



# NS210

## Documentation and Reference Design Guide for Major Substations

February 2009

Amendments: NSA1530 Jul 09, NSA1553 Dec 09, NSA1631 Oct 11



## SUMMARY

Network Standard NS210 details general documentation and reference design guidance for the Environmental, Civil, Architectural, Electrical Primary and Electrical Secondary aspects that shall be considered and included into the design and construction of Ausgrid's major substations.

## ISSUE

**Ausgrid staff:** This Standard is for issue to all staff, Accredited Service Providers' and Alliance Partners' staff involved with the design of Ausgrid's major substations.

Where this standard is issued as a controlled document replacing an earlier edition; remove and destroy the superseded document.

**Accredited Service Providers:** This document is issued on an uncontrolled basis. Users are responsible for ensuring that the document they are using is current and includes any amendments issued since the date on the document. Ausgrid will not accept any liability for work carried out to a superseded standard. Ausgrid may not accept work carried out which is not in accordance with current standard requirements.

Ausgrid maintains a copy of this and other Network Standards together with updates and amendments on [www.ausgrid.com.au](http://www.ausgrid.com.au).

Ausgrid also offers a subscription service which provides for updates and amendments to standards on payment of an annual fee.

## 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 is to 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 ensure 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 Network Standard.

## 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.

Network Standard  
NS210  
Documentation and Reference Design Guide for Major Substations  
February 2009

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# 1 INTRODUCTION

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The Ausgrid planning process has identified that major augmentation work needs to be carried out at about 80 major substations over the next five years.

Approximately:

- 70% of the augmentation work will be at substations with a primary voltage of 132kV
- 10% of the augmentation work will be at substations with a primary voltage of 66kV
- 20% of the augmentation work will be at substations with a primary voltage of 33kV.

There are three basic configurations of Ausgrid subtransmission substations:

- 132kV/66kV/33kV
- 132kV/66kV
- 132kV/33kV.

These substations utilise transformers having nameplate ratings of 60MVA and 120MVA.

There are three basic configurations of Ausgrid zone substations:

- 132kV/11kV
- 66kV/11kV
- 33kV/11kV.

These substations utilise transformers having nameplate ratings of 19MVA, 33MVA, 37.5MVA and 50MVA.

To reduce the cost and time taken to complete this list of work, without a reduction in quality, standardisation shall be employed in the following areas to reduce design, procurement and construction effort:

- switchyard layouts;
- buildings, building layouts and services;
- earthing;
- structures and footings;
- electrical plant and equipment; and
- control, protection, communications and SCADA.

To facilitate this standardisation, Ausgrid has developed this Network Standard. This Network Standard is supported by a set of integrated Network Standards and Technical Specifications that shall be used as the basis for all green field and brown field substation projects.

These referenced Network Standards and Technical Specifications shall be supported by a separate *Development Brief* prepared by Ausgrid for each particular project defining the scope, objectives and delivery strategies. Major substations shall be designed to meet the technical requirements defined by Ausgrid including, but not limited to, the following areas;

- development stages;
- single line diagram;
- plant data; and
- protection and control schemes.

All work shall meet the requirements of the various Standards specified in this Network Standard and all plant and equipment shall comply with Ausgrid's Technical Specifications. However, as part of its partnering philosophy, Ausgrid invites and welcomes suggested improvements or changes to this Network Standard, the referenced Network Standards or the Technical Specifications.

It is envisaged that a suite of further Ausgrid standardised designs shall be developed and approved by Ausgrid and these standardised designs shall be replicated as required. Alliance Partners may be involved in the development and documentation of these designs.

As part of the Ausgrid continuous improvement process, post-implementation reviews shall be carried out on every project with the view of achieving best practice in major substation design, construction, operation and maintenance.

## 2 OCCUPATIONAL HEALTH & SAFETY

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### 2.1 NSW Occupation Health & Safety Act

The NSW *Occupational Health and Safety Act 2000* provides that a person who designs, manufacturers or supplies any plant or substance for use by people at work must:

- (a) ensure that the plant or substance is safe and without risks to health when properly used, and
- (b) provide, or arrange for the provision of, adequate information about the plant or substance to the persons to whom it is supplied to ensure its safe use.

The duties under this section:

- (a) apply only if the plant or substance is designed, manufactured or supplied in the course of a trade, business or other undertaking (whether for profit or not), and
- (b) apply whether or not the plant or substance is exclusively designed, manufactured or supplied for use by people at work, and
- (c) extend to the design, manufacture or supply of components for, or accessories to, any plant for use by people at work, and
- (d) extend to the supply of the plant or substance by way of sale, transfer, lease or hire and whether as principal or agent, and
- (e) extend to the supply of the plant or substance to a person for the purpose of supply to others, and
- (f) do not apply to a person merely because the person supplies the plant or substance in the course of a business of financing the acquisition of the plant or substance by a customer from another person.

In this section, "manufacture" plant includes assemble, install or erect plant.

## 2.2 Ausgrid Health & Safety Policy



# Be Safe Policy

### Our Objective

Ausgrid is committed to achieving our vision of zero workplace harm and ensuring the health, safety and welfare of our employees, contractors, visitors and those impacted by our work. We will achieve this by maintaining a focus on safe people, safe places and safety processes. By maintaining the highest health and safety standards and encouraging these standards to be maintained outside of the workplace, we will be able to strive to have a positive impact on the lives of those with whom we work.

### Our Commitment

We demonstrate our commitment to Be Safe through:

- The Board and all Ausgrid managers and leaders striving together using safety as a common and shared value that guides our actions and behaviours every day.
- Increasing the visible safety leadership across Ausgrid to inspire all people, in all Ausgrid workplaces to work safely.
- Striving for a positive safety culture that makes health and safety a part of all business decisions through ensuring active participation, consultation and contribution in the promotion and development of decisions and measures that improve our health, safety and welfare in the workplace.
- Eliminating or managing risks and practices in our business that could cause injury or illness to our people or unacceptable impacts on our community.
- Maintaining and promoting our commitment to safety excellence through the implementation of our Be Safe Management System and the implementation of this Be Safe Policy.
- Establishing measurable OHS objectives and targets in Be Safe Plans to ensure continuous improvement.
- Complying with all relevant laws and regulations and where practicable, industry codes of practice, standards and other relevant requirements, and applying responsible standards where laws do not exist.
- Providing appropriate health and safety training to all people in the business to ensure their health, safety and welfare in the workplace.
- Providing employees, supervisors and other people at our workplaces with information and the necessary instruction and training to ensure that no one is injured as they perform their work and they get home to their families safely from work every day.
- Ensuring continuous improvement through enhancing our standards of incident management, investigation and communications to ensure a just and learning culture is maintained.
- Actively responding to all incidents and ensuring the provision of timely and effective injury management that promotes early and sustainable return to duties.
- Striving for continuous improvement to eliminate and prevent all work related illness and injury.
- Promoting awareness of health and safety issues in the community and our workplaces.
- Continually reviewing and updating our Be Safe policy and management system as our business and the safety community evolve.
- Ensuring the provision of adequate resources to implement this Be Safe Policy.
- Making safety a part of everything we do, every day.



*George Malabarow*  
 George Malabarow  
 Managing Director

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## 3 PROJECT OVERVIEW

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### 3.1 General

This document outlines the technical criteria that shall be considered in the design of Ausgrid major substations. It specifies the environmental, civil, architectural, electrical primary, electrical secondary, control, protection, communications and SCADA work to be completed in the zone substation and line works to be completed external to the zone substation.

The substation may be developed in stages to accommodate the ultimate layout as outlined in the Ausgrid *Development Brief* and the associated *plant data sheet*, *single line diagram*, *control schedules* and *protection schedules*. Ausgrid shall advise in writing of any required departures or variations from Ausgrid's Network Standards.

To establish or develop the major substation, complete in every way, the project scope shall include:

- the design, engineering, administration, project management, supply, construction, installation, testing and commissioning of the major substation;
- the supply of the plant, equipment and materials, other than those to be free issued by Ausgrid, necessary to commission the major substation into service in a manner that meets Ausgrid's requirements; and
- the co-ordination of all work required for the development of the site.

The characteristics of Ausgrid's electrical network shall be detailed in the Ausgrid *Development Brief* and the associated plant data sheet, single line diagram, control schedules and protection schedules for each major substation.

All design work drawings, calculations and manufacturer's information shall be co-ordinated, carried out and reviewed by a Chartered Professional Engineer unless otherwise authorised in writing by Ausgrid. All persons shall be qualified and experienced in the design of major substations. All design work shall clearly identify the name and authority of the design engineer, the reviewing engineer and the approving engineer.

### 3.2 Consultation and Approvals

Community consultation issues shall be dealt with by Ausgrid in accordance with the Ausgrid's *Stakeholders Relations Plan* and the environmental aspects for the related works shall be covered in Ausgrid's *Environmental Impact Assessment*. Both documents shall be produced by Ausgrid for all projects.

The project scope may include selected community consultation activities under the direction of Ausgrid as well as requirements for obtaining the necessary planning permits, building permits and approvals from Statutory Authorities for the development of the site.

### 3.3 Alternative Plant and Equipment

Plant or equipment failures and any outages necessary to carry out maintenance can have a major impact on Ausgrid's performance. If plant or equipment other than that available on Ausgrid contracts is proposed for use, supporting data shall be supplied on the historical performance of the plant and equipment to confirm that the plant and equipment being offered is reliable, easily maintained and repaired, with readily available spare parts. Any special tools or parts that are required shall be itemised and costed as part of the design proposal.

All proposals requiring the use of alternative plant and equipment shall be subject to the written approval of Ausgrid.

### 3.4 Project Execution Plan

A detailed Project Execution Plan, covering all aspects of the project work, shall be prepared. This is to be approved by Ausgrid and updated as required by, or with the agreement of, Ausgrid. Project management meetings shall be scheduled and convened on a regular basis to manage the completion of the major substation in accordance with this Plan. The milestones in this Plan shall be used to generate the Key Performance Indicators that shall be used to monitor progress.

Work shall not commence until the Project Execution Plan has been reviewed and accepted by Ausgrid.

The Project Execution Plan shall make provision for the project and equipment design reviews required by Ausgrid. This shall include but not be limited to the following:

- Site Assessment
- Project Delivery Risk Review
- Value Management and Buildability Assessment
- Equipment OH&S Review
- Equipping, Operability, Maintainability and End of Life Replacement Assessment
- Construction Hazard Assessment Implication Review (CHAIR)
- Environmental Assessment Review
- Post Civil Construction Evaluation
- Post Commissioning Review

The project and equipment design reviews shall commence at the completion of the high level concept design for the major substation. The high level concept design shall include the initial civil plans and sections, primary general arrangement and sections, building layout, indoor switchgear arrangement and cubicle layout.

The project and equipment design reviews shall involve Ausgrid personnel from the field, operations, engineering, project management and asset investment as appropriate.

The Project Execution Plan shall also include Inspection and Test Plans for each item of plant and equipment as well as programs for the delivery of documentation, drawings and training for the project.

Commissioning shall be undertaken by Ausgrid in accordance with the Commissioning Plan included in the Project Execution Plan. At least eight weeks notice of the proposed commissioning program shall be provided to the Ausgrid Representative to ensure that it can be integrated into the overall network works program.

### 3.5 Strategic Spares

Ausgrid has an established strategic spares policy for major substations that defines the technical, purchasing and inventory requirements for strategic spares. Ausgrid shall advise in writing of any specific requirements for strategic spares associated with the project work.

## 4 STANDARDS

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All plant and equipment supplied, and the design and construction work shall be carried out in accordance with ALL relevant Legislative, Regulatory and WorkCover New South Wales requirements and the relevant Ausgrid Network Standards (NS), Network Engineering Guidelines (NEG) and Specifications, relevant Australian Standards (AS) and the relevant IEC Standards if an Australian Standard does not exist.

Special consideration shall be given to safe work at heights. Adequate space shall be provided around equipment to ensure that ladders, scaffolding and elevated work platforms can be utilised safely as required. Consideration shall be given to the provision of permanent work platforms in areas where work will be carried out frequently.

### 4.1 Ausgrid Standards

All work shall comply with the requirements of the Ausgrid's general standards:

Electrical Safety Rules

Network Management Plan

Bushfire Risk Management Plan

Security Risk Policy

All work shall comply with the requirements of the Ausgrid's Network Standards including:

NUS100	Field Recording of Network Assets
NS104	Network Project Design Plans
NS126	Specification for Design and Construction of High Voltage Overhead Mains
NS129	11kV Joints and Terminations – Paper Insulated Lead Covered cables
NS130	Specification for Laying of Underground Cables Up to 22kV
NS135	Specification for the Design & Construction of Overhead Subtransmission Lines
NS143	Easements
NS149	Drawing Content for Chamber Type Substations, Control Points, Cable Risers and Ductlines
NS156	Working Near or Around Underground Cables
NS158	Labelling of Mains and Apparatus
NS161	Specification for Testing of Underground Cables
NS162	Specification for the installation of Communication Cables in Ductlines and Substations
NS165	Safety Requirements for Non-Electrical Work in and around Live Substations
NS168	Specification for the Design and Construction of Underground Subtransmission Lines
NS171	Fire Stopping in Substations
NS172	Design Requirements for Cable Jointing Pits and Vaults
NUS174	Environmental Procedures
NS177	11kV Joints (including transition joints) & Terminations – Polymeric Insulated Cables

NS178	Secondary System Requirements for Major Substations
NS179	Vegetation Safety Clearances
NUS181	Approval of Materials and Equipment and Network Standard Variations
NS185	Major Substations Building Design Standard
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
NS190	Oil Containment Operational Requirements for Major Substations
NS191	Batteries and Battery Chargers in Major Substations
NS200	Major Substations Ventilation Design Standard
NS210	Documentation and Major Reference Guide for Major Substations
NS215	Telecommunications Allocation and Recording of Fibre Use Design I Work Instruction
NS220	Overhead Line Design Manual
NS221	Telecommunications, Changes to In service Teleprotection Equipment Configuration Policy
NS225	Allocation of Optical Fibre Tubes Design Work Instruction
NS226	Protection Communications Links Construction Policy
NS227	Requirements for Diversity Planning Policy
NS203	Planning and Design Standards for Electrical Network Communications Assets
NS204	Communication Pits – Specifications and Installation Guideline
NRS208	Design and Installation of Ausgrid Communication Cabinets
NS212	Integrated Support Requirements for AUSGRID Network Assets

## 4.2 Ausgrid Network Engineering Guidelines

All work shall comply with the requirements of the Ausgrid Network Engineering Guidelines (NEG), including:

NEG-EP07	Network Access and Security – Locks and Keys
NEG-EP09	Intruder Resistant Fences
NEG-SE01	Power Frequency EMF – Prudent Avoidance
NEG-SE 10	Traffic Management
NEG-SM04	Specification for Design and Construction of Major Substations
NEG-SM04.1	Introduction and Reference Documents
NEG-SM04.5	Auxiliary Power Supplies and Switchgear
NEG-SM04.6	Selection of Substation Batteries
NEG-SM04.7	Batteries and Battery Chargers
NEG-SM04.8	Earthing
NEG-SM04.11	Power Cables
NEG-SM04.14	Insulation Coordination
NEG-SM04.21	Light and Power
NEG-SM04.24	Testing and Commissioning
NEG-SM04.25	Switchyard Steelwork
NEG-SM04.27	Power Cable Conduits
NEG-SM05	Site Assessment Process for Major Projects

- NEG-SM06 Reclosing Requirements for 11kV Vacuum Circuit Breakers at Zone Substations
- NEG-SM07 Active Fire Systems for Substations
- NEG-SM08 Noise Assessment
- NEG-SM09 Sulphur Hexafluoride (SF6)
- NEG-SM10 Spring Charging of Circuit Breakers
- NEG-SM12 Value Management, & Buildability Assessment and Post Construction Evaluation
- NEG-TC02 DNP3 over TCP/IP for Master Station to RTU Communications
- NEG-TC04 Protection Scheme Availability Model
- NEG-TC05 DC Power Connection to PINC Communication Racks
- NEG-TC07 Requirements for testing and commissioning of Optical Fibre Communications Systems
- NEG-TC08 Telecommunications Dictionary and Reference
- NEG-TC12 Telecommunications Site Codes
- NEG-TC15 Telecommunications Scheduled Outage Management of optical fibres
- NEG-TC16.1 Substation Design Deliverables
- NEG-TC 17 Telecommunications Naming Conventions
- NEG-VR01 Voltage Regulation Objectives for Low and High Voltage Networks

#### 4.3 Other Ausgrid Guidelines and Standards

- DG 33 Distribution Guideline 33, Fire Bans
- DS 111 Design Standard 111, CAD Drawing Guidelines and Procedures
- SEC01 Protective Security Standard – Electronic Security Systems

#### 4.4 Ausgrid Technical Specifications

All work shall comply with the requirements of the Ausgrid plant and equipment technical specifications contained in Ausgrid's "Balin" internal website under, Plant – Engineering & Procurement.

#### 4.5 Australian Standards

All work shall comply with the relevant Australian standards including:

- AS/NZS 1026 - Electric cables - Impregnated paper insulated – For working voltages up to and including 19/33 (36) kV.
- AS 1055 - Acoustics (Series).
- AS 1100 - Technical drawing (Series).
- AS 1102 - Graphical symbols for electrotechnical documentation (Series).
- AS/NZS 1170 - Structural design actions (Series).
- AS 1243 - Voltage transformers for measurement and protection.
- AS 1307.2 - Surge arresters - Metal-oxide surge arresters without gaps for a.c. systems.
- AS/NZS 1429.1 - Electric cables - Polymeric insulated- For working voltages 1.9/3.3 (3.6) kV up to and including 19/33 (36) kV.
- AS/NZS 1429.2 - Electric cables - Polymeric insulated - For working voltages 19/33 (36) kV up to and including 87/150 (170) kV.
- AS 1767 - Insulating Liquids (Series).
- AS/NZS 1768 - Lightning protection.

- AS 1883 - Guide to maintenance and supervision of insulating oils in service.
- AS 1931.2 - High-voltage test techniques - Measuring systems.
- AS 2067 - Substations and high voltage installations exceeding 1 kV a.c.
- AS 2374 - Power transformers – Parts 1 to 8.
- AS 2650 - Common specifications for high voltage switchgear and control gear standards (IEC 60694, Ed.2.2 (2002) MOD).
- AS 2758.7 - Aggregates and rock for engineering purposes - Railway ballast.
- AS 2676 .1,.2 - Guide to the installation, testing and replacement of secondary batteries in buildings; Part 1 – Vented cells and Part 2 - Sealed cells.
- AS/NZS 3835.1,.2 - Earth Potential Rise - Protection of telecommunication network users, personnel and plant; Part 1 – Code of Practice and Part 2 – Application guide.
- AS/NZS 4029.2 - Stationary batteries – Lead acid – Valve regulated type.
- AS 4044 - Battery chargers for stationary batteries.
- AS/NZS 4853 - Electrical hazards on metallic pipelines.
- AS 7000 - Overhead line design – Detailed procedures.
- AS 60044.1- Instrument transformers - Current transformers (IEC 60044-1 Ed.1.2 (2003) MOD).
- AS 60044.2 - Instrument transformers - Inductive voltage transformers (IEC 60044-2:Ed.1.2 (2003) MOD).
- Plus: current standards for insulating oil, HV bushings, HV cables, capacitors and circuit breakers etc.
- AS 60214.1 - Tap changers – Performance requirements and test methods.
- AS/NZS 60265.1 - High-voltage switches - Switches for rated voltages above 1 kV and less than 52 kV
- AS 62271 - (9 parts: 100,200,300) High voltage switchgear and controlgear (Series) (including relevant IEC 62271, Ed.1.0(2003) MODs).
- AS ISO 128 - Technical drawings, general principles of presentation (Series).
- Building Code of Australia (BCA)
- D (b) 31 - Guide for the Maintenance of High Voltage Paper/Oil Insulated Cables and Accessories, Electricity Supply Association of Australia.
- ENA National Electricity Network Safety Code (NENS -01)
- ENA EG1-2006 Substation Earthing Guide.
- IEC 60141 - 1 Tests on Oil Filled and Gas-Pressure Cable and their Accessories- Part 1: Oil filled, paper or polypropylene paper laminate insulated, metal-sheathed and accessories for alternating voltages up to and including 500 kV.
- IEC60502 - 2 Power cables with extruded insulation and their accessories for rated voltages from 1 kV up to 30 kV - Part 2: Cables for rated voltages from 6 kV up to 30 kV.
- IEC 60229 - Electric cables – Tests on extruded oversheaths with a special protective function.
- IEEE P400.2/D5 - Guide for Field Testing of Shielded Power Cable Systems Using Very Low Frequency (VLF).

## 4.6 Industry Codes and Guidelines

Where no relevant Ausgrid, AS or IEC standard exists, the work shall comply with recognised standards of good electricity industry practice as adopted by the Australian Electricity Supply Industry. Where Ausgrid's requirements conflict with any Standard, the Ausgrid requirements shall apply.

Where the plant does not comply in some aspect with the requirements of this Network Standard, other Network Standards, Network Engineering Guidelines or Specifications, this shall be clearly stated in the design proposal.

ALL deviations from this Network Standard, other Network Standards, Network Engineering Guidelines or Specifications SHALL be clearly stated and reported to the Ausgrid Representative. In the absence of other information it shall be assumed that the major substation complies with ALL of the requirements specified in this Network Standard, other Network Standards, Network Engineering Guidelines and Specifications.

## 4.7 Climatic Service Conditions

The climatic conditions to which the plant, equipment and the major substation shall be exposed are detailed in:

- *AS/NZS 1170 Structural design actions,*
- *AS 2067 Substations and high voltage installations exceeding 1kV A.C.,*
- Bureau of Meteorology Climate maps for the “Annual Rainfall”, “Minimum Temperatures” and “Maximum Temperatures” in New South Wales,
- Engineers Australia “Australian Rainfall and Runoff – A Guide to Flood Estimation”.
- *NS185 Major Substations Building Design Standard*
- *NS186 Major Substations Civil Works Design Standard*

## **5 QUALITY ASSURANCE**

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The standard of major substation design shall be controlled by the effective implementation and administration of a quality system that meets Ausgrid's requirements. The quality system elements shall be in accordance with ISO 9001 and Ausgrid may conduct reviews to ensure that these standards are being maintained.

### **5.1 Quality of Materials, Equipment and Workmanship**

Materials and equipment shall be new and of a quality at least equal to that stated in this Network Standard, other Network Standards, Guidelines or Technical Specifications.

All work shall be carried out by suitably qualified persons having experience in the particular types of work to be executed.

### **5.2 Quality in the Absence of Detailed Specification**

Where no detailed specifications have been provided for the supply of materials or manufactured articles, the materials and manufactured articles shall be of the most suitable grade in quality and workmanship obtainable in the market from firms of established good reputation or, if not ordinarily carried in stock, shall conform to the best accepted standard of the relevant trade for articles of the kind required with due consideration of the use to which these are to be put, and the specified design life. An approval process shall be put in place by Ausgrid for these materials or manufactured articles.

## 6 ENVIRONMENT AND SAFETY

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### 6.1 Environmental Code of Conduct

Ausgrid has established an environmental code of conduct, which explains Ausgrid requirements and the need for all employees and contractors to act in relation to environmental laws. Refer to *NUS174* and Ausgrid Website at [www.ausgrid.com.au](http://www.ausgrid.com.au).

### 6.2 Environmental Impact Assessment (EIA)

Environmental Impact Assessments (EIA) must be prepared and submitted with the concept design documents for all Ausgrid projects in accordance with *NUS174* and related documents.

The design of the *substation* and the environmental impact assessment are integral processes. Early interaction is required to ensure effective co-ordination between the design and the environmental impact assessment. This is to ensure environmental controls are incorporated into the substation design for greater effect and cost efficiency.

### 6.3 Electrical Safety

All work involving access to Ausgrid's network must be carried out in accordance with the *Electrical Safety Rules*, particularly in relation to access permits, system alterations and equipping permits.

### 6.4 Site Contamination

Site investigations shall be carried out to confirm there are no significant site contamination issues and that the proposed site is suitable for the location of a major substation. All work shall be carried out in accordance with the *NUS174 Environmental Procedures*, *Environmental Handbook*, *EIA Guidelines*, *EIA Worksheet*, and *NEG-SM05 Site Assessment Process for Major Projects*.

### 6.5 Material Safety Aspects

Full details shall be provided, including composition and toxicological information, regarding the health and safety aspects of any materials that are to be used in the substation and that are known to have a risk to health or the environment.

Material Safety Data Sheets shall be provided together with the recommended procedures for the safe handling, operation, maintenance and disposal of the products employed.

### 6.6 EMF Study

The electromagnetic field levels shall be considered during the design phase, and shall be measured and recorded across the substation site before any construction work commences and following the completion of the construction work. Attention is drawn to *NEG-SE01 Power Frequency EMF—Prudent Avoidance* and The National Health and Medical research Council *Interim Guidelines on Limits of Exposure to 50/60Hz Electric and Magnetic Fields*.

### 6.7 Electro-magnetic Fields (EMF)

Adequate clearances may be a suitable control measure, when required, for electro-magnetic fields generated by the electrical equipment and cables. Appropriate boundary clearances are required to ensure minimum section safety

clearances are maintained to the electrical equipment. Refer to *NEG-SE01 Power Frequency EMF – Prudent Avoidance*.

## 6.8 Sound Levels

The major substation shall comply with the sound level requirements of the New South Wales *Protection of the Environment Operations Act*, the *NSW Industrial Noise Policy* and any Development Consent Conditions for the development.

The background sound levels shall be considered during the design phase, and shall be measured and recorded across the substation site before any construction work commences.

Noise assessment for the substation shall be undertaken in accordance with the requirements of *NEG-SM08 Noise Assessment*.

The maximum permissible sound level for each major plant item is specified in the Ausgrid *Technical Specification* for the particular item of plant.

## 6.9 Sustainable Development

The design of substations must take into account issues associated with sustainable development. The main issues to consider are:

- Material usage in relation to energy efficiency and greenhouse gas emission abatement
- Reduced natural resource consumption
- Waste avoidance, reuse and recycling
- Plant efficiency
- Design Life and Durability
- Water conservation and stormwater control
- Pollution prevention – noise, water, air, soil and light
- Compatibility and sensitivity with the local built environment.

These issues must be addressed and resolved during the feasibility and concept design stages.

## 7 CIVIL AND BUILDING WORKS

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### 7.1 Site Investigations

Refer to *NS186 Major Substations Civil Works Design Standard* and *NEG-SM05 Site Assessment Process for Major Substations* for requirements regarding site investigations.

### 7.2 Boundary Clearances

The boundary clearance is influenced by requirements of the following:

- Local Authority,
- BCA radiant heat limits,
- Ausgrid radiant heat limits,
- EMF,
- electrical clearances,
- access,
- security,
- maintenance, and
- noise constraints/emissions.

Refer also to, and comply with, *NEG-EP09 Intruder Resistant Fences*.

Boundary and other clearances are also required to facilitate the installation of the earthing ring. The Block Plan and Layout Plan shall provide clearances for use in design.

### 7.3 BCA Compliance

Substations are currently considered to be Class 8 buildings under the Building Code of Australia (BCA). All substations shall comply with the relevant provisions the BCA as required by *NS185 Major Substations Building Design Standard*.

### 7.4 Transformer Foundations, Bunding and Enclosures

Transformer installations shall meet the requirements of *NS189 Oil Containment for Major Substations*.

The transformer foundations and oil bunds shall be installed in a manner that caters for the ultimate transformation capacity of the station. Suitable foundation provisions shall be made to facilitate the installation of sound walls or thermal barriers, as required.

The oil separator shall be an AJM EnviroSEP type OS 7500 or approved equivalent and shall be installed in accordance with the manufacturer's recommendations.

### 7.5 Radiant Heat

The requirements of *NS187 Passive Fire Mitigation Design of Substations* must be met in relation to radiant heat flux levels from substation elements such as transformers which can burn. These heat flux levels may dictate separation distances to neighbouring properties.

## 7.6 Segregation

Adequate separation distances shall be provided between the edge of a transformer bund and;

- other transformers
- the substation building(s).

Where transformer bunds are common or the necessary separation distances cannot be satisfied, a fire separation wall shall be installed between the transformers and/or building(s) in accordance with *NS187 Passive Fire Mitigation Design of Substations*.

## 7.7 Fire Services

Fire services shall be installed and commissioned in accordance with the requirements of Local Authorities and *NS185 Major Substations Building Design Standard*, *NS186 Major Substations Civil Works Design Standard*, *NS187 Passive Fire Mitigation Design of Substations* and *NEG-SM07 Active Fire Systems for Substations*.

## 7.8 Overpressure

The design of the substation building shall consider the impact of overpressures and, where appropriate, shall comply with the overpressure requirements of *NS185 Major Substations Building Design Standard* and *NS188 Design for Substation Overpressure*.

## 7.9 Mine Subsidence

At site locations within or near a mine subsidence area the design of the substation building shall comply with the mine subsidence provisions of *NS185 Major Substations Building Design Standard*.

## 7.10 Security

Design and commissioning of intruder detection systems/services shall comply with Ausgrid's *Security Risk Policy* and *SEC01 Protective Security Standard – Electronic Security Systems*, *EP07 Network Access and Security – Locks and Keys*, *EP09 Intruder Resistant Fences* in addition to the *ENA National Guidelines for the Prevention of Unauthorised Access to Electrical Infrastructure*, electricity industry security standards and State/Federal Government Critical Infrastructure Protection Frameworks.

## 7.11 Substation Building Design

The design of the substation building shall comply with *NS185 Major Substations Building Design Standard*.

## 7.12 Site and Civil Works

The design of the substation site and civil works shall comply with *NS186 Major Substations Civil Works Design Standard*.

## 8 PRIMARY ELECTRICAL WORKS

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### 8.1 Substation Layout

The substation shall be designed to accommodate the ultimate arrangement as shown in separate Ausgrid documents for each substation and the associated *plant data sheet, single line diagram, control schedules* and *protection schedules*.

The substation shall be designed to facilitate the installation of Ausgrid's mobile substation in the event of an emergency.

### 8.2 Plant and Equipment

Plant and equipment shall be designed to be supplied and installed in stages, to accommodate the ultimate arrangement, as outlined in Ausgrid *Development Brief* for the particular substation and the associated *plant data sheet, single line diagram, control schedules* and *protection schedules*.

The plant and equipment supplied shall meet the requirements of Ausgrid's *Technical Specifications*. Where no Ausgrid *Technical Specification* exists, the technical details of the proposed plant and equipment shall be submitted to Ausgrid Representative for approval.

Technical specifications shall be supplied by Ausgrid on request. The current plant and equipment technical specifications are provided in Ausgrid's "Balin" internal website under, Plant – Engineering & Procurement.

### 8.3 Electrical Clearances

Appropriate safety and working clearances shall be maintained in the design of equipment and structures. Clearances in air and safety clearances shall comply with the requirements of Ausgrid's *Electrical Safety Rules* and associated documents.

All designs are to ensure appropriate safety and working clearances are maintained in the design of equipment and structures.

Safe approach distances shall comply with the requirements of the *Electrical Safety Rules*.

Section safety clearances must comply with the following Ausgrid engineering drawings:

- 221830 – Outdoor Substations Diagrammatic Layout of Equipment Safety Clearances for Substation Design.
- 221831 – Outdoor Switchyards Comparison of High Voltage Clearances.

### 8.4 Earthing and Lightning Protection

The earthing system shall be designed so that it manages the transfer of fault energy in such a manner as to limit the risk to people (both Ausgrid staff and the general public), equipment and system operation to acceptable levels. Refer to *NEG-SM04.8 - Earthing* for details.

Insulation co-ordination issues need to ensure that incoming lines and substation equipment BIL/lightning impulse levels are not exceeded as a result of lightning activity. Designs are to be in accordance with *AS 1786:2003* to ensure adequate lightning protection for personnel within the substation site. Refer to *NEG-SM04.14 - Lightning Protection* for details.

## 8.5 Auxiliary Power Supplies

The auxiliary power supplies shall be designed and installed in accordance with *NEG-SM 04.5 Specification for Design and Construction of Major Substations, Auxiliary power Supplies and switchgear*.

The substation light and power system shall be designed and installed in accordance with *NEG-SM 04.21 Specification for Design and Construction of Major Substations, Light and Power*.

## 8.6 DC Supplies

### **Batteries and Battery Chargers**

Substation batteries shall be designed and installed in accordance with the following:

- *NEG-SM 04.6 Specification for Design and Construction of Major Substations, Selection of Substation Batteries, and*
- *NEG-SM 04.7 Specification for Design and Construction of Major Substations, Batteries and Battery Chargers.*

## 8.7 Nameplates and Labelling

All nameplates shall be supplied and fitted in accordance with the requirements of *NS158 Labelling of Mains and Apparatus*.

A mimic diagram shall be applied to the front cover of all high voltage cubicles indicating the high voltage equipment that is installed in the compartment and the direction of busbar conductors. The graphical symbols shall be in accordance with *IEC Publication 417*.

## 9 OTHER ELECTRICAL WORKS

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### 9.1 Power Cable Works

All underground power cables shall be supplied and installed in stages, to accommodate the ultimate layout, as outlined in *Ausgrid Development Brief* for the major substation and:

- *NS129 11kV Joints & Terminations – Paper Insulated Lead Covered Cables*
- *NS130 Specification for Laying of Underground Cables up to 22kV*
- *NS161 Specification for Testing of Cables after Installation*
- *NS172 Design Requirements for Cable Jointing Pits and Vaults*
- *NS177 11kV Joints (including Transition Joints) and Terminations - Polymeric Insulated Cables*
- *NEG-SM 04.11 Power Cables*
- *NEG-SM 04.27 Power Cable Conduits*

### 9.2 Control, Protection, SCADA and Metering

Control, Protection, SCADA and Metering schemes shall be designed to meet the requirements of *Ausgrid Development Brief* and *NS178 Secondary System Requirements for Major Substations*.

Changes to the control, protection, SCADA and metering schemes at more than one major substation site may be required. These requirements shall be specified by Ausgrid.

### 9.3 Communications

Communications schemes shall be designed to meet the requirements of *Ausgrid Development Brief* and:

- *NS162 Specification for the Installation of Communication Cables and Ductlines and Substations*
- *NS169 Telecommunications Installations on Ausgrid HV Transmission Towers*
- *NRS 203 Planning and Design Standards for Electrical Network Communications Assets*
- *NS204 Communication Pits – Specifications and Installation Guidelines*
- *NRS 208 Design and Installation of Ausgrid Communication Cabinets*
- *NEG-TC02 DNP3 over TCP/IP for Master Station to RTU Communications*
- *NEG-TC05 DC Power Connection to PINC Communication Racks*

Changes to the communications schemes at more than one major substation site may be required. These requirements shall be specified by Ausgrid.

### 9.4 Provision for Emergency Mobile Substations and Switchrooms

The details of provisions to be made for accommodation and connection of emergency mobile substations and switchrooms shall be specified by Ausgrid.

## **9.5 11kV Works**

### **9.5.1 11kV Overhead Line Works**

The details of the required 11kV overhead line works shall be specified by Ausgrid for the major substation and shall be in accordance with *NS126 Specification for Design and Construction of High Voltage Overhead Mains*.

### **9.5.2 11kV Underground Cable Works**

The details of the required 11kV underground cable works external to the substation shall be specified by Ausgrid for the major substation and shall be in accordance with *NS130 Specification for Laying of Underground Cables Up to 22kV*.

## **9.6 33kV-132kV Works**

### **9.6.1 33kV-132kV Overhead Line Works**

The details of the required 33kV-132kV overhead line works shall be specified by Ausgrid for the major substation and shall be in accordance with *NS135 Specification for the Design and Construction of Overhead Sub-Transmission Lines*.

### **9.6.2 33kV-132kV Underground Cable Works**

The details of the required 33kV-132kV underground cable works external to the substation shall be specified by Ausgrid for the major substation and shall be in accordance with *NS168 Specification for the Design & Construction of UG Sub-Transmission Lines*.

## **9.7 Work at Other Substations**

The details of the work required at other substations shall be specified by Ausgrid for the major substation.

## **9.8 Other Works**

The details of the other work required shall be specified by Ausgrid for the major substation.

## 10 INSPECTION AND TESTING

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The Project Execution Plan shall include Inspection and Test Plans covering all aspects of the type, routine, factory acceptance, erection, functional and post-commissioning testing proposed for each item of plant and equipment. The testing shall be carried out in accordance with the Ausgrid *Technical Specifications* for each item of plant and equipment and, *NEG-SM 04.24 Specification for Design and Construction of Major Substations, Testing and Commissioning*.

Test requirements that are subject to agreement by Ausgrid shall be submitted for review and approval.

### 10.1 Test Procedures

All test procedures shall be documented and submitted to the Ausgrid Representative for approval at least eight weeks prior to the commencement of the testing. A complete, certified test report shall be produced in hard copy and electronic form, in English, for each test carried out. Each test report shall reference the test procedures that were followed in completing the tests and the certification / quality assurance of the test laboratory.

An "original" of all test records, reports, and certificates, including a comparison between expected and actual test results, shall be submitted in hard copy and electronic form to the Ausgrid Representative for approval within 2 weeks of the completion of the testing. Approval, or otherwise, together with any comments on the test records and reports, shall be provided by the Ausgrid Representative in writing within 3 weeks of the date of receipt of the report by the Ausgrid Representative.

**Note:** The Ausgrid Representative shall be informed, without delay, of any failure or abnormality in the test results and a written report shall be submitted within two weeks giving an explanation for the abnormality and recommended remedial action.

### 10.2 Tests and Certificate of Rating

Complete, certified type test reports shall be supplied for each type test that is completed on each item of plant and equipment.

Where type tests have been performed previously the complete test results, certified by a recognised independent NATA or equivalent certified Testing Authority, shall be submitted to the Ausgrid Representative for consideration.

Complete, certified routine test reports shall be supplied for all electrical, mechanical and functional tests completed on the plant and equipment installed to confirm that it is functioning correctly in accordance with the design, the manufacturer's specifications and Ausgrid's requirements.

### 10.3 Witnessing Tests and Ausgrid Testing

Ausgrid reserves the right to witness any type test OR routine test OR carry out any additional testing on the plant supplied to prove compliance with any Ausgrid requirement.

# 11 COMMISSIONING

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The Project Execution Plan shall include the Commissioning Plan covering all aspects of commissioning the substation into service. Commissioning shall be carried out in accordance with *NEG-SM 04.24 Specification for Design and Construction of Major Substations, Testing and Commissioning*.

**Note:** The energisation of all plant and equipment during commissioning shall be performed by Ausgrid operations staff.

## 11.1 Asset Register

A complete record of any modifications carried out and the new assets installed outside the substation shall be provided in accordance with *NUS100 Field Recording of Network Assets*.

The Ausgrid *Integrated Asset Management System (iAMS)* shall be updated to include a complete record of any modifications carried out and the new assets installed within the substation.

The information required to operate and maintain the new or modified assets throughout their operational lives shall be provided in accordance with *NS212 Integrated Support Requirements for Ausgrid Network Assets*.

## 11.2 Commissioning Plan

Commissioning shall be undertaken in accordance with the Commissioning Plan which shall detail all of the tests to be performed on the equipment prior to commissioning the equipment into service, including the pass or fail criteria.

The Commissioning Plan shall also detail the intended commissioning sequence for all primary plant and secondary equipment and include the following;

- a formalised risk assessment with mitigation steps to be undertaken in all commissioning sequences;
- a formalised process for interfacing with Ausgrid including notification time frames and documentation; and
- the necessary plant clearance documentation for each commissioning sequence.

A final commissioning report recording complete test results shall be submitted to the Ausgrid Representative within two (2) weeks of the completion of each equipment test.

## 11.3 Pre Commissioning Inspection

Authorised Ausgrid personnel shall perform an inspection of all plant and equipment one (1) week before first energisation. This inspection is an essential pre-cursor to the acceptance of the facility into service and the control of Ausgrid. The inspection will cover the entire site and assess its readiness for service. It shall include plant and equipment labelling, availability of appropriate operating equipment and the accessibility, functionality and earthing of manual operating provisions.

Commissioning will **not** proceed until all issues are resolved to Ausgrid's satisfaction.

## 11.4 Pre Commissioning Tests

Site testing shall proceed in two phases, pre-energisation tests and on-load tests. The pre-energisation tests shall ensure that the plant and equipment is in a condition suitable for connection to Ausgrid's high voltage system. On-load tests shall be used to ensure equipment performance is as expected.

Commissioning activities shall NOT commence until all of the tests specified in *NEG-SM 04.24 Specification for Design and Construction of Major Substations, Testing and Commissioning* have been completed and the required test reports submitted to Ausgrid and accepted by the Ausgrid Representative.

As part of the pre-commissioning tests, earth grid verification tests and "on-load" tests shall be completed and witnessed by the Ausgrid Representative.

## 11.5 Commissioning Activities

Prior to the commencement of commissioning activities all outstanding Access Authorities shall be relinquished to enable the appropriate clearance forms to be issued from authorised Ausgrid personnel.

The commissioning activities shall cover all:

- main transformers, including cooling controls and on load tap changer;
- circuit breakers, switchgear, instrument transformers, disconnect switches;
- buswork;
- capacitor banks;
- protection, control, metering, communications, SCADA and alarm schemes;
- audio frequency load control equipment;
- station service supplies and all station auxiliary supply circuits
- oil containment facilities;
- DC systems, batteries and chargers;
- fire protection systems; and
- building services.

## 11.6 Personnel Authorisation

Once plant and equipment has been commissioned into service and its control has been transferred to Ausgrid, only authorised persons shall be permitted on site and all access shall be under the terms of the appropriate Access Authority issued.

## 12 DOCUMENTATION AND DRAWINGS

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The delivery program for all documentation and drawings shall be detailed in the Project Execution Plan.

The required documentation shall be delivered, complete with document transmittal form, as:

- one complete hard copy;
- one electronic copy of all documents in Microsoft Word for Windows, version 7.0 and one AutoCAD 2008 version of all drawings; and
- one electronic copy of all documents and drawings in pdf format.

All documents and drawings shall be in English and the hard copies mounted in substantial bindings with an index to enable specific items to be quickly and accurately located. All dimensions and measurements shall be in metric units.

### 12.1 Project Documentation

Documentation to be supplied as part of the project shall include, but is not limited to, the following:

- Risk analysis workshop records
- Value Management Report and Buildability Assessment
- Site Assessment Report in accordance with NEG-SM05
- Details of any variations to accepted Network Standards, Network Engineering Guidelines or Specifications that are included in the design.
- Noise impact assessment report
- Schematic Design Stage Details
- Feasibility Stage Details
- DA Drawings
- Fire Report as required by NS187
- "As Built" drawings
- OEM Manuals for all Equipment
- OEM software versions applicable at time of commissioning
- Substation Design and Operation Manual
- Maintenance Procedures and Operating Manuals for building and civil works (Refer: NS185 and NS186)
- All test procedures, records, reports and certificates
- All site commissioning records
- Construction Certification
- Occupational Certificate – as built project documentation
- Updated GIS information (particularly for all feeder works)
- Updated iAMS information for all substation equipment
- Updated maintenance requirements and schedules
- Integrated support requirements in accordance with NS212

## 12.2 Substation Design and Operation Manual

A substation design and operation manual shall be provided, detailing the philosophy, criteria and standards adopted in the design of the major substation. This design and operation manual shall also detail the operating and maintenance philosophy to be employed to achieve the required standard of performance and service life of the assets.

A complete detailed design, supported by computations, shall be carried out of all civil, structural, building, primary electrical, protection, control, communication SCADA and other works to meet the specified technical requirements.

A Failure Modes, Effects and Criticality Analysis (FMECA) shall be carried out for each major plant item, each equipment item and the substation as a whole.

These detailed designs shall be documented in the form of drawings, schedules, specifications and instructions.

The substation design and operation manual shall include as a minimum the following sections:

### **Planning/Design Philosophy**

1. Design standards
2. Indoor/ outdoor decision
3. Planning approvals
4. Substation configuration; staged and ultimate; Plant Data Sheets and General Arrangement layouts
5. Expected reliability and security of supply service standards
6. Insulation co-ordination
7. Plant / equipment line and station ratings
8. Operational requirements / philosophy
9. Maintenance requirements / philosophy
10. Asset Life expectancy
11. Strategic spares policy and spares inventory requirements

### **Reference Standards and Documentation**

1. Legislative and Regulative requirements
2. Australian and International Standards
3. ENA, ISSC and other codes and guidelines
4. Ausgrid standards, specifications and guidelines
5. Purchase specifications, guaranteed performance and plant details for all plant and equipment
6. Nomenclature, drafting and labelling standards
7. Copy of manufacturer's drawings, type, routine and special test reports for all plant and equipment.

### **Health, Safety and Environmental**

1. Critical Failure Mode Analysis
2. Dangerous goods and Materials
3. Oil containment
4. Switchboard arc fault containment
5. Sound levels at equipment and at each boundary of the substation, initial background levels and levels after commissioning is complete
6. Equipment handling plan

7. Working at heights
8. Working in confined spaces
9. EMF, initial background levels and levels after commissioning is complete
10. Sewage Services
11. Waste water management

**Grounds and buildings**

1. Site access and security
2. Site amenities
3. Security fencing, gates and security systems
4. Aesthetics and Landscaping
5. Water supply and drainage
6. Basement and Substructure
7. Building, walls, floors, roofing, architectural
8. Building, overpressure, ventilation, services
9. Fire mitigation and fire rating (substation buildings, transformer enclosure, switchyard)
10. Internal Cranes

**Civil design (including computations)**

All civil, layout and cabling drawings and computations

1. Earthworks, grading
2. Earthing, cable trenches, conduits and ducts
3. Site Drainage and Diversion Works
4. Foundation Preparation
5. Surface, switchyard and roadway
6. Footings
7. Structures
8. Mobile Crane Access
9. Transformer bunds and enclosures
10. Oil containment / separation provisions (design capacity etc.)

**Primary Electrical design (including computations)**

1. Copies of all electrical primary layout drawings and computations
2. Copies of all type and routine factory test reports
3. Copies of all installation and commissioning test reports, including procedure followed and reference standards. (These must demonstrate compliance with manufacturer's requirements)
4. Earth grid design details including step and touch potential calculations and measurements in accordance with Ausgrid requirements (These shall be verified by current injection tests to be carried out on completion of installation)
5. Plant and equipment sizing and rating
6. Busbar sizing and rating
7. Underground cable sizing and rating
8. Bushing rating
9. Tap changer rating
10. DC supplies, batteries and battery chargers (including battery and battery charger sizing calculations)
11. Light and power design details for the entire installation.

### **Secondary Electrical design (including computations)**

1. Copy of all electrical wiring drawings and computations
2. Cable block diagrams
3. Copy of all installation and commissioning test reports, including procedure followed and reference standard
4. Logic diagrams
5. Configuration files
6. Setting calculations

### **Protection Settings**

Protection calculations shall be completed to determine all of the protection settings that are required to achieve the required protection reach, stability under through faults (out of zone faults for unit protection schemes), time coordination and load carrying capability.

These calculations shall demonstrate that the protection settings are fit for purpose prior to the commencement of commissioning works and they shall be documented in a complete protection study report for the substation.

Protection settings shall not restrict plant and equipment utilisation. Where protection settings may restrict plant and equipment utilisation, the restriction shall be documented and presented to the Ausgrid Representative for approval prior to ordering any equipment or commencing any site works.

### **Recording of Protection Settings**

“Setting sheets” shall be created and entered into a Computer Automated Protection Design System. All relevant information shall be attached to the setting sheets for the respective schemes and shall include:

- Summary documentation describing the relay settings in both primary and secondary values;
- Distance protection polar plots demonstrating protection coverage for line faults including arc resistance and coverage through transformers for remote backup conditions;
- Protection time vs current characteristics demonstrating protection coordination;
- Electronic setpoint files created with the native relay interfacing software for application into the relay;
- Relay setpoint inspection files (ASCII dump of all relay setpoints, .txt or .pdf files) to allow relay setting without the means of the relay interface software;
- Maximum Safe Load (MSL) charts, plotting operate and non operate regions of the protection relays for the applicable voltage levels. The charts shall be configured with the X Axis representing MW and the Y Axis representing MVAR with a series of curves for applicable bus voltages plotted.

## **12.3 Equipment Manuals**

Manuals shall be provided in accordance with *NS212 Integrated Support Requirements for Ausgrid Network Assets*.

## **12.4 Drawing Standards**

All drawings shall comply with the requirements detailed in the *Design Standard 111, CAD Drawing Guidelines and Procedures*.

Drawings shall be produced on templates supplied by Ausgrid and shall be prepared in accordance with *AS 128 Technical drawings, general principles of*

*presentation, AS 1100 Technical drawing, AS 1102, Graphical symbols for electrotechnical documentation and NS158 Labelling of Mains and Apparatus.* The templates shall include the Ausgrid border, title block and format. All drawings shall be consistent with the format of the Ausgrid "Major Substation Sample Drawings".

Electronic files shall be appropriately structured for quick and accurate location in accordance with Ausgrid written instructions. PDF copies of drawings and specifications are to be provided as well as editable AutoCAD and word documents.

Drawing revisions shall be clearly marked with the details of the respective revisions recorded in designated 'revision blocks'.

As Installed drawings, stencilled "As Installed Drawing", shall be provided that contain a complete record of the work as at Practical Completion.

## 12.5 Accessing Ausgrid's Engineering Drawings

Ausgrid has an electronic data base – Technical Documentation Management System (TDMS) for the management, storage and retrieval of engineering drawings. The TDMS also provides version control of Ausgrid's drawing files.

Guidelines in the use of the TDMS will be provided upon request.

Use of the TDMS should be arranged through the Design Portal Manager.

## 13 TRAINING

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Training shall be provided on the installation, operations and maintenance aspects of the substation including all of the plant and equipment used in the substation.

Training is a specific deliverable and shall be included as part of the Project Execution Plan. A training program in accordance with the requirements of *NS212 Integrated Support Requirements for Ausgrid Network Assets* shall be submitted to the Ausgrid Representative for approval. Training shall be provided in accordance with the approved training program as part of the project works.





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