South East Water

Electrical Standard

AM 2714

Document Control

Revision History

Revision No.	Date	Change Description
0	23/11/06	Draft
1	13/08/08	Instrumentation added (*by J. Myyrlainen)*
2	15/12/15	Various Revisions, Telemetry Section Removed as Obsolete *by J. Myyrlainen)*
3	80/3/16	Local isolation, conduit entry and PLC expansion clauses added. (Sections 2.8, 2.3.6, 3.2.7 *by J. Myyrlainen)*
4	13/04/16	Appendix A - Approved Equipment Schedule added to doc. (*by J. Myyrlainen)*
5	20/04/16	Document number renamed from No 07-01 to AM2714 *(by J. Myyrlainen)*
6	4/05/16	Fixed Equipment Connected to Socket Outlets, Safety Devices clauses added. (Sections 2.6.6, 2.7 *by J. Myyrlainen)*
7	24/05/16	Commissioning Inspection Test sheets added. Magnetic flowmeters (Appendix C, 5.1.7 *by J. Myyrlainen)*
8	8/06/16	Switchboard location details added (Sections 3.2.29 *by J. Myyrlainen)*
9	22/08/16	Magnetic Flowmeter clause revised. (Sections 5.1.7 *by J. Myyrlainen)*
10	03/11/16	Control of Equipment, Alternate Standby Generation Supply, Inspection Clauses, Electric Motors and UPS sections added. Instrumentation Section 5 headings revised. *(Sections 3.3.9 , 4.1.5, 5, 6.1.1,12 & 13 by J. Myyrlainen)*
11	10/1/17	Adhesive cable tie mount clause added. Approved Equipment – Surge Arrestors, Variable Speed Drive & Flow meter details revised. Vertical mounted motors. *(Sections 2.2.1, Appendix A,12.1.8 by J. Myyrlainen)*
12	31/3/17	Field Equipment Electrical Isolation clause include criteria for plug socket. Active Harmonic filter added to preferred equipment list. Cable pit clause revised. *(Sections 2.8, Appendix A, 2.3.9 by J. Myyrlainen)*
13	22/5/17	Special Tools clause revised. Drawing Integration clause added. Lock clause revised. Pre commissioning clause revised. Motor connections clause added. Magnetic flowmeter verification clause added *(Sections 1.3.9,1.6, 3.2.15, 6.1.2 12.1.9, 5.2.4, 6.1.2 by J. Myyrlainen)*

Revision No.	Date	Change Description
14	14/9/17	Rev notation. Cable tie clause added. Non-metallic field control stations. *(Sections 2.2.11, 3.3.9 by J. Myyrlainen)*
15	27/10/17	Instrument transmission clause revised. Approved equipment list revised. Temperature Sensor, Generator Controller added. *(5.1.9, Appendix A by J. Myyrlainen)*
16	7/2/18	Preferred UPS equipment added. UPS backup period changed from 2 to 4 hours. (Appendix A Section 13
17	5/3/18	Signal Convertor type added. *(Appendix A by J. Myyrlainen)*
18	1/8/18	ELV VAC wiring colour revised. Arc fault clause added. MCC ELV control separated from LV function units. PLC space requirements, Form Rating, Control of Equipment location clause added. Indicator light colours revised. *(Sections 2.2.7, 3.2.5, 3.2.6,3.2.7,3.2.12, 3.3.3, 3.3.9 by J. Myyrlainen)*
19	29/10/2018	Added new Network section and Appendix E - updated equipment lists for network related equipment. Document reformatted. *(Section 8 and Appendix E by P. Hodkinson, J Myyrlainen)*
20	16/1/2019	Update section 8.1.2 for better fibre ring physical redundancy, add Appendix E Topology Terms Examples and diagram *(Section 8 and Appendix E by P. Hodkinson, J Myyrlainen)*
20.1	3/5/19	Power Supplies DC - Meanwell SDR240-24 revised *(Appendix A by J Myyrlainen)*
21.0	1/7/19	Name change. Scope added. Improved integration with AM2779 Treatment Plant Monitoring and Control Spec, AM2779 Watershed collection details and AM2522 O&M Manual and Operator Training spec. New SEW doc template. Enhanced cross referencing of standards. Updated Approved products List (Various Sections *by R.Jagger, C. Paxman)*
22	12/8/19	Electric Valve Actuators section added, Board Colours, Approved Products *(Section 8 by J.Myyrlainen, C. Paxman)*
23	7/5/20	Introduction of Functional Safety *(Sections 1.5.11, 3,3.1,1.5.6, 2.8,5.3 (by A.Gabriel, C. Paxman)*
24.0 to 20.4	11/5/20	• v24.0 At treatment plants each sub board to have a MTS and gen connection point (Section 3 J. Street, C. Paxman) • v24.1 If multiple boards are to be built on one project, then they are to use the same switchboard builder for all boards. (Section 3.1 by J. Street, C. Paxman) • v24.2 Include hazardous area classification, if applicable. (Section 1.5.6 by A.Gabriel, C. Paxman) • v24.3 Standards such as AS61508, AS62061, AS61511 and AS 4024.1503 (ISO13849-1 and ISO13849-2), may be

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Revision No.	Date	Change Description
		applied where necessary. (Section 2.8 by A.Gabriel, C. Paxman) • v24.4 Consideration of Common Cause Failure (CCF) (Section 5.3 by A.Gabriel, C. Paxman)
0.0	13/08/2020	The EICC committee had reviewed various sections of this Standard on 5 occasions. We have set revision to rev 0. We have decided to segregate the original AM2714 into separate standards, namely: • AM2714 – Electrical Standards (this document) • AM2832 – Instrumentation & Controls Standards • AM2847 – Communications Standards • AM2851 – EIC Inspection, Testing & Completion Standards • AM2848 – Approved EIC Equipment List *(By EICC Committee, A. Gabriel, C. Paxman)*
0.1 to 0.4		• v0.1, dated 22/7/21: Minor updates to Unistrut Requirements, Cabinet Fans, Distances in switch rooms, Withdrawable ACB, Flexible conduit, Switchboard Labelling • v0.2 dated 22/03/22: Internal switchboard material, construction in corrosive, atmospheres. • v0.3 dated 13/09/22: Referred AM2943, Included Performance Level (PL) • v0.4 dated 01/03/2023: Switchboards that are not covered by AS61439 (e.g., 125A/10KA) shall need a construction certificate stating that are built to AS3000. Reviewed and approved by J. Street, L Bassett, J.Myyrlainen as a part of the EICC Committee
1.0	17/10/2025	Major periodic review to the document and change to new template with new document control page. Revisions have been made across all sections, with the addition of the following new sections: • Motor Starters • Arc Flash Design Requirements • Solar and BESS Requirements • EV Charging Requirements • Machinery Safety Design Requirements

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Revision Working Group (1.0)

Name	Reviewer Position
James Gourley	Energy, Carbon and Resource Recovery Planner
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Registered Engineer Approval

Revision No.	Name and signature	Position	Date
1.0	Milinda Senanayake Digitally signed by Milinda Senanayake Reason: Approved Date: 2025.10.17 09:51:56 +11'00'	Principal Electrical Engineer – Control & Power	17/10/2025

Authorised

Revision No.	Name and signature	Position	Date
1.0	Ranga Gayan Fernando Digitally signed by Ranga Gayan Fernando Reason: Authorised Date: 2025.10.17 10:00:45 +11'00'	Engineering & Design Manager	17/10/2025

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1. Introduction

1.1 Purpose

The purpose of this specification is to ensure that electrical assets across South East Water (SEW) sites are designed, installed, and maintained to be:

- Safe - protecting SEW personnel, contractors, and the public.
- Cost effective - optimising long-term operational, maintenance, and energy efficiency.
- Serviceable - ensuring accessibility for inspection, testing, upgrades, and maintenance.

This document shall be applied during both the Planning and Delivery phases of capital projects, with consideration for the whole-of-life cycle of the asset.

At the Tender stage, tenderers must confirm compliance with this standard. Relevant sections shall also apply to vendor-supplied packages.

Any deviations from the electrical standard must be clearly identified at the time of tender. Formal requests for dispensation must be submitted to South East Water's Engineering & Design Team for assessment, prior to the issue of Issued for Construction (IFC) drawings.

1.2 Scope

This specification outlines South East Water's minimum standards for the selection, fabrication, delivery, installation, and testing of electrical equipment and associated items used at new or renewed water and sewerage infrastructure sites.

Chapter Summary

- **Section 1 – Introduction**

  Defines scope and purpose, acronyms, standards and reference documents.

- **Section 2 – General Design Requirements**

  Defines contractor quality expectations, materials and equipment requirements, and drawing/documentation standards.

- **Section 3 – Installation Requirements**

  Covers cable systems, conduits, bends, supports, cable trays, underground services, labels, safety devices, isolations, and enclosures.

- **Section 4 – Electricity Supply**
  Defines supply requirements, capacity, power factor correction, and permanent/temporary standby generation supply.

- **Section 5 – LV Switchboards**
  Requirements for switchboard design, fabrication, arc fault protection, busbars, access, separation, spare capacity, and labelling.

- **Section 6 – Electric Motors**
  Section covering MEPS, IE efficiency levels, load characteristics, VSD-driven motors, temperature rise, protection devices, mounting, and connections.

- **Section 7 – Motor Starters**
  Requirements for DOL starters, soft starters, and VSDs, including harmonic compliance and monitoring.
- **Section 8 – Electric Valve Actuators**
  General requirements, actuator features, and integration with controls.
- **Section 9 – Battery Backup Power Supplies (UPS & DC Systems)**
  Enclosures, DC supplies, static/maintenance bypass, indicators, alarms, and commercial-grade UPS requirements.
- **Section 10 – Arc Flash Design Requirements**
  Mandates arc flash assessments (IEEE 1584), PPE categories (NFPA 70E), mitigation strategies, and labelling.
- **Section 11 – Solar PV, Battery Energy Storage Systems (BESS)**
  Technical design guidelines for grid connection, protection, island mode, warranties.
- **Section 12 – EV Charging**
  Technical design guidelines for EV charging infrastructure.
- **Section 13 – Machinery Safety**
  Risk management, AS 4024 compliances, guarding and interlocks, validation requirements, and documentation deliverables.
- **Section 14 – Equipment Identification**

  Defines the process for identifying and labelling significant maintainable equipment to ensure consistency in asset management and maintenance systems.

1.3 Limitations & Exclusions

This specification does **not** apply to:

- SEW assets not containing water and sewerage infrastructure (e.g., WatersEdge offices, depots).
- Functional or operational requirements relating to electrical assets.
- Content already covered in AM2988 SEW Water Recycling Plant Monitoring and Control General Requirements Manual.
- Civil, mechanical arrangements, pump selection, pump performance, or hydraulic assessment.
- Work practices associated with the management of electrical risks during construction and installation works.

Where there are any conflicts, this AM 2714 take takes precedence.

1.4 Reference documents

The following standards shall apply:

- Australian Standards or its IEC/ISO equivalent
- OH&S Regulations 2017 (Victoria)
- Electricity Safety (Installations) Regulations (Victoria)
- Victorian Service & Installation Rules

- Essential Services Commission Electricity Distribution Code
- Requirements of the Electricity Distribution Company
- Electricity Safety Act (Victoria)
- Manufacturer's Guidelines
- Water Industry Standards
- Manufacturer standards and instructions
- General good engineering practice

The order of precedence of documents shall be as follows:

- Legislated requirements
- Project specific specifications
- Project specific drawings
- South East Water standards
- South East Water standard drawings
- Water Industry Standards (WSAA)

The design consultant or contractor shall refer to the latest versions of all relevant International and Australian Standards, as well as applicable Water Industry and South East Water internal standards.

At the time of tendering or contract execution, the contractor must specify the latest standard versions and their release dates that they intend to comply with.

Table 1: International and Australian Standards reference

Document Number	Document Name
AS/NZS 61000 Part 3.2	Limits for harmonic current emissions
AS/NZS 61000 Parts 3.3 & 3.5	Voltage fluctuations and flicker
AS/NZS 61000 Parts 3.6 & 3.7	Emission limits for medium voltage systems
AS/NZS 4836	Safe working on or near low-voltage and extra-low voltage electrical installations and equipment
AS 60076.5	Power transformers – Ability to withstand short circuit
AS 1319-1994 REC:2018	Safety signs for the occupational environment
IEC 61000-4-6	Immunity to conducted disturbances (RF fields)
IEC 61000-6-2	EMC – Immunity for industrial environments
IEC/TR 61000.3.6	Assessment of emission limits for harmonics at PCC
IEEE 1584:2018	Guide for Performing Arc-Flash Hazard Calculations
NFPA 70E (2018)	Standard for Electrical Safety in the Workplace

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Table 2: Water Industry and SEW Internal Standards reference

Document Number	Document Name
AM2488	2D and 3D Drafting
AM2717	Generator Specification
AM2739	Corrosion Mitigation Specification
AM2755	Testing, Commissioning and Handover Plan
AM2758	Noise Specification
AM2759	Facility Resilience and Security Technical Standard
AM2775	Watershed Collection Details (SEW)
AM2776.3	Air Treatment Unit Specification and Commissioning
AM2832	Instrumentation & Control Standards
AM2847	Communications Standards
AM2848	Approved EIC Equipment List
AM2851	EICC Inspection Testing Completion and Decommissioning
AM2870	Requirements for EIC Contractors
AM2961	WSA04-2022 Sewage Pump Station Code SEW Supplement
STD & Templates*	Generator Electrical Standard Drawings (pdf)
STD & Templates*	SPS General Electrical Standard Drawings (pdf)
STD & Templates*	Treatment Plant Electrical Standard Drawings (pdf)
STD & Templates*	Water Pressure Reducing Station Electrical Standard Drawings (pdf)
STD & Templates*	Water Monitoring Site Electrical Standard Drawings (pdf)
STD & Templates*	SPS Soft Starter Electrical Standard Drawings (pdf)
STD & Templates*	SPS VSD Electrical Standard Drawings (pdf)
STD & Templates*	Water Pumping Station Electrical Standard Drawings (pdf)
STD & Templates*	South East Water P&ID standards (pdf)
WSA04	Sewage Pumping Station Code of Australia

Note*: The Electrical Standard Drawing Templates and P&ID symbols are provided as guidance for designers to develop the detailed design. SEW supplies these templates to improve efficiency and ensure consistency across electrical design drawings.

1.5 Abbreviations

Table 3: Abbreviations and Interpretation

Abbreviations	Interpretation
AC	Alternating Current
ACB	Air Circuit Breaker
ADMD	After Diversity Maximum Demand
AEP	Annual Exceedance Probability
AHF	Active Harmonic Filter
AI	Analogue Input
AO	Analogue Output
ATS	Auto Transfer Switch
CAD	Computer-Aided Design
CCF	Common Cause Failure
COTS	Commercial Off-The-Shelf
CT	Current Transformer
Cu	Copper
DC	Direct Current
DI	Digital Input
DIN	Deutsches Institut für Normung (German Institute for Standards)
DNP3	Distributed Network Protocol (version 3)
DNSP	Distributed Network Service Provider
DO	Digital Output
DOL	Direct-On-Line (starter)
ELV	Extra Low Voltage
EMC	Electromagnetic Compatibility
ESC	Essential Services Commission
FAT	Factory Acceptance Test
FDS	Functional Design Specification
FFL	Finished Floor Level
FOBOT	Fibre Optic Break Out Tray

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Abbreviations	Interpretation
FRL	Fire Resistance Level
HART	Highway Addressable Remote Transducer
HAZOP	Hazard and Operability Study
HMI	Human Machine Interface
HVAC	Heating, Ventilation & Air Conditioning
I: INST	Instantaneous
ICS	Industrial Control System
IE	International Efficiency
IEC	International Electrotechnical Commission
IFC	Issued For Construction
ILO	Integrated Lights Out
IO	Input Output
IP	Ingress Protection
IR	Insulation Resistance and Infrared
IT	Information Technology
ITP	Inspection Test Plan
L: LTD	Long Time Delay
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LV	Low Voltage
MCB	Miniature Circuit Breaker
MCC	Motor Control Centres
MCCB	Moulded Case Circuit Breaker
MEPS	Minimum Energy Performance Standard
NCC	National Construction Code
NFPA	National Fire Protection Association
OH&S	Occupational Health & Safety
PCC	Point of Common Coupling / Process Control Centre (dual use)
PIR	Passive Infrared Sensor

Abbreviations	Interpretation
PPE	Personal Protective Equipment
PSU	Power Supply Unit
PTC	Positive Temperature Coefficient
PVC	Polyvinyl Chloride
RCD	Residual Current Device
RFI	Radio Frequency Interference
RPEV	Registered Professional Engineer of Victoria
S: STD	S: Short Time Delay
SAL	Site Alarm List
SCA	Switchgear Control Assemblies
SCADA	Supervisory Control and Data Acquisition
SDM	System Design Matrix
SEW	South East Water
SFP	Small Form Pluggable
SID	Safety in Design
SS	Soft Starter
STP	Sewage Treatment Plant
SWB	Switchboard
TBA	To Be Advised
TBC	To Be Confirmed
TFT	Thin Film Transistor
THDi	Total Harmonic Current Distortion
THDv	Total Harmonic Voltage Distortion
TTP	Tertiary Treatment Plant
UF	Ultra Filtration
UPS	Uninterruptable Power Supply
UPVC	Unplasticised Polyvinyl Chloride
UV	Ultra Violet
VBA	Victorian Building Authority

Abbreviations	Interpretation
VSD	Variable Speed Drive
WRP	Water Recycling Plant

2. Design Requirements

2.1 General

2.1.1 Engineering Design

All Professional Engineering work in this field shall be undertaken by persons registered with the Victorian Building Authority (VBA) as a Registered Professional Engineer of Victoria (RPEV).

2.2 Drawings

2.2.1 Standards

South East Water has a number of standard electrical drawings which shall be used as much as practical in the generation of electrical project drawings. These are available in CAD format so that as much of the content as possible can be used as a guide for the development of the detailed design drawings.

Table 4: Standards

Table Heading	Table Heading
AM2488	2D and 3D Drafting (South East Water standard)
AS1102.107	Graphical symbols for electro-technical documentation - Switchgear, control gear and protective devices
AS1101.6	Graphical symbols for general engineering - Process measurement control functions and instrumentation.

2.2.2 Drawings to be Included

Prepare electrical schematics in a logical manner for ease of use in AutoCAD 2024 version or more recent.

Adequate spare space shall be left in drawings for spare/unused terminals on equipment to allow for future use of the spares and inclusion of additional equipment (e.g. spare IO on PLC or telemetry equipment). All drawings shall have either line or grid numbers, and cross references are to be shown for all contacts on each item of equipment (e.g. relay contacts).

Drawing shall consist typically of but not limited to.

- Process and Instrumentation Diagrams (P&ID).
  Refer to AM2488-2D and 3D Drafting and associated CAD template files for standard P&ID blocks.
- Single line diagrams for all Control Assemblies and Distribution Boards.
- Instrument schedules.
  Refer to AM2488-2D and 3D Drafting and associated CAD template files for standard instrument labels.
- Instrument loop diagrams.
- Plant room layout plans identifying all electrical equipment.
- Switchboard and control panel general arrangement.

- Electrical equipment schedules.
- Label schedules.
- Embedded conduit arrangement and pit locations
- Earthing arrangement Diagrams
- Power and Lighting Plans
- Cable/conduit route drawings.
- Cable support systems
- Cable Identification schedule showing cable type, size, identification tag and cable route (notably routes between field pits).

The following drawings shall also be included in the drawing set as specified

- Electrical control schematics.
- Motor Starter Diagrams
- PLC IO module connection/wiring diagrams.
- PLC and communications network topology.
- RTU connection diagrams.
- Terminal block diagram
- Any other drawings as specified within the Monitoring and Control standards.

2.2.3 Drawing Integration

Where electrical modification, augmentation or decommissioning works are part of an existing electrical installation, relevant drawings shall be created, revised or reproduced to indicate the integration between existing and the completed works.

2.3 Pre-Construction Submissions

2.3.1 Electrical Design Review Procedure

In line with the contractual arrangements, the designer shall submit detailed electrical design documentation for review at the following stages:

- Functional Design review (Typically this is the Planning Phase)
- 30% Design Review (Initial Design Review)
- 60% Design Review (Issued for Review)
- 90% Design Review (Issued for Acceptance)
- 100% Design Submission (Issued for Construction)

At each stage, the designer must consolidate reviewer feedback into a centralised Design Comments Register. This register, along with documented responses and updates, shall be submitted with the next design review package.

A HOLD POINT shall be applied prior to submission of the 90% Design Review package, requiring the designer to:

- Demonstrate full closure of all prior comments.

- Incorporate all changes resulting from HAZOP and Safety in Design (SID) workshops.
- Seek formal approval from the South East Water Project Manager prior to issuing the design for construction (IFC).
- Dispensation to be requested and accepted by SEW for any deviation from this standard.

2.3.2 Required Design Documentation

Here's an updated and **comprehensive checklist** of EICC deliverables for each project stage, now including the additional items required at the **90% Design Review** prior to HAZOP and Safety in Design (SiD) workshops:

Functional Design Review (Pre-Tender Stage)

- Functional Electrical Single Line Diagram (SLD)
- Functional Electrical Switchroom Layout
- Functional Electrical Switchboard General Arrangement
- Functional Communication Network Hardware Architecture
- Functional P&ID
- Maximum Demand Calculations
- Power Supply Sizing (Feeder CB / Transformer / Generator)
- Feasibility Assessment for Existing Supply Connection

Tender Submission

- Review of EICC Scope in FDS and Basis of Design
- Rationale for Proposed Design
- Proposed Equipment List
- Proposed High-Level I/O Summary
- Proposed Indicative Cable Schedule
- Proposed Field Layout and Conduit Routing

30% Design Review Stage

- Developed Basis of Design Report
- Updated Electrical SLD
- Updated P&ID
- Updated Switchroom Layout
- Updated Switchboard General Arrangement
- Updated Communication Network Architecture
- Updated Power Supply Sizing

Engineering Reports at 30% Design Review:

For basic engineering calculations—such as Maximum Demand, Cable Sizing & Voltage Drop, use Power CAD to generate the relevant engineering reports.

For all other complex engineering assessments, including Arc Flash Studies, the preferred software is SKM Power Tools.

The report shall include, but is not limited to, the following:

- Maximum Demand Report - Establishes site load requirements for service sizing, transformers, switchboards, and feeders.
- Cable Sizing & Voltage Drop Report - Confirms conductor size for current carrying capacity, derating, and voltage drop, fault loop
- Load Flow Report - Calculates voltage profiles, feeder loading, power factor, and system losses.
- Short-Circuit / Fault Level Report - Determines prospective fault current at each board to size switchgear and check fault withstand ratings.
- Protection / Discrimination Study - Verifies protective devices coordinate and clear faults selectively.
- Arc Flash Hazard Report - Assesses incident energy and defines PPE & labels.
- Harmonic Analysis Report – Harmonic mitigation, PF correction, AHF sizing

Table 5: Engineering Reports

Report / Study	AS/NZS 3000 Relevance
Maximum Demand	Clause 2.2
Short-Circuit / Fault Level	Clause 2.5
Protection / Discrimination	Clause 2.5
Load Flow / Voltage Drop	Clause 3.6
Cable Sizing / Compliance	Clause 3.4 3.6, 3.9, 5.7
Arc Flash Hazard Report	IEEE1584 + AS/NZS 4836
Harmonic Analysis Report	AS/NZS 61000

<u>**60% & 90% Design Review (Detailed Design Submission)**</u>

Drawings and Diagrams

- Detailed SLDs (Plant-wide, Switchboard, DB, MCC)
- Detailed Switchroom Layout
- Detailed Switchboard General Arrangement
- Detailed Communication Network Architecture
- MCC GAs, SLDs, Multi-line & Schematics
- Motor Starter Schematics (DOL, Soft Starter, VSD)
- Electrical & Instrumentation Layouts
- Lighting & Power Layouts incl. Luminaire & Emergency Lighting
- Cable Schedules & Routing Drawings

- Instrument Loop Diagrams
- Ethernet/Network Topologies & Connection Diagrams
- UPS & 24V DC Distribution
- Earthing & Lightning Protection System Design
- Circuit Schedule Report
- Control Philosophy
- I/O List
- Finalised Equipment & Instrument Datasheets
- PLC I/O Wiring & Cabinet Layouts
- Details of foundations, plinths, chases, ducts, pits and penetrations through structure
- Final Basis of Design Report

Switchboard Shop Drawings

- Shop Drawings per Section 5: Low-Voltage Switchgear and Controlgear Assemblies

Control and Communications

- Control Architecture & Communications Layout to SEW Frankston Server
- Instrumentation & Equipment Schedules
- I/O Lists and Cabling
- Equipment Specification Sheets & Manufacturer Data Sheets

Site Security and Monitoring

- Site Camera Layout
- Individual Camera Connection Diagrams (Fibre Media Converters, PoE, Digital I/O)

Hazardous Area

- Hazardous Area Classification Drawings
- Compliance with AS/NZS 60079 Series

Machinery Safety

- Safety Device Selection Report (AS 4024 – Safeguarding of Machinery)

HAZOP & Safety in Design (SiD)

- All above deliverables completed prior to HAZOP and SiD workshops
- Ready for Issue for Construction (IFC) Drawings

2.3.3 Timing for Submissions

- Make submissions in a timely manner, to suit the construction program. Allow time for review and possible amendment and re-submission. Avoid delays by making early and adequate submissions.
- Give notice before commencing work affected by contractor’s submissions, unless the submissions have been reviewed with no exception taken.

- Where HOLD POINTs are specified, do not commence work affected by contractor's submissions until the submissions have been reviewed with no exception taken.

2.3.4 Technical Acceptance and Approval

For all Electrical, Instrumentation, Controls and Communications (EICC) disciplines, final technical acceptance/ endorsement must be obtained from South East Water (SEW) prior to construction release.

All design reviews, Technical Requests for Information (RFIs), and dispensations shall be formally directed to:

- The Engineering Team, through to the Principal Electrical Engineer, and
- The Asset Integration Team, through to the Senior Electrical Technical Officer, acting jointly for both treatment plant and network projects.

No EICC design element shall be deemed approved for construction until written technical acceptance has been issued by both parties.

Note: The designer remains fully responsible for the completeness and compliance of the design with the contract specifications and all relevant standards. The absence of comments from South East Water does not constitute approval of any non-compliant equipment, undocumented assumption, or deviation from specification.

2.4 Materials, Equipment and Components

2.4.1 Design Life

Table 6: Design Life

Equipment Type	Minimum Design Life (Years)
Electrical equipment	25 years for electrical distribution & cable trays 25 years for switchboards, motor control centres (MCC) and process control centres (PCC) 15 years for electric motors
Instrumentation	15 years for Flow, Level, Pressure, Temperature, Position, Analytical (excluding consumable parts)
Controls & communications Equipment (i.e. SCADA /PLC	15 years

For assets incorporating embedded software, firmware, or relying on digital platforms, the design life must account for both physical durability and the technology lifecycle. This includes considerations such as:

- End of vendor support or availability of security patches for the product
- Obsolescence of required software, communication protocols, or hardware interfaces

2.4.2 Quality

All electrical components and materials shall be selected and installed to ensure reliable and satisfactory operation in which safety is the first consideration, and to facilitate inspection, cleaning and repairs. Materials shall be new, of the best quality and class and shall withstand the variations of temperature and atmospheric conditions without distortion or without affecting the strength and suitability of the various parts for which they must perform. No electrical equipment shall be exposed to direct sunlight. Quality of the equipment shall be:

- Designed for 24/7 operation
- Comply with recognised industrial standard (e.g. IEC, ISO, AS/NZS) and carry relevant certifications
- Enclosures, cabling and components meet or exceed minimum IP/NEMA ratings, including corrosion and vermin resistance
- Use industrial grade materials (e.g. metal housings, industrial connectors) suited for our operating environment

2.4.3 Selection of equipment

Equipment shall be selected from established manufacturers regularly engaged in the manufacture of such equipment, who issue comprehensive rating data and certified test data on their products. Materials and associated peripherals such as conduits, trays, brackets among others shall be selected to withstand harsh environments such as but not limited to corrosive, ultraviolet and temperature. Equipment manufacturers' management system may be audited as required.

To maintain standards between sites, the preferred South East Water equipment schedule shall be followed as per AM2848 – Approved EIC Equipment List. If alternative equipment is proposed the contractor shall provide supporting documentation indicating equipment is of equal or better quality.

Not all approved products may necessarily be appropriate in all installations. It is the designer's responsibility to assess the approved product to validate that it is suitable, and where it is not, propose an alternative product.

Commercial-Off-the-Shelf (COTS) products shall be used wherever possible. No open source or custom-built components may be used without specific approval from the South East Water.

2.4.4 Access to Equipment

The arrangement of equipment and cable support systems shall permit safe and reasonable access to components for installation, addition, isolation, inspection, maintenance and replacement. Equipment shall be accessible from a standing position, otherwise a permanent structure shall be provided to provide safe access.

2.4.5 Non-Standard Control Equipment

Control Equipment not designated in AM2848 – Approved EIC Equipment List requires South East Water approval.

If non-standard equipment such as an embedded PLC in a process skid is supplied by the Contractor, all configuration software, programming cables and any other non-standard items are to be supplied as part of the works. This includes spares as specified in this document.

If a local HMI is supplied as part of the skid package it shall be as per AM2848 – Approved EIC Equipment List, configured as described in the relevant Monitoring and Control standard.

2.4.6 Principal Supplied Equipment

Certain items of equipment may be supplied by SEW. These are generally IT hardware and communications devices which will be provided in accordance with project documentation.

2.4.7 Rating

Equipment shall be selected to conform to the designed rated voltage, load current, prospective fault current level, insulation class, ingress protection (IP), duty cycle, electromagnetic compatibility and hazardous area classification (if applicable).

2.4.8 Electromagnetic Compatibility

Equipment with nonlinear voltage/current characteristics that generate harmonic disturbances, radio frequency interference or rapid fluctuations of the power supply shall be selected and appropriately installed to meet acceptable levels as outlines by AS/NZS 61000 (parts of) Electromagnetic compatibility (EMC) and the Essential Services Commission Electricity Distribution Code.

2.4.9 Consistency

For the whole quantity of each material or product use the same manufacturer or source and provide consistent type, size, quality and appearance.

Do not provide without approval products that are obsolete, discontinued or about to be discontinued.

2.4.10 Efficiency

Give due regard to equipment selections and system design to minimise energy usage, operating and maintenance costs.

2.4.11 Noise

Select and install plant and equipment and provide acoustic control measures so that the noise levels arising from simultaneous operation of all services do not exceed the maximum sound levels requirements regarding noise to the external environment emanating from plant. Refer AM2758_Noise Specification for requirements.

2.4.12 Special Tools

Supply special tools necessary to dismantle equipment requiring periodic maintenance or replacement. The tools shall not be used for the erection of equipment during construction.

Equipment requiring configuration or setup using a proprietary hand-held device or PC connection shall be supplied with either or a hand-held unit, configuration software, leads, convertors and connections. The number of configurator units / peripherals shall be one per each installed piece of equipment with a maximum of two per equipment type.

Example, supply 2 sets of infrared hand-held configurators when three electric valve actuators are installed

2.5 After Diversity Maximum Demand (ADMD)

2.5.1 Maximum Demand in Consumer Mains and Submains

In accordance with AS/NZS 3000 Clause 2.2.2, maximum demand shall be determined by one of the following methods:

- Calculation
- Assessment
- Limitation
- Measurement (most accurate)

Guidance:

- For greenfield sites, the calculation or assessment method is generally appropriate.
    - For simple installations, such as SPS or water pump stations with up to three connected (Duty/ Assist) motors, the calculation method is preferred.
    - For larger or more complex installations involving multiple processes, assessment methods should be applied to accurately determine the ADMD.
- For brownfield sites, ADMD values must be validated using Supply Authority data and solar feed-in information, or by logging from a data logger.

2.5.2 Calculation Method (Motor Loads)

When using the calculation method:

- For motor loads, the default approach from AS/NZS 3000 Appendix C, Table C2 (Columns 2 and 3) shall apply to non-domestic installations.
- This method requires the following assumptions:
    - Largest motor 100%, Next largest motor 75%, Remaining motors = 50%
    - Standby motors (interlocked) = 0%

Table 7: Recommended DF for calculation method

Installed Emergency, Duty, Assist Motors	Diversity Factor
1	100%
2	88%
3	75%
4-5	65%
5 or more	56%

2.5.3 Assessment Method (Motor Loads)

This approach is generally more accurate than the calculation method, as it accounts for operational duty cycles (e.g., duty, assist, standby), and load utilisation.

The assessment method may be used where:

- Equipment operates under fluctuating or intermittent loading, or a defined duty cycle.
- The installation is large or complex.
- Special occupancy types exist.

Utilisation Factor

- In practice, motors seldom operate at their full load or Non-Overload (NOL) power rating.
- Under normal operating conditions, depending on the duty point, the actual shaft power typically utilised is in the range of **75%–85%** of the motor's nominal nameplate rating.
- A utilisation factor shall therefore be applied to reflect realistic operating conditions.

Diversity Factor

- In large or complex Motor Control Centres (MCCs), not all duty or assist pumps operate simultaneously, as operation depends on process requirements.
- Accordingly, the duty/assist diversity factor may range from **75%–100%**.

Application of Utilisation and Diversity Factors for consumer mains supply

- Wherever practicable, the utilisation and diversity factors recommended by the Original Equipment Manufacturer (OEM) shall be applied to each installed motor when calculating the After Diversity Maximum Demand (ADMD) under the Assessment Method.
- The combined multiplier of the utilisation and diversity factors shall not be less than **56%** (e.g., 0.75 × 0.75 = 0.5625 ≈ 56%), and where unsure use the highest factors.

Table 8: Recommended Diversity and Utilisation Factors for each installed motor

Role	Diversity Factor	Utilisation Factor
Emergency	1.0	1.0
Duty	0.75 - 1.0	0.75 - 0.85
Assist	0.75 - 1.0	0.75 - 0.85
Standby	0.0	0.0

2.6 Discrimination requirements

2.6.1 General

Discrimination between upstream, downstream, or inline protection devices shall comply with *AS/NZS 3000 Clause 2.5.7 – Reliability of Supply* or be demonstrated through a formal protection and discrimination study.

2.6.2 Phase Failure Replay Tapping Point

Where the phase failure signal is tapped between Q1 (upstream main protection device) and Q3 (downstream protection/ATS breaker or changeover), discrimination between Q1 and Q3 shall either:

- Comply with *AS/NZS 3000 Clause 2.5.7 – Reliability of Supply*, or
- Be verified by a formal discrimination study using electronic OCRs.

If discrimination cannot be achieved, the Q1 main breaker trip position shall be interlocked with the Q3 changeover switch. This interlocking shall prevent the PFRN from misinterpreting a genuine Q1 trip as a supply outage, thereby avoiding unnecessary generator starts and incorrect Q3 ATS operation.

3. Installation Requirements

3.1 General

3.1.1 Engineering Workmanship

Workmanship is to be of a high standard throughout utilizing skilled electrical labor in accordance with the requirements of the Electrical Contractors and Electricians Licensing Act, or any other requirements of a Statutory Authority.

Refer to “AM 2870 Requirements for EIC Contractors”

3.1.2 Fixing Requirements

Provide all stands, cabinet fixing components, supports, brackets, plates etc. for the mounting and positioning of all electrical, instrumentation equipment and systems.

All equipment unless stated otherwise shall be installed in accordance with the manufacturer’s requirements.

Mount equipment on fixed structures. Where no fixed structure exists, supply and install an approved structure for the mounting of the equipment.

Fix all plant directly to structure in approved manner. Submit details of types of fixings, locations and loads for approval.

Fix only lightweight items to non-structural building elements.

Unless specifically stated otherwise all supports, brackets and fixings within corrosive areas shall be 316 stainless steel.

Protect all equipment and cables from weather, fire (as much as practical), UV, ingress of dirt, moisture, vandalism and tampering. Provide vandalism and tampering protection also within sites that include compound fencing. All equipment shall be arranged and installed to minimise the risk of fire and the damage which may result in the event of fire.

3.1.3 Access

Provide access to all components without the use of portable or mobile platforms unless specifically stated otherwise.

3.1.4 Asset Protection

External switchboards, switchgear, control gear, and air conditioning unit shall be protected from damage as per SEW’s Facility Security Standard AM2759. Typically, bollards and careful placement away from overhanging trees and flood prone areas is required at a minimum.

3.1.5 Building Penetrations

Seal penetrations around conduits and sleeves with cement mortar or mastic. Seal around cables within conduits and sleeves.

Limitations

Do not penetrate, or chase the following without approval:

- Structural building elements including external walls, core walls, fire walls, floor slabs, beams and columns.
- Acoustic barriers
- Other building services.
- Membrane elements including damp-proof courses, waterproofing membranes and roof coverings.

3.1.6 Metalwork

Use metalwork capable of transmitting the loads imposed, and sufficient to ensure the rigidity of the assembly without causing deflection or distortion of finished surfaces. Construct to prevent rattle and resonance.

To avoid galvanic corrosion, prevent contact between dissimilar metals, by using insulating insertion layers.

Keep edges and surfaces clean, neat and free from burrs and indentations. Remove sharp edges.

3.1.7 Bolts, nuts, washers and jointing materials

Bolts, nuts, washers and other demountable fastenings shall be appropriate material and shall remain unpainted. Isolating washers shall be fitted between dissimilar metals.

Metal coating using electro-galvanising, nickel, cadmium, chromium or other similar type of plating process shall not be acceptable in external to building applications.

Fixing into concrete shall be by chemical anchors with Grade 316 stainless steel studs.

All bolts and nuts shall have metric threads to AS 1111 and AS 1112.

3.1.8 Mechanical protection

Supply and install approved mechanical protection of all electrical equipment and in particular under the following conditions:

- all conduits for a distance of 300 mm above any floor, walkway or concrete surface.
- where subject to damage during plant operation and maintenance.
- on which scaffolding and/or planks may be placed, or which may be used as means of access for abnormal plant maintenance.

Sheet metal covers installed to provide mechanical protection of electrical equipment shall be constructed to withstand the shock loading likely to occur in the area. Covers shall be constructed of material suitable to the environment as per AM2739 Corrosion Mitigation Specification.

3.1.9 Degree of Protection

Table 9: Degree of Protection

Situation	Required Minimum IP Rating
Indoor assemblies isolated or separated by more than 5m from pressure pipe	IP54

Situation	Required Minimum IP Rating
Indoor assemblies in line of site and within 5m of pressure pipework	IP56
Exterior assemblies, outer surfaces	IP56
Exterior assemblies, inner surfaces (escutcheon)	IP41

Note: All seams shall be fully welded.

3.2 Switchroom Building

Standalone permanent switch rooms must be considered as Class 8 buildings with type 'C' construction designed in accordance with the NCC and all relevant Australian Standards. All switchrooms in this document refer to low voltage switchrooms.

3.2.1 Flood Risk

- The switchroom must be located outside designated flood-prone areas, the finished floor level (FFL) must be set at least 300 mm above the 1% AEP (1-in-100-year) flood level based on local council or Melbourne Water flood mapping.
- The base of the power and control cubicle, electrical turrets and the top of electrical pits shall be at least 300 mm above the 1% AEP flood level.
- Designs must comply with NCC Volume One Clause E1D6, AS/NZS 3000:2018, and relevant Victorian floodplain management guidelines.
- Designers must provide evidence of flood levels and FFL compliance in the design documentation.

3.2.2 Fire resistance

- Switchrooms must comply with the fire resistance level (FRL) requirements outlined in the National Construction Code (NCC). Any penetrations through external walls—such as for conduits, cable trays, ducts, or trenches—must be appropriately sealed to maintain the fire rating and ensure water tightness.
- The switchroom structure should be designed to sustain equipment operation for the maximum practical duration during a fire event. Where the function or criticality of the electrical equipment is high, a higher FRL may be required.
- If any external wall is located within 3 metres of a fire source, louvres must not be installed on that wall unless fitted with fire-rated dampers. Similarly, any door located in a fire-rated wall must be certified and rated to the same FRL as the wall.
- Switchrooms in bushfire-prone areas must comply with the latest version of AS 3959 (Construction of buildings in bushfire-prone areas). Additional bushfire resilience measures must be applied for critical sites, with all fire protection provisions to be confirmed with SEW during the design phase.
- Fire extinguishers suitable for use on electrical fires must be installed in all switchrooms, as determined by a site-specific risk assessment. This assessment must be conducted in consultation with SEW operations staff. Where fire extinguishers are not present and works are to be carried out, temporary extinguishers must be made available for the duration of the works.

- Fire Extinguishers shall be as per AS 2444: “Portable Fire Extinguishers and Fire Blankets – Selection and Location.”
- A fire extinguisher shall be installed at a distance between 2 m and 20 m from any significant switchboard. A 5 kg carbon dioxide extinguisher, or an alternative extinguisher with a minimum classification of 1A: E and equipped with a hose, shall be provided and positioned closest to the switchboard.

3.2.3 Doors

The minimum requirements for switchroom doors shall comply with AS/NZS 3000, Clause 2.10.2 – Location of Switchboards.

All doors shall:

- Swing outward and be lockable externally only.
- Always remain operable from the inside, regardless of the external locking mechanism.
- Panic bars to facilitate emergency egress, operable without a key inside.
- Self-closing with a spring loading, unless latched to stay open.
- Be fully sealed with weatherproof and dustproof strips on all edges (top, bottom, and frame) to prevent water and dust ingress.
- Conform to the NCC code
- Door must be lockable from the outside using the approved SEW Corporate key.
- Doors must have the provision to be locked and monitored in the SCADA access.

For treatment plant switchrooms, a minimum of two exit doors shall be provided, with the following configuration:

- One double door with a minimum clear opening of 2000 mm (W) × 2500 mm (H), to allow safe and efficient movement of equipment.
- One single personnel access door with a minimum clear opening of 900 mm (W) × 2200 mm (H).

3.2.4 Walls & Floor

Flooring Requirements:

- Anti-Slip:
  Minimum slip resistance rating shall be suitable for both dry and potentially wet conditions to ensure safe access and egress.
- Anti-Static:
  Flooring materials shall be static-dissipative or conductive to minimize electrostatic discharge (ESD) risks to sensitive electrical equipment. Compliance shall be demonstrated against recognized ESD flooring standards (e.g., IEC 61340 series) or equivalent industry guidelines.
- Durability and Maintenance:

  Flooring shall be resistant to wear, chemicals, and moisture, and maintain its anti-slip and anti-static properties throughout its service life. All switchroom, pump room, and building floors shall be sealed with battleship grey floor paint to reduce dust accumulation.

False Flooring and Cable Routing: The new treatment plant switchroom building shall be fitted with false flooring, with cable entries routed from the underside of the switchboard.

Wall and Colour Requirements: Switchroom building walls shall be coloured grey or match the existing building colour scheme.

Switchroom Layout:

- The layout shall allow any individual switchboard to be removed and reinstated without disturbing other switchboards or fixed equipment.

Separation of Equipment:

- Where pump sets and pipework are located in the same room as switchboards, the switchboards shall be separated by internal walls.
- If the building element is weatherproof, acoustic-rated, or pressure-rated, these ratings shall be maintained.

Penetrations and Acoustic Sealing:

- All penetrations through plant room walls and floors shall be acoustically sealed and painted to maintain integrity and reduce noise transmission.

3.2.5 Thermal Insulation and Condensation Management

Electrical switchrooms in Class 8 buildings that are mechanically ventilated or air-conditioned shall incorporate thermal insulation in accordance with the National Construction Code (NCC) Volume One – Section J and AS/NZS 4859.1. Insulation must form a continuous thermal barrier across the building envelope to minimise heat transfer and manage condensation risk. Design must ensure insulation does not interfere with electrical equipment or compromise ventilation and safety clearances.

3.2.6 Emergency Lights

In all buildings, emergency lighting shall be designed and installed in accordance with AS 2293 Emergency escape lighting and exit signs. Emergency exit signs with minimum 100 mm high lettering shall be fitted above exit doors. Exit and emergency lighting is to be 'non-maintained' type with battery backup supply, such that is not illuminated until such times as normal power supply is lost. They shall be tested using proprietary brand test station as per AS 2293.3. Size of backup battery shall be sufficient for operation of 90 minutes in service and 120 minutes during initial commissioning.

Emergency luminaires shall be supplied and installed in all rooms, corridors and galleries to provide sufficient lighting evacuation of personnel in case of power blackout.

3.2.7 Amenities

A water supply and toilet facilities shall be provided to the building or switchroom structure, as applicable

3.2.8 Building Permit

Switchroom building layouts shall only be developed after switchboard general arrangements have been designed and approved by SEW, and the approved switchroom building layouts shall form the basis of the building permit application.

3.3 Location of Switchboard

As per AS/NZS 3000, *"Clause 2.10.2 Location of switchboards",* Switchboards" shall be—

- installed in suitable well-ventilated places; and
- protected against the effects of moisture to which they may be exposed; and

arranged to provide sufficient space for the initial installation and later replacement of individual items of the control and protective devices and accessibility for operation, testing, inspection, maintenance and repair.

3.3.1 Switchrooms

Unless otherwise specified in project-specific requirements,

- **Treatment Plant Sites:** All switchboards shall be installed within purposely built switchroom buildings where such buildings are part of the facility infrastructure (e.g., treatment plants or network site). At treatment plants, all switchboards must be located within dedicated switchrooms.
- **Network Sites:** for network sites, switchboards with a supply rating above 250 A, must be housed within purpose-built switchrooms.

3.3.2 Alternative to Switchrooms

Alternatively, if approved by SEW, external switchboards shall be supplied with carport style roofs that extend 2m past the front of the board and 1m past the sides and rear of the switchboard. These carport roofs shall have colour bond roofing and guttering to match the switchboard colour, with downpipes located to direct stormwater away from work areas. Lighting shall be provided to illuminate the switchboard and the area surrounding the carport style roof.

Wherever practicable, external switchboards located in full sun shall be aligned north/south to minimise the effect of the sun with heat sensitive equipment located at the south end of the switchboard. Where not practicable, east/west aligned switchboards shall arrange heat sensitive equipment at the east end.

3.3.3 Clearance and Accessibility around Switchboards

In addition to the minimum clearance and accessibility requirements stated in AS/NZS 3000 *Clause 2.10.2.2 Accessibility and emergency exit facilities",* following shall apply for the clearance around existing, planned, or future switchboards.

- General: Switchboard installations shall provide adequate exit paths to enable safe evacuation under emergency conditions and safe access for maintenance and operational purposes.
- For switchboards rated 800 A or greater per phase, or exceeding 3.0 m in length, means of escape shall be provided in more than one direction with exit paths spaced well apart.
- Existing switchrooms: Only for switchboards rated 800 A or greater per phase, or exceeding 3.0 m in length:
    - An unimpeded clearance of 1.2 m shall be maintained around the switchboard with all switchgear doors fully open and withdrawable units fully racked out.

- Where boards face each other, a minimum clearance of 1.2 m shall be maintained between doors in the fully open position.
- New: For all new switchboards installed in new switchrooms or external, regardless of current rating or length:
  - An unimpeded clearance of 1.2 m shall be maintained around the switchboard with all switchgear doors fully open and withdrawable units fully racked out.
  - Where boards face each other, a minimum clearance of 1.2 m shall be maintained between doors in the fully open position.

3.3.4 Restricted locations

In addition to the *AS3000 Clause 2.10.2.5 "Restricted locations",* following restrictions applies.

- No double storey switch rooms are allowed
- Switchrooms shall not be built on top of the Wet wells and adjacent from the direct corrosive environment.

3.3.5 Switchroom Layouts and Spare Space

Requirements

When constructing a new switchroom, sufficient spare capacity and space shall be provided to accommodate future switchgear and instrumentation. This ensures flexibility for minor upgrades and expansions without requiring major modifications.

- A minimum of 30% usable floor space in the switchroom plan layout shall be reserved for future expansion.
- The 30% spare space calculation shall exclude:
  - Minimum unimpeded clearance in front of existing, planned, or future switchboards.
  - Door swing clearance.
- In all layout drawings, the 30% spare space footprint for future switchboards shall be clearly marked and dimensioned.

Example Calculation – Switchroom Size

- For calculation purposes, assume:
  - ~ 1.0 m envelope for switchboard depth, and equipment on opposite wall
  - Variable switchboard width to suit the available wall space.
  - ~ 0.9 m envelope for door swing.
- Planned switchboard floor area: SB + Comms + AHF + VSDs + Equipment = (5.35 m x 2) × 1.0 m = 10.7 m²
- Future usable 30% spare space: 10.7 m² × 30% = 3.21 m²
- Total switchroom space required 10.7 m² × 130% = ~14 m²

- Equivalent future spare switchboard length (at 1.0 m depth): 3.21 m² ÷ 1.0 m = 3.21 m or ~1.6m each side

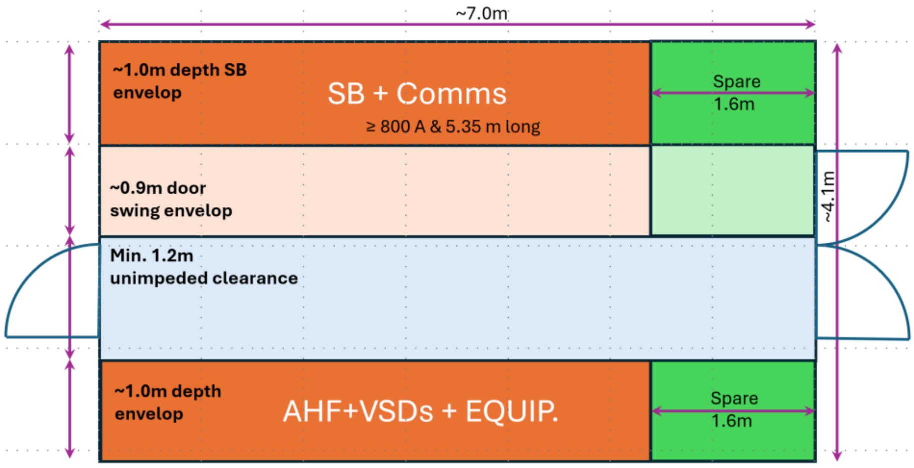


Figure 1: Switchroom Layout

The electrical switchroom shall have a minimum internal width of 4.0 m, with the length determined by the total space required for the switchboard, associated equipment, and future spare capacity.

3.4 Spares for Installations

Where an upgrade is required, existing spare capacity of the rear gear tray may be used. Full access to existing equipment shall be maintained and the side walls of control compartments shall not be used to mount new equipment.

Where there is inadequate spare rear gear plate to install new equipment, new switchboard compartment(s) shall be provided for the new equipment.

All spare quantities nominated below are minimums.

Table 10: Spares

Item	Requirement
Power Supply & Distribution:	
Main Switchboard / Main Distribution Board	Main switchboard (MSB) or Main Distribution Board (MDB) shall include a provisional spare incomer reserved for a third alternative source (e.g., Solar), in addition to the Normal Supply Incomer, an Alternative Supply Incomer.
Distribution boards (MCCs)	25% spare capacity for each switch board tier and equivalent for the largest tier. *See example below*
Spare Ampacity	25% space current capacity to be allowed when calculating ADMD (After Diversity Maximum Demand)
Switchroom	30% spare usable floor space not including walk areas.
Distribution boards	50% spare poles
Ducts and cableways	50% spare volume

Item	Requirement
Conduits	One additional spare conduit of maximum allowable diameter shall be provided whenever a trench is excavated
RTU / PLC and IO	
Control compartment	50% spare gear tray area. This is the space required for future IO terminals, PLC / RTU racks and relays etc.
IO Installed	25% spare IO for each type of IO used (i.e.: DI, DO, AI, AO) including at least one spare point per analogue card
PLC Racks	One spare rack per control system for treatment plant fitted and one spare rack area for Networks
Spare Slots per Rack	3 spare slots per rack shall be provided as spare for treatment plant and 1 spare slot for Networks. Space for spare slots shall have a suitable blank placed into the rack that is compatible with the IO type installed. For treatment plant installations, Rack 0 shall be fully populated first, with any remaining spare capacity distributed across the subsequent racks. Rack 0 is the only hot-swappable rack, and prioritizing its use provides enhanced flexibility for field operations and maintenance.
Terminal strips and spare IO	All spare (unused) IO points in PLC/RTU cards to be wired and ferruled to terminal strips. All PLC connections shall be terminated in both ends including spares. Cable shall be multi-cored.
Terminal strips for future IO	Provision should be provided for the installation of terminal strips for all future IO cards based on the number of spare slots available in installed IO racks and the maximum density card available for the installed IO type.
Communications	
Fibre Cores	Number of fibre cores shall be 12 cores per fibre type (i.e. for both fibre types of Single-Mode and Multi-Mode)
Spare Fibre Cores	50% spare fibre cores or spare conduit capacity. Spare cores shall be spliced/terminated.
Subnet & Programming Ports	1 port per switch on the network shall be allocated for programming use [Note: Switches shall be preconfigured by BTS – check if existing in other document]
Spare Network Switch Ports	25% spare ports per switch (Total ports used includes ports allocated for programming)

3.4.1 Spare Space for Switchboards

Requirements

When designing switchboards, spare compartment capacity shall be provided to allow for future expansion of MCC (Motor Control Centre) modules.

- A minimum of 25% usable spare compartment in the switchboard

Calculation Scenario

- Switchboard total height: 2.0 m
- MCC module compartment width: 0.6 m
- MCC module heights: 200 mm, 400 mm, 600 mm, arranged in multiple tiers

Example Calculation – Switchboard/MCC Spare Space

- Switchboard MCC total height: 2000 mm
- MCC module width: 600 mm
- Total planned module heights: 0.4 + 0.4 + 0.4 + 0.2 + 0.6 + 0.4 + 0.4 + 0.2 + 0.2 = 3.2 m
- Spare module allowance (25% of planned total): 3.2 m × 25% = 0.8 m
- Spare space may be configured as: 0.4 m + 0.4 m (two compartments), or 0.6 m + 0.2 m (one large + one small compartment), depending on future requirements.

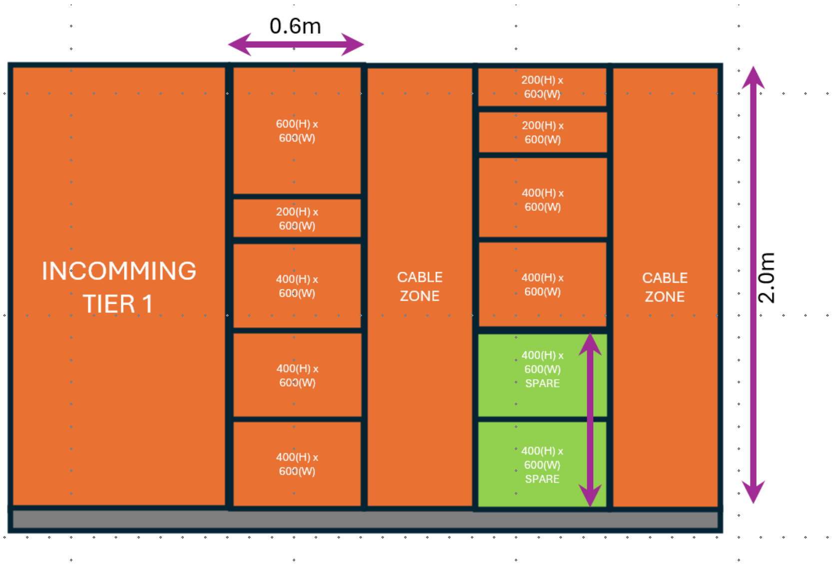


Figure 2: Switchboard Layout for spares

3.4.2 Spare Space for Control compartment

Requirements

When designing control compartments, 50% of the spare gear tray area is required.

Required capacity shall be calculated as follows:

1) Establish the requirements for the current project
2) Estimate the requirements for planned or proposed future work, assuming all spare capacity from the current project would by then be **un**available.
3) Add the required allotment of spare capacity based on the combined requirement for 1) and 2).

Example Calculation

0.3m^2 is required for the control compartment gear tray in this project and future proposed upgrade is estimated to require an additional 0.15m^2, then the control compartment gear tray area A should be: A = 1.5 x (0.3 + 0.15) = 0.675m^2.

3.4.3 Spares and Tools Storage

Spare parts shall be provided as per AM2848 Approved EIC Equipment List.

Minimum one (1) spare requirement shall be provided if the item.

- will not be available in one (1) business day.
- does not appear in SEW store and treatment plant list.
- can only be provided by a single vendor.
- is critical to the operations (to be defined by relevant SEW stakeholders)

To store spares, provide one of the following storage facilities in the given order of preference:

- locate within existing spares shelving where there is adequate unallocated space, or;
- locate within new additional shelving located adjacent existing spares shelving, or;
- Locate within new shelving where there is adequate space in an indoor utility area within the facility, or;
- build a new shelving area if there is no adequate space.

Spares shelving shall be:

- located indoors, on shelving rated for the loads
- Electrical, control and instruments shall be stored in a dust proof and controlled environment facility.
- PLC and RTU cards shall be sealed in their original packaging.
- Place special tools (e.g., racking handles) in one partitioned area and spares in another section
- have all spares stored on shelves or within bins which are labelled with the contents
- be accessible by trolley through doors > 1.5m wide.
- All identified spares should be appropriately tagged with details entered in the Maximo asset management system.
- Spares storage facilities should be fitted with CCTV, door monitoring and keyed locks.

Large spares not sensitive to dust or water may be located on undercover racks on approval of South East Water. Racks shall be located at ground level unless a folk lift is available, can safely access the racking and multilevel racking is already located on site.

3.5 Switchgear and Equipment Support Structure

3.5.1 Supporting Structure

Provide concealed fixings or brackets to allow assemblies to be mounted and fixed in position without removing equipment.

3.5.2 Wall-mounting

Reinforce at bolt holes. For flush or semi-flush assemblies, provide angle trims of the same material and finish as the enclosure.

3.5.3 Floor-mounting

Provide mild steel channel plinth, galvanized, nominal 75 mm high x 40 mm wide x 6 mm thick, complete with fixing tabs to enable vertical drilling. Drill M12 clearance holes in assembly and channel and bolt assemblies to channel. Bolt channels to structural floor. Provide shimming for levelling. Backfill air gaps with epoxy.

3.5.4 Mounting

Floor mounted: Assemblies generally.

Wall mounted: Front access assemblies with frontal areas <1m^2 where space permits.

3.5.5 Hard stand Area

Provide a concrete hard stand area in front of all external switchboards. Similarly provide a concrete hard stand areas for cubicles and equipment where maintenance activities are performed e.g. control cubicles, instruments, analysers, security panels, solar invertors and alike.

The hard stand area dimension shall be as follows.

- Width - full width of a switchboard /cubicle.
- Length – front of switchboard / cubicle plus 600mm from an open-door swing radius.
- Minimum width and length of 900mm x 900mm.

3.5.6 Clearance

Switchgear and associated equipment shall be installed on walls or adjacent to each other, ensuring compliance with the manufacturer’s clearance requirements and adequate ventilation.

3.6 HVAC

3.6.1 General Requirements

HVAC systems are required in Electrical Switchrooms, server room, control rooms, network/control rooms across Network and Treatment Plant site.

- HVAC systems shall be reverse cycle, providing both heating and cooling.
- Temperature and humidity sensors, running or failed signals shall be installed and wired back to site SCADA systems for continuous monitoring and alarming.

3.6.2 Positive Air Pressure

- Positive pressurisation with filtered air is required for any switchrooms located in the areas classified as “Hazardous Areas” as per AS/NZS 60079 series.

3.6.3 System Configuration

- Split-type or ducted HVAC systems are to be used depending on room size and configuration.
- Minimum of two identical HVAC units each sized to 100% of the required mechanical load, operating as (Duty / Standby) per room shall be installed to provide redundancy and reliability. HVAC design to provide for N+1 redundancy with automatic duty changeover across all units.
- By default, the system shall operate in automatic cooling mode year-round, maintaining a room temperature of 23 °C ±2 °C during summer, while remaining inactive in winter.
- On demand, when operators visit the switchrooms, the system shall be capable of being manually switched to heating mode during winter to maintain a room temperature of 23 °C ±2 °C. If the operator forgets to return the unit to its default automatic cooling mode, a daily timer function shall automatically reset the system back to default automatic cooling mode.

3.6.4 Design Conditions

- The HVAC system shall be designed to maintain a maximum indoor temperature of 23°C ±2°C under the worst-case summer outdoor ambient conditions (typically up to 45°C depending on site location).
- Humidity control is not essential unless specified; however, recommended to keep below 60% RH to prevent condensation and corrosion.
- Equipment must be selected with adequate temperature derating if ambient exceeds equipment thresholds.

3.6.5 Installation Requirements

- No indoor HVAC units are to be mounted directly above switchboards or critical electrical infrastructure.
- All condensate drains must be plumbed to the site-approved point of discharge using appropriately graded and trapped piping.
- Outdoor units must:
    - Be installed on and bolted to a level concrete pad (elevated 100mm from FL) or securely wall mounted.
    - Provide a dedicated concrete pad with a minimum 600 mm clearance on all sides for maintenance access.
    - The pad should, at a minimum, match the footprint of the unit.
    - Place rubber vibration pads between the HVAC unit's feet and the concrete pad
- Indoor units shall be installed with clearance around all sides to allow for maintenance, coil cleaning, and full unit removal without obstruction.
- Maintenance access to all HVAC components (indoor and outdoor) shall be unobstructed and safely accessible from ground level or permanent platforms.
- For network sites, the outdoor condensing unit must be housed within a lockable galvanised security cage to prevent vandalism or theft.

3.6.6 Component & Technology Preferences

- Units shall use inverter technology compressors for energy efficiency and capacity modulation.
- Refrigerants shall comply with environmental regulations (e.g. R-32 preferred for low GWP).
- All materials and finishes shall be suitable for corrosive environments, especially near coastal or wastewater processing areas.

3.6.7 WTP-Specific Requirements

- At Water Treatment Plants (WTPs), use industrial-grade HVAC systems suitable for continuous operation and suitable H2S Hydrogen Sulfite filtration.

3.6.8 Air Conditioning Load Calculation

The designer shall undertake a HVAC system capacity (kW) calculation based on parameters such as:

- Maximum outdoor ambient temperature (site-specific, e.g. 45°C)
- Desired indoor temperature (23°C ±2°)
- Internal heat load from:
  - Electrical equipment (i.e. VSDs) and switchboards
  - Lighting and occupancy (if applicable)
- Solar gain (if windows present)
- Ventilation or air leakage (if any)
- Safety factor (typically 10–15%)

3.7 Electrical Equipment in Hazardous Areas (EEHA)

3.7.1 General Requirements

All electrical installations within hazardous areas shall comply with EEHA requirements in accordance with the AS/NZS 60079 series, AS/NZS 4761 competency standards, and relevant regulatory obligations.

3.7.2 Hazardous Area

- A Hazardous Area (HA) is any location where flammable gases, vapours, dusts, fibres, or combustible materials may be present in quantities that could form an explosive atmosphere.
- Common in: wastewater plants (H_2S, CH_4), fuel depots, chemical plants, flour mills, silos, battery rooms.
- Defined in terms of likelihood and duration of the hazardous atmosphere.

3.7.3 Classification of Hazardous Areas

Gas/Vapour Environments (AS/NZS 60079.10.1)

- Zone 0: Explosive gas atmosphere present continuously or for long periods (e.g., inside a fuel tank).
- Zone 1: Likely to occur occasionally in normal operation (e.g., around pump seals, wet wells in sewage plants).
- Zone 2: Unlikely in normal operation, but if it occurs it is infrequent and short duration (e.g., around vent pipes).

Dust Environments (AS/NZS 60079.10.2)

- Zone 20: Combustible dust present continuously or for long periods.
- Zone 21: Likely to occur occasionally in normal operation.
- Zone 22: Unlikely, and if it occurs, it is infrequent/short duration.

3.7.4 Standards Governing Hazardous Area Equipment

Table 11: Key Australian (and harmonised IEC) standards

Standard	Document title
AS/NZS 60079 series	Explosive atmospheres (general, electrical equipment, testing)
AS/NZS 4761	Competencies for working with electrical equipment in hazardous areas.
IECEx Certification Scheme	International equipment approval for use in HAs

3.7.5 Electrical Equipment Requirements

- **Must be certified Ex-rated** for the relevant Zone, Gas Group, and Temperature Class.
- **Protection Techniques** (per IEC 60079):
  - *Ex d*: Flameproof
  - *Ex e*: Increased safety
  - *Ex i*: Intrinsic safety (common in instrumentation)
  - *Ex n*: Non-sparking
  - *Ex p*: Pressurisation/purging
  - *Ex t*: Dust protection (enclosures)
- **Marking Example**: Ex d IIB T4 Gb
  - **Ex d** = Flameproof
  - **IIB** = Gas Group (methane, propane, etc.)
  - **T4** = Max surface temp ≤ 135°C
  - **Gb** = Equipment protection level (high protection, Zone 1 use)

3.8 Plant Area Lighting

All work area and access lighting shall be LED type. Where practical, all lighting located greater than 3m above floor level shall be fixed to swivel poles or be accessible from access platforms.

Work area and access lighting shall conform to the requirements and recommendations of the current revisions of AS/NZS 1680, with particular attention to the following parts:

- Part 0 - Interior lighting safe movement
- Part 1 - General principles and recommendations
- Part 2.2 - Circulation spaces and other general areas
- Part 2.4 - Industrial tasks and processes
- Part 3 - Measurement, calculation and presentation of photometric data
- Part 5 - Outdoor workplace lighting

Lighting Design Requirements

The lighting design shall consider the following performance and environmental factors to ensure compliance, efficiency, and occupant comfort:

- Glare Control: Minimise direct and reflected glare to enhance visual comfort and safety.
- Illumination Uniformity: Ensure consistent light distribution across all relevant areas.
- Lamp Efficiency: Select luminaires with high energy efficiency ratings to support sustainability objectives.
- Surface Reflectivity Assumptions:
    - Ceilings: 80%
    - Walls: 50%
    - Floors: 10%
- Maintenance Factor: 0.8 — to account for light depreciation due to dust accumulation, aging, and wear over time.

All lighting designs shall comply with relevant Australian Standards and SEW internal guidelines.

Illumination levels shall be as set out in the table below and in the appropriate Australian Standards, whichever is higher:

Table 12: Lighting Lux Levels

Area	Minimum Average Maintenance Luminance (Lux)	Maximum Working Plane (m)
Control rooms	240	0.75
Switchrooms, MCC rooms, and Local Control Stations	160	0.75
Plant and Machinery	160	On drive/structure
Office	160	0.75

Inspection Area/Tasks	80	0.75
Internal Walkways	40	0
Platforms	40	0
Internal Stairs	80	0
External Stairs and Catwalks	20	0
Building Access, roadways	10	0
Building surrounding	5	0

Control room lighting shall be designed such that light images or reflections will be minimised on computer monitors. Where existing lighting installations become no longer effective due to changes in plant areas and equipment, the lighting system shall be upgraded, where necessary, to comply with the above requirements.

Emergency lighting, exit signs and warning systems, shall be provided in accordance with AS 2293 and latest Building Code of Australia regulatory requirements so as to enable safe activity around the site and allow for evacuation of persons from all plant areas in the event of power failure. This includes all switch rooms, control rooms, sub yards, walkways, access areas, office areas, loading bays, work area and outside access locations.

For treatment plants, lighting of the facility entrance and main carpark shall be controlled via a separate a 3 pole Manual-Off-Auto switch located at the main switchboard for the facility (labelled "front entrance lighting"). When switched to "Auto", this lighting shall be switched using industrial grade dual-technology PIR detectors focused on the facility entrance. The PIR detectors shall be set up so that once the lighting circuit is powered, it remains powered for 5 minutes after the motion detector(s) cease to detect motion. When in "Auto", lights shall be able to be switched on or off via the SCADA host whereby the PIR detector switching will be overridden. When switched from "Manual" to "Auto", this lighting shall stay active for at least 5 minutes to enable safe egress of workers from the facility.

Each plant area (functional area) shall have a separate lighting circuit whereby all lighting fixtures in that plant area come on or off together. Each lighting circuit shall be controlled via a 3 pole Manual-Off-Auto switch located at the local plant area electrical board. Lighting of circulation spaces (labelled "general lighting" for paths which transit between plant areas) or smaller facilities with only one plant area shall be controlled via a 3 pole Manual-Off-Auto switch located at the facility's main switchboard. When control switches for these areas are in "Auto", lights shall be able to be switched on or off by operators via the SCADA host.

3.9 Cables

3.9.1 General

This section specifies the requirements for Low Voltage (up to 1000V AC / 1500V DC) and Extra Low Voltage (up to 50V AC / 120V DC) power and control cables used in electrical installations.

Cables shall be designed, manufactured, tested, and installed in accordance with:

- AS/NZS 5000.1 (PVC insulated)
- AS/NZS 5000.2 (XLPE insulated)

- AS/NZS 1125, AS/NZS 3000, and relevant parts of AS/NZS 3808
- IEC 60228 for conductor class and sizing

Design, supply and install all cable routes and related materials, e.g., cable trays, ladders, conduits and the like necessary for the overall cabling of the plant and associated sites.

3.9.2 Conductor Material

All cable conductors shall be:

- Annealed copper, Class 2 stranded (or Class 5 flexible where specified)
- Compliant with IEC 60228
- Tinned copper for areas exposed to corrosive or marine environments (if specified)

3.9.3 Installation of Cable

Process, Power and Control Cabling in the switch room shall be neatly arranged in cable trays or ladders and shall be segregated from one another. Cables on ladder shall not exceed two layers.

Cables throughout the site shall be segregated into the following groups.

- Power – main incomer
- Power - sub mains
- Power - motor cables
- 230V control cables
- 24V dc control cables, thermistor cables etc.
- Instrumentation cables, potentiometer cables, PLC data cables etc.
- Ethernet and fibre optic cables

Where three or more conduit or cable runs are grouped together, they shall be mounted on suitable sized cable trays and ladders. Single or double runs may be fixed direct to walls, structural members and the like. Holes shall not be drilled through RSJs, channels or structural members.

Cable trays must be designed and installed such that the whole length is easily accessible via mobile platform (not via scaffolds). The maximum height shall be 2.5m (not obstructing the typical height of the switchboard of 2.0m). Cables transferring across the roads shall be run underground.

Run cables without intermediate straight-through joints unless unavoidable due to length (>300 m) or difficult installation conditions. Located cable joints suitably in stainless steel junction boxes above ground level or provide cast resin submarine type joins located with an accessible pit.

In external applications protect all cables from UV deterioration due to sunrays.

Adhesive cable tie mounts shall not be used to support cables or wiring looms.

3.9.4 Segregation of different voltage levels

Instrumentation and control (extra-low voltage, ELV) cabling shall maintain a minimum separation of 300 mm from all low voltage (LV) power cabling and shall be installed in separate containment systems.

Cables of low voltage and extra-low voltage circuits may only be installed within the same wiring system where one of the following conditions is satisfied:

- The LV cables are of a type that provides double insulation equivalent protection.
- All cables, or each conductor of a multi-core cable, are insulated for the highest voltage present in the wiring system.
- The LV and ELV cables are installed in separate, fixed compartments within a common trunking system, with continuous barriers provided between compartments.

3.9.5 Cable Insulation

Insulation shall be either:

- PVC type V-75 or V-90, in accordance with AS/NZS 5000.1, or
- XLPE type X-90 or X-110, in accordance with AS/NZS 5000.2

Provide cables capable of withstanding maximum thermal and magnetic stresses associated with relevant fault level and duration.

Insulation must have the following properties:

- Rated voltage:
  - LV: 0.6/1kV
  - ELV: 0.6/1kV
- Thermal class: Operating temperature up to 75°C (PVC) or 90°C (XLPE)
- Flame retardant as per IEC 60332

Cables installed outdoors and above ground, where exposed to sunlight, shall be UV-stabilised with a minimum of 1% carbon black content in the outer sheath, unless adequate mechanical protection such as conduit or cable guarding is provided to shield the cable insulation from UV degradation.

TPS cables shall not be used in industrial applications, except within habitable buildings such as treatment plant control rooms.

3.9.6 Cable Markers

Identify power and control cables between switchboard assemblies and equipment in accordance with the cable schedules and/or interconnection wiring diagrams.

For indoor applications or environments corrosive to 316 stainless-steel, PVC ring type ferrules characters supported on a PVC carrier fastened using nylon cable ties.

For outdoor areas, 316 stainless steel marker plates engraved or laser etched characters fastened using stainless steel ties.

Install cable markers in switchboards above the gland plates in the cable zones clearly visible from the access position.

3.9.7 Spare or Unused Cables

All spare power, control and instrument cables shall be terminated in a manner that provides a minimum degree of protection of IP 2X in accordance with AS 60529 Degree of Protection and labelled accordingly.

Within switchboards – connect to DIN mounted screw terminations or cover cable ends with resin heat shrink sleeve.

Within cable trenches or pits – cover cable ends with heat shrink sleeve or cover cable ends within a polycarbonate termination enclosure appropriately glanded.

3.9.8 Cable Glands

Only one cable shall occupy each cable gland opening unless multi hole cable glands inserts are used.

Unused cable glands shall be removed and penetrations filled with stop ends.

Cable entries using bushed penetrations may not be suitable in maintaining the IP rating of switchboards.

3.9.9 Cable Size

The following cable sizes shall be observed where not specified.

Table 13: Cable Colours

Type	Size
Control Wiring	0.50 mm² flexible (minimum) Cu.
PLC IO	0.50 mm² flexible Cu.
Instrumentation Wiring	0.30 mm² stranded (twisted pair, individual & overall aluminium Mylar screen and base copper drain wire) Cu
Instrumentation power	Flexible cord to AS 3191
CT Secondary Wiring	2.50 mm² stranded Cu
General Power Wiring	2.50 mm² stranded Cu
Lighting	1.50 mm² stranded Cu.

3.9.10 Cable Colours

For fixed wiring, use coloured conductor insulation. If this is not practicable, slide at least 150 mm of close-fitting coloured sleeving on to each conductor at the termination points.

Table 14: Cable Colours

Type	Colour
Phase/Line 1	Red
Phase/Line 2	White
Phase/Line 3	Blue
Neutral	Black

Earth	Green-yellow
Control, LV VAC	Grey
Control Neutral, LV VAC	Black
Control ELV VAC	Orange
Control Neutral ELV	Orange
Control ELV VDC	Violet
Control Neutral ELV VDC	Violet
Instrumentation (Screened) Positive	White
Instrumentation (Screened) Negative	Black

3.9.11 Wire Number Identification

South East Water standard drawing SEWL-STD-037.

Table 15: Wire Number Series

Type	Colour
0	Reserved for special purposes
1	LV Control
2	ELV Control
3	Instrumentation
4	Reserved for special purposes
5	Indications where separate circuits are used
6	Alarms
7	Telemetry or PLC Inputs /Outputs
8	Reserved for special purposes

Example

LV Control $\underbrace{1}_{\text{Number Series}}$ $\underbrace{0\ 6}_{\text{Identifier}}$

After the identifier reaches 99, continue at 100 e.g. 1100

Convention

Typically, ELV control, PLC and DC supply circuits the identifier start at 00 with the return or 0V at 99.

Example

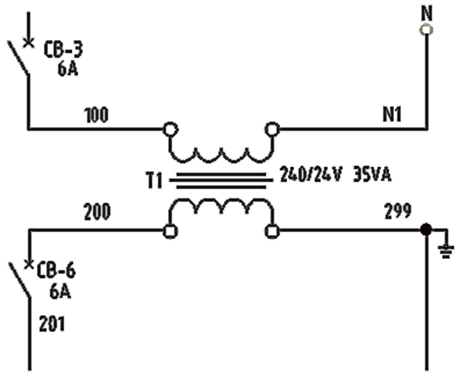


Figure 3: Conversion

Equipment Number

Wire numbers may be duplicated where circuits have no commonality. Where circuits are collective or where circuits create ambiguity an equipment prefix maybe used.

Example. $\underbrace{\text{PM01}}_{\text{*Equipment Number}}$ - $\underbrace{1}_{\text{Series}}$ $\underbrace{0\ 6}_{\text{Identifier}}$

*Refer to Section – "Equipment Identification."

Power

$\underbrace{\text{R}}_{\text{Phase}}$ $\underbrace{0\ 6}_{\text{Identifier as per isolation device designation.}}$

Labels

Terminated cables shall be identified by the means of a printable insert set into a square faced transparent cable carrier. The printed insert shall have the ability to be changed before or after termination. Printed inserts shall be white with black lettering.

3.9.12 Cable Sizing

Calculate cable rating and voltage drops based upon actual cable lengths and selected make of cables. Allow for standby plant and future demand as indicated within the intended Electrical Scope of Works. Take into consideration installation conditions and external influences, short circuit fault levels and ratings of protection equipment.

3.9.13 Cable Ties

Where cable ties are used in areas directly exposed to sunlight, 316 stainless-steel ties shall be used.

3.10 Conduits

3.10.1 Standards

- 2053 Series: Conduits and fittings for electrical installations

3.10.2 Requirements

Conduit may be either hot-dip galvanised steel or PVC subject to the following requirements:

- Conduit on a surface exposed to mechanical damage: Hot-dip galvanised steel conduit.
- Exposed external conduit: hot-dip galvanised steel or PVC painted with a light coloured acrylic paint or covered from UV exposure.
- Conduit cast into concrete, chases or concealed areas: PVC conduit must be used. heavy duty conduit may be used in areas where not subject to the risk of mechanical damage.
- Conduit buried in ground: heavy duty UPVC conduit. Wafer style PVC conduit is not permitted to be installed

3.10.3 Minimum sizes

Required size and number of conduits shall be determined in accordance AS/NZS 3000 Appendix C6 *"guide to maximum number of cables installed in conduits",* whilst meeting the minimum conduit size requirment of South East Water.

Table 16: Condit Sizes

Application	Between Pits (TP*)	Between Pits (NW*)	End Circuits
Power Conduit	100mm	50mm	25mm
Controls/ Comms Conduit	100mm	50mm	25mm

Note* NW: Network Sites, TP Treatment Plant Sites.

3.10.4 Conduits Segregation

Power cables should be installed in conduits that are physically separated from those containing control or communication cables—including Cat 6 and fiber optic cables—to minimize electromagnetic interference (EMI) and preserve signal integrity.

If both power and control cables are to occupy the same electrical pit, a physical barrier or segregation must be implemented between them to maintain this separation within the pit. This can be accomplished using a removable flexible corrugated conduit with a minimum diameter of 50mm, installed between the ridged conduit openings inside the pit.

3.10.5 Rigid conduits

Provide straight long runs, smooth and free from rags, burrs and sharp edges. Set conduits to minimise the number of fittings. Remove sharp edges prior to drawing-in wires.

Where Ridged conduit for single cables has an open end installed in the upright position it must be sealed with a correct sized cable gland.

3.10.6 Flexible conduits

Flexible conduit shall only be used where rigid conduit cannot be supported or in applications where equipment requires frequent removal due to maintenance, example, electric motors and instruments. Flexible conduit shall consist of heavy duty spiral reinforcing with PVC only used in indoor applications. Flexible conduit shall be limited to <600mm in length.

Transition between flexible conduit and equipment / enclosures, use manufacture specific corrugated glands on either end. Where one side of the flexible conduit is to be left open. ie onto a tray or inserted into large conduit to sleave a cable. Cable Glands must be used to seal the cable to the equipment / enclosures. The flexible corrugated shall be pushed against the cable gland and sealed / held in place with black heat shrink. If flexible conduit is coming from above equipment, it must be sealed.

When Flexible conduit is installed onto a cable tray the maximum length of 300mm shall be installed on the tray.

Where Flexible conduit has an open end installed in the upright position it must be sealed with silicone.

3.10.7 Set out

Install conduits truly vertical or horizontal and in parallel runs with right angle changes of direction.

3.10.8 Conduit Entry

Conduits subjected to moisture shall enter into a switchboard, junction box, isolator or instrument enclosure via a bottom entry. Vertical conduits from above shall incorporate a drip loop if side entry is the only option to bottom entry.

External and internal junction boxes shall have a minimum of IP56 degree of protection.

Recommended products can be found in AM2848 Approved EIC Equipment List.

3.10.9 Inspection fittings

Provide in accessible locations.

3.10.10 Draw Cords

Provide draw cords in conduits not in use. Leave 1 m of cord coiled at each end of the run. Polypropylene cord, conductive wire shall not be used.

3.10.11 Draw-In Boxes

Provide draw-in boxes in accessible positions and at intervals not exceeding 30m in straight runs, and at changes of level or direction. Provide draw-in boxes no greater than 7.5 m apart for vertical lengths of conduit runs.

3.10.12 Sealing Conduits

Seal buried entries to ducts and conduits using waterproof seals. Seal spare ducts and conduits immediately after installation. Seal other ducts and conduits after cable installation. Seal the ends of conduits entering the building with expanding foam to prevent moisture and vermin entry.

3.10.13 Bends and elbows

Make with easy sweeps. Provide bends of 90° with a radius of not less than three times the external diameter of the conduit, without mechanical stress sufficient to cause deformation. Limit the number of 90° bends between boxes in any conduit run to 2.

3.10.14 Conduit saddles and brackets

Space conduit saddles a maximum of 1200 mm apart for metallic conduit and 1000 mm apart for non-metallic conduit. In areas subject to high ambient temperatures or other severe duty, provide maximum saddle spacing for non-metallic conduit of 500 mm.

Provide conduit support saddles close to flexible couplings to permit free movement for expansion and contraction.

To minimise eddy current effects ferrous cable saddles shall not be fitted over single core cables.

Where two or more conduits are run in parallel they may be grouped. Provide suitable surface brackets where conduits cannot be fixed.

Provide stainless steel saddles in exterior or high corrosive environments.

3.10.15 Corrosion Protection

For steel conduits, paint ends and joint threads with zinc rich binder. 316 stainless steel conduit shall be used where metallic conduit is required to penetrate through soil level.

3.10.16 Sets and bends

Form with a spring or other device inserted in the conduit to prevent distortion of the walls. The forming of conduit bends using heat from a naked flame or similar method which may damage or deform the conduit shall not be accepted.

3.11 Cable Pits

3.11.1 Standards

- AS/NZS 3996: Load Classification

3.11.2 Load Classification

The Australian Standard AS 3996 specifies load classifications for access covers and grates (including pits) used in infrastructure such as roads, footpaths, malls, and commercial or industrial sites. The classes primarily relevant for general civil works and utility pits are Class A, B, C, and D.

Table 17: Load Classification

Class	Nominal Wheel loading (Kg)	Serviceability Design Load	Ultimate limit state Design	Typical Usage:
Class B (Light Duty)	2670 kg	53 kN	80 kN	Footways, designated easements, light traffic areas, driveways—excludes commercial vehicles.
Class C (Medium Duty)	5000 kg	100 kN	150 kN	Areas are occasionally subject to slow-moving commercial vehicles.

Class	Nominal Wheel loading (Kg)	Serviceability Design Load	Ultimate limit state Design	Typical Usage:
Class D (Heavy Duty)	8000 kg	160 kN	240 kN	Areas open to commercial driveways, and areas regularly accessed by trucks and heavy vehicles.

3.11.3 Required type of usage

For SEW Treatment plant and Network sites, the allowed load classification is

- Class B: In Indoors
- Class D: For all other areas.

3.11.4 Material

- Class B: Polyethylene base, Steel lids and access covers are hot dip galvanised
- Class D: Precast concrete base with a Ductile Iron concrete Infill Covers
- All class D electrical pits shall be precast concrete in Treatment plants and Networks. Polymer concrete or glass reinforced concrete pits shall not be accepted.

3.11.5 Spacing

Provided cable pits at every major change in direction of underground conduit or at 100 m minimum intervals on long straight duct and conduit routes.

Minimum 600 x 600mm pit size allowing for turning of cables at above the minimum acceptable bending radius.

3.11.6 Labelling

Pit shall be numbered using the following convention: EPXX. Where X is a number within an incremental numeric sequence used to identify individual pits.

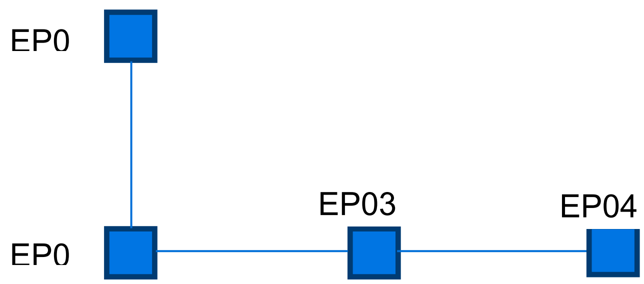


Figure 4: Pit Layout

The pit identification number shall be engraved with black filled lettering on a 316 stainless steel, 1.5mm minimum thick round label. The label shall be fixed to the pit cover using a high quality, single component joint sealant / high adhesive strength such as ‘Soudal Fix All High Tack’ or ‘Sikaflex 11FC’.

3.12 Supports and Uprights

All Unistrut used as equipment supports or cable ducting, must be fitted with end caps and closure Strip.

- Indoors – Plastic or Aluminum closure strip.
- Outdoors or outdoors under cover (Open Wall Structure) – Aluminum closure strip only to be used.

3.12.1 Cable Trays

Provide a complete cable support system consisting of trays or ladders and including brackets, fixings and accessories. Fabricate brackets, racks and hangers from structural steel sections or other materials in sections of equivalent strength.

Cable ladder tray used on open tanks shall be mounted on the inside of walkway handrails to prevent personnel requiring access to the tank or for having to be physically restrained to work on.

Maintain earth continuity of the entire cable support system. Provide rounded support surfaces under cables where they leave trays or ladders. Provide cable tray covers on externally installed cable ladder systems subject to UV exposure.

3.12.2 Spare

Provide an additional 25 percent (25%) spare ladder and cable tray space in excess of that determined by the design calculations and the known future cabling.

3.12.3 Applications

For interior applications provide Zinc-coated steel, or steel with two-pack liquid coating, air-drying enamel or stoving enamel finish.

For general exterior applications provide hot-dip galvanised steel or within corrosive environments e.g. marine, underground pits or waste water treatment plant applications, sewer pump stations, chlorinators, corrosive chemicals shall use 316 stainless steel.

Note: Marine area is defined as 25Km from the coast.

3.13 Underground Services

3.13.1 Excavation

Make trenches straight and at uniform grade between pits, personnel access ways and junctions. Preferably changes in route shall be at right angles.

3.13.2 Dewatering

Keep trenches free of water. Place bedding material, services and backfilling on firm ground free of surface water.

3.13.3 Backfilling

Install underground marking tape to AS/NZS 2648.1 and backfill service trenches as soon as possible after the service has been laid, bedded and tested. Place the backfill in layers 150 mm thick and compact to the density applicable to the location of the trenches, to minimise settlement, and so that pipes are buttressed by the trench walls.

3.13.4 Backfill Material

Underground conduit and pits shall be backfilled as per gravity sewers and structures with wash sand at height of 300mm above the flowmeter and pipe and in compliance with the MRWA Backfill Specification 04-03.

3.13.5 Underground Cable Routes

General

Provide all changes in grade or direction in easy stages, and bends with a radius of not less than fifteen times the conduits overall diameter.

Survey

Accurately record the routes of underground cables before backfilling. Accurately plot conduit routes, pits, junction boxes, etc., and note levels of ducts at the following points:

- Changes in direction.
- Entry and exit from structures.
- Changes in depth.

Marker Tape

Provide orange marker tape complying AS/NZS 2648.1. Install marker tape at 150mm or 50% of the depth of burial, whichever is greater, below finished ground level. Where chased in rock, concrete or installed directly below slab, lay marker tape directly on top of wiring system

3.14 Standard SEW Labels

3.14.1 General

Mark equipment, electrical switchboards, circuit breaker designations, electrical cables, instruments and controls with a means of identification to match design drawings and conforming to section "Equipment Identification."

Manufacturers' labelling and compliance labels shall be fitted on internal side of external doors on external boards.

3.14.2 Material

For indoor applications or environments corrosive to 316 stainless-steel, engraved two-colour laminated PVC or Traffolyte. Stencil with black or white lettering contrasting with black or white background.

For outdoor areas, engraved with black filled lettering on 316 stainless steel minimum thickness 1.5mm.

Note printed self-adhesive shall not be permitted.

3.14.3 Size

If labels exceed 1.5mm thickness, use radius or bevelled edges.

Minimum lettering heights:

- Major equipment nameplates: 40mm

- Minor equipment nameplates: 20mm
- Main switches 10mm
- Outgoing electrical functional units: 8mm
- Danger, warning and caution notices: 10mm for heading 5mm for text (White on Red).
- Automatic controls electrical equipment and instruments: 5mm
- Components inside electrical enclosures and control panels: 3.5mm.
- Minor lettering: 3mm

3.14.4 Labels fixing methods:

Traffolyte labels are typically attached to switchboard or equipment surfaces using one of the following methods:

Screws or Rivets

- Labels are pre-drilled and mechanically fastened, at least two pins or screws per 80 mm of label length for labels fixed to flat surfaces.
- Ideal for rough or uneven surfaces, or where a permanent fix is required.
- Common in outdoor or high-vibration environments.

Cable Ties or Clips

- Where flat surfaces are not presented fit labels to equipment using cable ties where appropriate.
    - For all outdoor applications, stainless-steel cable ties to be used.
    - For indoor applications or environments corrosive to 316 stainless-steel, nylon cable ties to be used.
- Used when labels are mounted on cables or conduits rather than flat surfaces.
- Traffolyte tags are punched with holes and secured using ties.

Adhesive Backing

- Double-sided industrial adhesive tape (e.g., 3M VHB) is commonly used.
- Suitable for smooth, clean surfaces.
- Quick to apply and provides a strong bond.
- Indoor switchrooms only, without any UV exposure.

Note: Handwritten labels are not acceptable

3.14.5 Danger, Warning and Caution Labels

Provide labels where applicable as recommended by equipment manufacturer or as a result of a risk assessment.

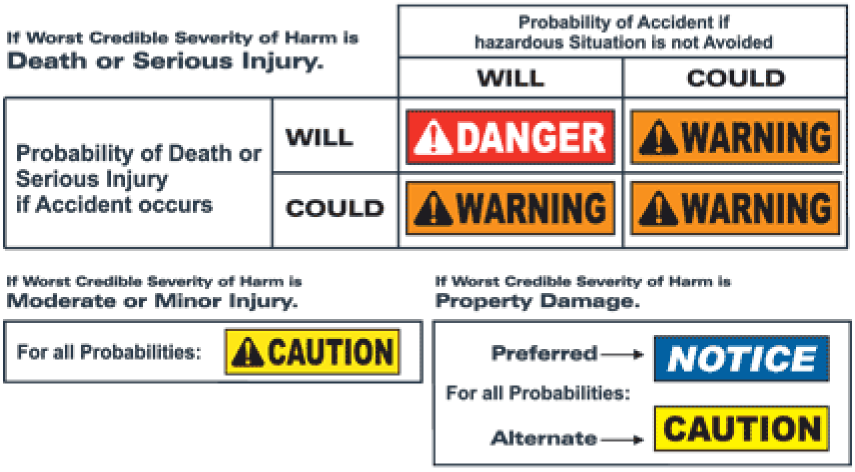


Figure 5: Label Types

Table 18: Labels

Term	Definition
DANGER:	Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury. Safety Signs identified by the signal word DANGER should be used sparingly and only for those situations presenting the most serious hazards.
WARNING:	Indicates a potentially hazardous situation which, if not avoided, will result in death or serious injury. Hazards identified by the signal word WARNING present a lesser degree of risk of injury or death than those identified by the signal word DANGER.
CAUTION:	Indicates a hazardous situation, which if not avoided, could result in minor or moderate injury. It may also be used without the safety alert symbol as an alternative to “NOTICE”.
NOTICE:	the word “CAUTION” without the safety alert symbol may be used to indicate a message not related to personal injury.

3.14.6 Fixed Equipment Connected to Socket Outlets

Fixed or stationary equipment connected by a low voltage single or polyphase phase flexible cable to a socket outlet where the cable is not flexed, not moved in normal use, not exposed to damage or not in a hostile environment shall have the equipment tagged with a ‘INSTALLED’ label indicating the connected equipment start date of operation. The label type shall be of a 'Self Debossing Foil Write on Label'.

Figure 6: Installed Label

3.14.7 Field Equipment Electrical Isolation Devices

Switches shall be of the “on-load” type complying with AS/NZS IEC 60947.3.

Switches shall have insulated or effectively earthed operating handles appropriately sized to allow easy operation in both the ON and OFF positions. Switches shall:

- be rated at not less than 125% of the maximum demand current of the circuit being controlled; and
- have the same or higher minimum short-time withstanding current.

All field equipment supplied by a voltage equal to or greater than low voltage shall be fitted with a local isolator. Local isolation shall include lockable isolators for hard wired equipment, de-contactors or plug socket combinations. Field equipment shall be defined as equipment installed external to a switchboard assembly or motor control centre.

A plug socket combination complete with local isolator shall be installed on equipment where either of the following applies.

- The equipment is required to be moved to perform regular reactive maintenance. i.e., pump blockages.
- The equipment is required to be replaced by an immediate critical spare.
- Disconnection is regularly required by non-electrical licensed personnel.
- Unique equipment can only be connected.
- Personal safety is evident.

Non-metallic field isolators subject to direct sunlight shall be shrouded by either a stainless steel or aluminium cover.

Where practicable the location of isolators shall be adjacent to the equipment i.e. line of sight within 2 metres.

Where electromagnetic compatibility is to be maintained suitable EMC enclosures shall be used complete with EMC cable glands and earth termination.

Exemption to the Field Equipment Electrical Isolation clause includes local isolation of lighting or equipment otherwise specified.

3.15 Junction, Termination or Electrical Equipment Enclosures

Where applicable provide enclosures with an IP56 degree of protection and material to suit the following.

- Indoor: ABS, polycarbonate or powder coated *mild steel.
- Outdoor: 316 stainless steel or aluminium.

**Mild Steel unsuitable within indoor applications subject to moisture or corrosive environments.*

3.16 Lightning Protection System (LPS) Design

3.16.1 General Requirements

The design of earthing and lightning protection systems shall ensure the safety, reliability, and protection of electrical and structural assets under all operating conditions.

3.16.2 Lightning Protection System (LPS)

Where applicable, the LPS design shall comply with the requirements of AS 1768 – Lightning Protection. A station-level risk assessment must be conducted in accordance with AS 1768 to determine the need for lightning protection.

LPS shall be mandatory for high-risk or exposed structures, including but not limited to:

- Water tanks
- Treatment plant buildings
- Pump stations
- Communication towers

The assessment and resulting design shall consider:

- Structure size and geometry
- Occupancy and asset criticality

Environmental exposure (e.g. elevation, lightning strike density)

3.17 General Earthing Arrangements

The design and installation of earthing systems shall comply with AS/NZS 3000, Section 5: Earthing Arrangements and Earthing Conductors.

3.17.1 Earthing Design

The earthing system shall be designed to:

- Maintain touch and step voltages within safe limits under fault conditions.
- Ensure effective operation of overcurrent and protection devices.
- Comply with AS/NZS 3000, AS 2067, and AS/NZS 3017, as applicable.

Earthing and LPS systems shall be fully integrated, documented, and shown on all electrical layout and site grounding drawings.

3.17.2 General Earthing

- Outbuilding installations shall not be provided with a separate MEN connection or a separate earth electrode.
- All outbuildings and satellite sub-distribution boards shall be supplied via submains that include a dedicated protective earth conductor directly bonded to the MEN link at the Main Switchboard (MSB).

3.17.3 Materials

- Earthing conductors shall be copper only.
- Minimum size shall comply with AS/NZS 3000 Table 5.1 and shall not be less than 6 mm^2.
- Insulation shall be green/yellow, rated to 0.6/1 kV.

3.18 Server/communications rack

Unless otherwise specified, allowance shall be made to house the server rack inside the Electrical Switchroom with following basic details:

- Small Rack (Network Sites): APC ER6202: 42U, Black, 1991H x 600W x 1000D mm
- Large Rack (TP Sites): APC AR3350: 42U, Black, 1991H x 750W x 1200D mm

3.19 Control and SCADA Vendor packages

Refer to AM2988 SEW Water Recycling Plant Monitoring and Control General Requirements Manual. All vendor package plant shall be conformed to this standard, and approved equipment list in AM2848 Approved EIC Equipment List.

Standalone “package” or “vendor” PLC’s shall not be used to control significant or critical items of process equipment unless approved by SEW.

All code, including vendor-packaged devices, to use the SEW standard code library for PLC, SCADA and HMI. Any diversions shall be approved by SEW.

All code, including but not limited to PLC and SCADA, shall be provided fully accessible and free of password protection to SEW. The code shall be license free.

All ICS and networked systems capable of time synchronization shall be configured to use SEW's centralized NTP service.

All vendor HMI functions shall be built into the plant SCADA. A vendor HMI failure shall not stop the vendor equipment operation and the equipment will be fully operational from the SCADA, including all functions including but not limited to alarming and event logging.

4. Electricity Supply

4.1 Normal Supply

4.1.1 General

The electricity supply configuration shall follow a 400/230 low voltage, three phase, four wire 50Hz with a Multiple Earth Neutral earthing system.

4.1.2 Capacity

Calculate the supply cables size to support the required and nominated future load with a minimum 15 % spare capacity.

4.1.3 Power Factor Correction

Power factor correction, utilising advanced active harmonic filter technology, shall be installed where the site power factor falls below 0.95 and the installation is subject to distribution kVA demand charges.

Distribution demand and/or usage criteria are as follows.

Ausnet

- NSP56 Critical Peak Demand multirate > 50 kVA and < 400 MWh
- NSP75 Critical Peak Demand multirate > 150kVA and < 750 MWh
- NSP76 Critical Peak Demand multirate > 280kVA and > 750 MWh
- NSP77 Critical Peak Demand multirate > 550kVA and > 2 GWh
- NSP78 Critical Peak Demand multirate > 850kVA and > 4 GWh

United Energy

- LVkVATOU Low voltage large KVA time of use > 150KVA and/or >400MWh

4.2 Alternate Supply - Generators

4.2.1 General

Emergency generators shall be sized to:

- limit voltage drop to ≤15% during starting of the largest motor (with the applicable starter)
- ≤10% where sensitive/electronic equipment is supplied
- ensure total harmonic voltage distortion at the switchboard LV busbar from VSDs during generator operation does not exceed 8%

Provide continuous monitoring of incoming, distribution and control power with SCADA alarms. For South East Water Technical Specification, refer to AM2717 Generator Specification.

4.2.2 Security of Supply

A single low-voltage supply from the electricity distribution company is acceptable under normal operating conditions, provided that connection facilities for a mobile generator are available.

All site Main Switchboards must be equipped with a generator connection point and a changeover switch (Automatic Transfer Switch – ATS, or Manual Transfer Switch – MTS), with provision for either a permanent or temporary generator.

Each station must be individually assessed for power supply reliability and security.

For large, critical, or environmentally sensitive stations, or where supply reliability is poor, a duplicate supply from a separate distribution zone or a permanent on-site generator shall be provided.

4.2.3 Alternate Standby Generation Supply – Permanent

Unless otherwise specified in project-specific requirements,

- A permanent onsite generator shall be supplied and installed at treatment plant and network sites where asset operation is considered critical. This requirement applies to sites with a supply rating exceeding 250 A.
- This does not exclude sites with supply ratings below 250 A from having a permanent generator, where asset criticality justifies it or process requires it.
- For permanent standby generators, the switchboard shall incorporate the standby generator supply changeover system. Supply changeover switches shall consist of two circuit breakers with mechanical interlock, contactors shall not be accepted.
- External to the switchboard, an intermediate junction cubicle shall terminate the generator supply feeders. Terminations within the junction cubicle shall allow connection of a secondary generator in the event the primary generator is offline due to failure or prolonged maintenance.

4.2.4 Alternate Standby Generation Supply – Temporary

Where a permanent generator is not required,

- Provision shall be made for a temporary generator connection point at the Main Switchboard, regardless of the supply rating.
- The switchboard shall incorporate the standby generator supply changeover system. Supply changeover switches shall consist of a manual load break switch incorporating an off position.

4.2.5 Temporary Generator Connection Points on Sub-Boards

Distribution boards that meet the following criteria shall be provided with a manual transfer switch and a generator connection point (plug) to enable emergency backup supply in the event the upstream board is unavailable due to planned or unplanned outages. This requirement applies, but is not limited, to MCCs, process control distribution boards, PLC panels, and chlorination systems.

- For Treatment Plant sites, this applies where the sub-distribution board has a rated supply of 250 A or greater.
- For Network sites, this applies where the rated supply of the sub-distribution board is 50 A or greater.

4.3 Operational Modes and Commissioning

4.3.1 Operational Requirements

- Standby generators shall auto-start and transfer supply without operator intervention. Generator performance shall be verified by load bank testing during commissioning.
- For process-critical sites (e.g. treatment plants), embedded generation shall synchronise with the normal mains supply.
- A **make-before-break** arrangement must be provided to ensure supply continuity and avoid blackouts during planned power transfers.
- Contractor responsibilities:
  - Liaise with the Power Authority to obtain connection offers/agreements for Solar, BESS, Diesel, and CHP.
  - Undertake staged commissioning and synchronisation of all embedded generation sources.
  - Apply CHP only where anaerobic digestion processes are present.
- All transitions between sources must occur without loss of supply (make-before-break), the only permitted blackout is from an unplanned outage of the DNSP transformer.
- The Designer shall liaise with the relevant DNSP to confirm the embedded generation connection requirements, as detailed in the tables below and as applicable to each specific site. Note that not all sites will include all power sources.
- For Treatment Plant sites where an ATS is installed, the Normal Supply main switch trip status and Generator supply trip status signals shall be provided and integrated into the site SCADA system for continuous monitoring and alarm functions.

4.4 Comparison of Key Definitions

Table 19: Comparison of Key Definitions

Term	VIC SIR Definition	AS/NZS 3000 Definition
Consumer's Mains	Conductors installed between the point of supply/consumer's terminals and the main switchboard.	Conductors between the point of supply and the main switchboard. (Clause 1.4.37)
Point of Supply	The point at which the electricity distributor's service cable or supply main connects to the consumer's terminals.	The junction of the consumer mains with: (a) conductors of an electricity distribution system; or (b) output terminals of an electricity generating system within the premises. (Clause 1.4.95)
Point of Entry	Not defined in VIC SIR.	The point at which the consumer mains or the underground service cable enters a structure. (Clause 1.4.94)

Term	VIC SIR Definition	AS/NZS 3000 Definition
Main Switchboard (MSB)	Not explicitly defined in VIC SIR.	A switchboard from which the supply to the whole electrical installation can be controlled. (Clause 1.4.122)
Main Switch	Not explicitly defined in VIC SIR.	A switch whose primary function is isolation of the supply to the electrical installation. (Clause 1.4.82)
Distribution board	Not explicitly defined in VIC SIR.	A switchboard other than a main switchboard. (Clause 1.4.46)
Electricity distributor	“Distributor” is also known as the Local Network Service Provider (LNSP). “relevant Distributor” is the Distributor who operates the Network in the area associated with an electrical installation.	Any person or organization that provides electricity from an electricity distribution system to one or more electrical installations. Includes distributor, supply authority, network operator, local network service provider, electricity retailer or electricity entity, as may be appropriate in the relevant jurisdiction. (Clause 1.4.57)

South East Water

5. Low-Voltage Switchgear and Controlgear Assemblies

5.1 General

5.1.1 Scope

This specification applies to factory-built low-voltage switchgear and controlgear assemblies (LV SCAs) intended for use on low-voltage electrical installations, rated up to and including 1000 V AC or 1500 V DC.

This section defines the minimum technical requirements to ensure the safe, reliable, and durable operation of LV SCAs.

5.1.2 Applicable Standards

All assemblies shall be designed, manufactured, and tested in accordance with the following:

Table 20: Standards

Standard	Title
AS/NZS 61439.1	Low-voltage switchgear and controlgear assemblies Part 1: General rules
AS/NZS 61439.2	Power switchgear and controlgear assemblies Part 2: Power switchgear and controlgear assemblies
AS/NZS 61439.3	Low-voltage switchgear and controlgear assemblies Part 3: Distribution boards intended to be operated by ordinary persons (DBO)
SA/SNZ TR 61439.0:2016	Technical Report – Guidance to specifying AS/NZS 61439 compliant assemblies

5.1.3 System Parameters

Assemblies shall be designed to suit the following system parameters unless otherwise specified:

- Rated operational voltage: 400 V AC, 3-phase, 50 Hz
- Rated insulation voltage: ≥ 690 V
- Rated impulse withstand voltage (Uimp): Minimum 6 kV
- Short-circuit withstand rating: Specific fault level studies & min. SEW requirements
- Pollution degree: 2 or 3 depending on environment
- Ambient temperature: -5 °C to +40 °C (Average not exceeding +35 °C over 24 hours)

5.1.4 Design and Construction

Assemblies shall:

- Be constructed using components verified to AS/NZS 61439.

- Use Type Tested Assemblies (TTA) or Partial Type Tested Assemblies (PTTA) with evidence of design verification in accordance with AS/NZS 61439.1 Clause 10.
- Include internal separation between functional units, busbars, and terminals, appropriate to the application (refer to Forms of Separation).
- Be designed with top or bottom cable access as specified.
- Include comprehensive labelling and identification as per AS/NZS 61439.1 Clause 5.2.
- Switchboards that are not covered by AS/NAZ 61439 (e.g., 125A/10 kA) shall need a construction certificate stating that are built to AS/NZS 3000.

5.1.5 Testing and Verification

All assemblies must be verified in accordance with **Clause 10 of AS/NZS 61439.1**, which includes:

- Verification of temperature rise limits,
- Verification of dielectric properties,
- Verification of short-circuit withstand strength,
- Verification of the effectiveness of protective circuits,
- Mechanical operation and degree of protection (IP rating).

Manufacturer's Design Verification Documentation shall be submitted with the tender or at the IFC design package.

5.1.6 Installation and Operation

- Assemblies shall be suitable for site conditions (corrosive, UV, humidity, pollution).
- Shall allow safe access and maintenance in accordance with AS/NZS 3000 and site-specific safety requirements.
- Shall be installed on level surfaces and securely anchored.
- Shall have appropriate arc flash warning labels, where required by risk assessment.
- Shall provide appropriate clearances, ventilation, and cable entry/exit paths.

All LV switchboards shall be inspected and tested in accordance with AM2851 EIC Inspection, Testing & Completion.

5.2 Switchboard Types and Purpose

5.2.1 Main Switchboard (MSB)

As defined in AS/NZS 3000 and VIC SIRs, a switchboard from which the supply to the whole electrical installation can be controlled. Main Switchboard also houses the “Main Switch” A switch whose primary function is isolation of the supply to the electrical installation.

5.2.2 Distribution Boards (DBs)

A distribution board is any switchboard other than the main switchboard. This includes, but is not limited to, the Main Distribution Board (MDB), Motor Control Centres (MCCs), Process Distribution Boards, and Lighting & Power Distribution Boards.

5.2.3 Main Distribution Board (MDB)

The purpose of the Main Distribution Board (MDB) becomes relevant when the Main Switchboard (MSB) is installed externally as the point of electrical entry, typically housing the DNSP CT metering (or direct metering) and the main incoming switch.

In this setup, the MDB is located inside the switchroom and serves as the central distribution point for internal loads. It also provides provisions for generator connection via a changeover switch, as well as alternative supplies such as solar feeders.

Separating the MSB (external) from the MDB (internal) also has a safety benefit — it helps reduce arc flash incident energy at the incoming terminals of the MDB and other internal switchboards, improving operational safety during maintenance or fault conditions.

5.3 Generator connection Point

5.3.1 Generator Connection Point Types

- Clipsal ISO switch or equivalent: 50A
- NHP Proconect: 90A – 150A – 250A
- PowerSafe Connectors: 250A – 400A
- Tinned Copper bars: above 400A

Refer SEW external webpage, under Technical Standards for to standard drawings

5.4 Switchboard Contractor's Submissions

The contractor shall submit the following for review, approval, and record prior to manufacture:

5.4.1 Shop Drawings

Submit shop drawings indicating:

- Switchboard form.
- Types and model numbers of items of equipment.
- Overall dimensions.
- Switchboard general arrangements, plan view, front elevations and cross-section of each compartment and clearances or inadvertent operation, such as handles, knobs, arcing-fault venting flaps and withdrawable components.
- Front and back equipment connections and cable entries.
- Door swings.
- Locking systems.
- External and internal paint colours and paint systems.
- Construction and plinth details, ventilation openings and gland plate details.
- Terminal block layouts and control circuit identification.
- Busbar arrangements, links and supports, spacing between busbar phases, and spacing between assemblies, the enclosure and other equipment and clearances to earthed metals.

- Dimensions of busbars and interconnecting cables in sufficient detail for calculations to be performed to AS standards.
- Internal separation and form of separation and details of shrouding of terminals
- Labels and engraving schedules.
- Paint colours and finishes.

5.4.2 Technical Documentation

Provide the following documents for review:

- General arrangement and schematic diagrams
- Switchgear and controlgear component datasheets
- Design verification and type test reports, including:
  - Temperature rise, dielectric strength,
  - short-circuit withstand, IP, and IK ratings
- Routine test certificates as per AS/NZS 61439

5.5 Switchboard Current and Fault Ratings

5.5.1 Definitions

- **Rated Short-Time Withstand Current (Icw):** The switchboard shall have a rated short-time withstand current (Icw) that is equal to or greater than the prospective short-circuit current (Icp, r.m.s. value) at each point of supply connection. The Icw rating shall be verified for standard time intervals (e.g. 0.2 s, 1 s, 3 s) in accordance with IEC/AS 61439.
- **Prospective Short-Circuit Current (Icp):** The Icp is defined as the r.m.s. value of the current that would flow under a short-circuit condition, where the supply conductors are faulted by a negligible-impedance conductor located as close as practicable to the supply terminals of the assembly.
- **Rated Peak Withstand Current (Ipk):** The switchboard assembly shall have a rated peak withstand current (Ipk) that is equal to or greater than the peak value of the prospective short-circuit current of the connected supply system**.**
- **Rated Current (InA):** The rated current is the current declared by the assembly manufacturer which the switchboard can continuously carry without exceeding the specified temperature-rise limits under defined service conditions

5.5.2 Design Verification Requirement

The contractor / power system designer shall undertake a power system study (short-circuit and load flow analysis) to confirm the minimum switchboard ratings. The study shall demonstrate that the switchboard busbars, main switchgear, and protective devices comply with both the design requirements and the minimum withstand values specified in these tables for both the rated current and short circuit withstand currents.

5.5.3 Required Minimum Busbar Current Rating and Main Protection device Nominal Rating (In, A)

Table 21: Main Switchboard minimum ratings

This table applies where the supply transformer is dedicated to SEW.

Nominal Supply Rating (A) Tx FLC (A) @ 400Vac	(Informative) Nominal Tx Size (kVA)	Required min. Bus Current Rating	Required min. Nominal Size for Main Switch (In)A	(Informative) rated current for Protection Device (Ir) A with settings	Required Trip Unit/ Breaker Type*
Up to 72	50	80	80	(x0.8) 64	MCCB, MCB
Up to 144	100	160	160	(x0.63) 128	EOCR MCCB
Up to 289	200	400	400	(x0.63) 252	EOCR MCCB
Up to 455	315	400	400	(x1.00) 400	EOCR MCCB
Up to 722	500	800	800	(x0.85) 680	EOCR MCCB
Up to 1443	1000	1600	1600	(x0.85) 1360	EOCR ACB
Up to 2165	1500	2500	2500	(x0.85) 2125	EOCR ACB
Up to 2887	2000	3200	3200	(x0.85) 2720	EOCR ACB

Note*: Required Trip Unit

- TM: Thermal Magnetic
- EOCR: Electronic Overcurrent Relay with min. LSI protection functions.
  - L: Long Time Delay (LTD)
  - S: Short Time Delay (STD)
  - I: Instantaneous (INST)

Table 22: All Switchboards minimum ratings (additional to MSB)

Range of rated Current (A) [a]	Required min. Bus Current Rating	Required min. rated current for Protection Device (In)A	Required Trip Unit/ Breaker Type
0 to 65	80	80	MCCB, MCB
65 to 130	160	160	TM or EOCR MCCB
128 to 250	250	250	TM or EOCR MCCB
250 to 400	400	400	EOCR MCCB
400 to 500	500	500	EOCR MCCB
500 to 630	630	630	EOCR MCCB
630 to 800	800	800	EOCR MCCB or ACB

Range of rated Current (A) [a]	Required min. Bus Current Rating	Required min. rated current for Protection Device (In)A	Required Trip Unit/ Breaker Type
800 to 1000	1000	1000	EOCR MCCB or ACB
1000 to 1250	1250	1250	EOCR ACB
1250 to 1600	1600	1600	EOCR ACB
1600 to 2000	2000	2000	EOCR ACB
2000 to 2500	2500	2500	EOCR ACB
2500 to 3150	3200	3200	EOCR ACB
3150 to 4000	4000	4000	EOCR ACB

Note a: The value of the rated current shall be greater than the first value and less than or equal to the second value.

Values in the above table applies irrespective of whether a dedicated transformer is provided and covers internal Sub Distribution Boards.

Key requirement: For all switchboards (Main SB and Sub DBs), the minimum required busbar continuous current rating shall be equal to the upper limit of the rated current range corresponding to the overload protection device rating, as per the table above.

Additionally:

- The Maximum Demand (existing, planned, and future) of the power system must be less than both the nominal available supply rating and the rated size of the main switch.
- Protection devices and breaker types must be selected to ensure coordination with the system's upstream supply (e.g., supply authority transformer).

Example – Continuous Current Requirement

- Maximum Demand (MD): 640 A
- Supply Rating: up to 722 A
- Applicable Range of Rated Current: 630–800 A
- Typical Upstream Supply: 500 kVA transformer (supply authority-owned)

Therefore:

- Required minimum busbar continuous current rating = 800 A
- Required minimum nominal main switch rating = 800 A (set in line with MD)

5.5.4 Required Minimum Short-Time Withstand Current (Icw, kA, 1s)

A short circuit may occur at any point in the electrical system, subjecting switchgear assemblies to electrodynamic stresses at busbars, cables, equipment terminals, and load points. The short-circuit current, expressed in kiloamperes (kA), is a function of the transformer kVA capacity and the distance between the fault location and the source.

The rated short time withstand current (Icw) test shall verify the busbar system's ability to withstand electrodynamic forces under short-circuit conditions. In accordance with IEC

61439-1, Table 7, the test current shall peak at 2.1 times the RMS value for systems up to 50 kA, and at 2.2 times the RMS value for systems above 50 kA.

Table 23: Required Icw

(I)psc Prospective Short Circuit fault current (kA)	(Informative) Nominal Tx Size (kVA)	(Informative) Nominal Tx Z% AS/NZS 60076.5	Required min. Icw, kA 1s (Rated Short-Time Withstand Current)
Up to 1.80	50	4.0%	10
Up to 3.61	100	4.0%	10
Up to 7.2	200	4.0%	10
Up to 11.4	315	4.0%	16
Up to 18	500	4.0%	25
Up to 28.9	1000	5.0%	40
Up to 36.1	1500	6.0%	50
Up to 48.1	2000	6.0%	65

Key requirment:

- The Rated Short-Time Withstand Current (Icw) of each switchboard must be at least 120% of the available calculated maximum Prospective Short-Circuit Fault Current (kA). This provides a safety factor of 0.83.
- The minimum values in the tables above do not account for embedded generation, generator synchronisation or motor contribution at the time of the fault. These scenarios must be incorporated in site-specific fault level calculations.
- The protection device rating shall be equal to or greater than the required Rated Short-Time Withstand Current (Icw).

Example – Short-Circuit Withstand Requirement

- Prospective short-circuit current (Ipsc): 17kA, "> 11.4 kA and ≤ 18 kA"
- Typical upstream transformer: 500 kVA, Z% = 4.0%
- Required minimum short-time withstand current (Icw, 1 s): 25 kA

5.5.5 Protection Against Switchboard Internal Arcing Fault Currents

Protection from internal arcing faults within switchboards shall be managed through two key measures:

(a) Reducing the likelihood of arc initiation

- Achieved by adopting higher separation forms and improving segregation of internal components.
- For switchboards rated above 250 A, this generally requires Form 4a, or Form 4b construction, which provides enhanced isolation of functional units and lowers the probability of fault initiation.

(b) Limiting the impact of arcing faults

- Mitigated by ensuring fast detection and automatic disconnection of faults.
- Protective devices shall be configured to clear arcing faults promptly.
- Arcing fault currents—whether phase-to-phase or phase-to-earth—are typically 30–60% of the prospective short-circuit current.
- Protection must be set to operate at levels below 30% of the calculated three-phase prospective fault current.

These requirements, consistent with AS/NZS 3000, ensure that arc faults are both prevented through proper switchboard design and contained through effective protection settings.

The primary reasons for specifying separation forms above Form 4a are to provide protection against internal switchboard arcing faults and to allow Operations and Maintenance staff to work safely within isolated compartments, without needing to isolate the entire switchboard.

The preferred order for form ratings is always the highest level, offering optimal protection, and should only be reduced when the highest form is impractical due to physical limitations (such as space constraints in brownfield sites), or where continuous operation (24/7) is not critical and full board isolation is acceptable.

Table 24: Switchboard Form rating preference Matrix

Supply Rating	≤ 100A	> 100A, ≤250A	> 250A, ≤800A	> 800A
Main Switchboard	2b	4a, 3bih[1]	4b, 4a	4b, 4a
Sub Distribution Boards	2b	4a, 3bih[1]	4b, 4a	4b, 4a
MCC (Treatment Plant)	2b	4a, 3bih[1]	4b, 4a	4b, 4a
MCC (Network)	2b	4a, 3bih[1]	4b, 4a	4b, 4a
Chlorinators	2b	n/a	n/a	n/a
L&P DBs, UPS DBs (DBO[2])	2b	3bih	n/a	n/a
Process DBs (DBO)	2b	3bih	n/a	n/a

Note 2: DBO is Distribution Boards intended to be operated by ordinary persons, as per AS/NZS 61439.3

Standard Forms of Separation (> 250A)

- The standard separation forms are Form 4b and Form 4a.
- For boards above 250 A, only these forms are acceptable.
- Alternative forms (those with “i” or “h” suffixes) are allowed, in addition to the standard form of separation, not as an alternative.

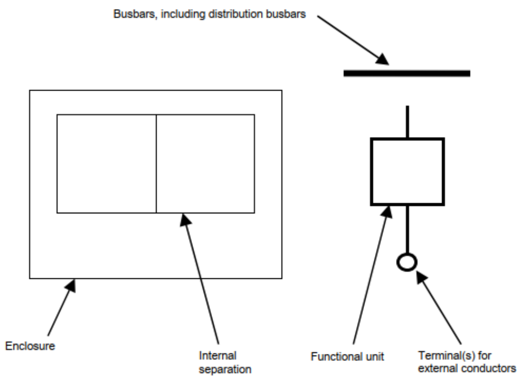
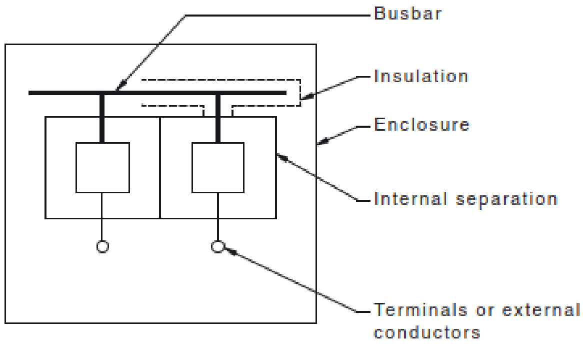
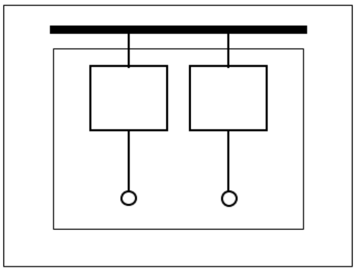
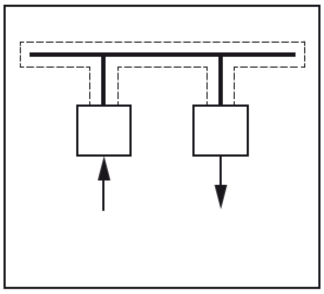
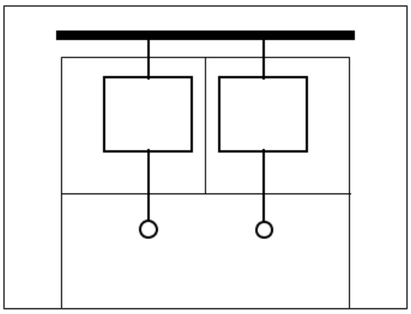
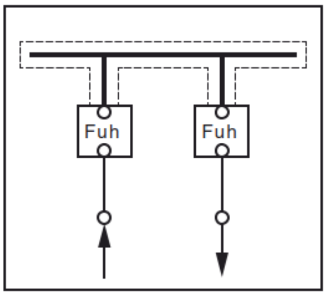
Alternative Forms of Separation (≤ 250 A)

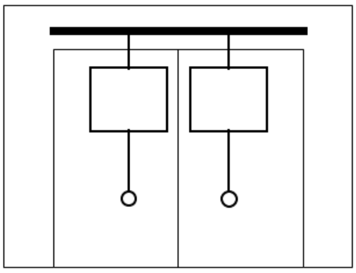
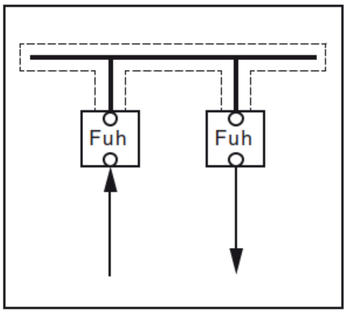
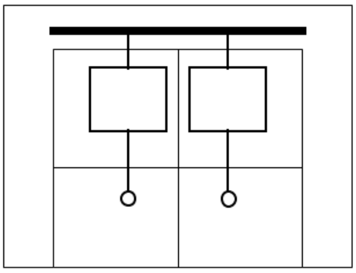
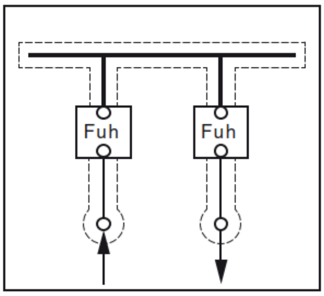
Note 1: Form 3bih may be accepted as an alternative to Forms 4a, but only for:

- boards rated ≤ 250 A, or
- distribution boards where 24/7 operation is not critical and full board isolation is acceptable (e.g., NW-SPSs, L&P DBs).

This option balances safety and cost in lower-current applications where full shutdowns are tolerable.

Table 25: Form of separation explained

Standard Forms of Separation	Alternative Forms of Separation
Legend: Extract from AS 61439.2 Annex AA  	**Legend:** Extract from AS 61439.2 Appendix ZB 
Form 2b: Terminals separated from busbars 	**Form 2bi:** Separation by insulation 
Form 3b: Terminals and external conductors separated from busbars 	**Form 3bih:** Separation by insulation and integral housing 

Standard Forms of Separation	Alternative Forms of Separation
Form 4a: Terminal in same compartment as associated functional unit 	**Form 4aih:** Separation by insulation Separation by integral housing 
Form 4b: Terminal not in the same compartment as associated functional unit. 	**Form 4bih:** Separation by insulation Separation by integral housing 

5.6 Switchboard Assemblies

Switchboards shall be designed so that common equipment shall be located in dedicated compartments within the switchboard. For example, LV power system devices shall be located in one compartment, control and communications equipment shall be located in a separate compartment.

5.6.1 Construction

Provide rigid, ventilated switchboards consisting of panels, doors, or both, giving the designated enclosure separation and the required degree of protection.

5.6.2 Materials

Internal Switchboards - constructed from 2.0 mm (minimum) cold-rolled commercial quality mild steel folded and welded construction, powder coated finish for frame and panels.

If the internal switchboard is to be located in an environment corrosive to mild steel, then the external switchboard specification as mentioned below (as first preference) or suitable material (as second preference) shall apply.

External Switchboards – constructed from 3.0 mm 5005 H34 grade aluminium folded and welded construction, powder coated finish for frame and panels.

As directed by WSA 201, all powder coating shall and designed and performed in accordance with AS 4506, with minimum pre-treatment and coating thickness requirements suitable for atmospheric corrosivity classification C4: High and C5: Very High for industrial and marine environments.

Minimum powder coating thickness for

- all indoor installations and internal parts of the switchboards: ≥60 µm
- all external installations (with direct or indirect UV exposure): ≥75 µm

5.6.3 Colours

Standard: AS 2700, Colour standards for general purposes.

Table 26: Electrical panels and control panels:

Assemblies	Colour
Indoor assemblies	Orange X15
Outdoor assemblies	Rivergum 2700 Green G62
Internal surfaces (including gear tray)	White N14
Instrumentation panels	refer to AM2832 – Instrumentation & Controls Standards. in a cabinet White N14

5.6.4 Cable Entries

To minimise the risk of water ingress into electrical cubicles, cable entry points shall be restricted as follows:

- Outdoor cubicles: Bottom entry only.
- Indoor cubicles with underfloor ducting: Bottom entry only.
- Indoor cubicles without underfloor ducting: Bottom or top entry permitted.

For bottom cable entry provide a horizontal cable zone above the switchboard plinth. The cable zone shall include a hinged lockable front panel to allow access to ground level cables beneath the switchboard.

For a bottom entry switchboard, the cabinet and any marshalling cubicle shall have a minimum 150mm (W) x 100mm (H) cable duct installed along the bottom of the gear pan. There shall be a minimum 200mm vertical clearance between the gland plate and the bottom of this cable duct. This duct shall remain empty of switchboard control wiring and shall be dedicated to field cable entries.

Cable entry area shall come ready drilled with holes for all required cables plus 30% spare capacity. The spare holes will be of various sizes to approximately match the ratios of existing holes. Unused holes will be plugged.

5.6.5 Bus Bar Access

Switchboards constructed with main bus connecting joints and cable connection terminal pads shall have the bus bar tinned where the switchboard to installed in areas subject to high concentrations of hydrogen sulphide.

Switchboards shall be designed and installed to provide safe and convenient access to main busbars for the installation of new circuit breakers, and for repairs or maintenance activities.

- Busbars shall be accessible from the front of the switchboard wherever practicable.
- Where busbars are located behind functional units or modules, access shall be provided by one of the following methods:
    - Rear access via removable covers, with a minimum clearance of 1.0 m to any wall, column, or fixed structure; or
    - Front access by removal of functional unit (MCC) covers or sections, applicable where switchboards are installed against a wall or arranged back-to-back.
- All access provisions shall comply with the requirements of AS/NZS 61439.

5.6.6 Component labels

Provide engraved two-colour laminated PVC labels fixed to equipment gear trays and control escutcheon doors to depicting component designations matching the design schematics. Labels shall not be fixed to cable ducts.

5.6.7 Multiple Supply Warning Notices

Provide warning notices stating that assemblies may be energised from more than one source i.e. generator stand-by supply, UPS or spate control supply.

5.6.8 Layout

- Position equipment to provide safe and easy access for operation and maintenance with adequate clearances at front, rear, sides and overhead.
- Optimise functional relationships between items of equipment in laying out the assembly.
- Section sizes: Limit dimensions to facilitate transport to final position.
- Withdrawable switchgear: Provide for withdrawal without opening adjacent doors.
- Withdrawable MCC compartments are not acceptable.
- Locate equipment to permit dismantling or removal without disturbing other equipment or wiring.
- Allow space for cable entry and terminations.
- Equipment shall not be installed on internal / external side walls.
- Separate ELV control terminations from MCC functional units, LV terminations and vertical busbar compartments.

5.6.9 Accessibility

Devices, which have to be operated and monitored on the Switchboard shall be easily accessible.

Equipment mounting heights above floor to the centre line of the equipment:

- Toggles and handles of circuit breakers, fused switch units and isolators on doors:
    - Wall mounted assemblies: 500 - 1900mm.
    - Floor mounted assemblies: 400 - 1900mm
- Control switches, indicating lights, meters and instruments on doors:
    - Wall mounted assemblies: 500 - 1900mm.

- Floor mounted assemblies: 400- 1900 mm.

- Emergency switching devices
  - Floor/Wall mounted assemblies: 800 - 1600mm

Control gear installed on gear trays shall be ergonomically accessible and positioned at a minimum height of 300 mm above the finished floor level (FFL).

Equipment on doors: Set out in a logical manner in functional unit groups, so it is accessible without the use of tools or keys (internal mounted switchboards only).

5.6.10 Gland Plates

Gland plates: Provide removable gland plates fitted with gaskets to maintain the degree of protection.

Gland plates shall be easily removable without obstruction from duct works. Cable shall be separately glanded.

Gland plates shall have 25% spare plate area for the future cable glands.

5.6.11 Doors

Where lids or doors in any insulating enclosure can be opened without the use of a tool or key, conductive parts shall be located behind an insulating barrier that provides a degree of protection not less than IP2X. Doors of switchrooms or other rooms dedicated to switchboards shall open in the direction of egress without the use, on the switchboard side of the door, of a key or tool.

Table 27: Doors

Requirment	Details
Width	900 mm maximum.
Door Swing	At least 120° - with positive retainer in open position. Door retainer fixed and shall not be removable without the use of tools.
Adjacent doors	Space adjacent doors to allow both to open to 90 at the same time.
Construction	Provide single right angle return on all sides and fit resilient neoprene seal to provide the degree of protection and prevent damage to paintwork. All doors exceeding 500 mm in width or 750 mm in height shall be provided with internal channel section stiffener.
Hanging	Provide corrosion-resistant pintle hinges or integrally constructed hinges to support doors. For removable doors, provide staggered pin lengths to achieve progressive engagement. Provide 3 hinges for doors higher than 1m

Table 28: Door hardware: Internal switchboards

Requirment	Details
Doors > 1.5m high	Corrosion-resistant “T” handles located at three points.
Doors <1.5m high	Corrosion-resistant "T" handles located at one or two points as applicable

Table 29: Door hardware - External switchboards

Requirment	Details
Doors > 1.4m high	Recessed handles, dual locking, top lock 100 night latch, and bottom lock 213 deadbolt.
Doors <1.4m high	Recessed handles, single lock, 100 night latch
Escutcheon Door Power Distribution:	Captive, corrosion-resistant knurled thumb screws. Thumb screws secured by ‘nutserts’ within cubicle body.
Doors > 1.5m high	Corrosion-resistant “T” handles located at three points
Doors <1.5m high	Corrosion-resistant "T" handles located at one or two points as applicable.

Table 30: Escutcheon Door Power Distribution

Captive, corrosion-resistant knurled thumb screws. Thumb screws secured by ‘nutserts’ within cubicle body.

Requirment	Details
Doors > 1.5m high	Corrosion-resistant “T” handles located at three points
Doors <1.5m high	Corrosion-resistant "T" handles located at one or two points as applicable.

Table 31: Door mounted equipment:

Protect or shroud door mounted equipment and terminals to prevent inadvertent contact with live termi-nals, wiring, or both.

Requirment	Details
Drawing pockets:	Provide internal pockets for wiring diagrams and circuit schedules.
3 point locking mechanisms	3 point locking mechanisms on all boards by means of a rods are not acceptable.

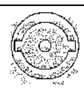
Door & Escutcheon Stays shall be proved where:

- Doors and escutcheon of enclosures dedicated to switchboards that open into a passage or narrow access way shall be capable of being secured in the open position to prevent workers being inadvertently pushed towards the switchboard.

- Doors and escutcheon of enclosures dedicated to switchboards located in outdoor areas.
- Door seals to be self-adhesive neoprene rubber. Seals incorporating metal reinforcement shall not be used.

5.6.12 Locks

Table 32: Locks

Lock	Description
External Switchboards	Network Assets i.e. waste water, water pump stations, tanks, pressure reducing stations etc. Abloy 201-cylinder locks, 5AP100 locking system keyed to M3 security level. Available from API Locksmiths.
Waste Water Treatment Plants	South East Water security level “A” key – Lockmart Frankston
Internal Switchboards	Locks keyed to standard CL001.
Locks keyed to standard CL001.	Housing cable terminations - Double bit 3mm DIN Locks 

5.6.13 Cable Ferrules

Provide suitably sized cable lugs or ferrules unless the equipment (circuit breaker, contactor, thermal overload and alike) comprise of tunnel type terminals and the conductor size is larger than 4.0mm².

5.6.14 Mounting Rails

Screw or rivet mounting rails to assembly $\leq$ 500 mm centres. Provide sufficient length to accept a further 20% terminals.

5.6.15 Terminations

Table 33: Terminations

Size	Details
Connection to circuits $\leq$ 16 mm^2	Provide DIN-type tunnel terminal blocks. Terminal blocks screw-tightened, clip-on, 35 mm DIN-type.
Connection to circuits > 16 mm^2	Provide stud-type terminals $\geq$ 5mm diameter, sized to continuously carry the load
Cables > 70 mm^2	Stud type terminals, fixed to a DIN-type or G rail.
Location:	Locate terminals to provide access for connections to outgoing terminations
Marking:	Number terminals individually to match design drawings.

Spring loaded, ‘push in’ tension clamp or self-pierce insulation terminal technology shall not be used.

All instruments shall have disconnect in the IO terminal and a knife switch at the marshalling panel, if applicable.

5.6.16 Earthing for Switchboards

- Provide continuous earth continuity to all door-mounted indicating and control devices using flexible, multi-stranded copper earth wire or braid of equal cross-sectional area.
- Neutral and earth bars shall be:
  - Continuous throughout the switchboard.
  - Sized in accordance with AS/NZS 3000 and designed for the maximum prospective fault current.
- All switchboard frames, equipment assemblies, and metallic enclosures shall be bonded to the protective earth conductor.
- Painted surfaces at bonding points shall be stripped and coated with corrosion inhibitor prior to bolting.
- Serrated washers shall be installed under all bolts and nuts at painted or structural metal-to-metal joints.

5.6.17 Neutral and Earth Links

- Configuration: One [1] neutral and one [1] earth terminal shall be provided for each spare circuit breaker pole.
- Mounting: Mount neutral links on an insulated base.
- Control circuits: Provide separate neutral and earth links.
- Labels: Provide labels for neutral and earth terminals.
- Cables > 10mm² provide bolts or studs.

5.6.18 Termination Organisation

Terminate switchboard internal wiring to one side of the terminal block, leaving the other side for outgoing circuits.

Where mixed voltages exist on common terminal rails provide oversized barriers to partition each group of terminals having different voltages.

Within each voltage partition, segregate and label terminals so that each section of terminals contains common elements as follows:

Table 34: Terminations Organisation

Device Type	Segregation	Order
Control IO	Analogue In	Alphabetical or numerical order of wire ID
	Analogue Out	
	Digital In	
	Digital Out	
Telemetry (SCADA) IO	Analogue In	Alphabetical or numerical order of wire ID
	Analogue Out	

Device Type	Segregation	Order
	Digital In	
	Digital Out	
Power Supply	ELV	Group by Battery, Instrument, Actuator or Control & Telemetry Devices
Power Supply	Single Phase LV	Group LV related to common plant / functional area or common cable size
Power Supply	Three Phase LV	Group LV related to common plant / functional area or common cable size

Provide insulating covers on terminals where voltages exceed ELV and where a degree of protection to a minimum of IP2x is required. Provide and clearly display a warning notice to prevent accidental contact by persons during service.

5.6.19 Ventilation

Provide adequate low-level inlet and high-level outlet vents at top, sides or rear of switchboards as required to keep ambient air temperature not exceed +40 °C and its average over a period of 24 h does not exceed +35 °C as per service conditions stated in AS/NZS 61439.

Provide mechanical forced ventilation for equipment where required air refresh specified rates exceed natural ventilation.

Cover ventilation openings using non-combustible and non-corroding 1mm mesh complete with replaceable dust filters (where specified) of adequate area.

All cabinet fans to be installed so filter material is replaceable without the need of a tool. e.g. fans to be installed using hinges and clips.

Forced Ventilation Design for Switchboards:

Switchboards shall be designed with a passive bottom air inlet and a fan-assisted top outlet to promote effective vertical airflow. This configuration enhances natural convection by allowing cool air to enter from the bottom and warm air to be actively expelled from the top, thereby improving internal heat dissipation and maintaining optimal operating temperatures for electrical components.

5.6.20 Equipment Mounting Trays

Shall be strong enough to support the weight of mounted equipment. Construct using 3mm mild steel plate, 15mm fold on all edges, bolted to switchboard studs. Gear tray shall be full height and width.

5.6.21 Lifting Provisions

For assemblies with shipping dimensions exceeding 1.8 m high x 600 mm wide, provide fixings in the supporting structure and removable attachments for lifting. Lifting provision shall be by flint as per approved drawing.

5.7 Switchboard General Items

5.7.1 Indicator Lights

Construction: Separate termination block and LED globe.

Colours: Unless denoted on the electrical design schematics the following lens colours shall follow. Examples not limited to.

Table 35: Indicator Light Colours (Network Sites)

Colour	Function	Application
Red	Not Operating due to Fault	Valve Closed, Motor Fault, Batching, PLC Fault
Green	Operating	Valve Open, Motor Running, Generator Running, Mixing, Dosing.
Amber	Warning or Process Fault Condition	High Level, No Flow
Blue	In Duty	Duty Available for Pumps, Blowers, Backwash, Motor Heaters

For detailed lamp color requirements, refer to the standard drawing templates applicable to Network and Treatment Plant installations.

Lamp Test Facility

Provide individual push-to-test or common test circuit.

5.7.2 Control Relays

Construction

Provide test button and energisation status indicator either light emitting diode or mechanical flag.

5.7.3 Phase Failure Relays

Provide separate solid-state phase failure relays which release at

- 85% of normal voltage; adjustable hysteresis
- single phase failure; or
- Reverse phase sequence after an appropriate time delay.

Sensing circuit: Rejects induced voltage spikes, and disturbances with frequencies other than 50Hz.

Back-up protection: Provide high rupturing capacity fuses to each phase.

5.7.4 Anti-Condensation Heaters

General

Rating: Provide heaters rated at not less than 20 W/m^2 of total external area including top of weatherproof enclosure.

Type: Black heat type which may be touched without injury, mechanically protected and thermostatically controlled.

5.7.5 Surge Protection Devices

Surge Protection Devices shall be installed as per AS/NZS 3000 Appendix F.

Primary Protection

High discharge capacity tested with an 8/20 μs waveform: 20 or 40 kA per phase.

- Lines protected L-L, L-N, L-G, N-G
- LED indication representing protection status and surge event.
- Remote contact output representing surge event.
- Modular construction per phase and neutral.

Connection

- Maximum length between main circuit supply active and associated fuse, isolator, arrestor, neutral and earth conductor connections: 1 m.
- Maximum length between earth conductor and earth grid/electrode system: 5 m.
- Minimum cable size: 6 mm^2, stranded, green/yellow PVC insulated cable installed such that it is segregated from all other cables.

5.7.6 Control of Equipment

General

Provide panel or field mounted selector switch and/or pushbuttons to determine equipment modes of operation. Typical selectable modes are: Manual - Off - Automatic. The use of proprietary keypads for example as provided on VSDs, soft starters and valve actuators shall not be used to select the equipment modes of operation. Note: Treatment Plants and Networks have different requirements. Please refer to standard drawings.

Equipment

Pumps, fans, compressors, motorised valves, solenoid valves, mixers, blowers, screws, scrapers, skimmers, conveyors and the alike.

Modes of operation

Start, stop, run, manual, jog, on, off, open, close, forward, reverse, speed up, speed down, local, remote and auto.

Location

Where practicable, position control switches within direct line of sight of the equipment to be controlled. Exceptions are remote internal motor control centres.

UV Protection

Non-metallic field control stations subject to direct sunlight shall be enclosed within a either a stainless steel or aluminium enclosure.

5.7.7 Equipment Accessories

Handle Assembly: A **stainless-steel handle kit**, including shafts and a shaft locking mechanism, shall be installed for all external handles to ensure durability and corrosion resistance.

Alignment Guides: Alignment cones shall be provided to guide the shaft back into its correct position each time the cubicle door is opened and closed, ensuring reliable operation.

Shaft Support: Where the shaft length exceeds **200 mm**, a **mechanical mid-span support** shall be installed to prevent shaft wobble and maintain alignment during operation.

5.8 Electrical Switchboard Access Labelling

5.8.1 Labelling

Provide labels on switchboard doors and escutcheons to indicate authorised access level.

Table 36: Access Labels for Switchboards

Label	Switchboard Degree Of Protection (IP Rating)	Additional Information
Authorised Person Only	min *IP2X or IP4X	Label requirements for Low Voltage switchgear and control gear assemblies intended to be installed in places where unlicensed persons require access for their use.
Licensed Person Only	Unrestricted.	Electric shock risk sign required. Access may only be gained by the use of a tool.

Note*: The degree of protection of an item of enclosed equipment is expressed as an IP (International Protection) rating, in accordance with AS60529.

5.8.2 Definitions

Authorized Person

The person in charge of the premises, appointed contractor or other persons appointed by the person in charge to perform duties on the premises, as defined in BS 2681 Working on or near Electricity Procedure.

Licensed Person

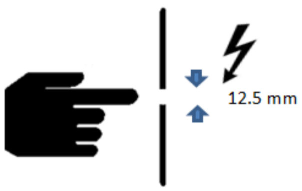
Holder of a Victorian Electrical Worker's Licence entitled to carry out low voltage electrical installation work.

Low Voltage

Exceeding 50 Va.c. or 120V ripple-free d.c but not exceeding 1000 Va.c. or 1500 Vd.c.

IP2X

Switchgear and control gear assemblies constructed such that the jointed finger shall have adequate clearance from hazardous parts. Penetrations of >12.5 mm diameter sphere not allowed.



5.8.3 Electric Shock Risk Signage

Where access to live parts is required. Attention is required for the removal of covers and the like.

In addition, a danger sign with appropriate message displayed on the enclosure of the assembly to alert person to the hazard

5.8.4 Switchboard Unlicensed Access Areas

To enable switchboard areas requiring access by unlicensed personnel to perform duties such as programming of PLC / RTUs or calibration of instrumentation, switchboards shall be designed and constructed to segregate ELV from LV such that any adjacent LV items have a minimum protection rating of IP4X from ELV accessible areas (Refer “Electrical Switchboard Access Labelling” within this document).

5.8.5 Power Monitoring

Purpose: The purpose of continuous monitoring and data logging is to support:

- Energy optimisation and management, and
- Determination of maximum demand using the measurement method.

Exceptions:

- Outgoing feeders (e.g., sub-distribution board loads) are not required to be monitored, as monitoring is performed at the switchboard incomer.
- Switchboards rated ≤100 A are not required to be monitored; maximum demand shall instead be determined using the limitation method.
- VSD outgoing circuits are not required to be monitored; energy consumption for these loads shall be obtained through VSD data via communication.

Requirement:

- Power monitoring devices shall be installed on all switchboard incoming sections with a rating greater than 100 A.
- All power monitoring devices shall be connected to SCADA and commissioned to record, at minimum: Voltage, Current, Power (kW)
- Recommended products are listed in AM2848 – Approved EIC Equipment List.

South East Water

6. Electric Motors

6.1 General

This requirement applies to single-speed three-phase squirrel-cage type, induction motors designed for use in water and wastewater applications with a rated voltage up to and including 400V. Motors shall be totally enclosed fan-cooled (TEFC) unless otherwise specified.

Excluded from the scope of this specification are motors for use in hazardous locations, where additional specific features are required.

6.1.1 Applicable Standards

Table 37: Standards

Standard	Title
IEC 60034-1	Rotating electrical machines – Part 1: Rating and Performance.
IEC 60034-2-1	Rotating electrical machines – Part 2-1: Standard methods for determining losses and efficiency from tests (excluding machines for traction vehicles).
IEC 60034-30-1	Rotating electrical machines – Part 30-1: Efficiency classes of line operated AC motors (IE code).
IEC 60050-411	International Electrotechnical Vocabulary – Chapter 411: Rotating machinery.
	Australian Government Legislative instrument: Greenhouse and Energy Minimum Standards (Three Phase Cage Induction Motors) Determination 2019.

6.2 Pump Power and Motor Sizing requirements

The electric motor driving a pump shall be sized to ensure reliable operation under all expected duty conditions. The selected motor must provide sufficient capacity above the duty point to accommodate:

- Increases in power demand resulting from higher flow rates and/or higher pressures.
- Additional power demand due to wear and increased pump clearances over time.

The sizing process shall consider both the duty power and the maximum power the pump may require (Non-Overload Power, NOL).

6.2.1 Pump Power Calculation

Pump power shall be calculated using the following formula:

$$kW = \frac{(\text{Flow } [\text{L/s}]) \times (\text{Head}[\text{mH}]) \times 9.8 \times \text{SG}}{1000 \times \eta}$$

Where:

- **Flow** = Pump flow rate (L/s)
- **Head** = Total dynamic head (mH)
- **SG** = Specific gravity of pumped liquid (typically 1.0 for water) (dimensionless)
- **η** = Pump efficiency (decimal fraction)

Note: Calculation provides a more accurate result than directly reading power off the pump curve due to pump manufacturing tolerances.

6.2.2 Motor Sizing Method

The electric motor shall be sized based on the Maximum Power or Non-Overload Power (NOL Power) that the pump may draw with the installed impeller.

- NOL Power is generally identified at the end of the pump curve.
- The selected motor shall exceed this maximum power requirement

6.3 Motor efficiency requirements

6.3.1 Minimum energy performance standard (MEPS)

Motors shall comply with the Greenhouse and Energy Minimum Standards (Three Phase Cage Induction Motors) Determination 2019.

The IEC has contributed to the definition of energy-efficient electric motor systems through the internationally relevant test standard IEC 60034-2-1 for electric motors and the IEC 60034-30-1 classification scheme comprising several levels of motor efficiency "IE, International Efficiency -code"

- IE1 Standard Efficiency
- IE2 High Efficiency
- IE3 Premium Efficiency
- IE4 Super Premium Efficiency
- IE5 Ultra-Premium Efficiency

These IE-codes serve as a reference for governments who specify the efficiency levels for their minimum energy performance standards (MEPS).

Preferred:

- Motors ≥90 kW shall meet IE5 Ultra-Premium Efficiency or IE4 (Super Premium Efficiency) where available.

Minimum SEW Requirement:

All motors from 0.75 kW to 185 kW shall comply with:

- IE3 (Premium Efficiency) rating, as defined in IEC 60034-30-1.

Exception:

- IE2 (High Efficiency) rating may be accepted for rarely operating pumps such as sump pumps (subject to approval by SEW.

6.3.2 Motor IE (International Efficiency)

Refer to Table below for minimum IE3 efficiency values by motor rating and pole count (Extract from Greenhouse and Energy Minimum Standards, dated 2019)

Table 38: Motor IE

Rated output power (kW)	50 Hz motors IE3 (min. Premium Efficiency %)			
	2-pole	4-pole	6-pole	8-pole
0.73	80.7	82.5	78.9	75.0
0.75	80.7	82.5	78.9	75.0
1.1	82.7	84.1	81.0	77.7
1.5	84.2	85.3	82.5	79.7
2.2	85.9	86.7	84.3	81.9
3	87.1	87.7	85.6	83.5
4	88.1	88.6	86.8	84.8
5.5	89.2	89.6	88.0	86.2
7.5	90.1	90.4	89.1	87.3
11	91.2	91.4	90.3	88.6
15	91.9	92.1	91.2	89.6
18.5	92.4	92.6	91.7	90.1
22	92.7	93.0	92.2	90.6
30	93.3	93.6	92.9	91.3
37	93.7	93.9	93.3	91.8
45	94.0	94.2	93.7	92.2
55	94.3	94.6	94.1	92.5
75	94.7	95.0	94.6	93.1
90	95.0	95.2	94.9	93.4
110	95.2	95.4	95.1	93.7
132	95.4	95.6	95.4	94.0
160	95.6	95.8	95.6	94.3
185	95.7	95.9	95.7	94.5

6.4 Load characteristic

The motor shall have a maximum continuous shaft power rating 15% greater than the maximum required power of the driven load and shall be sufficient to accelerate the driven machine and motor to the design full speed and to perform the specified repeated number of starts, within the limits of temperature rise of the motor.

6.5 Degree of protection

The minimum degree of protection for electrical parts of non-submersible motors shall be IP56 in accordance with AS 60529. Submersible motors shall be IP68 and shall be fitted with moisture detection sensors for both the motor winding and oil chamber.

6.6 Temperature rise

To maintain insulation life, motors shall be provided with a minimum Class ‘F’ insulation operating under a Class ‘B’ temperature rise and class ‘H’ insulation operating under a Class ‘F’ temperature rise.

- Insulation Class B Maximum winding Temperature 130°C
- Insulation Class F Maximum winding Temperature 155°C
- Insulation Class H Maximum winding Temperature 180°C

6.7 Thermistors / Resistance Temperature Detectors

PTC thermistors shall be fitted for all motors rated over 5.5kW and up to 75kW with RTDs fitted for motors greater than 75kW.

6.8 Anti-condensation

Anti-condensation heaters shall be fitted to motors rated at and over 1.0 kW which remain inoperative for >12 hours and are subject to cold temperature or high humidity. The heater shall operate when the motor is turned off to ensure and the motor temperature is held above the surrounding dew point, typically 5-10°C above ambient. Anti-condensation heaters shall automatically turn off when motor is running, and shall be isolated from the local isolator as shown on the typical schematics.

6.9 Vertical Mounting

Motors mounted vertically exposed to rain or installed where exposed to falling condensate shall be fitted with a protection cover over the fan shroud.

6.10 Connection

Motor winding configurations shall be terminated within the motor terminal box permitting a 3-wire cable connection only.

6.11 VSD-Controlled Motors (≥90 kW)

Motors greater than 90 kW shall be equipped with, Insulated bearings on the Non-Drive End (NDE) and Earthing (shaft grounding) ring on the Drive End (DE).

Motor windings shall have,

- Minimum insulation voltage rating of 1,200 V.
- Nominal operating voltage of up to 430 V.
- Withstand voltage gradient (dV/dt) ≥ 5,200 V/µs

7. Motor Starters

7.1 General

This section specifies the design and installation requirements for motor starting equipment, including Direct-On-Line (DOL) Starters, Soft Starters (SS), and Variable Speed Drives (VSDs). It applies to fixed- and variable-speed motor-driven systems used in water, wastewater, and industrial process applications.

Motor starters shall be selected based on:

- Load type and torque profile
- Site-specific requirements for energy efficiency, control, or process optimisation.

7.2 Environmental Requirements (VSDs and SS)

VSDs and electronic soft starters installed in corrosive environments (e.g. wastewater or chemical dosing areas) shall be supplied with conformal coating on all printed circuit boards (PCBs).

Equipment shall have the following minimum ingress protection (IP) ratings:

- IP54 for wall- or field-mounted units.
- IP20 or higher for units mounted inside enclosures.

Cooling requirements must be assessed during the design phase and verified during commissioning.

The ambient operating temperature must remain within the manufacturer’s specified limit, typically:

- 40°C continuous operation.
- Apply derating factors for installations above 1000 m elevation.

Air filters and ventilation systems must be easily accessible for inspection and maintenance.

7.2.1 Thermal Management and Ventilation

VSD, SS systems must be designed to maintain internal temperatures below manufacturer-specified limits.

Thermal assessment must consider:

- VSD, SS power rating and thermal output.
- Number of drives operating simultaneously.
- Size and layout of the switchboard, switchroom, or equipment housing.

Suitable thermal control measures include:

- Utilizing the internal fan of the VSD or soft starter (SS) to vent heat directly outside, where supported by the equipment design. Note: rear heatsinks must not be cut through or protrude through walls.
- Fan-forced ventilation (inlet or extraction).
- Air conditioning for enclosed environments.

- Thermal zoning or physical separation of high-heat equipment.

Where heat dissipation exceeds 50 W/m² of enclosure volume, forced cooling is mandatory.

7.3 Direct On Line (DOL) Starters

7.3.1 General

DOL starters shall be used for fixed-speed, three-phase induction motors up to and including 5.5 kW, provided the locked-rotor current does not exceed seven (7) times the full-load current.

Motors rated over 5.5 kW and above shall be started using soft starters or variable speed drives based on design requirements.

7.3.2 Design & Installation Requirements

All motors shall:

- Be nameplate rated for continuous duty.
- Deliver rated shaft power without exceeding allowable temperature rise.
- For ratings above 0.37 kW: operate on a three-phase, 415 V, 50 Hz supply.
- For ratings 0.37 kW or below: operate on single-phase, 240 V supply subject to approval from South East Water.

DOL starter assemblies shall:

- Withstand switching transients from contactor operation during motor starting and stopping.
- Be fitted with one (1) PTC semiconductor temperature sensor in each motor phase.
- Incorporate current and power transducers/meters for local and remote monitoring.
- Provide automatic restart after restoration of supply following a power outage.

Assemblies shall include:

- A motor protection relay (thermal or electronic).
- Adequate overload protection including locked rotor protection.
- Contactor and protective devices sized per duty class.
- Contactor Mechanical Endurance ≥ 3 million operating cycles

7.3.3 Standards & Compliance Requirements

DOL starters shall comply with:

- AS/NZS IEC 60947.4.1 (contactors and motor starters).
- AS/NZS IEC 60947.4.2 (semiconductor motor controllers and starters).

Duty ratings:

- Intermittent duty Class 0.1 [8–12 starts per hour; refer Clause 7.6.3(b)].
- Continuous duty category AC-3 with ≥ 10 operating cycles per hour (S value) or as required by the specified duty.
- On-load ratio (F value) ≥ 70%, or as required by the specified duty.

Type 2 coordination with short-circuit protective devices (as per AS/NZS IEC 60947.4.2).

Electromagnetic compatibility (EMC) in accordance with Clause 8.3 of AS/NZS IEC 60947.4.2.

7.4 Soft Starters (SS)

7.4.1 General Requirements

Soft starters shall be used for starting and stopping fixed-speed three-phase induction motors. Their selection shall be based on supply capacity, load type, and motor rating. As a general guideline, motors over 5.5 kW shall be fitted with soft starters unless a Variable Speed Drive (VSD) is considered more appropriate due to process or energy efficiency requirements.

Soft starters shall:

- Provide smooth acceleration and deceleration to reduce mechanical stress on equipment
- Be suitable for use in industrial applications such as water/wastewater treatment, pumping, and general motor-driven systems
- Include comprehensive motor protection and monitoring

Soft starters are suitable where:

- Variable speed control is not required.
- The load exhibits low to moderate inertia.
- Infrequent starting is expected.

Typical applications include:

- Booster pumps.
- Dewatering and stormwater pumps operating at fixed speeds.
- Sewage Pumps operating at fixed speeds.

7.4.2 Standards & Compliance

Soft starters shall comply with the following standards:

- IEC/EN 61131 (Industrial automation and control systems)
- IEC/EN 61000 series (EMC emissions and immunity)
- All SSs shall be manufactured to ISO 9001
- AS/NZS IEC 60947.4.2 including:
    - Type 2 coordination with associated short-circuit protective devices.
    - Utilisation category AC-53a or AC-53b (with bypass contactors).
    - Independent ramp-up and ramp-down periods.
    - Adequate torque provision at all stages.

7.4.3 Electrical Ratings

Table 39: Soft Starters Electrical Ratings

Parameter	Specification
Power Rating	7.5 kW to 1,400 kW (typical range)
Supply Voltage	3 × 380–690 VAC
Frequency	50 Hz
Current Rating	Up to 1,250 A (higher on request)
SCR PIV Rating	Minimum 1,200 V
Starting Duty	6 × FLC for 30 seconds

7.4.4 Design & Construction

- The soft starter assembly shall include:
  - A three-phase air-break contactor for electrical isolation
  - Line-side fuses – one per phase – to protect the power electronics
  - A semiconductor module with six (6) SCRs arranged in a full-wave bridge
  - A motor protection relay, either thermal or electronic
- For motors:
  - < 120 kW: the soft starter shall support continuous operation without external bypass
  - ≥ 120 kW: the soft starter shall be used with an external bypass contactor that does not impair monitoring or protection functionality after startup
  - Cooling: natural or forced air, depending on rating and enclosure
- Environmental Protection:
  - Minimum enclosure IP20; higher IP (e.g., IP54) or NEMA types available
  - In corrosive or humid environments, conformal coating on PCBs is required

7.4.5 Start/Stop Control Capabilities

- Control Modes:
  - Adaptive acceleration/deceleration
  - Constant current or current ramp
  - Kick-start function for high-inertia loads
  - Jog operation for slow-speed alignment
  - DC injection braking during stop (selectable)
  - Coast-to-stop, soft stop, and TVR stop
- Adjustable Parameters:
  - Initial Torque: adjustable 20–100%
  - Acceleration Ramp: 5–30 seconds

- Deceleration Ramp: 5–60 seconds
- Motor current during stop shall remain below start-up current

- Special Features (where required):
  - Pump-cleaning cycle to prevent clogging
  - Motor preheating to prevent condensation
  - Emergency Run mode under faulted conditions

7.4.6 Monitoring & Protection

- Motor & system protection functions shall include:
  - Overcurrent, phase loss, phase imbalance
  - Ground fault detection (with compatible CT)
  - Motor stall and underload detection
  - Motor overtemperature via thermistor/PTC input
- Operational Redundancy:
  - In case of partial SCR failure, the device shall be capable of operating in two-phase control mode
- Diagnostics:
  - Real-time monitoring of current, voltage, and status
  - Fault history with minimum 300 event log memory
  - Unique identification and USB data export for event review

7.4.7 Control, Monitoring & Interfaces

Table 40: Soft Starters Control, Monitoring & Interfaces

Feature	Requirement
Digital Inputs/Outputs:	Minimum 4 programmable digital inputs Minimum 2 digital or relay outputs
Analog I/O:	One analog input (0–10 V or 4–20 mA) One analog output (4–20 mA)
Communication	Modbus RTU / TCP, PROFIBUS, PROFINET, EtherNet/IP, DeviceNet, BACnet/IP
Programming Interface	USB port for parameter backup/restore Optional software tool for advanced configuration and diagnostics

7.4.8 User Interface

- Local Control Panel (LCP):
  - Graphical multi-line LCD display
  - Supports Quick Setup and Advanced parameter views

- Password protection for critical configuration changes

- Remote access (optional):

Wired or wireless panel extension for external cabinet mounting

7.5 Variable Speed Drives (VSDs)

7.5.1 General

VSDs shall be suitable for controlling three-phase squirrel cage induction motors in water, wastewater, and industrial applications, offering reliable speed control, motor protection, and energy optimisation. As a general guideline, motors over 5.5 kW shall be fitted with Variable Speed Drive (VSD).

- Drives shall be matched to motor/load torque profiles, with selectable control modes for quadratic or constant torque loads.

7.5.2 Standards & Compliance

VSDs shall comply with the following standards:

- IEC 61800-5-1,
- IEC 61800-3,
- AS/NZS 61000, series (EMC emissions and immunity)
- CE, UL, cUL, and RCM marked.
- All VSDs shall be manufactured to ISO 9001

7.5.3 Electrical Ratings

Table 41: VSD Electrical Ratings

Parameter	Requirement
Voltage Range	690 V AC, 3-phase
Power Rating	0.25 kW to 1,400 kW (typical range)
Frequency	50 Hz input; 0–590 Hz output
Cable Length Support	Up to 100 m shielded without derating
Control Modes	V/f, Sensorless Vector, Closed-loop
Efficiency	≥96% at rated load
EMC / RFI Compliance	IEC 61800-3 C2 or better
Enclosure Options	IP20 to IP66 / NEMA 1, 12, 4X
Harmonics Compliance	THDi ≤ 5%, AS/NZS 61000.3.6 compliant
Interfaces	DI, DO, AI, AO, USB, Fieldbus
Monitoring & Protection	Comprehensive fault/diagnostic logging
Overload Capacity	110% for 60s (Normal); 150% for 60s (Heavy Duty)
Power Factor	≥0.95 displacement; ≥0.90 total

Ramp Control	Independent ramp settings (up to 3 configurable)
Safety Features	STO input, earth leakage protection
Software Support	USB & PC interface, backup, diagnostics
Starting Torque	≥110% (quadratic), ≥160% (constant torque drives)

7.5.4 Enclosure & Environmental

- Enclosure Options: IP20, IP54
- Cooling: Back-channel or forced air, based on rating
- Ambient Temp: −25 °C to +50 °C without derating
- Humidity: 5–95% RH, non-condensing
- Altitude: Up to 1,000 m without derating
- Conformal coating of PCBs shall be provided for corrosive or humid atmospheres

7.5.5 Control, Monitoring & Interfaces

Table 42: VSD Control, Monitoring & Interfaces

Feature	Requirement
Manual Control	Panel-mounted 10-turn potentiometer (Network VSDs as per Standards drawing template) + local/remote switch
Auto Control	4–20 mA and digital signal compatibility
Digital Inputs	Min. 6 (programmable, PNP/NPN selectable) Thermistor input for motor thermal protection
Dual-channel STO input	24VDC, minimum SIL 2/PL d
Digital Outputs / Relays	Min. 2 (status, alarms, fault)
Analog Inputs	Min. 2 (0–10 V / 4–20 mA)
Analog Outputs	Min. 1 (0/4–20 mA)
Fieldbus Support	PROFINET
User Interface	6-line display, parameter backup, RTC timer
Software	USB/PC interface for setup, backup, and diagnostics
key functions	Start/Stop, forward/reverse, Basic parameter programming, Display of operating status, Fault indication and reset capability

7.5.6 Application Features

- Pump Control: De-ragging, dry-run detection, end-of-curve, pipe-fill, and no-flow shutdown.

- Energy Monitoring: Real-time power, kWh tracking, and reporting.
- Enable Energy optimisation mode that
  - Continuously monitor motor load
  - Reduces magnetising current when demand is low
  - Maintain stable torque
- Protection Functions:
  - Over/under voltage
  - Phase loss/imbalance
  - Overload, stall, ground fault
- Diagnostics: Fault log (≥10 events), trend logging, and local display alarms

7.5.7 EMC & Cable Requirements

- Comply with IEC 61800-3, Category C2 or better
- Screened motor and control cables required
- Shielding must be earthed at both ends
- EMC filters shall be built-in and rated for up to 100 m motor cable
- Correct EMC glands must be used for screened cable terminations, bonded to earth using 360 degree low impedance terminations

7.5.8 Harmonic Compliance

- All drives shall include minimum 3% line reactor or DC choke
- Total Harmonic Current Distortion (THDi) shall not exceed 5% at full load
- Design and installation must comply with AS/NZS 61000.3.6
- Additional mitigation (e.g. Active Harmonic Filters) required where site-level harmonics exceed utility limits

7.5.9 Safety & Fault Management

- STO (Safe Torque Off) circuit input (SIL2/SIL3)
- Earth fault protection: ELR or toroid-based with Class B trip functionality
- Protection must include:
  - Open circuit/load disconnection
  - Loss of input power or one phase
  - Output short circuit
  - Motor regeneration / turbining conditions
- Electronic shear pin protection for critical processes

7.5.10 Installation & Control Panel Requirements

- Drives shall be installed in ventilated compartments or MCCs with airflow/fan operation triggered by motor run signal

- Dust filters must be externally replaceable
- If motor speed <25 Hz continuously, external cooling fans are mandatory
- Control cubicles must:
    - Comply with AS/NZS 61439.1
    - Be IP54, vermin/dust proof
    - Include 24 V DC I/O, PLC interface, and LED lighting
    - Be fabricated from 2 mm steel, fully welded

7.5.11 Earthing for VSDs

Where variable speed drive fed motor cables are installed, the VSD manufacturers' installation recommendations shall be followed. This will typically include grounding of the cable at both ends, the use of braided earth straps between the VSD and the earth bars, the use of screened cable with appropriate earthing rings and metallic glands.

7.5.12 RFI Suppression

- All VSDs shall incorporate EMC filters tested to meet local regulations
- Compliance with AS 61800-3, Category C2 minimum
- Cabling and grounding must follow best practice to reduce RFI

7.5.13 Operational Range and Hydraulic Stability

Minimum operating frequencies shall be:

- ≥ 40 Hz for raw sewage pumps.
- ≥ 25 Hz for general water applications.

Systems designed to operate below 25 Hz continuously must be fitted with forced cooling fans, either motor-mounted or external.

VSD-driven pumping systems must:

- Maintain stable pressure and flow under all load conditions.
- Avoid hydraulic instability, surging, or cavitation.

Be supported by PID tuning, flow damping, or valve modulation where applicable.

7.6 Active Harmonic Mitigation

7.6.1 General

The equipment shall incorporate harmonic mitigation technology to minimise the generation and transmission of current harmonics into the supply network. Harmonic mitigation shall be applied at the point of conversion so that harmonics are addressed at the source, rather than relying solely on external filtering.

- As a preference, Variable Speed Drives shall be of the Low Harmonic type, incorporating an integrated Active Front End (AFE) rectifier and input harmonic mitigation. The drive shall be designed to reduce the creation and injection of harmonic currents into the supply system.

- As a standard minimum, where installation of low harmonic drives is not feasible, standard VSDs may be used, provided that a common Active Harmonic Filter is installed at the main switchboard or at distributed MCCs to achieve equivalent harmonic mitigation performance.
- Passive filters or traditional Power Factor Units are not permitted (unless approved by SEW) on new installations.
- Harmonic limits shall comply with AS/NZS 61000 series, IEC/TR 61000.3.6, and the Electricity Distribution Code of Victoria (2022).
- Utility consultation shall be undertaken prior to installation of power factor correction equipment. Exemptions may apply for small VSD installations where harmonics remain within limits.

7.6.2 Standards

- AS/NZS 61000 Parts 3.2, 3.3, 3.5, 3.6, 3.7
- IEC 61000-4-6, IEC 61000-6-2, IEC/TR 61000.3.6
- Electricity Distribution Code of Victoria (2022)
- Devices must be RCM/CE certified for EMC and comply with DNSP requirements.

7.6.3 Application

Install AHM where:

- Non-linear (Inductive) load per switchboard >50 kW; or
- Predicted THDv >3% or THDi >10%; or
- Required by SEW/DNSP.
- Systems shall maintain THDv ≤5% at PCC and THDi ≤5% at installation.

7.6.4 Sizing & Design

- Harmonic study required at design stage.
- Size for compliance at both switchboard and PCC.
- With AHF, Provide at least 25% spare filtering capacity for future load growth or system expansion.
- The study shall be signed off by a Registered electrical engineer, with results submitted as part of the electrical design approval.

7.6.5 Technical

- Compensate up to 50th harmonic order.
- Provide PF correction (lag/lead).
- Operate continuously up to 45 °C.
- Protection: overload, temperature, voltage.
- Monitoring: self-diagnostics, alarms, HMI/SCADA interface.

7.6.6 Installation

- Centralised (main board) or distributed (MCCs).
- Enclosures min. IP54 (IP55 outdoors).
- Maintain EMC cabling and ventilation clearances.
- Refer to AM2848 – Approved EIC Equipment List

7.6.7 Commissioning

- Verify THDi/THDv before and after installation.
- Record compliance under load variation.
- Integrate alarms and logs into SCADA.
- Submit: final study, test results, datasheets, drawings, service instructions.

8. Electric Valve Actuators

8.1 General

- Electric actuators shall be suitable for operating valves and penstocks in water, wastewater, and corrosive service environments.
- Protection rating: Minimum IP68, including motor, gearbox, and internal controls, suitable for submersion up to 8 m for 96 hours.
- Rated for continuous duty, with no back-drive or creep under static load.
- Environmental tolerance:
  - Ambient temperature: –20 °C to +70 °C (unless otherwise specified)
  - High humidity, UV exposure, salt fog, and aggressive sewer gases
- Actuators must be capable of:
  - 20 starts/hour (part-turn)
  - 50 starts/hour (multi-turn)
  - 600 starts/hour (modulating)
- Duty cycles:
  - 2-position duty: S2-15min
  - Modulating duty: S4-25%, per IEC60034.1

8.2 Mechanical Requirements

- Enclosure: Cast aluminium alloy or ductile cast iron, corrosion-resistant epoxy-coated.
- All removable covers shall have captive stainless-steel screws and O-ring seals.
- Self-locking in all positions without need for additional mechanical brake.
- Manual Operation:
  - Integral handwheel with clutch mechanism to prevent simultaneous electric and manual engagement.
  - Automatic disengagement of manual mode when motor starts.
  - Max handwheel operating force: <160 N
- When installed horizontally, hand wheels shall be at a height between 1100 mm and 1300 mm from the walkway or access platform level. If installed vertically, the handwheel centreline shall be 1000 mm to 1400 mm above the walkway or access platform level. This height may be achieved by appropriate length of shaft on the handwheel.
- Mechanical position indicator: Graduated dial and pointer, showing % open/closed.
- External fasteners: 316 SS, with 304 SS nuts.
- Spare drive nut to be provided

8.2.1 Gear System

- Fully enclosed and permanently lubricated-for-life gear system.

- Reduction through hardened steel worm and bronze/cast iron worm wheel.
- Bearings: Anti-friction roller or thrust bearings as required.
- Seals: Provided on all shaft penetrations to maintain enclosure integrity.

8.3 Motor and Electrical Requirements

8.3.1 General

- Motor: Integral, 3-phase, 400 V ±10%, 50 Hz ±2%, squirrel cage induction motor.
- Insulation: Class F, with temperature rise limits per IEC60085.
- Over-temperature protection:
  - Embedded PTC sensors in all windings.
  - Tripping via relay at 155 °C.
  - Capable of withstanding instantaneous reversal at any travel point.
- Power factor: ≥ 0.8
- Output: ≥ 15% in excess of required torque at any operating condition.
- Equipped with a self-regulating anti-condensation heater, with heater failure alarm.

8.3.2 Integral Starter and Controls

- Modular reversing starter (DOL), compliant with AS 60947.4.1 / 4.2.
  - Contactor: AC-3
  - Semiconductor: AC-53b
  - Min 10 million no-load operations.
- Modular design allowing field to replacement/retrofit of starter and communication modules.
- Actuators must retain last state on power loss but return to SCADA-controlled mode on recovery.
- Field-local control selector: LOCAL – OFF – REMOTE, with push buttons: OPEN – STOP – CLOSE – RESET, lockable for safety.

8.3.3 Communications and SCADA Integration

- Wireless Bluetooth interface for actuator setup and retrieving operational diagnostic information. In addition to wireless we should support USB.
- Protocol: Industrial Ethernet using Profinet (default); Where supported HART protocol can be used for configuration and diagnostics, but not for process control or operational data.
- Additional features:
  - Bluetooth interface for wireless commissioning and diagnostics
  - LCD graphic display with clear visibility in full sunlight and vandal-proof cover
  - Real-time viewing of: configuration, torque profile, operational logs, fault status

- Fail-safe logic for communications:
- Actuator behaviour must be configurable for maintained vs non-maintained on comms loss.
    - Actuators must allow SCADA to enable/disable local controls.
    - Optional: “Fail open” or “fail close” configuration with adjustable delay timer.
    - Comms loss response: Should allow actuator to complete travel if "maintained", or stop if "non-maintained", and followed up with a “global reset”.

8.3.4 Input/Output Signals and Fault Monitoring

- Analog Input Signal (to actuator): 4–20 mA position setpoint (for modulating control).
- Analog Output Signal (from actuator): 4–20 mA internally powered feedback signals:
    - Valve position feedback (4–20 mA)
    - Actuator torque feedback (4–20 mA)
- Digital Inputs (to actuator):
    - Open/close commands
    - Fault Reset
    - Enable/Disable Valve operation (optional)
- Digital Outputs (from actuator):
    - Fully Open/close positions
    - Fault
    - Healthy
    - Limit reached
    - Torque trip
    - Mode: LOCAL – OFF – REMOTE
- Common fault relay (0.5A, 24 V DC), indicating collective faults including:
    - Power failure
    - Incorrect phase/phase loss
    - Motor over-temp
    - Torque switch trip
    - Thermal switch trip
    - Fault and alarm conditions available via digital outputs and Profinet.
- Fault relays shall de-energise under fault conditions (fail-safe).
- LCD Display
    - LCD graphic display to view actuator configuration, torque profiles, status, service alarms, name plate data and operational logs accessible. Display clearly visible under all lighting conditions.
    - LCD display and controls fitted with a factory fit cast vandal proof cover

8.3.5 Limit and Torque Switches

- Limit switches:
  - Factory installed, geared, and adjustable from actuator front
  - IP68 sealed, brass-constructed, no exposed contacts
  - 2x voltage-free contacts (0.5A, 24V DC) for fully open/closed signals
- Torque switches:
  - Independent adjustable switches in both directions
  - Stop motor without latching out opposite direction
  - Rated at 0.5A, 24V DC
  - Constructed from brass; plastic not permitted unless approved
  - Actuators must be selected to provide sufficient torque and duty required for safe valve operation.
  - Actuator output torque must be available at 90 % of nominal voltage

8.3.6 Terminal Connections

- Plug/socket or terminal strip must be IP67 (or IP68 where specified), integrally mounted.
- Indexable design for cable entry flexibility.
- All signal, control, and power wiring must be terminated in multi-pin connectors to facilitate quick disconnect during maintenance.

8.3.7 Power and Controls for Actuator

- Actuator power and control wiring shall comply with the latest standard drawings E-SRP-STD-005. (Treatment Plants)
- Each valve shall have isolation and control equipment located within a dedicated MCC compartment, unless otherwise approved.
- Where actuated valves are non-critical to process operations, a shared distribution board (DB) may be used, provided that common DB outages will have minimal operational impact.
- The selection of individual MCC compartments or a shared distribution board shall be determined by the operational criticality of the valve.

8.4 Identification and Accessories

Engraved stainless-steel nameplate affixed to actuator showing:

- Manufacturer, Model/Serial, Year
- Electrical specification
- Torque output and speed
- Handwheel ratio
- IP Rating

- Spare boss keys and spare actuator drive coupling (with serial) for each valve/actuator combination

8.5 Remote Hand Station Installation Requirements

Actuators must be equipped with a hand wheel for manual operation. Remote hand stations shall be provided where actuator-mounted controls are located in positions that do not meet OH&S access requirements, including but not limited to below-ground chambers, confined spaces, elevated installations, or hazardous environments. Remote stations shall be installed at a safe and accessible location outside the hazard zone, at an ergonomic operating height of approximately between 500mm –1.7 m above floor level.

8.6 Spares

Provide a spare actuator drive coupling (& serial number) for each unique actuator valve assembly.

9. Battery Backed Up Power Supplies

9.1 General

Battery backed up power supplies normally fall in to two categories:

DC Power Supplies: 230V AC charged batteries which supply 24V DC power to all control, instrumentation, protection and communications devices at both Network Facilities and Treatment Plants. Where a 48V or 12V DC supply is required, it shall be provided via a connection to the 24V DC Power Supply system with a 24V to 12V DC or 24V to 48V DC converter.

Uninterruptable Power Supplies (UPS): Treatment facility 230V AC charged batteries which supply uninterruptable power to critical 230V AC devices such as SCADA clients, servers and computers used to operate the plant.

Typically, Treatment Plants will have both a DC Power Supply and a UPS, with the DC Power Supply supplied by the UPS.

In either case, the battery backed up power supply shall when fully charged, on loss of mains supply be capable of supplying the connected load for 4 hours back up time on full load to 80% depth of discharge. The battery storage capacity required shall be calculated based on the expected demand with all IO on and at the worst case “i.4-20mA loops at 20mA and all outputs on”. Calculations on the storage capacity shall be supplied to SEW at the design stage.

9.2 DC Power Supplies

All batteries used in DC Power Supplies shall be 12V. Network Facility DC power supplies shall typically be integrated into the main switchboard. In such cases, the DC battery charger, battery(s) and DC power supply shall be contained within the controls compartment of the main switchboard. Treatment Plant DC power supplies shall typically be provided as an off the shelf self-contained unit in a single cabinet, separate from other switchboards.

9.3 Battery Enclosures

Larger batteries (i.e; ≥ 50 A hr) shall be separately installed from electronic components in a ventilated enclosure. The layout of batteries inside enclosures shall be such that all battery terminals and cells are easily accessible for examination of the electrolyte level, topping up, cleaning and replacement.

9.4 UPS

UPS systems are typically only required at Treatment Plants and shall be used to supply continuous bumpless power to SCADA clients, servers and computers used to operate the plant. UPS systems shall typically be provided as an off the shelf self-contained unit in a single cabinet, separate from other switchboards.

A Low Voltage Disconnect (LVD) function shall be incorporated into the unit to protect the batteries against excessive discharge. Upon activation of the Low Battery alarm and when the mains supply is unavailable, the PLC and other connected devices will initiate a orderly shutdown of the connected equipment where possible.

In the event of battery bank failure provision of D.C. voltage at specified level shall remain available to the D.C. load circuits direct from the charger.

9.5 UPS Static Bypass

A static bypass switch shall be provided to effect an automatic no-break transfer of load from the UPS supply to the bypass supply in the event of an equipment malfunction or overload.

Following operation of the static bypass switch due to an overload, the load shall be automatically restored to the UPS when normal conditions return. For any other cause, restoration to normal conditions shall require manual operation. Transfer of load to the automatic bypass shall be inhibited when the UPS output is not in synchronism with the bypass supply.

9.6 UPS Maintenance Bypass

A manual maintenance bypass switch shall be provided for online transfer of the load from the UPS to mains supply for maintenance purposes. The maintenance bypass shall be interlocked with the static bypass such that the maintenance bypass is only operable when the static bypass is in service and the 2 supplies can be connected in synchronisation.

9.7 UPS Indications

The following indications shall be provided on the UPS unit as a minimum:

- Mains on
- Charger on float
- Charger on charge
- Charger on boost
- Inverter on
- Static bypass on
- Maintenance bypass on
- UPS fault
- Overload
- Battery volts low

Monitoring voltage free contacts shall be made available to interface to the PLC/RTU system. Any of the above alarms are to be able to be assigned to the configurable contacts.

9.8 UPS Indicating instruments

The following operating values be provided via individual meters or an LCD display:

- Inverter output AC volts
- Inverter output AC amps
- Inverter output frequency
- Battery charger DC volts
- Battery charger DC amps
- Rectifier input AC volts

9.9 Commercial Grade UPS Units < 5kVA rating

It is acknowledged that for small ratings full industrial grade units are not cost effective in the longer term and thus commercial grade units are acceptable. The concessions from the previous clauses apply to UPS units of rating less than 5kVA.

10. Arc Flash Design Requirements

10.1 General

The purpose of this section is to ensure that electrical assets across SEW-operated sites are designed and maintained to be safe, cost-effective, and serviceable for both South East Water (SEW) personnel and contractors.

This section outlines two key requirements:

1. **Arc Flash Assessment** – Establishing the process and criteria for conducting arc flash assessments in accordance with IEEE 1584, using approved software tools.
2. **Engineering Controls and Design Requirements** – Defining minimum design requirements for electrical switchboards to limit incident energy exposure and support safe operation.

10.1.1 Arc Flash Assessment Criteria

It is recommended by Australian Standards (specifically AS/NZS 4836 - Safe working on or near low-voltage and extra-low voltage electrical installations and equipment) that a person conducting a business or undertaking (PCBU) with high current equipment should complete an arc fault study as part of their hazard identification and control process.

For all new installations or modifications, an arc flash engineering assessment must be carried out for all low-voltage switchboards (≥400VAC) with the supply rated over above >63 Amps, or where the prospective short-circuit current at the incoming terminals exceeds >2 kA, or if the system includes a dedicated main or alternative supply greater than 50 kVA. The assessment should ensure arc flash energy control and protection measures at all possible fault locations within the switchboard.

10.1.2 Applicable Standards

The following International and Australian standards are referenced:

Table 43: Standards

Standard	Title
AS/NZS 4836	Safe working on or near low-voltage and extra-low voltage electrical installations and equipment
IEEE 1584:2018	IEEE Guide for Performing Arc-Flash Hazard Calculations
NFPA 70E	NFPA 70E “Standard for Electrical Safety in the Workplace
AS 60076.5	Power transformers Ability to withstand short circuit
AS 1319-1994 REC:2018	Safety signs for the occupational environment

10.1.3 PPE Categories – Based on NFPA 70E (2018)

NFPA 70E (2018) defines four Personal Protective Equipment (PPE) categories ranging from Category 1 to Category 4. Two additional categories have been adopted by South East

Water defined to correspond to low (Category 0), or extreme (Category 4+) arc flash hazards.

Although Category 0 is not officially defined in the standard, it has been adopted by South East Water for practical use in cases where incident energy is < 1.2 cal/cm².

Category 4+ corresponds to an extremely dangerous arc flash hazard more than 40 cal/cm². In this case, the PPE necessary to mitigate the hazard may not be practically available, and as such additional controls are required.

Table 44: PPE Categories per NFPA 70E (2018)

PPE Category	Incident Energy (cal/cm²)
Min. CAT 0	<1.2
Min. CAT 1	≥ 1.2 to < 4
Min. CAT 2	≥ 4 to < 8
Min. CAT 3	≥ 8 to < 25
Min. CAT 4	≥ 25 to < 40
DANGEROUS (CAT 4+)	≥ 40

Figure 7: Incident Energy Levels

10.2 Engineering Controls and Design Requirements – Arc Flash Mitigation

Arc Flash Analysis must be carried out for all switchboards including equipment types such as “Switchgear, Motor Control Centres (MCCs) and Cable Junction Box” in accordance with the latest editions of IEEE 1584 and NFPA 70E standards. The analysis shall be conducted via system modelling and consider worst-case operating scenarios.

All relevant energy sources must be included in the model, including but not limited to:

- Utility grid supply
- Alternate/backup supplies (e.g., diesel generators, solar PV systems, cogeneration units)
- Motor contributions ≥ 37.5 kW

The target arc flash incident energy level for all boards must be as low as reasonably practicable and not exceed Category 2 (8 cal/cm²). If higher energy levels are unavoidable, prior approval from SEW must be obtained, and proposed risk mitigation strategies must be formally accepted before procurement or installation.

10.2.1 Mitigation Measures (Hierarchy of Controls)

Arc flash mitigation strategies shall follow the hierarchy of control and include, but not be limited to, the following design measures:

- Remote operation and racking of ACBs and switchgear to eliminate operator exposure.
- Arc flash detection systems with current confirmation to enable high-speed protection tripping.
- Protection settings review to reduce fault clearance time; any changes impacting grading must be submitted to SEW for approval.
- Maintenance mode functionality on protection relays to activate instantaneous tripping during service, with alarms to ensure timely deactivation post-maintenance.
- Zone-Selective Interlocking (ZSI) to ensure the nearest ACB trips rapidly, reducing arc energy even under time-delayed protection settings.
- Upstream protection design coordination, where applicable, using DNSP protection to reduce incident energy at the incoming side.

10.2.2 Design Requirements

- Incoming circuit breakers ≥ 800A shall be Air Circuit Breakers (ACBs) with full remote switching and racking capabilities to avoid operator exposure to arc flash hazards during normal or emergency operation.
- Protection settings shall be configured to limit incident energy to below Category 2, or in alignment with the fault level and supply characteristics, without compromising discrimination.
- Where the incomer cannot be fully arc-controlled, apply high-integrity phase conductor insulation and provide clear labelling:
    - Apply standard arc flash labels to the downstream section
    - Apply “Danger – Do Not Access While Energized” label on the incomer section
    - Include incomer-specific arc flash category and associated mitigation rationale in the arc flash report

10.2.3 Physical Construction Requirements

- If external arc blast chutes or vents are used, clear signage must restrict personnel access during operation. These vents must discharge safely outside the board or building.
- If multiple board sections have different arc flash categories and mutual arc containment has been verified, cableways must be designed so they do not compromise segregation.
- All incoming and outgoing feeders must be protected from accidental contact, including dropped tools or conductors.
- Minimum segregation ratings:
    - Between modules and between modules and busbars: IP4X
    - Between modules and cable zones: IP2X
    - Vertical segregation to prevent object fall-through: IP4X

10.2.4 Main Switchboards

- Main switchboards are typically standalone units and may include main and emergency circuit breakers, generator inputs, transfer switches, metering, and MEN links.
- They must be rated to withstand the highest possible network fault level and be arc fault contained, with a maximum arc flash energy rating below 40 cal/cm² (Category 4), but preferably below 8 cal/cm² (Category 2 or lower), as detailed in the table below.
- If Category 4 or lower cannot be achieved due to upstream device limitations, the designer must coordinate with the utility to modify or replace the protective device to reduce risk.
- Maximum Permitted Arc Flash Category Ratings for Main Switchboards are detailed in Table below.

Table 45: Maximum permitted arc flash category rating for Main Switchboards

Main Switchboard Supply Rating	Supply Authority Incomer Side (with doors open)	Non-Incomer Side (with doors open)
≤ 250A	CAT 0 (<1.2 cal/cm²)	CAT 0 (<1.2 cal/cm²)
> 250A, ≤ 800A	CAT 2 (< 8 cal/cm²)	CAT 1 (< 4 cal/cm²)
> 800A, ≤ 2000A	CAT 4 (< 40 cal/cm²)	CAT 2 (< 8 cal/cm²)

10.2.5 Distribution Switchboards (>250A)

- Distribution switchboards are usually standalone and supply various plant loads. Where integrated into larger boards, they must be sealed or have insulating barriers.
- Arc flash control requirements are determined by site-specific assessments, targeting < 4 cal/cm² (Category 1) or < 8 cal/cm² (Category 2), as detailed in this section.
- Typical loads include local distribution boards, MCCs, control panels, process equipment, and UPS systems.

10.2.6 Motor Control Centres (MCCs)

- MCCs are standalone units with main breakers, metering, motor control gear, and control system interfaces.
- Arc flash control is based on site assessment, aiming for < 4 cal/cm² (Category 1) or < 8 cal/cm² (Category 2), as detailed in the table below.
- VSDs should be IP54 and, where possible, mounted externally to the switchboard.
- Multiple MCCs should be considered if:
  - Category 1 or 2 cannot be achieved with a single board
  - Demand exceeds 800A
  - Board length complicates logistics
  - Redundancy or future replacement is beneficial

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10.2.7 Distribution Boards/Sections ≤ 250A

- These boards, often accessed by non-electrical personnel, must be limited to 250A and protected by a 250A breaker in the upstream board.
- Arc flash energy must be < 1.2 cal/cm² (Category 0), allowing safe access with standard (non-Arc rated) PPE.
- For sections accessible to unlicensed personnel, protection must be at least IP2X (2.5 mm holes, 100 mm from live parts), and all accessible cables must be double insulated to AS/NZS3000.
- Maximum Permitted Arc Flash Category Ratings for Distribution Boards

Table 46: Maximum permitted arc flash category rating for DBs

Distribution Switchboard Supply Rating	Incomer Side (with doors open)	Non-Incomer Side (with doors open)
≤ 250A	CAT 0 (<1.2 cal/cm²)	CAT 0 (<1.2 cal/cm²)
> 250A, ≤ 800A	CAT 1 (< 4 cal/cm²)	CAT 1 (< 4 cal/cm²)
> 800A, ≤ 2000A	CAT 2 (< 8 cal/cm²)	CAT 2 (< 8 cal/cm²)

10.3 Design Process

10.3.1 Arc Flash Engineering Standards

The arc flash study methodology and outcomes must comply with the latest versions of IEEE 1584:2018 “Guide for Performing Arc-Flash Hazard Calculations” and NFPA 70E “Standard for Electrical Safety in the Workplace.

10.3.2 Software Tool

All arc flash calculations are to be performed using SKM Power Tools for Windows (PTW) Version 11 or higher. Use of PowerCAD5 may be permitted as an alternative.

10.3.3 Arc flash analysis locations

There are three general locations on a main switchboard where an arc flash could occur:

- Location 1 (Incomer) – Incomer terminals on the line side of the incomer protection.
- Location 2 (Non-Incomer) – Terminals, main busbars and droppers located between the main incoming protection and the outgoing feeder protection.
- Location 3 (Non-Incomer) – Feeder terminals on the load side of the outgoing feeder protection.

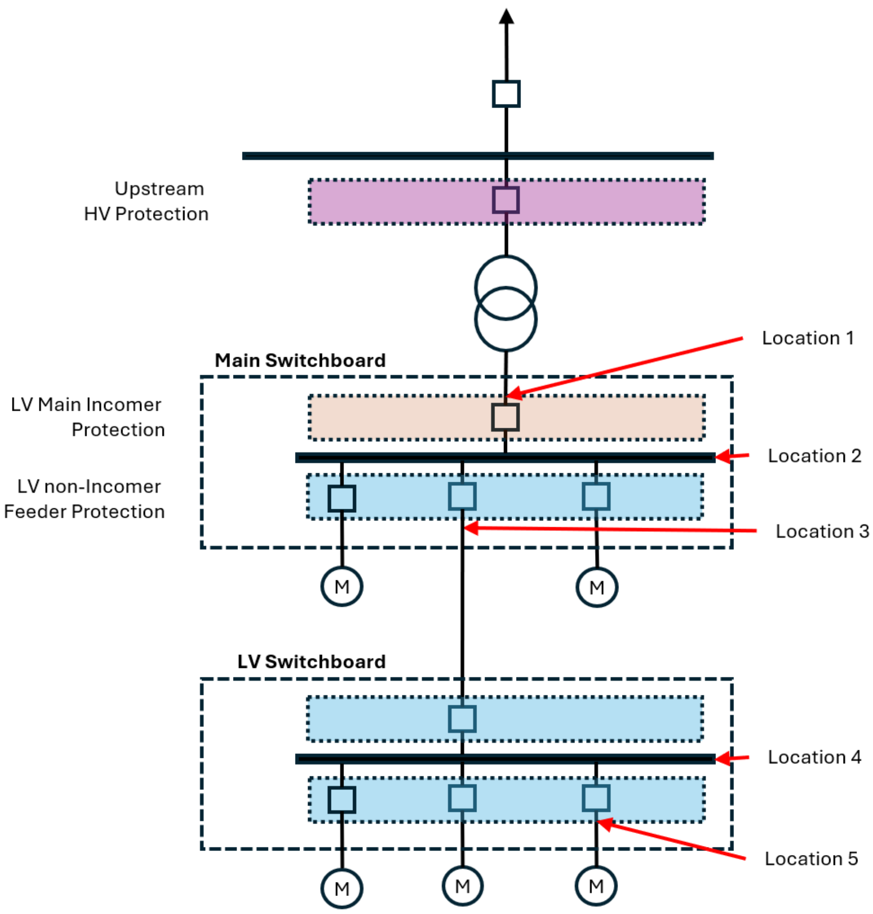

Figure 8: Arc Flash Assessment Locations

Arc flash incident energy varies across the multiple locations due to the involvement of different protection devices, each with distinct operating times. Typically, upstream (remote) feeder protection is coordinated with the switchboard's incoming protection, which is further graded with the outgoing feeder protection. This results in the following severity profile:

- Location 1: Protected by the upstream feeder device, which has the slowest response. This results in the highest incident energy, as the arc is interrupted after the longest delay.
- Location 2: Protected by the switchboard's incoming device, which operates faster than the upstream protection. Consequently, the incident energy is lower than at Location 1.
- Location 3, 4 & 5: Protected by the outgoing feeder device, which responds the fastest. This results in the lowest incident energy compared to Locations 1 and 2.

Arc flash assessments must be conducted at both Location 1 and Location 2. For Locations 3, 4, and 5, calculations are required where protection devices are rated over 63 A or above, or where the prospective short-circuit current at the location exceeds 2 kA.

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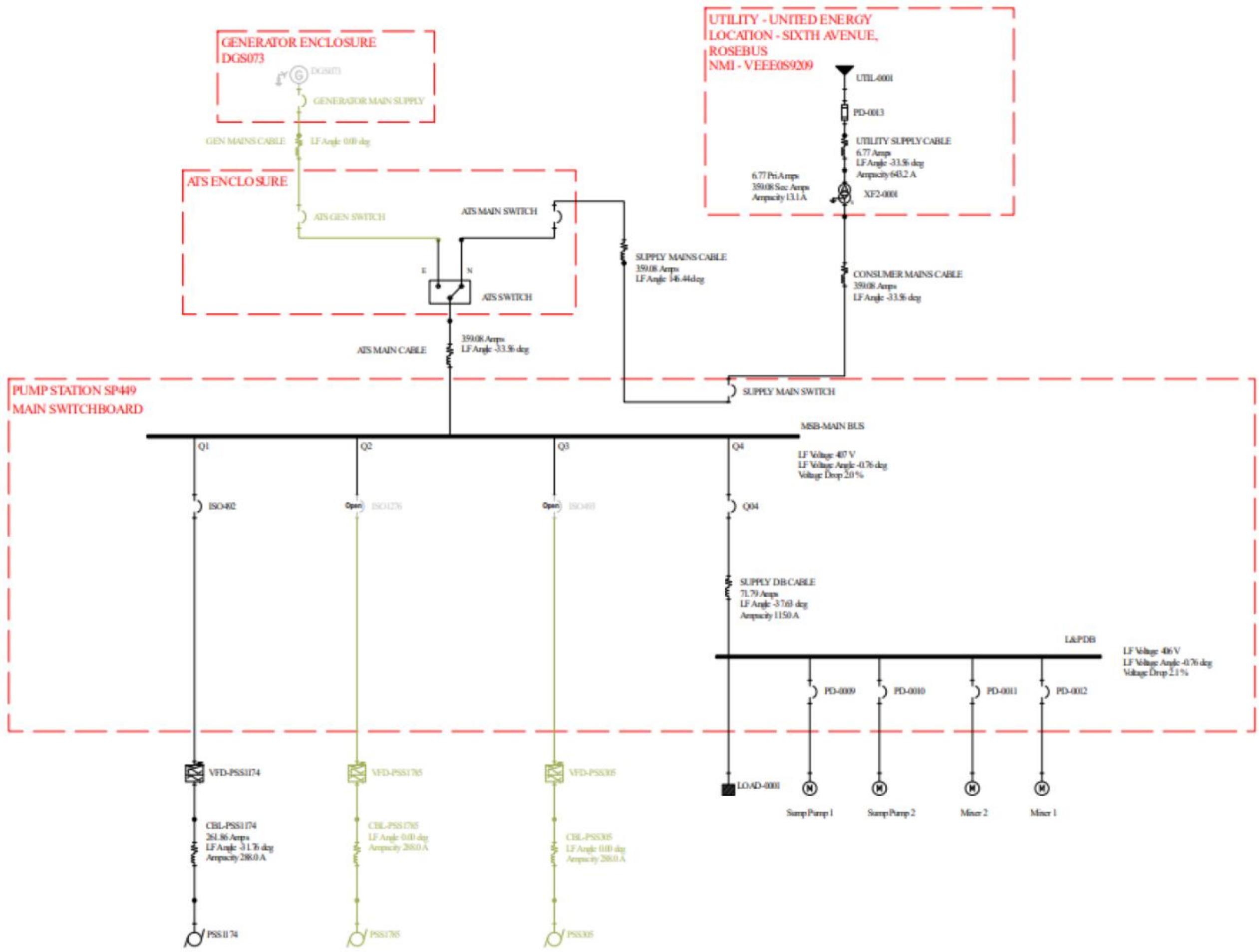

Figure 9: Example High Level SLD

10.3.4 Required Data for Modelling

The data required for arc flash modelling of any given site is summarized in the list below. All elements of this data must be confirmed with site visitation, or through confirmation from the project manager, or overseeing engineer.

- Utility protection and fault ratings
    - Minimum and Maximum 3 phase and SLG fault contributions and X/R ratio.
- Main transformer details
    - Tap Settings, Nominal Rating (kVA), Typical Impedance (%)
- Operating Configurations
    - Utility supply, generator arrangement, other supply modes (PV or battery)
- Diesel generator information, including Alternator
    - Transient and Sub transient behavior
- Motor contribution (all motors ≥37.5 kW with DOL, soft starter, or VSD)
- Normal and abnormal switching scenarios
    - Changeover Arrangement

    - Existing protection system (including Arc Flash Protection Relay details, if applicable)
- Switchboard construction details
    - Short-time fault withstands rating (kA for 1 second)
    - Main Bus ratings (current and voltage)
- Protection Device information
    - Make and model, settings and trip curve information
- Equipment bus gaps and electrode configurations
- Cable information
    - Size, Length, insulation and installation information.

All assumptions must be clearly documented in the report.

Exemption: In cases where exact network fault level data is unavailable, the maximum prospective short-circuit current shall be estimated based on the transformer's rated capacity and impedance. This estimation must follow the guidance provided in AS 60076.5, specifically Table 1 – Recognised minimum values of short-circuit impedance for transformers with two separate windings.

Exemption: In cases where an electrical asset is backed up by a temporary generator (there does not exist a permanent back-up diesel generator on-site), no generator data is required. Only the Mains Operation scenario is to be assessed for Arc Flash Hazard.

All modelling parameters shall be based on IEEE 1584-2018 using metric units (mm) as the standard unit of measurement.

- Working Distance: The distance from the potential arc flash source to the worker. This is typically pre-populated with standard values from IEEE 1584-2018, based on the specified equipment type.
- Equipment Types: Common low voltage (LV) equipment to be modelled including LV Switchgear, LV Motor Control Centres (MCCs) and Panels, LV Cable Junction Boxes
- Equipment-specific dimensions: Electrode configuration, Conductor gap, Enclosure dimensions (height, width, depth)

Exemption: In cases where exact “designed” or "as-constructed" equipment-specific dimensions are not available, use the standard IEEE 1584-2018 equipment types and their associated default values as outlined in Table 5.

Table 47: Equipment types with dimensions from IEEE 1584-2018

Equipment type	Conductor gap	Working distance	Enclosure size		
			Height	Width	Depth
LV Switchgear	32 mm	610 mm	508 mm	508 mm	508 mm
LV MCCs and Panels	25 mm	457 mm	356 mm	305 mm	203 mm
LV Cable Junction Box	13 mm	57 mm	356 mm	305 mm	203 mm

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10.3.5 Model Parameters

To ensure consistency in the delivery of Arc Flash models, the following settings/system behaviors are required for acceptance.

- Global maximum arcing time is to be 2 seconds (2000ms)
- Generator and Motor contributions must be considered on all examined busses
- Upstream coordination must be checked for all main switching devices
- Arc Fault Clearance minimum must be at least 80%.
- In cases where the exact electrode configuration is indeterminate, both VCB and VCBB must be assessed, and worst-case reported.
- PPE levels to manage incident energy hazard must be presented in accordance with the South East Water PPE Table.
- The *Comprehensive* fault analysis mode must be used for all Arc Flash fault analyses (IEC60909 will not be accepted).

10.4 Arc Flash Assessment Deliverables

10.4.1 Assessment Submission Checklist

A complete arc flash analysis must include both a comprehensive report, and a full-featured CAD Model that is to be submitted for verification. Each submission contains:

Arc Flash Hazard Analysis Report, that includes:

- Protection coordination study
- Short circuit analysis of the network
- Accurate as-constructed Single Line Diagrams (SLDs) and protection settings
- As-exists incident energy calculations for Incomer and Non-Incomer elements
    - Safety mitigation strategy and PPE requirements
- In cases where incident energy calculations exceed 8.0cal/cm², hazard mitigation strategies that are based in best practice (outlined in this chapter).
- Post-mitigation incident energy calculations
- Populated Arc Flash labels

A complete CAD Model for each site, including:

- All relevant third-party or non-default libraries, including
    - Existing Protective devices and cables (AS3000 compliant componentry)
    - Proposed Protective devices
- Access to the CAD Project folder directory and files.
    - Submitted W*hen using PTW, models to be submitted using build-in functionality “Create a backup”*

10.4.2 Arc Flash Labelling

Labels must follow the required template and contain:

- Hazard warning symbols (per AS 1319)
- Electrical shock symbol (per AS 1319)
- Site and Asset Details
  - Station/Site Name
  - Station/Site Number
  - Switchboard Maximo Identifier
- Nominal bus voltage
- Assessment date format: Month/ Year
- Arc Flash Hazard Information for all site Operational Modes (Mains, Gen, Solar, etc)
  - Incident energy (cal/cm²), both line and load side, for Door Open scenario
  - Arc flash boundary (mm)
  - Minimum safe working distance
- Required PPE category for:
  - Door Open Scenario (as determined by application of IEEE 1584)
  - Door Closed Scenario (as determined by individual review of site hazards and specifications)

The below label is a templatised version of the label that has been deemed acceptable for use by south East Water and includes all major design elements listed above.

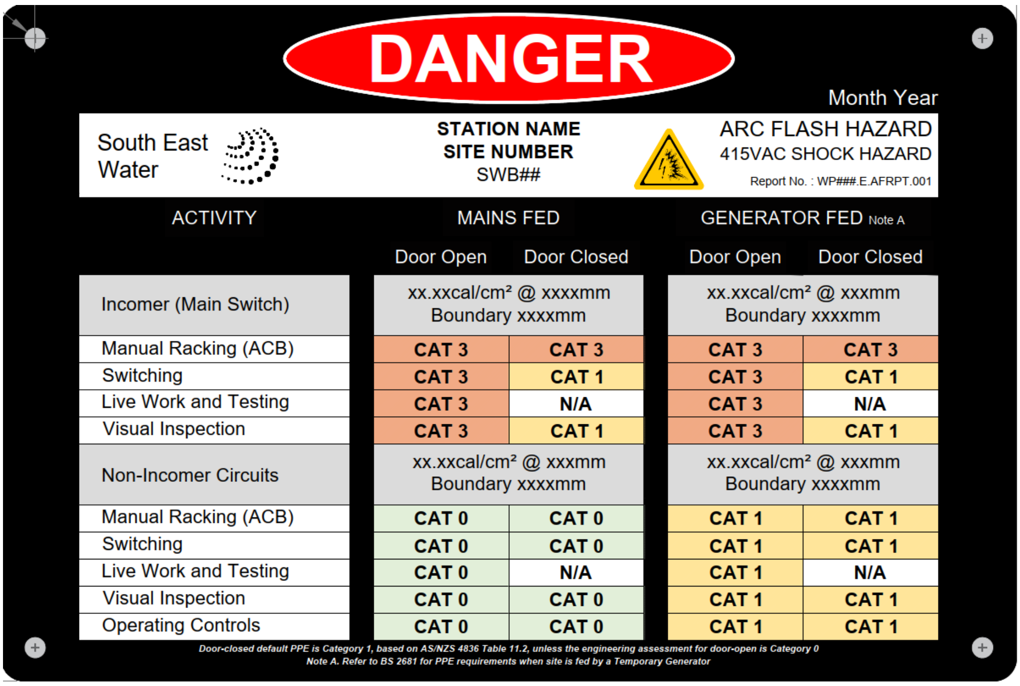

Figure 10: Arc Flash Label Template

11. Solar and BESS Requirements

11.1 General

This section provides high-level technical guideline for the design and sizing of Solar Photovoltaic (PV) and Battery Energy Storage Systems (BESS). These systems must be designed based on site-specific energy demand, operational schedules, critical load needs, and long-term cost and emissions reduction objectives.

11.1.1 Applicable Standards

The following Australian standards are referenced:

Table 48: Standards

Standard	Title
AS/NZS 4777.1:2024	Grid connection of energy systems via inverters – Installation requirements
AS/NZS 4777.2:2020	Grid connection of energy systems via inverters – Inverter requirements
AS/NZS 5033:2021	Installation and safety requirements for photovoltaic (PV) arrays
AS/NZS 5139:2019	Electrical installations – Safety of battery systems for use with power conversion equipment
SA TS 5398	Electrical Energy Storage Equipment – Safety Requirements

11.2 Design considerations

- Solar Generation: Typical daily yield in Melbourne ~3.6 kWh/kW of installed PV.
- PV Sizing: Must support on-site consumption, maximise self-use, and minimise export.
- Inverter Sizing: PV array 1.15–1.25 × inverter size (inverter typically 80–87% of PV array).
- BESS Sizing: Sized for daily load shifting, peak demand management, and backup (typically 0.5–1.0 × daily consumption).
- Critical Loads: BESS capacity shall be increased to provide extended backup for essential processes.
- Load Profiling: Designs shall use measured hourly/daily load profiles, not transformer rating alone.
- Other Factors: Energy audits, structural/site constraints, export limits, operational priorities (backup vs offset), budget, and incentives must be considered.
- Conductors: Only copper conductors are permitted.
- System Voltage: LV (≤ 1000 V AC, ≤ 1500 V DC) and ELV voltages only.

11.3 Grid Connection Requirements

The system must be connected at the LV point of common coupling (PCC) of the supply transformer for grid integration; High Voltage (HV) coupling is not permitted, as SEW is an LV consumer only and does not operate or maintain HV assets.

11.3.1 Grid-Connected (Hybrid) Operation

Solar and battery storage system that runs in parallel with the grid for daily use and automatically switches to supply power from the battery (and solar, if the sun is out) in the event of an outage.

This configuration is common and is referred to as a "hybrid" or "grid-interactive" system with backup or "blackout protection"

- Normal Operation: The solar and battery system works synchronously with the grid—generating, consuming, storing, and exporting energy as needed.
- Grid Outage: The system’s backup feature detects the power loss and automatically switches from grid-synced mode to "island" mode. It isolates (islands) essential circuits or the entire site from the grid.
- Backup Power: The battery supplies loads directly. If adequate sunlight is available and the system design allows, the solar PV can charge the battery and supply loads even during the outage, prolonging backup duration.
- Return to Grid: When the grid is restored, the system detects the stable grid and safely reconnects/synchronizes.

11.3.2 BESS – Coupling Requirements

- BESS installations for industrial sites shall be AC-coupled.
- The BESS inverter shall connect at the site low-voltage AC switchboard (400 V or 690 V as applicable) via a dedicated circuit breaker with coordinated protection.
- The system shall support:
  - Grid-following mode during normal operation.
  - Grid-forming mode for islanded and black-start operation.
- Interfaces shall comply with *AS/NZS 3000*, *AS/NZS 4777.2*, *AS/NZS 5139*, and the requirements of the local electricity distributor.
- DC-coupled BESS configurations shall not be permitted.

11.4 Array Support Structure

Solar PV panels and frames shall be installed using one of the following foundation methods:

- Pile-driven posts
- Concrete footings

All installations must meet site-specific structural, geotechnical, and environmental requirements.

11.4.1 Concrete Footings:

- Design in accordance with AS 3600 and AS/NZS 1170

- Consider terrain category and geotechnical conditions

11.4.2 Pole Support Structure:

- Designed per AS/NZS 4509.1, AS/NZS 1170.2
- Galvanised steel (AS 4100) or aluminium (AS/NZS 1664)
- Support full load including PV modules and cubicles
- Anti-theft/vandalism design with optimum solar angle

11.5 Electrical Equipment

11.5.1 Photovoltaic Array

The Photovoltaic (PV) array for renewable power generation shall be designed and installed in accordance with AS/NZS 4509.2, AS/NZS 5033, and the following requirements:

- Nominal output voltage of 12 VDC or 24 VDC.
- Suitable for continuous operation at the installation location, taking into account ambient temperature extremes and severe weather conditions (e.g., hail, snow).
- Warranted to deliver at least 90% of nominal power output for a minimum of 10 years.
- Fitted with bird deterrent devices to prevent birds from perching or nesting on modules.
- All PV modules in the array to be of the same make, model, and performance characteristics.
- Each parallel string to contain an equal number of modules.
- Array to be capable of meeting the required load, including a minimum 20% capacity margin.
- Sizing to consider seasonal solar variations and site-specific geographic factors.
- Array to be sized in accordance with AS/NZS 4509.2, considering the regulator capacity.
- Appropriate de-rating to be applied for component efficiencies, manufacturing tolerances, and system losses, in line with AS/NZS 4509.2.
- Bypass diodes to be installed in parallel with each module (preferably with each module sub-section) to prevent reverse-biasing and the formation of hot spots, with selection minimising efficiency loss and complying with AS/NZS 5033.
- Consider incorporating solar tracking and self-cleaning features.

11.5.2 Batteries

Batteries for the storage and supply of power shall be designed and installed in accordance with AS/NZS 4509.2, AS 4086.1, AS/NZS 5139, AS 3011, and the following requirements:

- Battery must be selected from the Clean Energy Council's list of currently approved batteries, using either lead-acid or lithium-ion technology.
- Lead-acid batteries shall be sealed Valve-Regulated Lead Acid (VRLA) type, with either gel or Absorbed Glass Mat (AGM) electrolyte.
- Lithium-ion batteries shall include an integrated Battery Management System (BMS) for cell balancing, overcharge/over-discharge protection, and thermal monitoring.

- Minimum round-trip efficiency be 80% for lead-acid and 90% for lithium-ion.
- Supplied with a minimum 12-month manufacturer's defect warranty, unless otherwise specified.
- Selected to provide maintenance-free service life of at least, 3 years for VRLA, and 6 years for lithium-ion
- Standard size and capacity, with individual units not exceeding 35 kg for manual handling compliance.
- Designed for ergonomic, field-replaceable installation.
- Self-discharge rate not exceeding 0.5–1.0% per week.
- Capable of meeting the surge demand of the installation.
- Fully compatible with the specified regulator and system voltage.
- Deep cycle capable.

Battery Bank Requirements

- All batteries shall be of the same make, model, and characteristics.
- Sized to allow the solar power system to operate for at least five (5) days without charging from the PV array.
- Sizing calculations shall be provided for approval, considering geographical location, load profile, and ambient conditions.
- Service life calculations for stand-alone operation shall consider:
    - Discharge and charge characteristics
    - Effect of ambient temperature and available solar radiation throughout the year
    - Cycle service life in relation to depth of discharge
- Battery interconnections shall be designed to minimise voltage drop and ensure balanced charging/discharging across all units.
- Battery banks shall be mounted in a manner that allows safe access for inspection and replacement without disturbing adjacent units.

11.5.3 Inverter:

- Comply with AS/NZS 5603
- Input: 12VDC, Output: 230VAC/ 400VAC, 50Hz
- Sized for load + 20% capacity

11.5.4 Indication:

- Regulator voltage
- Load current
- State of charge (%)
- PV array open-circuit voltage
- Prefer integrated or multi-function meter

11.5.5 Output Signals:

- Analog voltage signal (protected circuit)
- Low battery alarm (voltage-free contact, 12VDC, 1A)

11.6 Protection & Safety

11.6.1 Islanding Protection

- Inverter automatic anti-islanding protection must comply with AS/NZS 4777 requirements.
- Backup transfer to island mode normally occurs within 30s.
- Critical circuits should be clearly segregated and protected to prevent inverter overload.

11.6.2 System Components

- Hybrid/Backup-Capable Inverter: Manages both grid and standalone operation.
- Battery Management System (BMS): Monitors and protects battery health and performance.
- Changeover Switches/Contactors: Ensure safe disconnection of non-essential loads.
- All protective devices must be compliant and correctly rated.
- Not all batteries offer backup—ensure the chosen system supports essential load transfer and blackout protection.
- Installation and commissioning must be by qualified and accredited professionals.

11.7 Monitoring

11.7.1 Monitoring System Requirements

- All new solar + BESS installations must integrate with Solar Analytics.
- Monitoring must enable real-time tracking of:
  - PV generation
  - Battery charge/discharge status
  - Grid import/export
  - Consumption of critical and general loads
- New sites must be connected to SEW's centralized Solar Analytics monitoring portal.

11.7.2 Connectivity

- A dedicated 4G/5G SIM must be installed for each system.
- The SIM must be pre-paid for the entire system life (minimum 25 years).
- System must remain accessible by always SEW remotely for performance and fault monitoring

11.8 Warranties

- Solar Panels:
    - Product Warranty: Minimum 15 years
    - Performance Warranty: 25 years (90% at 10 yrs; 80% at 25 yrs)
- Inverter:
    - Product Warranty: Minimum 10 years
- Battery:
    - Product Warranty: Minimum 10 years
    - Performance Warranty: 15 years (80% State of Health(SOH) maximum degradation rate)
- Workmanship:
    - Minimum Warranty: 5 years

11.9 Spares

- Spare stock: 15% spare panels
- One spare inverter (where multiple are installed)

11.10 VPP Readiness – Requirements for BESS Integration

11.10.1 General

Batteries shall be capable of connection to a Virtual Power Plant (VPP) at any time after installation, should SEW elect to participate.

11.10.2 VPP-Capable Battery

- Batteries shall be selected from Solar Victoria's approved battery list.
- Batteries shall comply with the Australian Energy Market Operator (AEMO) *National Electricity Market VPP Demonstration Program Minimum Capability Specifications*.
- Batteries shall be assessed for:
    - Performance and safety
    - Internet connectivity and cybersecurity
    - Remote registration, monitoring, and control
- Batteries shall provide capability for participation in VPPs and delivery of network support services.

11.10.3 VPP-Ready Battery

A VPP-ready battery, as defined by AEMO, shall:

- Respond to remote charge/discharge requests (e.g. charging during peak PV export periods).
- Communicate state of charge, voltage, and power flow at battery terminals to market operators.
- Support network reliability and security through advanced ride-through and system security functions

11.11 Design Deliverables

At both the functional and detailed design stages, the solar system designer shall assess and provide the following key deliverables to guide system feasibility, planning, and economic performance:

11.11.1 Site & System Assessment Considerations:

- Evaluation of available roof or ground area, including shading analysis from buildings or vegetation.
- Review of historical and forecast site electricity usage patterns, including peak load periods.
- Consideration of electricity tariffs and applicable feed-in rates.
- Local climate data relevant to solar generation potential.
- Alignment with available budget and any applicable incentives.

11.11.2 Design Outputs Required:

- Recommended system capacity (in kW) suited to the site's operational profile.
- Estimated installation cost, including application of Australian Government rebates.
- Panel layout and estimated maximum number of panels that can be installed.
- Assessment of annual generation and shading impacts.
- Projected annual electricity bill savings and self-consumption uplift.
- Estimated financial payback period and lifetime benefit to SEW.
- Estimated annual carbon emissions avoided, based on local grid intensity.
- Comparative cost and savings analysis when including a battery component in the system.
- Perform AS/NZS 1768 risk assessment for lightning protection

12. EV Charging Requirements

12.1 General

Electric Vehicle (EV) charging infrastructure shall be designed, supplied, and installed in accordance with:

- SA TS 5397:2022 – Electric vehicle (EV) chargers for commercial applications
- AS/NZS 3000 – Wiring Rules
- AS/NZS 4777.1 – Grid connection of energy systems via inverters – Installation requirements
- AS/NZS 5139 – Electrical installations – Safety of battery systems for use with power conversion equipment
- Relevant network service provider requirements for connection of electrical loads

12.1.1 Minimum Charging Infrastructure

- 22 kW AC Chargers: For locations where vehicles are parked for extended periods (e.g., depots, staff vehicles).
- 50 kW DC Chargers: For fast-charging applications, such as high-rotation fleet vehicles or where short dwell times are expected.

12.1.2 System Integration Requirements

- Chargers must support OCPP (Open Charge Point Protocol) version 2.1 or higher for interoperability, remote monitoring, diagnostics, and load management.
- Chargers must be capable of dynamic load control and time-based charging to align with energy availability and demand profiles.
- Integration with onsite Solar PV and Battery Energy Storage Systems (BESS) shall be evaluated to maximise use of renewable energy and reduce grid dependency.

12.2 Power Supply and Electrical Considerations

- Assess transformer, main switchboard, and sub-board capacity to confirm suitability for proposed charger loads.
- Each charger shall be installed with dedicated protection devices in accordance with AS/NZS 3000 and manufacturer requirements.
- Design shall provide for staged expansion of EV chargers without major rework of site infrastructure.

12.3 Installation and Safety Requirements

- EV charger installation shall comply with AS/NZS 3000, including segregation of services and clearances.
- Charging areas shall be:
  - Safely accessible and free from operational conflict
  - Provided with adequate lighting, signage, and line marking

- Designed to avoid nuisance tripping or grid overload

12.4 Commissioning and Testing

- All EV chargers must be commissioned, tested, and integrated into the site SCADA or energy management systems as applicable.
- A complete test report and remote monitoring setup shall be provided post-installation.

12.5 Documentation and Handover

- As-installed drawings, product manuals, warranty certificates, and maintenance schedules shall be submitted.
- Asset registration and training for site personnel shall be completed prior to handover.

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13. Machinery Safety Design Requirements

13.1 General

The purpose of this section is to outline the minimum safety design requirements for all new machinery used at South East Water (SEW) sites. These requirements ensure the safety of personnel and the public through systematic hazard identification, risk reduction, and compliance in accordance with the AS/NZS 4024.1 series and relevant OH&S legislative requirements.

This requirement applies to all new or replaced machinery installed at SEW facilities, including but not limited to pumps, conveyors, screens, scrapers, compressors, rotary drum filters, and rotating biological contactors. It covers machinery across its lifecycle stages—from concept, procurement and installation, through commissioning, operation, maintenance, and decommissioning.

13.2 Applicable Standards

All machinery safety design shall conform to the **AS/NZS 4024.1 series**, with particular attention to the following standards:

Table 49: Standards

Standard	Title
	Occupational Health and Safety Act 2004 (Vic)
	Occupational Health and Safety Regulations 2017 (Vic)
	WorkSafe Compliance Code for Plant (2019)
AS 61508	Functional safety of electrical/electronic/programmable electronic systems
AS 61511	Functional safety – Safety instrumented systems for the process industry sector
AS 62061	Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems
AS/NZS 4024.1201	Risk assessment and risk reduction
AS/NZS 4024.1204	Electrical safety of machinery
AS/NZS 4024.1302 & 1303	Control of emissions and practical guidance on risk assessment
AS/NZS 4024.1501–1503	Safety-related control system design
AS/NZS 4024.1601–1604	Emergency stops, control functions, and guarding systems
AS/NZS 4024.1701–1704	Anthropometric design
AS/NZS 4024.1801, 180	Safety distances and crushing prevention
AS/NZS 4024.1901–1907	Displays, signals, and human interaction

13.3 Risk Management Approach

13.3.1 Risk Assessment

Risk assessment must be performed in accordance with AS/NZS 4024.1201 and involve:

- Definition of intended machine use and limits
- Identification of hazards throughout the machine's lifecycle
- Estimation and evaluation of risks using severity, frequency, probability, and avoidance metrics
- Selection of appropriate Safety Integrity Level (SIL) or Performance Level (PL)
- Validation by a TUV-certified Functional Safety Engineer (for PLr ≥ d or SIL ≥ 2)

Tasks considered: operation, cleaning, inspection, unblocking, maintenance, troubleshooting, and decommissioning.

13.3.2 Risk Reduction Hierarchy

Risk controls must follow the hierarchy below, aligned with AS/NZS 4024 and OH&S Regulation

- Elimination
- Substitution
- Engineering controls (e.g., guards, interlocks)
- Administrative controls (procedures, signage)
- Personal protective equipment (PPE)

13.4 Safety Requirements

13.4.1 Guarding and Interlocks

Design must conform to:

- AS/NZS 4024.1601–1604 – Guarding and interlock principles
- AS/NZS 4024.1801 & 1803 – Safety distances and minimum safety gaps
- OH&S Regulation 77 & 78

Guard Design Considerations:

- Prevent access to moving or hazardous parts
- Fixed or interlocked movable guards
- Tamper-resistant and visible where required
- Comply with minimum gap and reach distances

Performance Level Requirements:

- PLr c or higher for emergency stops and critical interlocks
- Interlocks validated as per AS/NZS 4024.1502

13.4.2 Control Systems

Control elements must adhere to:

- AS/NZS 4024.1901–1907 – Displays, actuators, warnings
- AS/NZS 4024.1204 (IEC 60204-1) – Electrical safety

Requirements:

- Clearly labelled and ergonomic
- Prevent accidental activation
- Where required, Emergency stops per AS/NZS 4024.1604:
    - Red mushroom-head buttons, palm-operable
    - Must latch in stop condition and require manual reset
    - Not hinder normal machine stopping

13.4.3 Electrical Safety

- Compliant with AS/NZS 3000 and AS/NZS 4024.1204
- Isolation and lockout points provided and labelled
- Surge protection, IP-rated enclosures, cable protection
- Earth fault protection and residual current devices where applicable

13.5 Validation

Performed per AS/NZS 4024.1502 and includes:

- Functional testing of safety-related parts of control systems (SRP/CS)
- Performance Level (PLr) or SIL target verification
- Simulation or fault injection for interlock testing
- Cybersecurity risk assessment if programmable safety controllers are used (IEC 62443)
- Table 2 of AS/NZS 4024.1502 details the validation documentation that is required

13.6 Design Deliverables Checklist

The following items shall be submitted as part of the **Machinery Safety Design Report** for review and acceptance by **South East Water**:

1. Machinery Safety Design Overview: Summary of machinery type, function, and intended use within water industry operations.
2. Standards Register: List of applied standards (e.g., AS/NZS 4024.1 series, AS 61508, ISO 13849-1/-2), including rationale for selection.
3. Risk Assessment Report: Comprehensive risk assessment in accordance with AS/NZS 4024.1201, covering all identified hazards and control measures.
4. SIL/PL Determination Documentation: Documentation of Safety Integrity Level (SIL) or Performance Level (PL) analysis, including risk graphs or calculations.
5. Functional Safety Plan: Outline of functional safety approach, responsibilities, tools, and methodologies.

6. Guarding Design and Compliance Statement: Detailed drawings showing guards, safety zones, and interlocking mechanisms, and Confirmation of compliance with AS/NZS 4024.1601–1604
7. Emergency Stop Risk Assessment and System Design: Emergency stop span, category, and design of emergency stop functions, with compliance to AS/NZS 4024.1603
8. Operator Control System Design: Layouts and specifications for operator controls, including ergonomic considerations and labelling.
9. Electrical Safety Design Documentation: Schematics and descriptions of electrical systems, earthing, interlocks, and safety devices per AS/NZS 4024.1204.
10. Signage, Warnings, and Lighting Layout: Plans for hazard signage, warning lights, alarms, and task lighting in operational areas.
11. Verification and Validation Plan: Methodology for verifying and validating safety systems pre- and post-commissioning.
12. Cybersecurity Measures: (If applicable) per IEC 62443
13. Maintenance Access Plan: Timetable and process for ongoing safety testing and inspection in accordance with the safety lifecycle.
14. Deviation Log / Compliance Gap Register (if applicable): Record of any deviations from standards or requirements, including justification and mitigation measures.
15. TUV Functional Safety Engineer Review Evidence: Confirmation of oversight or sign-off by a TUV-certified Functional Safety Engineer

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14. Equipment Identification

This requirement is primarily directed to Treatment Plant facilities where equipment identification and labelling is considerable.

14.1 Equipment Assignment

South East Water assigns unique asset identification prefixes and numbers associated with installed mechanical and electrical equipment such as pumps, motors, blowers, fans, valves, actuators, instruments and the alike. The identification prefix and number is utilised within South East Water's maintenance services and equipment information systems. To provide conformity with these systems and identification of installed equipment the following process shall be followed.

1. The principal designer shall produce an asset listing of all significant maintainable equipment. Examples of significant maintainable equipment include PLCs, HMIs, RTUs, VSDs, soft starters, main isolators, UPSs, harmonic filters, power factor correction units, valve actuators, motors, compressors, fans, pressure transmitters, analysers, flowmeters, level transmitters and the alike. Examples of insignificant equipment include control relays, fuses, control transformers, power supplies, lighting, control switches, ammeters, indicators and the alike.
2. Against each item on the asset list South East Water shall assign a unique asset prefix, number and description.

Example Plant Effluent Flowmeter FMR 1 01

Prefix (Flowmeter Description Number)

3. All design drawings, site equipment labels, SCADA tags, HMI labels, O&M manuals and the like shall generally refer to the assigned asset numbers and descriptions.

14.2 Site Equipment Labels

Significant maintainable equipment shall be identified by a label in accordance with the assigned asset prefix, number and description. Additionally, for ALL electrically supplied equipment external to switchboards shall include within the label the source of supply.

Table 50: Site Equipment Labels

Example	Equipment Label
Flowmeter	PLANT EFFLUENT FLOWMETER FMR101 SWB4502 F6 Switchboard Fuse No
General Purpose Outlet (note no allocated asset ID).	SWB4502 CB17

Refer Installation Requirements section above for Labels material, size and fixing details.

Physical identification shall be by a label or nameplate approved by SEW.

The same style of labelling shall be used on all equipment. Engraved traffolyte/plastic (undercover/inside use only), stamped aluminium or stainless steel labels (to be used outside in exposed areas), or an alternative approved by SEW shall be used.

Label sizes shall be compatible with the size/type of equipment.

14.3 Electrical Isolation

Continuity of equipment labels shall be adopted to identify electrical connection between the supply source and the end equipment (nominally equipment installed external to the switchboard) to ensure no confusion during electrical isolation. The controlled piece of equipment i.e. pump motor, valve actuator, compressor, fan etc. shall dictate the label's first row of text at each device within the electrical connection.

Table 51: Example Labels

Equipment	Equipment Label Prefix and Asset Number
WAS Pump 1 Circuit Breaker (located at SWB450 position 6)	WAS PUMP 1 MTR4550
Was Pump 1 Motor Variable Speed Drive (*mounted external to switchboard) If the drive is mounted within switchboard line 3 of label not required.	WAS PUMP 1 MTR4550 STARTER STR4750 SWB4500 CB6
WAS Pump 1 Motor Isolator (field isolator)	WAS PUMP 1 MTR4550 SWB4500 CB6
WAS Pump Motor (field mounted)	WAS PUMP 1 MOTOR MTR4550
Electrical switchboards shall also be labelled to ensure appropriate isolation information is communicated between switchboards.	CONTROL ROOM LIGHT & POWER SWB6430 SWB6425 CB2

14.4 Proprietary Plant

Equipment not specifically itemised within the design drawings that are supplied as a proprietary package such as generators, dosing skids and analyser panels shall be identified with a single equipment label.