011 (NSW).

12.3.5 Equipment handling plans

Equipment Handling Plans shall be prepared for each substation site.

The Equipment Handling Plans shall be prepared in conjunction with the Electrical Layout Plan and 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.

Development of 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.

Equipment Handling Plans are to be prepared by the Designer and approved by Ausgrid.

12.3.6 Equipment loading docks

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.

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

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.

12.3.7 Cabling marshalling area requirements

The design of cabling marshalling areas is to ensure these spaces are not to be classified as confined spaces wherever possible. Consider a design that utilises low level and high level natural ventilation. Cable marshalling areas shall be ventilated in accordance with the requirements of NS 200 Major Substations Ventilation Design Standard.

Fit-out and clearances information regarding cable handling, installation and access are to be provided by the Designer to Ausgrid.

12.3.7.1 Safe egress

All personnel entering and working within cabling marshalling areas are trained and inducted. On this basis, all personnel are aware of the site-specific safety risks and are familiar with the location of emergency egress points.

Emergency egress paths shall be maintained unobstructed.

In cable marshalling areas the 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. In establishing this, consideration shall be given to overhead cable trays and other equipment or services supported from ceilings, beams or walls and cables located at low level above the floor. 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.

12.3.7.2 Adequate working space

Adequate working and circulation space is to be provided in cabling marshalling areas to ensure all maintenance activities, cable pulling and emergency escape and rescue can be safely undertaken.

12.3.7.3 Internal cable trenches

Internal cable trenches within a building shall allow for a suitable bending radius to be provided for cables and other services installed in the trench. In particular, suitable 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 Clause 12.8.

Suitable measures shall be taken to ensure that internal cable trenches do not have exposed sharp edges or corners which may cause damage to cables during installation works.

12.3.8 General circulation and personnel access

Adequate movement throughout the substation is required for personnel and equipment. This section details Ausgrid's minimum requirements for general circulation.

12.3.8.1 Corridors and passageways

Corridors and passageways are to meet minimum BCA and AS 1657 Fixed platforms, walkways, stairways and ladders – Design, construction and installation requirements. In addition, suitable provision shall be made for the site specific and ultimate equipment handling dimensions including equipment installation and maintenance requirements.

Refer to the Equipment Handling Plan to ensure all corridors and passageways are adequate for all equipment movement.

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

12.3.8.2 Lifts

Where lifts are required in substations they shall be designed for the transport of personnel, equipment and ambulance or emergency stretchers which may be required in an emergency.

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.
- Minimum lifting capacity shall be 1200 kg.
- The Equipment Handling Plan shall ensure sufficient space to utilise lifts for the installation and replacement of equipment.

12.3.9 Access for 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 Clause 12.8.

12.3.10 Access for people with disabilities

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

12.4 Amenities

The Designer shall incorporate the following amenities into substation building designs.

12.4.1 Minimum requirement

The minimum level of amenities at Major Substations which are determined by Ausgrid as requiring amenities shall comprise a unisex toilet, wash basin and wall mounted hose tap.

Where possible, access to the toilet is to 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.

12.4.2 Additional amenities

Depending on location and frequency of use and as determined by Ausgrid, further amenities may be specified including some items as listed below. The provision and extent of any additional amenities at a Major Substation shall be requested in writing by Ausgrid, and included in the Design Brief issued to the Designer.

12.4.2.1 Meal room / Plan layout room

A separate meal room / plan layout room with the following:

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

12.4.2.2 Toilet/shower

A unisex toilet/shower area 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 are to be WELS minimum 5 star (maximum 7.5 L/min) tap.
- A wall mounted hose tap for the cleaner's use.
- All other water fixtures should achieve a minimum 5 star WELS rating.
- All amenities to be contained within one area with privacy locks on the entry door, the shower cubicle and the toilet.

12.4.3 Lighting

All lighting in staff amenities shall be motion activated to ensure the energy levels are kept to a minimum. Refer to Clause 12.7 for specific lighting requirements.

12.5 Emergency facilities

One (1) emergency eyewash and safety shower facility shall be provided for the substation to meet SafeWork NSW and Ausgrid requirements. Any additional emergency facilities shall be subject to the approval of Ausgrid.

The emergency facility shall be located near the area considered to be of highest personnel risk. Generally, this will be a location that is external to, and as near as possible to, a switch room door. Where reasonably practicable, the emergency facility should 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 sealed battery cells as used by Ausgrid.

The preferred location of the emergency facility is external to the building where possible. 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.

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

A self-contained emergency facility without fixed plumbing may be acceptable 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.

12.6 Security

12.6.1 General design requirements

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

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. 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.

For further details of the live switchyard security fence, gates and boundary fences, refer to NS 186 Major Substations Civil Works Design Standard.

The substation building security shall be designed in accordance with the requirements ENA Doc-15 National Guideline for Prevention of Unauthorised Access to Electricity Infrastructure. However, the construction materials to be used for the roof, walls and other major building elements shall be based on the requirements of this Network Standard. Refer to Section 8.0.

All doors and other substation building openings must be adequately secured against forced entry. Windows and ventilation louvres are to be secured against forced entry by a secondary security grille on the inside of any window or louvre.

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

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

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

12.6.2 External doors

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

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

Note: Typically, external doors should 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.

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

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

12.6.3 Internal doors

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

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

Note: Typically, internal doors should be a painted 45mm external grade solid core blockboard door, or a solid core fire rated door, both with 1.6mm metal door frame.

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

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

12.6.4 External windows and louvres

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

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.

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

12.6.5 External roller shutters

The minimum requirements for external roller shutters shall be in accordance with the Design Brief issued by Ausgrid / Development Services

Note: Typically, external roller shutters should be constructed of unperforated galvanised steel. The steel slats should be a minimum thickness of 0.8mm.

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 may be required to provide a positive resistance to lateral removal of the door curtain from the guides.

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 is to 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.

12.6.6 Doors, locks and keys

Refer to NEG EP07 Network Access and Security – Locks and Keys for lock system requirements.

Doors shall meet the requirements of ENA Doc - 015 National Guideline for Prevention of Unauthorised Access to Electricity Infrastructure.

Keys to all Ausgrid yards and buildings are issued only to Ausgrid Security Services.

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

12.6.7 Monitoring and alarms

Smoke alarms, meeting the requirements of T0059 NEG SM07 Active Fire Systems for Substations, shall be installed throughout the building and connected to the Ausgrid SCADA system and to the local fire authority fire detection system.

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

12.7 Power and lighting

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

All electrical installation work shall be carried out in accordance with T0007 NEG SM04.21 Light & Power.

Refer to T0059 NEG SM07 Active Fire Systems for Substations for smoke detector requirements.

12.7.1 Emergency lighting

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 BCA requirements. A separate battery and emergency DC lighting is not required.

12.7.2 Task lighting

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 should be used where adequate permanent lighting is impracticable or not cost effective.

Task lighting shall be in accordance with T0007 NEG SM04.21, AS/NZS 1680.1 Interior and workplace lighting - General principles and recommendations, AS/NZS 1680.2.4 Interior lighting - Industrial tasks and processes and AS/NZS 1680.5 Interior and workplace lighting - Outdoor workplace lighting.

12.7.3 External lighting

The type and layout of fittings shall conform to T0007 NEG SM04.21. Refer to the intrusive lighting provisions of AS 4282 Control of the obtrusive effects of outdoor lighting and the general lighting provisions of AS/NZS 1680.5 Interior and workplace lighting - Outdoor workplace lighting.

12.7.4 General power outlets

General power outlets shall be as required by T0007 NEG SM04.21.

12.7.5 Location of switches, cables and lights

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

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.

12.8 Data and communications

12.8.1 Standards

All data and communication installation work shall be carried out in accordance with the BCA, Ausgrid requirements, Australian Standards and Network Standards. Refer to NS203 Telecommunications Network: Master Policy Document and NS208 Series: Telecommunications Substations Communication Cabinet - Design Work Instructions for further details.

12.8.2 Telecommunications brief

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

12.8.3 Communications cabinets

Communications cabinets shall be designed, supplied and installed in accordance with NS208 series of standards. 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.
- Arrangement of equipment inside communications enclosures.

12.8.4 Communication installation works

The Communications/Data technician is to 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.

12.8.5 External communications conduits

Conduits that run from internal pits or buildings to outside the Major Substation boundary are considered to be external communications conduits.

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

1. One white 50mm conduit is required to be 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 should be such that it minimises the civil works required by the incumbent National carrier (Telstra).

2. One white 50mm conduit is required to a communications pit outside the boundary of the substation. The placement of the pit outside the substation boundary should be such that it minimises the civil works by a competitive National carrier (non-Telstra).

3. One orange 50mm conduit is to be run with each 11kV bank of conduits to the cable marshalling area. Conduits are to be capped outside of the substation boundary, unless otherwise specified in the Telecommunications Brief.

4. A minimum of one orange 63mm conduit for Protection Fibre is to be run with each 33kV or higher voltage bank of conduits to the vicinity of the nearest joint bay. These conduits do NOT to enter the joint bay, but rather enter an adjacent communications specific pit.

5. A minimum of one orange 50mm conduit for Distributed Temperature Sensing (DTS) is to be run with each 33kV or higher voltage bank of conduits to the nearest joint bay. These conduits DO enter the joint bay. Refer to the Telecommunications Brief and the Transmission Mains Underground design for the bank of conduits.

12.8.6 Internal communications conduits

Conduits that run between buildings within the Major Substation are considered to be internal communications conduits.

Where the substation consists of multiple buildings the communications conduits shall be run between the buildings in such a manner as to securely and reliably provide connectivity. This will 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:

1. Conduit depths shall align with NEG TC28 Installation of Optical Fibre Infrastructure within Substations to ensure minimum disruption to the conduits due to normal substation works.

2. A minimum of two orange 80mm diverse conduit routes are required between all buildings. This may be facilitated in a “ladder” or “ring” arrangement. Contact Ausgrid Communications for assistance in route planning.

For most substations, a bank of control and protection conduits will typically be constructed between buildings. The required internal communication conduits can be run together with these conduits.

12.8.7 Cable trenches and trays

Both the external and internal communications cables for the substation are run to a designated end-point, typically a telecommunications cabinet.

For external switchyards, the communications cables can transition between conduits buried in the ground to conduits located within the cable trenches. Upon entry into the building cable marshalling

area, the communications cables should remain within conduits and be run on the existing internal cable trays.

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

1. Maintain minimum bend requirements. For fibre optic cables the minimum bend radius for cables is typically 21 times the outer diameter of the cable. This usually translates to approximately 300mm minimum bend radius.
2. 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.
3. Saddle the cable conduits to the side wall of any cable trenches when running conduits through an external switchyard.
4. 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).
5. Maintain cable diversity as required by the Telecommunications Brief (refer to Ausgrid / Communications).
6. Label all conduits with the cable number at all substation transition (entry/exits) points. Should the conduit run be significant, label also every 10 metres of conduit.

12.9 Future expansion of control rooms

The Designer shall consider the need for future expansion of the control room. 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.

The Designer shall consider the following aspects when determining the type and extent of control room 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 6.6.3.
4. Future Flexibility – enable future flexibility by providing a shared common space designed for alternative applications using common panels wherever possible.
5. Potential Reductions – consider potential reductions in future space requirements (i.e. control and protection) that may offset increases elsewhere over a similar timeframe.
6. New Technologies – consider new applications which are on the horizon and expected to develop over the Design Life.
7. Future Contingency – consider 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 – consider 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.).

The key design requirements that should 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 considerations.
- 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 suitable 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 variations are approved by Ausgrid.
- Ensure that the future expansion provisions are clearly indicated on the design drawings together with the approved nominal allocations.

Most designs for Major Substations 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. The amount of space provided for future expansion will vary from site to site and as new technologies emerge.

Substations in CBD locations have specific requirements and may require additional considerations to those that are indicated above.

12.10 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 Labelling of Mains and Apparatus.

12.11 Building signage

Statutory building signage shall be provided to ensure compliance with the relevant legislation, Australian Standards, ENA Standards / Guidelines, the BCA or other statutory authority requirements. Refer to ENA Doc 015 - 2006 National Guideline for Prevention of Unauthorised Access to Electricity Infrastructure for information on building signage.

External building identification signs are to be made of stainless steel, engraved, colour filled and fixed to the requirements of Ausgrid Drawing No. 167191.

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

12.11.1 Compartment/room names

Identification signs shall be provided in accordance with Ausgrid Drawing No. 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.

12.11.2 Standard Ausgrid operational signs

Ausgrid shall supply the following signs where appropriate:

- Electrical equipment operating safety signs.

12.11.3 Emergency information diagrams

12.11.3.1 General

Emergency information diagrams shall comply with the Department of Planning & Infrastructure – Hazardous Industry Planning Advisory Paper No 1 – Emergency Planning, AS 3745 Emergency control organisation and procedures for buildings – Planning for emergencies in facilities and relevant sections of AS 1319 Safety signs for the occupational environment.

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. Additionally, the diagrams shall be inspected for relevancy and accuracy at least annually during routine substation inspections. Any deficiency in the emergency diagrams shall be reported to Ausgrid / Development Services.

Emergency information diagrams are to be posted adjacent to substation phones (generally 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, are to be made 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.

12.11.3.2 Emergency drainage diagrams

Emergency drainage diagrams are to 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 are to be posted adjacent to, and together with, each Emergency information diagram.

12.12 Building design documentation

12.12.1 Drawings and specifications

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

12.12.2 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.

12.12.3 Maintenance procedures and operating manuals

The Maintenance Procedures and Operating Manuals shall:

- Be prepared based on information contained in the Preliminary Maintenance Procedures and Operation schedules.
- 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 Documentation and Reference Design Guide for Major Substations and NS212 Integrated Support Requirements for Ausgrid Network Assets.
- Be in a format and structure that is suitable for uploading into the Ausgrid record management system (HPRM).

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.

Should Final Maintenance Procedures and Operating Manuals not be provided within such time, Ausgrid may prepare these documents at the Contractor's cost, which shall be deducted from the retention monies.

12.12.4 Design and construction certification

A Certification or Design Statement as per Clause 6.4 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.

Certification 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.

13.0 RECORDKEEPING

The table below identifies the types of records relating to the process, their storage location and retention period.

Table 3 – Recordkeeping

Type of Record	Storage Location	Retention Period*
Approved copy of the network standard	BMS Network sub process Standard – Company	Unlimited
Draft Copies of the network standard during amendment/creation	HPRM Work Folder for Network Standards (HPRM ref. 2014/21250/294)	Unlimited
Working documents (emails, memos, impact assessment reports, etc.)	HPRM Work Folder for Network Standards (HPRM ref. 2014/21250/294)	Unlimited

* The following retention periods are subject to change eg if the records are required for legal matters or legislative changes. Before disposal, retention periods should be checked and authorised by the Records Manager.

14.0 AUTHORITIES AND RESPONSIBILITIES

For this network standard the authorities and responsibilities of Ausgrid employees and managers in relation to content, management and document control of this network standard can be obtained from the Company Procedure (Network) – Production / Review of Engineering Technical Documents within BMS. The responsibilities of persons for the design or construction work detailed in this network standard are identified throughout this standard in the context of the requirements to which they apply.

15.0 DOCUMENT CONTROL

Content Coordinator : Manager-Asset Engineering Standards

Distribution Coordinator : Senior Engineer-Guidelines, Policies and Standards

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.

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.

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
AFLC Rooms	Unpainted unless otherwise specified − P1	Unpainted unless otherwise specified − P2	For Steel Trowel Monolithic Slabs;

Room/Area	Ceiling	Walls	Floors
			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

Notes: 1. For details on applied finishes, refer to Table B3: Paint Finishes.

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

B2 Off-form concrete finishes

The following off-form concrete finishes are to 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 following paint systems and colours are only to be provided at the locations that are specified by Ausgrid. Proposed alternative paint systems and colours will require the written approval of 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	'Rich Earth'
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	Clear
P9	Roofs	Metal	Manufacturer's Standard	As Specified	As Specified

Notes: **1.** All painting shall comprise a sealer coat, primer coat and two finish coats of paint as specified above.

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

Annexure C – Ecologically Sustainable Development

C1 General principles

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.

For additional guidance on ESD refer to the Department of Sustainability, Environment, Water, Population and Communities website shown below:

http://www.environment.gov.au/about/esd/index.html#nsesd

In particular, the National Strategy for Ecologically Sustainable Development provides the broad strategic directions and framework for governments to direct policy and decision-making.

Annexure D – Sample Compliance Checklist

Network Standard Checklist Form

NS185 Major Substations Building Design Standards

Project Identification:	
Prepared by: <Name & Position Title>	Date:

This checklist is for internal Ausgrid use and does not apply to ASPs or contractors who have separate compliance requirements. Each network standard has its own check sheet and these are available within BALIN and the BMS as a separate form that can be completed and saved in TRIM with the other project documentation.

This section is used to identify compliance checks that when applied to the work associated with this Network Standard will satisfy an audit process to establish that the requirements of the standard have been followed. It is expected that applicable items would normally be checked as Comply (Yes) as non-compliance is generally not tolerated.

Where non-compliance is the result of specific site conditions or design decisions this needs to be identified in the notes section of the form for each non-compliance and approval sought from an appropriately authorised Ausgrid manager responsible for design approval per NS239 Compliance Framework for Network Standards.

Should additional information be available to document non-compliance decisions, these can be attached to the checklist form. The checklist and any attached explanatory notes should be saved in the project document repository.

Item	Description	Refer Clause	Completed/ Actioned
	Scope		
	Network Standard NS185 details the general requirements for various Architectural, Civil and Structural engineering aspects to be considered and included into the design of buildings for Major Substations.		
	Functional Requirements		
1	Ausgrid's required Design Life advised to Designer.	6.1	Yes/No/NA
2	Design complies with all relevant Legislation, Australian Standards, Codes of Practice and the Building Code of Australia, relevant statutory and approving authority, and any specific requirements directed by Ausgrid.	6.2	Yes/No/NA
3	All structural components of the building are designed for the nominated Design Life.	6.3, 6.4	Yes/No/NA
4	Preliminary Maintenance Procedures and Operation schedules provided to Ausgrid.	6.5	Yes/No/NA
5	When requested by Ausgrid designs have been assessed on Life Cycle costing principles and a LCC assessment report provided.	6.6	Yes/No/NA
6	The principles of ecologically sustainable development have been applied as outline in Annexure C.	6.7	Yes/No/NA
	General and Material Requirements		
7	The general building design complies with the required thermal ratings,	7.1	Yes/No/NA

Item	Description	Refer Clause	Completed/ Actioned
	provides accommodation for the designated equipment and has the nominated aesthetic and other requirements of Cl. 7.1.		
8	A Designer Safety Report has been prepared and supplied to Ausgrid.	7.2	Yes/No/NA
9	A CHAIR review has been undertaken and supplied to Ausgrid prior to completion of the design phase.	7.3	Yes/No/NA
10	The design provides for the nominated requirements in relation to durability, noise, vibration, ventilation, air quality, and temperature control.	7.4-7.6	Yes/No/NA
11	Site investigations have been undertaken and assessments prepared as required.	7.7	Yes/No/NA
12	Special consideration has been given to the requirements in relation to sites in designated flood prone areas.	7.8	Yes/No/NA
13	Special consideration has been given to the groundwater table level and to the general collection and management of groundwater.	7.9	Yes/No/NA
14	Materials to be used meet the requirements of Section 8.	8.0	Yes/No/NA
15	The listed, restricted materials have not been used in the substation building design.	8.4	Yes/No/NA
16	Special provisions in relation to masonry have been met.	8.5	Yes/No/NA
17	Compliance with relevant Building Code of Australia requirements as outlined in Section 9 have been met.	9.0	Yes/No/NA
	Engineering, Structural and Architectural Requirements		
18	Specific requirements in providing for substation overpressure, mine subsidence, fire resistance and stability and thermal performance have been met.	10.0	Yes/No/NA
19	Structural requirements relating to floors, walls, ceilings, windows, doors, roofs and the building in general have been met.	11.0	Yes/No/NA
20	Provisions for permanent and imposed loads have been made.	11.6	Yes/No/NA
21	Wind loading and earthquake loads have been included in the design where appropriate.	11.7, 11.8	Yes/No/NA
22	Special provisions for structural redundancy, vibration, basements, cranes, pulling eyes and stanchions have been met where required.	11.12-11.15	Yes/No/NA
23	Architectural requirements concerning vermin proofing, termite protection, emergency facilities and general amenities have been met	12.0	Yes/No/NA
24	Provisions have been made for the special requirements for batteries, AFLC, equipment handling, cable marshalling areas, electrical equipment in general, egress and working space, and general circulation requirements.	12.0	Yes/No/NA
25	Security provisions comply with the stated requirements.	12.6	Yes/No/NA
26	Power and lighting requirements have been met.	12.7	Yes/No/NA
27	Data and communications requirements have been met.	12.8	Yes/No/NA
28	Future expansion requirements have been met.	12.9	Yes/No/NA
29	Plant and equipment labelling and building signage have been provided as required.	12.10, 12.11	Yes/No/NA
30	Design documentation has been provided in accordance with requirements.	12.12	Yes/No/NA

Notes:

The signatures panel of this document has been removed for privacy considerations. The remainder of the document is unchanged.