snowy hydro Limited renewable energy	
Snowy Technical Standards	
SHL-ELE-156	***General Low Voltage Electrical Requirements***
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1. Executive Summary

This Standard comprises of two parts:

- Overview section (this document).
- Annexure sections

This intended use of this document is that relevant annexures are appended to the overview section, as required.

This document and annexures should be used in conjunction with the project specific technical specifications and SHL design philosophy documents that will outline the detailed requirements for the project which may, or may not be covered by the General Electrical Requirements.

2. Scope

This document is intended to be a comprehensive set of General Electrical Requirements to be used for all Low Voltage and Extra Low Voltage electrical work across the Snowy Hydro business. This document has been written with the objective of standardising electrical work as much as possible whilst maintaining quality and flexibility to adapt to the wide variety of work that is undertaken at Snowy Hydro.

2.1. Applicable Standards

2.1.1. General

All electrical works must comply with the relevant annexures and latest issue of the relevant Australian Codes and Standards that are current at the date when the works are undertaken, or, provided there is no conflict with Australian Codes and Standards, must comply with the relevant international Standards and Codes. Where a Standard or Code is named in this General Electrical Requirements document, and it must take precedence over any other Standards or Codes.

2.1.2. Priority of Standards

In the event of a conflict between Standards or Codes, the standards appearing first in the following list must take precedence over those later in the list:

- Statutory regulations in force in relevant State;
- Standards and Codes named in this document or the annexures;
- Australian Codes and Standards/International Standards and Codes
- International Standards and Codes

New South Wales Acts and Regulations

Legislative requirements to be complied with include, but are not limited to:

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- Electricity Supply Act 1995
- Electricity Supply (General) Regulation 2018
- Service and Installation Rules 2006
- Environmentally Hazardous Chemicals Act 1985
- Work Health and Safety Act 2011
- National Electricity Act 1997
- Electricity (Consumer Safety) Act 2017
- Work Health and Safety Regulation 2017
- Building and Development Certifiers Act 2018
- Professional Engineers Regulation Bill 2019

Victoria Acts and Regulations

Legislative requirements to be complied with include, but are not limited to:

- Environment Protection (Prescribed Waste) Regulations 1998
- Electricity Safety Act 1998
- Occupational Health and Safety Act 2004 and Occupational Health and Safety Regulations 2017
- Electrical Safety (Installations) Regulations 1999
- Electrical Safety (Network Assets) Regulations 2009
- National Electricity Act 1997 and National Electricity Act 2005
- Energy Safe Victoria Act 2005
- Electrical safety (General) regulations 2019
- Vic Compliance Codes and codes of practice
- WorkSafe Victoria
- Professional Engineers Registration Act 2019

South Australia Acts and Regulations

Legislative requirements to be complied with include, but are not limited to:

- Electrical Act (1996)
- Electricity (General) Regulations 2012
- Occupational Health, Safety and Welfare (SafeWorkSA) Amendment Act 2005
- Work, Health and Safety Regulations 2012
- Work Health and Safety Act 2012 (SA)
- Environment Protection Act 1993
- Plumbers, Gas Fitters and Electricians Act 1995
- SA Codes of Practice
- Development Act 1993
- Professional Engineers Regulation 2019

Queensland Acts and Regulations

For design works undertaken from Queensland based companies or engineers, legislative requirements to be complied with include, but are not limited to:

- Professional Engineers Act 2002
- Professional Engineers Regulation 2019

Australian and International Standards

Electrical plants and equipment must be designed, supplied, installed and commissioned in accordance with the requirements of the specified Australian Standards, the following specific codes and standards; and any other relevant standards and regulations. These include, but are not limited to:

AS 1000	The International System of Units (SI) and its Applications
AS 1024	Direct recording electrical measuring instruments and their accessories
AS 1029	Low Voltage Contactors
AS 1046	Letter Symbols for use in Electrotechnology
AS 1049	Telecommunications cables - Insulation, sheath and jacket
AS 1081	Acoustics - Measurement of Airborne Noise Emitted by Rotating Electrical Machinery (both parts)
AS 1100	Technical Drawing
AS 1101	Graphical Symbols for General Engineering
AS/NZS 1102	Graphical Symbols for Electrotechnology
AS 1125	Conductors in Insulated Electric Cables and Flexible Cords
AS/NZS 1170	Structural design actions
AS/NZS 1200	Pressure Equipment
AS 1243	Voltage transformers for measurement and protection
AS 1284	Electricity metering
AS/NZS 1307.2	Surge Arrestors - Metal-oxide arresters without gaps for AC systems
AS 1319	Safety signs for the occupational environment
AS 1345	Identification of the contents of pipes, conduits and ducts
AS/NZS 1359	Rotating electrical machines - General requirements
AS 1428	General requirements for access - buildings
AS 1530	Methods for fire tests on building materials, components and structures (4 parts)
AS 1554	Structural steel welding (all parts)
AS 1562.1	Design and Installation of sheet roof and wall cladding

AS 1566	Copper and copper alloys - Rolled flat products
AS 1571	Copper - Seamless tubes for air conditioning and refrigeration
AS 1603	Automatic fire detection and alarm systems (all parts)
AS 1627	Metal finishing - Preparation and pre-treatment of surfaces
AS/NZS 1657	Fixed platforms, Walkways, Stairways, and ladders
AS/NZS 1668	The use of mechanical ventilation and air-conditioning in buildings
AS/NZS 1680	Interior Lighting
AS 1682	Fire, Smoke and air dampers
AS/NZS 1768	Lightning protection
AS/NZS 1841	Portable Fire Extinguishers
AS 1851	Routine service of fire protection systems and equipment
AS 1905	Components for the protection of openings in fire-resistant walls (all parts)
AS 1940	The storage and handling of flammable and combustible liquids
AS 2067	Substations and HV installations
AS/NZS 2107	Acoustics - Recommended design sound levels and reverberation times for building interiors
AS 2220	Emergency warning and intercommunication systems in buildings (all parts)
AS/NZS 2293	Illuminated exit signs and emergency lights
AS 2312	Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings
AS 2360	Measurement of fluid flow
AS 2362	Fire detection, warning, control and intercom systems - method of test
AS 2373	Electric cables - Twisted pair for control and protection circuits
AS 2381	Electrical equipment for explosive gas atmospheres – Selection, installation and maintenance
AS 2444	Portable fire extinguishers and fire blankets - selection and location
AS 2648	Underground Marking Tape
AS 2669	Sulphuric acid for use in lead-acid batteries
AS 2676	Guide to the installation, maintenance, testing and replacement of secondary batteries in buildings
AS 2700	Colour standards for general purposes
AS 2729	Rolling bearings - Dynamic load ratings and rating life
AS/NZS 3000	Wiring Rules

AS/NZS 3008.1.1	Electrical installations - selection of cables - Cables for alternating voltages up to and including 0.6/1kV - Typical Australian installation conditions
AS 3010	Electrical installations - Generating sets
AS 3011	Electrical installations - Secondary batteries installed in buildings
AS/NZS 3012	Electrical Installations – Construction and demolition sites
AS 3013	Electrical installations - Classification of the fire and mechanical performance of wiring system elements
AS/NZS 3017	Electrical installations – Verification guidelines
AS/NZS 3080	Information technology - Generic cabling for customer premises (ISO/IEC 11801:2011, mod)
AS/NZS 3084	Telecommunications installations - Telecommunications pathways and spaces for commercial buildings
AS 3085	Telecommunications installations - Administration of communications cabling systems
AS 3808	Insulating and sheathing materials for electric cables
AS/NZS 3100	Approval and Test Specification - General requirements for electrical equipment
AS/NZS 3111	Approval and test specification for miniature over-current circuit-breakers
AS/NZS 3133	Approval and test specification air break switches
AS/NZS 3190	Approval and test specification - RCD (current operated earth leakage devices)
AS/NZS 3560	XLPE Power cables for rated voltages up to 1kV
AS/NZS 3666	Air-handling and water systems of buildings - Microbial Control
AS 3808	Insulating and sheathing materials for electric cables
AS 3814	Industrial and Commercial Gas-Fired Appliances
AS/NZS 3820	Essential service requirements for electrical equipment
AS 3835	Earth potential rise, protection of telecommunications networks users, personnel and plant
AS 4024	Safety of Machinery (all parts)
AS 4029	Stationary Batteries (Parts 1-3)
AS 4040	Methods of testing sheet roof and wall cladding
AS 4044	Battery Chargers for Stationary Batteries
AS 4070	Recommended practices for protection of low-voltage electrical installations and equipment in MEN systems from transient overvoltages
AS 4086	Secondary batteries for use with stand-alone power systems.
AS 4100	Steel Structures
AS 4254	Ductwork for air handling systems in buildings

AS 4383	Preparation of documents used in electrotechnology
AS 4428	Fire detection, warning, control and intercom systems - control and indicating equipment (all parts)
AS/NZS 4509	Stand-alone power systems (Parts 1 and 2)
AS/NZS 4600	Cold-formed steel structures
AS 4680	Hot-dip galvanised (zinc) coatings on fabricated ferrous articles
AS 4702	Polymer Cable Protection Covers
AS 4775	Emergency eyewash and shower equipment
AS 4802	Local Area Networks
AS 4836	Safe working on or near low voltage electrical installation and equipment.
AS/NZS 4853	Electrical hazards on metallic pipelines
AS/NZS 5000	Electric cables - Polymeric insulated
AS 5139	Electrical installations – safety of battery systems for use with conversion equipment
AS/NZS ISO/IEC 24702	Telecommunications Installations - Generic cabling - Industrial premises
AS 60034	Rotating electrical machines (All parts)
AS 60038	Standard Voltages
AS 60044	Instrument Transformers
AS/IEC 60060	High-voltage test techniques
AS/NZS 60076	Power transformers (all parts)
AS/NZS 60079	Explosive atmospheres
AS 60146	Semiconductor converters (Parts 1.1, 1.2, 1.3 and 2)
AS 60335.2.41	Household and similar electrical
AS 60479	Effects of current on human beings and livestock
AS 60529	Degrees of protection provided by enclosures (IP Code)
AS 60849	Sounds systems for emergency purposes
AS/NZS IEC 60947	Low-voltage switchgear and controlgear (all parts)
AS/NZS 61000	Electromagnetic compatibility (EMC)
AS IEC 61131	Programmable controllers (all parts)
AS 61204.1	Low voltage power supply devices D.C. output - Performance characteristics
AS 61386	Conduits and Fitting for Electrical Installations (all parts)

AS 61439	Low-Voltage switchgear and controlgear assemblies
AS IEC 61508	Functional safety of electrical/electronic/programmable electronic safety related systems.
AS IEC 61511	Functional safety – safety instrumented systems for the process industry sector
AS 62040	Uninterrupted Power Systems (UPS)
AS 62026	Low-voltage switchgear and control gear - Controller-device interfaces
AS/NZS 61000	Electromagnetic compatibility (EMC) (All parts)
AS/NZS IEC 61935	Testing of balanced communication cabling in accordance with ISO/IEC 11801 - Installed cabling
IEC 62599	Alarm systems (all parts)
AS/ACIF S009:2006	Installation requirements for customer cabling (Wiring Rules)
AS/ACIF S008:2006	Requirements for customer cabling products
AS/NZS CISPR 11	Industrial, scientific and medical equipment—Radio-frequency disturbance characteristics - Limits and methods of measurement
AS/NZS CISPR 14.1	Electromagnetic compatibility - requirements for household appliances, electric tools and similar apparatus
AS/NZS CISPR 22	Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement
BS 6739	Code of practice for instrumentation in process control systems: installation design and practice
IEC 60051	Direct Acting Indicating Electrical Measuring Instruments and Accessories
IEC 60071	Insulation coordination
IEC 60073	Basic and safety principles for man-machine interface, marking and identification – Coding principles for indication devices and actuators
IEC 60255	Measuring relays and protection equipment
IEC 60258	Direct recording electrical measuring instruments and their accessories.
IEC 60269	Low-voltage fuses
IEC 60304	Standard colours for insulation for low-frequency cables and wires
IEC 60478	Stabilised power supplies dc output
IEC 60584	Thermocouples
IEC 60688	Electrical measuring transducers for converting A.C. and D.C. electrical quantities to analogue or digital signals
IEC 60751	Platinum Resistance Elements (PT100)

IEC 60793	Optical Fibres
IEC 61010	Safety requirements for electrical equipment
IEC 61158	Fieldbus
IEC 61660	Short-circuit currents in dc auxiliary installations in power plants and substations
IEC 61850	Communication Networks in Substations
IEC 61868	Instrument Transformers (Parts 1-5)
IEC 62606	General requirements for arc fault detection devices
IEC 62443-2	Security for industrial automation and control systems
IEC 62443-3	Industrial communication networks - Network and system security
IEC ISO 80000	Quantities and units
IEC TR 61641	Enclosed low voltage switchgear and controlgear assemblies – guide for testing under conditions of arcing due to internal fault
IEC TR 61869-102	Instrument transformers - Part 102: Ferroresonance oscillations in substations with inductive voltage transformers
IEC TR 61869-103	Instrument transformers - The use of instrument transformers for power quality measurement
IEEE 80	Guide for safety in ac substation grounding
IEEE 81	Guide for measuring earth resistivity, ground impedance and earth surface potentials of a grounding system
IEEE 142	IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems
IEEE 450-2002	Recommended practice for maintenance, testing, and replacement of vented lead-acid batteries for stationary applications
IEEE 484-2002	Recommended practice for installation design and installation of vented lead-acid batteries for stationary applications
IEEE 485-2010	Recommended practice for sizing lead-acid batteries for stationary applications
IEEE 979	Guide for Substation Fire Protection
IEEE 1050	Guide for Instrumentation and Control Equipment grounding in Generating Stations
IEEE 1184	Guide for the selection and sizing of batteries for uninterruptible power systems
IEEE 1187-2002	Recommended practice for installation design and installation of valve-regulated lead-acid storage batteries for stationary applications
IEEE 1188-2005	Recommended practice for maintenance, testing, and replacement of valve-regulated lead-acid (VRLA) batteries for stationary applications

IEEE 1491	Guide for selection and use of Battery Monitoring Equipment in stationary applications
IEEE 1584	Guide for Performing Arc Flash Hazard Calculations
IEEE 1613	Environmental and Testing Requirements for Communications Networking Devices in Electric Power Substations
IEEE 1635	Guide for ventilation and thermal management of batteries for stationary applications.
IEEE 1881	Battery glossary
IEEE C37.90.1	Surge Withstand Capability
ANSI IEEE C37.2	Electrical Power System Device Function Numbers, Acronyms, and Contact Designations
EN 50081-2	Electromagnetic compatibility. Generic emission, Industrial environment
EN 50082-2	Electromagnetic compatibility. Generic immunity, Industrial environment
EN 55011	Limits and methods of measurement of radio disturbance
EN 61000	Electromagnetic Compatibility (EMC)
ENA EG1	Substation earthing guide
ENA DOC 018	Guideline for fire protection of electricity substations
NFPA 70E	Standard for Electrical Safety in the Workplace
HPLIG 0370	Grounding Guide of Best Practice for Hydraulic Stations
AS/NZS ISO 9001	Quality Management Systems
AS/NZS ISO 14001	Environmental Management Systems
AS/NZS ISO 45001	Occupational Health and Safety
NER	National Electricity Rules
NCC	National Construction Code
KKS	Kraftwerk Kennzeichensystem

2.1.3. Units of Measure

The metric (SI) system must be used for electrical work in accordance with the provisions of AS ISO 1000 and IEC ISO 80000. All data, drawings, information and calculations must be presented in the metric unit system. Where British or American units are used by Suppliers, the equivalent SI units must be indicated on the drawing together with the non-SI original value.

3. Definitions

Extra-Low Voltage (ELV)	Not exceeding 50 V A.C. or 120 V ripple-free D.C.
Low Voltage (LV)	Exceeding extra-low voltage, but not exceeding 1000 V A.C. or 1500 V D.C.
High Voltage (HV)	Exceeding Low Voltage

4. Safety, Environment and Quality

4.1. Design and Manufacturing

All electrical works must be designed, manufactured, tested and commissioned to operate safely, reliably and efficiently in accordance with the requirements of the General Electrical Requirements.

The electrical works design must enable cost effective and safe manufacture, installation, operation and maintenance. Where possible, the design should allow for safe and easy access for operational and maintenance activities without affecting other in-service plants or adjacent generating units.

Electrical works design must conform to current best practice.

Electrical works must be capable of operation within the entire operating range and site conditions without undue stress or loss of operating life.

The plant and equipment must be designed to:

Minimise the risk of fire and consequent damage which may follow a fire;

Prevent the ingress of vermin;

Minimise the ingress of dust into enclosed areas;

Prevent accidental contact with high temperature parts and live electrical equipment; and

Minimise unnecessary obstructions and intrusion into plant spaces by reviewing the size, shape and location of systems to be installed.

4.1.1. Safety in Design

In the course of executing electrical work in accordance with the requirements of the General Electrical Requirements, where any design work is undertaken or Drawings are prepared, the concepts of Safety in Design must be followed as per the Commonwealth Government's Guidance on the Principles of Safe Design for Work (2006). A Safety in Design process must ensure diligent engineering design and documentation is undertaken.

The safety of personnel and equipment on or near the plant is considered mandatory for all electrical work.

Design of the equipment must be in accordance with the requirements of current legislation, statutory regulations and the applicable Australian Standards. Equipment must include any auxiliary devices for safety in operation.

The design must meet the mandatory National Electricity Rules (NER) and regulatory requirements.

The symbols used for electrical diagrams must be in accordance with AS1102.

The Professional Engineers Act 2002 requires that only engineers who are registered as RPEQs or who are directly supervised by engineers who are registered as RPEQs are permitted to carry out professional engineering services in Queensland or any engineering services originating in Queensland. Best engineering practice requires all engineering services to be undertaken or supervised by a Chartered Professional Engineer (CPEng)

4.2. Quality

Any product, service or equipment shall be in accordance with a quality assurance system accredited to AS/NZS IS 9001 and be accompanied with a quality control program.

Materials

Materials most suited to the particular service must be used such as to enhance service life, operational reliability as well as facilitate ease of maintenance, inspection and adjustment.

4.2.1. Assembly During Manufacture

All parts of the plant must be assembled during manufacture to the full extent necessary for the purpose of inspection and testing at the Suppliers works. This must assist SHL in verifying that the plant will function satisfactorily once commissioned on-site.

4.2.2. Workmanship

The workmanship is to be of the highest standard throughout. Skilled labour must be employed and must be licensed in accordance with the requirements of the relevant State Electricians and Contractors Licensing Act, or any other requirements of a Statutory Authority.

Personnel engaged in the construction of electrical installations shall be suitably experienced, competent and skilled in the particular field of work in which they are engaged. All works shall be completed by or under the direct supervision of fully qualified tradesperson.

The production of each part of the plant must be monitored at every stage of its manufacture by personnel other than the craftsmen involved in the production.

All plants must be designed and manufactured in the soundest manner. The design and manufacturing must be such as to enhance service life and operational reliability, minimise wear and facilitate ease of maintenance, inspection and adjustment.

Items of commercial equipment to be incorporated into the plant must be of high quality produced by reputable manufacturers and of adequate capacity to perform the required service under all operating conditions.

4.2.3. Certification of Compliance

Certificates of Compliance or Certificates of Electrical Safety must be supplied for all installed or modified electrical works in accordance with the relevant State Acts and Regulations.

4.3. Site Handling and Storage

All plants must be suitably protected against damage during shipping and site handling and against the weather, corrosion, damage, deformation or distortion and contamination by dirt whilst being stored on-site.

4.4. Erection

Appropriate equipment must be used to carry out and check all precision and detailed layout including setting and alignment of equipment and machinery.

4.5. “Off the Shelf” Components

The system components must be 'off the shelf' where possible and available from a number of alternative suppliers/manufacturers.

Where it is not possible to use 'off the shelf' components, all proprietary components (with the exception of electronic components), must be fully repairable and be supplied with full detail drawings.

All wearing and perishable parts must be replaceable.

4.6. Standard and Modular Approach

A standard and modular approach is to be taken with all equipment to be provided. Similar installations are to have compatible and modular equipment where possible.

Equipment types are to be similar and rationalised as far as possible to minimise spares requirements

4.7. Interchangeability of Components

Replacement components, where ever possible, must be totally interchangeable between similar units in order to minimise the stock of spare parts required.

5. References

N/A.

6. Deviation

Any deviations to the standards to be approved by the subject matter expert.

APPENDIX A - List of Annexures

Annexure Reference	Annexure Title
A	Switchrooms
B	Low voltage switchboards
C	Electrical cubicles and junction boxes
D	Low Voltage Cables and Cable Management Systems
E	General hardware requirements
F	Low voltage motors
G	Control systems
H	Instrumentation and transducers
I	Current and voltage transformers
J	DC battery supplies
K	Low voltage earthing
L	Uninterruptible power supplies
M	Lighting and Power
SHL-GEN-123	Protective Coatings
O	Asset identification requirements
SHL-GEN-119	CAD Standards and Exchange of Electronic Drawings
Q	Preferred suppliers