

Electrical Standards

Document Number AM 2714

Contents

1.	General Requirements	10
1.1	Acronyms and Abbreviations	10
1.2	Scope	11
1.3	Standards	11
1.4	Quality of Workmanship – Suggested Contractors	12
1.5	Materials, Equipment and Components	12
1.5.1	Quality.....	12
1.5.2	Selection	12
1.5.3	Access to Equipment.....	13
1.5.4	Non-Standard Control Equipment.....	13
1.5.5	Principal Supplied Equipment.....	13
1.5.6	Rating.....	13
1.5.7	Electromagnetic Compatibility	13
1.5.8	Consistency.....	13
1.5.9	Efficiency.....	13
1.5.10	Noise.....	13
1.5.11	Safety.....	14
1.5.12	Special Tools.....	14
1.6	Drawings	14
1.6.1	Standards:.....	14
1.6.2	Drawings to be Included.....	14
1.7	Pre-Construction Submissions	15
1.7.1	Procedure.....	15
1.7.2	Timing	15
1.8	Drawing Integration	16
1.9	Building Facility	16
1.10	Plant Area Lighting	16
2.	Installation Requirements	18
2.1	General	18
2.1.1	Requirements.....	18
2.1.2	Access	18
2.1.3	Building Penetrations	18
2.1.4	Metalwork.....	18
2.1.5	Bolts, nuts, washers and jointing materials	19
2.1.6	Mechanical protection	19
2.2	Cables	19
2.2.1	Installation of Cable.....	19

2.2.2	Low Voltage Sheathed Cables	20
2.2.3	Cable Markers	20
2.2.4	Spare or Unused Cables	20
2.2.5	Cable Glands	20
2.2.6	Cable Size	20
2.2.7	Cable Colours	21
2.2.8	Wire Number Identification	21
2.2.9	Cable Sizing	22
2.2.10	VSD Earthing	22
2.2.11	Cable Ties	23
2.3	Conduits	23
2.3.1	Requirements	23
2.3.2	Minimum sizes	23
2.3.3	Rigid conduits	23
2.3.4	Flexible conduits	23
2.3.5	Set out	23
2.3.6	Conduit Entry	24
2.3.7	Inspection fittings	24
2.3.8	Draw Cords	24
2.3.9	Cable Pits	24
2.3.10	Draw-In Boxes	24
2.3.11	Sealing Conduits	25
2.4	Bends and elbows	25
2.4.1	Conduit saddles and brackets	25
2.4.2	Corrosion Protection	25
2.4.3	Sets and bends	25
2.5	Supports and Uprights	25
2.6	Cable Trays	25
2.6.1	Spare	26
2.6.2	Applications	26
2.7	Underground Services	26
2.7.1	Excavation	26
2.7.2	Dewatering	26
2.7.3	Backfilling	26
2.7.4	Backfill Material	26
2.7.5	Underground Cable Routes	26
2.8	Labels	27
2.8.1	General	27
2.8.2	Material	27

2.8.3	Size	27
2.8.4	Fixing	27
2.8.5	Danger, Warning and Caution Labels	28
2.8.6	Fixed Equipment Connected to Socket Outlets	28
2.9	Safety Devices	28
2.10	Field Equipment Electrical Isolation	29
2.11	Junction, Termination or Electrical Equipment Enclosures	29
3.	LV Switchboards	30
3.1	Generator connection	30
3.2	Approved Switchboard Fabricators	30
3.3	Contractor's Submissions	30
3.4	Switchboard Position and Protection	31
3.5	Switchboard Assemblies	31
3.5.1	Construction	31
3.5.2	Materials	31
3.5.3	Degree of Protection	32
3.5.4	Colours.....	32
3.5.5	Fault Levels.....	32
3.5.6	Arc Fault Protection.....	32
3.5.7	Switchboard Separation	33
3.5.8	Spare Capacities	33
3.5.9	Cable Entries.....	34
3.5.10	Bus Bars	35
3.5.11	Component labels	35
3.5.12	Multiple Supply Warning Notices	35
3.5.13	Layout	35
3.5.14	Gland Plates.....	35
3.5.15	Doors	36
3.5.16	Locks.....	37
3.5.17	Neutral and Earth Links	37
3.5.18	Cable Ferrules.....	37
3.5.19	Mounting Rails	37
3.5.20	Terminations	37
3.5.21	Termination Organisation	38
3.5.22	Ventilation	38
3.5.23	Equipment Mounting Trays.....	39
3.5.24	Earth Continuity.....	39
3.5.25	Lifting Provisions	39
3.5.26	Supporting Structure	39

3.5.27	Wall-mounting	39
3.5.28	Floor-mounting	39
3.5.29	Mounting	39
3.5.30	Hard stand Area	39
3.6	Switchboard General Items	40
3.6.1	Switchboard Construction Unlicensed Access Areas.....	40
3.6.2	Variable Speed Drives.....	40
3.6.3	Indicator Lights	40
3.6.4	Control Relays.....	41
3.6.5	Phase Failure Relays	41
3.6.6	Anti-Condensation Heaters	41
3.6.7	Transient Protection	41
3.6.8	Spares and Tools Storage.....	41
3.6.9	Control of Equipment.....	42
3.7	Electrical Switchboard Access Labelling	42
3.7.1	Definitions	43
4.	Electricity Supply	44
4.1	General	44
4.1.1	Definitions	44
4.1.2	Electricity Supply	44
4.1.3	Capacity	44
4.1.4	Power Factor Correction.....	44
4.1.5	Alternate Standby Generation Supply – Permanent	44
4.1.6	Alternate Standby Generation Supply – Temporary.....	45
5.	Electric Motors	45
5.1	General	45
5.2	Minimum energy performance standard	45
5.3	Load characteristic	45
5.4	Degree of protection	45
5.5	Temperature rise	45
5.6	Thermistors / Resistance Temperature Detectors	46
5.7	Anti-condensation	46
5.8	Vertical Mounting	46
5.9	Connection	46
6.	Electric Valve Actuators	47
6.1	General	47
6.2	Actuator Features	47
7.	Battery Backed Up Power Supplies	47

7.1	DC Power Supplies	48
7.2	Battery Enclosures	48
7.3	UPS General	48
7.4	UPS Static Bypass	48
7.5	UPS Maintenance Bypass	49
7.6	UPS Indications	49
7.7	UPS Indicating instruments	49
7.8	Commercial Grade UPS Units < 5kVA rating	49
Appendix A – Equipment Identification		50

Document Control

Rev	Date	Revision Details	Clause	Author	Approved
0	23/11/06	Draft		J Myyrlainen	J Myyrlainen
1	13/08/08	Instrumentation added		J Myyrlainen	J Myyrlainen
2	15/12/15	Various Revisions, Telemetry Section Removed as Obsolete		J Myyrlainen	J Myyrlainen
3	80/3/16	Local isolation, conduit entry and PLC expansion clauses added.	2.8, 2.3.6, 3.2.7	J Myyrlainen	J Myyrlainen
4	13/04/16	Appendix A - Approved Equipment Schedule added to doc.	Appendix A	J Myyrlainen	J Myyrlainen
5	20/04/16	Document number renamed from No 07-01 to AM2714		J Myyrlainen	J Myyrlainen
6	4/05/16	Fixed Equipment Connected to Socket Outlets, Safety Devices clauses added.	2.6.6, 2.7	J Myyrlainen	J Myyrlainen
7	24/05/16	Commissioning Inspection Test sheets added. Magnetic flowmeters	Appendix C, 5.1.7	J Myyrlainen	J Myyrlainen
8	8/06/16	Switchboard location details added	3.2.29	J Myyrlainen	J Myyrlainen
9	22/08/16	Magnetic Flowmeter clause revised.	5.1.7	J Myyrlainen	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.	3.3.9 , 4.1.5, 5, 6.1.1,12 & 13	J Myyrlainen	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.	2.2.1, Appendix A,12.1.8	J Myyrlainen	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.	2.8, Appendix A, 2.3.9	J Myyrlainen	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	1.3.9,1.6, 3.2.15, 6.1.2 12.1.9, 5.2.4, 6.1.2	J Myyrlainen	J Myyrlainen

AM2714- Electrical Standards

		flowmeter verification clause added			
14	14/9/17	Rev notation. Cable tie clause added. Non-metallic field control stations.	2.2.11, 3.3.9	J Myyrlainen	J Myyrlainen
15	27/10/17	Instrument transmission clause revised. Approved equipment list revised. Temperature Sensor, Generator Controller added.	5.1.9, Appendix A	J. Myyrlainen	J Myyrlainen
16	7/2/18	Preferred UPS equipment added. UPS backup period changed from 2 to 4 hours.	Appendix A Section 13	J. Myyrlainen	J Myyrlainen
17	5/3/18	Signal Convertor type added.	Appendix A	J. Myyrlainen	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.	2.2.7, 3.2.5, 3.2.6,3.2.7, 3.2.12, 3.3.3, 3.3.9	J. Myyrlainen	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	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	P. Hodkinson	J Myyrlainen
20.1	3/5/19	Power Supplies DC - Meanwell SDR240-24 revised	Appendix A	J Myyrlainen	J Myyrlainen
21	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	R.Jagger	C. Paxman
	12/8/19	Electric Valve Actuators section added, Board Colours, Approved Products	Section 8	J.Myyrlainen	C. Paxman

AM2714- Electrical Standards

	7/5/20	Introduction of Functional Safety	Sections 1.5.11, 3.3.1,1.5.6, 2.8,5.3	A.Gabriel	C. Paxman
	11/5/20	At treatment plants each sub board to have a MTS and gen connection point	Section 3	J. Street	C. Paxman
	11/5/20	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	J. Street	C. Paxman
	11/5/20	Include hazardous area classification, if applicable.	Section 1.5.6	A.Gabriel	C. Paxman
	11/5/20	Standards such as AS61508, AS62061, AS61511 and AS 4024.1503 (ISO13849-1 and ISO13849-2), may be applied where necessary.	Section 2.8	A.Gabriel	C. Paxman
	11/5/20	Consideration of Common Cause Failure (CCF)	Section 5.3	A.Gabriel	C. Paxman
Rev 0	13/8/20	<p>The EICC committee had reviewed various sections of this Standard on 5 occasions. We have set revision to rev 0.</p> <p>We have decided to segregate the original AM2714 into separate standards, namely:</p> <ul style="list-style-type: none"> • AM2714 – Electrical Standards (<u>this document</u>) • <u>AM2832 – Instrumentation & Controls Standards</u> • <u>AM2847 – Communications Standards</u> • <u>AM2851 – EIC Inspection, Testing & Completion Standards</u> • <u>AM2848 – Approved EIC Equipment List</u> 	All	EICC Committee	A. Gabriel C. Paxman
Rev 0.1	22/7/21	Unistrut Requirements Cabinet Fans	2.5 3.5.23	J. Street	EICC Committee

AM2714- Electrical Standards

	Distances in switch rooms	3.4		
	Withdrawable ACB	3.4		
	Flexible conduit	2.3.4		
	Switchboard Labelling	2.8.1		

1. General Requirements

1.1 Acronyms and Abbreviations

All abbreviations and acronyms used in additional documentation, shall follow the conventions used through this and other related project documents.

Acronym	Description
AI	Analogue Input
AO	Analogue Output
ATS	Auto Transfer Switch
CT	Current Transformer
Cu	Copper
DI	Digital Input
DIN	German Institute for Standards (Deutsches Institut für Normung)
DNP3	Distributed Network Protocol (version 3)
DO	Digital Output
ELV	Extra Low Voltage
EMC	Electromagnetic Compatibility
FAT	Factory Acceptance Test
FDS	Functional Description Specification
FOBOT	Fibre Optic Break Out Tray
HMI	Human Machine Interface
IEC	International Electrotechnical Commission
ICS	Industrial Control system
iLO	Integrated Lights Out
IO	Input Output
IP	Ingress Protection
IR	Insulation Resistance
IT	Information Technology
ITP	Inspection Test Plan
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LV	Low Voltage
PSU	Power Supply Unit
PTC	Positive Temperature Coefficient
PVC	Polyvinyl Chloride
RCD	Residual Current Device
SAL	Site Alarm List
SCADA	Supervisory Control And Data Acquisition

SDM	System Design Matrix
SEW	South East Water
SFP	Small Form Pluggable
STP	Sewage Treatment Plant
TBA	To be advised
TBC	To Be Confirmed
TFT	Thin Film Transistor
TTP	Tertiary Treatment Plant
UF	Ultra Filtration
UPS	Uninterruptable Power Supply
UPVC	Unplasticised Polyvinyl Chloride
UV	Ultra Violet
VSD	Variable Speed Drive

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*.

Excluded from the scope of this specification are:

- a. South East Water assets not containing water and sewerage infrastructure (e.g., WatersEdge office, depots)
- b. Functional or operational requirements relating to electrical assets.
- c. Monitoring, protection, control and communication system design, configuration and programming. This is covered by other South East Water standards such as AM2779_Treatment Plant Monitoring and Control Specification.
- d. Civil, mechanical arrangements, pump selection, pump performance or hydraulic assessment.
- e. Work practices associated with the management of electrical risks during construction and installation works.

1.3 Standards

The following standards shall apply in the given order of preference:

- a) Australian Standards or its IEC/ISO equivalent
- b) OH&S Regulations 2017 (Victoria)
- c) Electricity Safety (Installations) Regulations (Victoria)
- d) Victorian Service & Installation Rules
- e) Essential Services Commission Electricity Distribution Code
- f) Requirements of the Electricity Distribution Company
- g) Electricity Safety Act (Victoria)
- h) Manufacturer's Guidelines
- i) Water Industry Standards, including:
 - i. WSA04 Sewage Pumping Station Code Of Australia
 - ii. South East Water supplementary manual to WSA04
 - iii. South East Water Standard Electrical Drawings
 - iv. AM2779_Treatment Plant Monitoring and Control Specification (SEW)
 - v. AM2717_Generator Specification (SEW)
 - vi. AM2522_O&M Manual Specification (SEW)
 - vii. AM2755_Testing, Commissioning and Handover Plan (SEW)

- viii. AM2739_Corrosion Mitigation Specification (SEW)
- ix. AM2727_Covers for Underground Structures (SEW)
- x. AM 2758_Noise Specification (SEW)
- xi. AM2775_Watershed Collection Details (SEW)
- xii. AM2776.3_Air Treatment Unit Specification and Commissioning (SEW)
- xiii. AM2488_2D and 3D Drafting

The order of precedence of documents shall be as follows:

- a) Legislated requirements
- b) Project specific specifications
- c) Project specific drawings
- d) South East Water standards
- e) South East Water standard drawings
- f) Water Industry Standards (WSAA)

1.4 Quality of Workmanship – Suggested Contractors

South East Water only accepts contractors and fabricators familiar with and experienced in supplying high quality of workmanship in electrical, instrumentation, controls & communications installations. South East Water only endorses appropriately* qualified, competent, recognised and SEW-approved** fabricators and contractors that were pre-qualified such that they have successfully worked on South East Water infrastructure in the past.

*shall be determined by SEW.

**shall be provided upon request

(suggested, preferred or approved Contractors/vendors are located at SEW Extranet)

<https://sew-prod.southeastwater.com.au/building-and-development/developers/accredited-contractors/>

1.5 Materials, Equipment and Components

1.5.1 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 have to perform. No electrical equipment shall be exposed to direct sunlight.

1.5.2 Selection

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.

1.5.3 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.

1.5.4 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.

1.5.5 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.

1.5.6 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).

1.5.7 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 uninstalled to meet acceptable levels as outlined by AS/NZS 61000 (parts of) Electromagnetic compatibility (EMC) and the Essential Services Commission Electricity Distribution Code.

1.5.8 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.

1.5.9 Efficiency

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

1.5.10 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.

1.5.11 Safety

Provide all necessary safety devices for the protection of personnel against injury and the protection of plant and equipment against damage including effective earthing of electrical components, insulation, barriers, electrical interlocks, warning lights, and signs, alarms and local lighting.

Functional Safety and compliance with Functional Safety standards taking into account the requirements from Australian safety standards and its equivalent such as *AS 61508*, *AS 62061*, *AS61511* and *AS 4024.1503 (ISO13849-1 and ISO13849-2)*, may be applied where necessary.

1.5.12 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.

1.6 Drawings

1.6.1 Standards:

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.

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 area available in CAD format so that as much of the content as possible can be exactly copied and pasted to ensure exact replication.

1.6.2 Drawings to be Included

Prepare electrical schematics in a logical manner for ease of use in AutoCAD 2017 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 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 in AM2779 Treatment Plant Monitoring and Control Specification (under development) and AM2780 Network Facility Monitoring and Control Specification (under development):

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

1.7 Pre-Construction Submissions

1.7.1 Procedure

Submit for review electrical schematics, equipment schedules, equipment location plans, switchboard general arrangements, calculations and shop drawings.

Calculations shall include but not limited to the following.

- Selection of safety devices as per AS4024 (set) - Safeguarding of Machinery.
- Cable Voltage Drop Calculations
- Circuit protection Co-ordination / Selection
- Arc Fault Protection
- Maximum Demand
- Cable Sizing
- Conduit Sizing
- Fault-loop Impedance
- Fault Level Calculations
- Power Factor Correction
- Harmonic Analysis
- Standby Generator Sizing

1.7.2 Timing

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.

1.8 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. Revision of drawings shall consist of but not limited to those listed in clause 1.6.2.

1.9 Building Facility

Switch room building walls shall be coloured grey or follow existing building colour. The switch room layout shall allow any individual switchboard to be removed from the building and later reinstated whilst all other switchboards and any other fixed equipment remain in place. No double storey switch rooms are allowed. Where pump sets and pipe work are located in the same room as switch boards then switchboards must be separated by internal walls. If the building element is weather proof, acoustic rated or subject to pressure, maintain the rating. Acoustically seal and paint penetrations through plant room walls and floors.

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.

1.10 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

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

Area	Minimum Average Maintenance Luminance (Lux)	Maximum Working Plane (m)
Switchrooms and Control rooms	240	0.75
MCC Control Cubicles 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
Building Access	10	0
External Stairs and Catwalks	20	0
Access Roadways	10	0
Building Surrounds	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.

2. Installation Requirements

2.1 General

2.1.1 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.

2.1.2 Access

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

2.1.3 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.

2.1.4 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.

2.1.5 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.

2.1.6 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.

2.2 Cables

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.

2.2.1 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
- 240V control cables
- 24V dc control cables, thermistor cables etc.
- Instrumentation cables, potentiometer cables, PLC data cables etc.

The minimum segregation requirements for cabling throughout the site shall be instrumentation and control cabling (ELV) 300 mm to all power cabling and shall occupy separate housing systems.

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 are easily accessible via mobile platform (not via scaffolds). The maximum height shall be 2 meters. 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 joints 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.

2.2.2 Low Voltage Sheathed Cables

Minimum V75 insulation rating with stranded copper conductors rated to AS/NZS 3008.1, *Cables for alternating voltages up to and including 0.6/1kV.*

Use cables with current ratings suitable for the ambient air temperature and for temperature rise limits of equipment within the installation.

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

Cables up to and including a cross section of 300 mm² installed external to switchboards shall be of a multi core construction.

2.2.3 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.

2.2.4 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.

2.2.5 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.

2.2.6 Cable Size

The following cable sizes shall be observed where not specified.

Control Wiring	0.50 mm ²	stranded (minimum) Cu.
----------------	----------------------	------------------------

PLC IO	0.50 mm ²	stranded Cu.
--------	----------------------	--------------

Instrumentation Wiring	0.30 mm ² 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 mm ² stranded Cu.
General Power Wiring	2.50 mm ² stranded Cu.
Lighting	1.50 mm ² stranded Cu.

2.2.7 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.

A phase	Red
B phase	White
C phase	Blue
Neutral	Black
Earth	Green-yellow
Control, LV VAC	Grey
Control Neutral, LV VAC	Black
Control ELV VAC	Orange
Control Neutral ELV VAC	Orange
Control ELV VDC	Violet
Control Neutral ELV VDC	Violet
Instrumentation (Screened) Positive	White
Instrumentation (Screened) Negative	Black

2.2.8 Wire Number Identification

Standard

South East Water standard drawing SEWL-STD-037.

Wire Number Series

- 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
- 9 Reserved for special purposes

Example

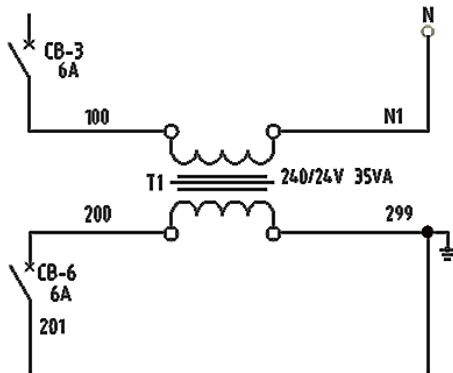
LV Control 1 0 6
 { {
 Number Series Identifier

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



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. PM01 - 1 0 6
 { { {
 *Equipment Number Series Identifier

*Refer to Appendix A – Equipment Identification.

Power

R 0 6
 { {

Phase Identifier as per isolation device designation.

Lables

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.

2.2.9 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 indented Electrical Scope of Works. Take into consideration installation conditions and external influences, short circuit fault levels and ratings of protection equipment.

2.2.10 VSD Earthing

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.

2.2.11 Cable Ties

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

2.3 Conduits

2.3.1 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 may be used. Light duty rigid PVC conduit may be used in areas where not subject to the risk of mechanical damage.
- Conduit buried in ground: heavy duty UPVC conduit.

2.3.2 Minimum sizes

Metallic and non-metallic conduits: 20mm.

2.3.3 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.

2.3.4 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 sleeve 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.

2.3.5 Set out

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

2.3.6 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.

2.3.7 Inspection fittings

Provide in accessible locations.

2.3.8 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.

2.3.9 Cable Pits

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

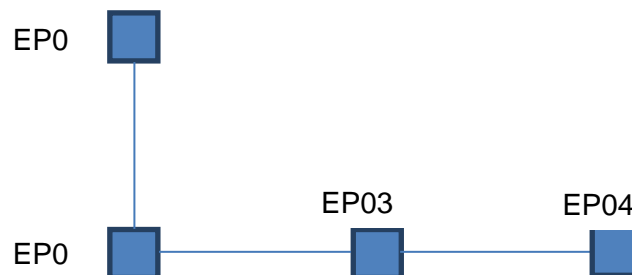
Minimum 600 x 600mm pit size allowing for turning of cables at above the minimum acceptable bending radius.

Pit covers shall be selected to suit expected loads of pedestrian or vehicular traffic in the location in which it is installed.

Pit shall be constructed of polyethylene or precast concrete. Polymer concrete or glass reinforced concrete pits shall not be accepted.

Pit shall be numbered using the following convention: EPXX.

Where X is a number within an incremental numeric sequence used to identify individual pits.



The pit identification number shall be engraved or laser etched 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'.

2.3.10 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.

2.3.11 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.

2.4 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.

2.4.1 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.

2.4.2 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.

2.4.3 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.

2.5 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.

2.6 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.

2.6.1 Spare

Provide an additional 20 percent (20%) spare ladder and cable tray space in excess of that determined by the design calculations and the known future cabling.

2.6.2 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 25 kilometers from the coast.

2.7 Underground Services

2.7.1 Excavation

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

2.7.2 Dewatering

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

2.7.3 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.

2.7.4 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.

2.7.5 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.

2.8 Labels

2.8.1 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 Appendix A – Equipment Identification.

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

2.8.2 Material

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

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

Note printed self-adhesive shall not be permitted.

2.8.3 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

2.8.4 Fixing

Locate labels so that they are easily seen from normal access adjacent to the item being marked. Do not install labels directly onto components or equipment.

Use mechanical fixings, at least two pins or screws per 80 mm of label length for labels fixed to flat surfaces. Where flat surfaces are not presented fit labels to equipment using nylon or stainless steel cable ties where appropriate.

Self-adhesive shall not be permitted.

2.8.5 Danger, Warning and Caution Labels

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

If Worst Credible Severity of Harm is Death or Serious Injury.		Probability of Accident if hazardous Situation is not Avoided	
		WILL	COULD
Probability of Death or Serious Injury if Accident occurs	WILL		
	COULD		

If Worst Credible Severity of Harm is Moderate or Minor Injury.		If Worst Credible Severity of Harm is Property Damage.	
For all Probabilities:		Preferred →	Alternate →
		For all Probabilities:	
		Alternate →	

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: is the preferred signal word to address practices not related to personal injury. The safety alert symbol should not be used with this signal word. As an alternative to “NOTICE”, the word “CAUTION” without the safety alert symbol may be used to indicate a message not related to personal injury.

2.8.6 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’.



2.9 Safety Devices

Safety devices shall be installed to eliminate or minimise personnel hazards and risks as well as safeguarding of machinery. Design, implementation and selection of devices shall be determined as per AS4024 (set) - Safeguarding of Machinery. Standards such as AS61508, AS 62061, AS61511 and AS 4024.1503 (ISO13849-1 and ISO13849-2), may be applied where necessary.

Safety guards shall be compliant with Regulation 77 of the OH&S (Plant) Regulations 2017 (Victoria).

Operator controls shall be compliant with Regulation 78 of the OH&S (Plant) Regulations 2017 (Victoria).

Emergency stop devices shall be compliant with Regulation 79 of the OH&S (Plant) Regulations 2017 (Victoria).

Appropriate Safety Integrity Level (SIL) shall be implemented based on hazard and risk assessments, safety requirements allocations and specifications. A TUV Functional Safety Engineer shall oversee this process.

2.10 Field Equipment Electrical Isolation

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.

The isolator switching capacity shall have an utilisation category conforming to the intended load characteristics.

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.

2.11 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. LV Switchboards

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

At this point in time, modular switchboards are only accepted for type-tested applications.

Switchboards constructed after year 2021 shall comply with AS/NZS 61439 type test standard for all assemblies having a rated short-time withstand current or rated short circuit current exceeding 10 kA rms. The 14 –point check shall be complied. There will be a significant shift in the construction of most switchboards when this requirement comes into effect.

3.1 Generator connection

At Treatment plants, each sub board shall have Manual Transfer Switch (MTS) and generator connection point. MTS shall have external generator connection point. Generator connections to Treatment plants shall be by tinned bars for all current ranges.

Generator connections to Networks shall be by:

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

Refer to standard drawings.

3.2 Approved Switchboard Fabricators

It is recommended that Switchboards be fabricated by a supplier listed in AM2848 – Approved EIC Equipment List.

All boards built for a project shall be constructed by the same switchboard supplier.

3.3 Contractor's Submissions

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.
- Access details.

3.4 Switchboard Position and Protection

Switchboards shall be located within buildings where buildings are associated with the facility (i.e., Treatment Plants or larger facilities where control rooms, toilets etc. are required). All switch boards in a treatment plant shall be in a switch room.

Switchboards located inside switch rooms shall be positioned to provide safe and easy access for operation and maintenance of all equipment. A minimum of 1.2m clear access shall be provided in front of all open doors including starter or equipment open doors / rackable ACB's (in the fully withdrawn position) etc. Door mechanisms to retain doors in open position on switchboard damaged. Treatment plant shall have false flooring.

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.

Where main busbar connections are located behind any module, the switchboard shall have removable rear covers with a minimum of 1.0m clearance to any wall, column or structure.

External switchboards 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.

External switchboards shall be located such that while any doors and covers at the facility are being opened, those covers and doors can never be closer than 1.2m from each other. External switchboards shall also be positioned so that there is at least 1.5m clearance between open doors and underground structure openings, steps, guardrails or above ground structures.

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.

3.5 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.

3.5.1 Construction

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

3.5.2 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.

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

Powder Coating shall be selected and implemented as per WSA 201, Selection and Application of Protective Coatings (ie: AS 4506, with minimum pre-treatment and coating thickness requirements suitable for atmospheric classification D – High Marine/Industrial).

3.5.3 Degree of Protection

Situation	Required Minimum IP Rating
Indoor assemblies isolated or separated by more than 5m from pressure pipe	IP52
Indoor assemblies in line of site and within 5m of pressure pipework	IP55
Exterior assemblies, outer surfaces	IP56
Exterior assemblies, inner surfaces (escutcheon)	IP41

All seams shall be fully welded.

3.5.4 Colours

Colours: To AS 2700, Colour standards for general purposes.

Electrical panels and control panels:

- Indoor assemblies: Orange X15
- Outdoor assemblies: Rivergum 2700Green G62
- Internal surfaces (including gear tray):White N14
- Instrumentation panels: [refer to AM2832 – Instrumentation & Controls Standards], in a cabinet White N14

3.5.5 Fault Levels

Rated short-circuit current: Maximum prospective symmetrical r.m.s. current at rated operational voltage, at assembly incoming supply terminal, excluding effects of current limiting devices (Imsc).

3.5.6 Arc Fault Protection

Arc fault protection shall be provided for switchboards rated at 800A or greater per phase to reduce the incident energy of an arc-flash event while the equipment is in service, or is undergoing maintenance. The supply conductors up to the line side of the protective devices within the switchboard shall be provided with means to reduce the probability of initiation of arcing faults by insulation or by separation. For switchboard requirements, refer to AS3439.1 or AS 61439.1. For busways, please refer to AS3439.2 and AS61439.6.

In addition to the above requirements, the switchboard shall comply with one of the following:

1. Provide internal separation in accordance with AS3439.1 or AS 61439.2;
Separation in accordance with AS3439.1 or AS 61439.2 may be achieved by the insulation of busbars, the use of barriers or by insulated housings.
2. Protective devices shall be provided to limit, as far as practicable, the harmful effects of a switchboard internal arcing fault by automatic disconnection;

Protection shall be initiated at a current less than 30% of the three-phase prospective fault level.

3. One of the forms of separation required by (1) together with (2) to reduce the probability of initiation and limit, as far as practicable, the harmful effects of internal arcing fault.

Internal arc fault testing of switchboard designs to AS3439.1 or AS61439 or IEC61641 is not required and is considered to be an enhancement of internal separation.

3.5.7 Switchboard Separation

Form of separation and degree of protection subject to switchboard rating and application.

- Switchboards shall be provided with internal separation by use of Form 4b in accordance with AS/NZS 3439.1.
- Alternate forms of separation shall be confirmed by South East Water pertaining to switchboard criticality, process isolation and accessibility for maintenance.
- Mounting shall be on gear tray.

3.5.8 Spare Capacities

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.

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 **unavailable**.
- 3) Add the required allotment of spare capacity based on the combined requirement for 1) and 2). e.g.,: if 0.3m² is required for the control compartment gear tray in this project and future proposed upgrade is estimated to require an additional 0.15m², then the control compartment gear tray area A should be: $A = 1.5 \times (0.3 + 0.15) = 0.675\text{m}^2$.

All spare quantities nominated below are minimums.

Item	Requirement
Power Supply & Distribution	
Switchboards	25% spare capacity for each switch board tier and equivalent for the largest tier
Switchroom	30% spare usable floor space not including walk areas
Distribution boards	50% spare poles
Ducts and cableways	50% spare volume
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 (ie: dig in, dig out, analogue in and analogue out) 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

Item	Requirement
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.
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)

There shall be a dedicated server/communications room separate from control room. Any racks in switchroom shall not impede in space calculations. The biggest size rack (1200mm deep) shall be in the admin building/dedicated comms room and the smaller size rack (800mm deep) shall be in the switchroom.

3.5.9 Cable Entries

Indoor cable entries: Bottom only.

Outdoor cable entries: Bottom only.

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.

Treatment plant shall have false flooring.

3.5.10 Bus Bars

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

3.5.11 Component labels

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

3.5.12 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.

3.5.13 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.
- 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.

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

- Toggles and handles of circuit breakers, fused switch units and isolators:
 - Wall mounted assemblies: 500-1900mm.
 - Floor mounted assemblies: 200 - 1900mm
- Control switches, indicating lights, meters and instruments on doors:
 - Wall mounted assemblies: 1000 - 1700mm.
 - Floor mounted assemblies: 1000 - 1700 mm.

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).

Common control equipment: Group common control relays, timers and fuses in a common panel or compartment.

3.5.14 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.

3.5.15 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.

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.

Door hardware: Internal switchboards.

- Doors \geq 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.

Door hardware: External switchboards.

- Doors \geq 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 Doors:

Power Distribution: Captive, corrosion-resistant knurled thumb screws. Thumb screws secured by 'nutserts' within cubicle body.

Other:

- Doors \geq 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.

3 point locking mechanisms on all boards by means of a rods are not acceptable.

Door mounted equipment: Protect or shroud door mounted equipment and terminals to prevent inadvertent contact with live terminals, wiring, or both.

Drawing pockets: Provide internal pockets for wiring diagrams and circuit schedules.

Earthing: Maintain earth continuity to door mounted indicating or control equipment using multi-stranded, flexible earth wire, or braid of equal cross-sectional area, bonded to the door.

Door & Escutcheon Stays shall be provided 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.

3.5.16 Locks

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.

Enclosures

Housing cable terminations - Double bit 3mm DIN



Locks

3.5.17 Neutral and Earth Links

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.

3.5.18 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.

3.5.19 Mounting Rails

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

3.5.20 Terminations

Connection to circuits \leq 16 mm²: Provide DIN-type tunnel terminal blocks. Terminal blocks screw-tightened, clip-on, 35 mm DIN-type.

Connection to circuits > 16 mm²: Provide stud-type terminals \geq 5mm diameter, sized to continuously carry the load.

Cables > 70 mm²: 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.

3.5.21 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:

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	
	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.

Self-adhesive type cable mounts shall not be accepted.

3.5.22 Ventilation

Provide adequate low level inlet and high level outlet vents at top, sides or rear of switchboards as required to keep all contained equipment to less than 38°C.

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. eg fans to be installed using hinges and clips.

3.5.23 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.

3.5.24 Earth Continuity

Effectively bond equipment and assembly cabinet metal frames to the protective earth conductor. Strip painted surfaces and coat with corrosion resistant material immediately before bolting to the earth bar. Provide serrated washers under bolt heads and nuts at painted, structural metal-to-metal joints.

3.5.25 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.

3.5.26 Supporting Structure

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

3.5.27 Wall-mounting

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

3.5.28 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.

3.5.29 Mounting

Floor mounted: Assemblies generally.

Wall mounted: Front access assemblies with frontal areas <math><1\text{m}^2</math> where space permits.

3.5.30 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 were 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 600 from an open door swing radius.
- Minimum width and length of 900 x 900.

3.6 Switchboard General Items

3.6.1 Switchboard Construction 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 3.4 Electrical Switchboard Access Labelling).

3.6.2 Variable Speed Drives

Motors greater than 90KW controlled by a VSD shall be fitted with insulated bearings NDE (Non Drive End) & earthing ring installed on DE (Drive End). The stator windings shall have a minimum insulation voltage rating of 1,200V, nominal operating voltage of up to 430V and withstand maximum voltage gradient (dV/dt) not less than 5,200 V/ μ s.

Operation of equipment fitted with a VSD shall be limited to panel mounted control switches with manual speed control via a 10 turn potentiometer.

Motors fitted directly with an integrated VSD shall not be accepted.

Drives installed in corrosive atmospheres shall be supplied with conformal coated circuit boards (includes electronic soft starters.).

Ventilation arrangements to reduce operating temperatures to below the manufacturer nominated operating temperature shall be assessed according to the load, number of VSDs or other heat loads operating in parallel and the size the of switchboard, switch room or building. For example, a 110 kW free standing VSD within a pump building may not require any additional ventilation compared with the same arrangement located within a switch room or switchboard.

To limit operational temperatures within the limits of the drive, measures may include:

- Venting VSD back channel heat directly external to the switchboard, switch room or building by means of vents, ducts or covers.
- Fan forced inlet or extraction within switchboards, switch rooms or buildings.
- Air conditioning within switchboards or switch rooms.
- Combinations of the above.

3.6.3 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.

Red	Not Operating / Fault:	Valve Closed, Motor Fault, Batching, PLC Fault
Green	Operating:	Valve Open, Motor Running, Generator Running, Mixing, Dosing.
Amber	Process Fault Condition:	High Level, No Flow.
Blue	Function:	Pump Duty Call, Backwash, Motor Heaters Operating.

Lamp Test Facility

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

3.6.4 Control Relays

Construction

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

3.6.5 Phase Failure Relays

General: 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.

3.6.6 Anti-Condensation Heaters

General

Rating: Provide heaters rated at not less than 20 W/m² of total external area including top of weatherproof enclosure.

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

3.6.7 Transient Protection

Primary Protection

High discharge capacity tested with an 8/20 μ s 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, arrester, neutral and earth conductor connections: 1 m.
- Maximum length between earth conductor and earth grid/electrode system: 5 m.
- Minimum cable size: 6 mm², stranded, green/yellow PVC insulated cable installed such that it is segregated from all other cables.

3.6.8 Spares and Tools Storage

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

Minimum one (1) spare requirements 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 during the design review);

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

- a) locate within existing spares shelving where there is adequate unallocated space, or;
- b) locate within new additional shelving located adjacent existing spares shelving, or;
- c) Locate within new shelving where there is adequate space in an indoor utility area within the facility, or;
- d) 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.
- have 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.

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 fork lift is available, can safely access the racking and multilevel racking is already located on site.

3.6.9 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.

3.7 Electrical Switchboard Access Labelling

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

Label	Switchboard Degree Of Protection (IP Rating)	Additional Information
Authorised Person Only	min *IP2X	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.

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

3.7.1 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.

Licensed Person

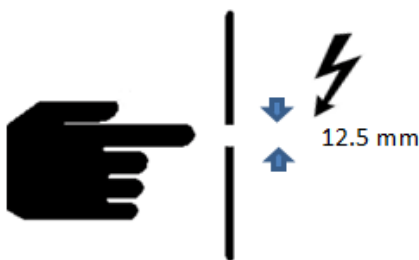
Holder of a Victorian Electrical Worker's Licence entitled to carry out low voltage electrical installation work.

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.



1.1.1 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.



4. Electricity Supply

4.1 General

4.1.1 Definitions

Ipsc: The Prospective Short Circuit current that would flow at point in the installation where a connection of negligible impedance is provided across all phases, without a change in supply.

Imsc calculation: The maximum Ipsc for the installation at any time is subject to the supply transformer impedance, cable impedance and voltage drop. The maximum Ipsc determines rms kA rating of protection devices.

4.1.2 Electricity Supply

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

4.1.3 Capacity

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

4.1.4 Power Factor Correction

Power correction shall be installed where the site power factor is less than 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

4.1.5 Alternate Standby Generation Supply – Permanent

All switchboards (main switchboards and sub-boards) shall be fitted with connections to either permanent generators or temporary standby generators (refer section 4.1.6).

Where a permanent standby generator is specified, 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.

Reference document - South East Water Standby Diesel Generator Specification AM2717.

4.1.6 Alternate Standby Generation Supply – Temporary

All switchboards (main switchboards and sub-boards) shall be fitted with connections to either permanent generators (refer section 4.1.5) or temporary standby generators.

Where a temporary standby generator connection point is specified, 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.

External to the switchboard generator connection shall be via a de-contactor socket or PowerSafe connectors (between 250A to 400A) complete with a sequential mating box. Either systems shall be housed within a lockable weatherproof enclosure.

5. Electric Motors

5.1 General

The requirement applies to single-speed three-phase squirrel-cage type, induction motors for general use, totally enclosed fan cooled with a rated voltage up to and including 400V.

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

5.2 Minimum energy performance standard

Three-phase cage induction motors with ratings in the range from 1 kW to 185 kW shall be high efficiency motors and shall comply with the Minimum Energy Performance Standard (MEPS) requirements of AS 1359.5 Tables A3 or B3.

5.3 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.

5.4 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.

5.5 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

5.6 Thermistors / Resistance Temperature Detectors

PTC thermistors shall be fitted for all motors rated over 5.0kW and up to 75kW with RTDs fitted for motors greater than 75kW.

5.7 Anti-condensation

Anti-condensation heaters shall be fitted to motors 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.

5.8 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.

5.9 Connection

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

6. Electric Valve Actuators

6.1 General

The requirement applies to electric valve actuators excluding the associated external gearbox and/or pedestal and stem extension.

6.2 Actuator Features

Actuator features shall include but not limited to the following.

- Protection class of actuator, including motor, shall be IP 68.
- Unless specified otherwise, the actuator shall be suitable for operating at 3 phase, 415Volt AC (+/- 10%), 50Hz (+/- 2%) power supply.
- 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.
- All control signals, communication signals as well as main power supply must be wired to a multi pin plug and socket allowing quick disconnection in the event of maintenance or repair.
- Provide a remote hand stations where actuators are mounted in areas that contravene OH&S.
- Provide an anti-condensation heater inside the actuator, suitable for continuous operation. An alarm signal shall be provided in the event of an anti-condensation heater failure.
- Actuators must be equipped with a hand wheel for manual operation.
- Local controls shall consist of push buttons OPEN-STOP-CLOSE-RESET, lockable selector switch LOCAL-OFF-REMOTE.
- Wireless Bluetooth interface for actuator setup and retrieving operational diagnostic information.
- 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
- Industrial Ethernet using Profinet communication protocol
- 4-20mA valve position output signal, internally powered.
- 4-20mA valve torque output signal, internally powered.
- Common fault relay output.
- Hart communications protocol.
- Provide a spare actuator drive coupling (& serial number) for each unique actuator valve assembly.

7. Battery Backed Up Power Supplies

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

- 1) 240V AC charged batteries which supply 24V DC power to all control, instrumentation, protection and communications devices at both Network Facilities and Treatment Plants. These are referred to as **DC Power Supplies**. 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, and

2) Treatment facility 240V AC charged batteries which supply uninterruptable power to critical 240V AC devices such as SCADA clients, servers and computers used to operate the plant. These are referred to as **Uninterruptable Power Supplies (UPS)**. 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.e. 4-20mA loops at 20mA and all outputs on). Calculations on the storage capacity are to be approved to SEW.

7.1 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.

7.2 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.

7.3 UPS General

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.

All printed circuit boards shall be conformal coded.

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.

7.4 UPS Static Bypass

A static bypass switch shall be provided to affect 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.

7.5 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.

7.6 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.

7.7 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

7.8 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.

Appendix A – Equipment Identification

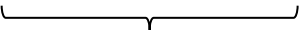


General

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

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
		 
	Description	Number

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

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.

Example 1 - Flowmeter.



Example 2 - General Purpose Outlet (note no allocated asset ID).

SWB4502 CB17

Refer Section 2.7 Labels for material, size and fixing details.

Physical identification shall be by a label or nameplate approved by the Superintendent’s representative. The same style of labelling shall be used on all equipment. Engraved traaffolyte/plastic (undercover/inside use only), stamped aluminium or stainless steel labels (to be used outside in exposed areas), or an alternative approved by the Superintendent’s representative shall be used. Label sizes shall be compatible with the size/type of equipment and subject to the Superintendent’s representative approval.

Stainless steel labels are to be fitted to equipment with Stainless steel cable ties or an alternative approved by the Superintendent’s representative shall be used. Plastic labels fitted require suitable fixing adhesive to ensure they are secure.

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.

Example:

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)	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

*note if drive mounted within switchboard line 3 of label not required.

Electrical switchboards shall also be labelled to ensure appropriate isolation information is communicated between switchboards.

Example

CONTROL ROOM LIGHT & POWER SWB6430
SWB6425 CB2

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.