TasWater Electrical & SCADA Technical Standard - Design

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taswater

1 Document Approval and Issue Notice

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Approved	M. Jordan (DM Infrastructure Investment Planning & Technical Standards Coordinating Group Chair)	Date: 16/05/2022

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0.1	23/09/2021	P. Johnson	DRAFT for review	All
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3.0	16/05/2022	M. Jordan	Approved	All

Amendments in this Release:

Section Title	Section Number	Amendment Summary
Design Activities	3.2.4.2	Arc flash requirements added. Additional drawing requirements added.
Multiple	3.2.4.3 to 3.2.4.7	New sections detailing design requirements for SPS and other works.
Sewage Pump Station Asset Design	6	Complete re-write to suit standard design.

Distribution:

Copy number	Version	Issue date	Issued to

Content

2 Purpose

2.1 Scope

This standard document includes specific TasWater requirements for the design of electrical & SCADA installations and shall be read in conjunction with *TDESTD102 - TasWater Electrical & SCADA Technical Standard – Construction & Application* which includes detailed installation requirements to be considered for any electrical design activities.

The technical documents identified in Table 1 below are **superseded** collectively by this document and *TDESTD102 - TasWater Electrical & SCADA Technical Standard – Construction & Application.*

Technical Documents Table		
Aconex Document No.	**Version/Revision No.**	**Specification Title**
Part 1 – TasWater Standards		
0001-STN-TW-EL-0021	1	TDEFRA01 - TasWater SCADA & Electrical Design and Installation Standard Framework
0001-STN-TW-EL-0012	1	TDEGDL01 - Small Sewage Pump Station Electrical Design & Installation
0001-STN-TW-EL-0013	1	TDESTD01 - SCADA & Electrical Asset Design Standard
0001-STN-TW-EL-0011	2	TDESTD02 - Sewage Pump Station Electrical Asset Design Standard
0001-STN-TW-EL-0023	1	TDESTD03 - Sewerage Treatment Plant - Electrical Asset Design Standard
0001-STN-TW-EL-0024	1	TDESTD06 - Water Treatment Plant - Electrical Asset Design Standard
0001-STN-TW-EL-0014	1	TDESTD11 - SCADA & Electrical Technical Requirements
0001-STN-TW-EL-0003	1	TDESTD12 - General Electrical Requirements Technical Standard
0001-STN-TW-EL-0006	2	TDESTD13 - Low Voltage and Extra Low Voltage Switchboards, Panels and Enclosures Technical Standard
0001-STN-TW-EL-0009	4	TDESTD14 - PLC/RTU and Radio Technical Standard
0001-STN-TW-EL-0015	8	TDESTD15 - SCADA Technical Standard
0001-STN-TW-EL-0004	1	TDESTD16 - Instrumentation Technical Standard
0001-STN-TW-EL-0008	1	TDESTD17 - Permanent Power Generators - Engine Driven Technical
0001-STN-TW-EL-0058	1	TDESTD18 - Electronic Security and Access Control Technical Standard
0001-STN-TW-EL-0002	1	TDESTD19 - Fire System Technical Standard
0001-STN-TW-EL-0017	1	TDESTD20 - Uninterruptable Power Supply Technical Standard
0001-STN-TW-EL-0005	2	TDESTD23 - Low Voltage and Extra Low Voltage Installation and Decommissioning Technical Standard

Technical Documents Table		
Aconex Document No.	**Version/Revision No.**	**Specification Title**
0001-STN-TW-EL-0007	1	TDESTD30 - Manhole Overflow Monitor Standard

Table 1: Superseded Technical Documents

3 General Electrical and SCADA Design Requirements

3.1 Interpretation

3.1.1 Abbreviations and Acronyms

For the purposes of this standard the following abbreviations and acronyms apply:

ac:	alternating current (root mean square)
ACB:	Air Circuit Breaker
ACMA:	Australian Communications and Media Authority
AFFL:	Above Finished Floor Level
AS:	Australian Standard
BOD:	Basis of Design
CPEng:	Chartered Professional Engineer as defined by the Royal Charter under which the Institute of Engineers Australia operates
CPR:	Cardiopulmonary resuscitation
CT:	Current Transformer
D&C:	Design and Construct
DB:	Distribution Board
dc:	direct current (ripple free)
DOL	Direct on-line
EEHA:	Electrical Equipment in Hazardous Areas
ELV:	Extra Low Voltage, i.e. voltages < 50 volt ac or 120 volt dc
EMC:	Electromagnetic Compatibility
ESS:	Electronic Soft Starter
FD:	Functional Description
GL&P:	General Light and Power
GPO:	General Purpose Outlet
HV:	High Voltage, i.e. voltages > 1,000 volt ac or 1,500 volt dc
HMI:	Human Machine Interface
IEEE:	Institute of Electrical and Electronics Engineers
I/O:	Input/Output
IP:	Ingress Protection
ITP:	Inspection and Test Plan
LCS:	Local Control Station
LV:	Low Voltage, i.e. voltages between 50 to 1,000 volt ac, or 120 to 1,500 volt dc
M2M:	Machine to Machine communications
MEN:	Multiple Earthed Neutral as per AS/NZS 3000
MCB:	Miniature Circuit Breaker
MCC:	Motor Control Centre
MCCB:	Moulded Case Circuit Breaker
MSB:	Main Switchboard
MTTR:	Mean Time To Repair

NCC	National Construction Code
NFPA:	National Fire Protection Association
NZS:	New Zealand Standard
O&M:	Operating and Maintenance
PCS:	Process Control System
PF:	Power Factor
PFC:	Power Factor Correction
PLC:	Programmable Logic Controller
PVC:	Polyvinyl Chloride
RCD:	Residual Current Device
RMS:	Root Mean Square
RTU:	Remote Terminal Unit
RU:	Rack Unit
SAA	Standards Association of Australia
SCADA:	Supervisory Control and Data Acquisition
SiD:	Safety-in-Design
SIM:	Subscriber Identity Module
SPS:	Sewage Pump Station
SS:	Soft Starter
STP:	Sewerage Treatment Plant
TBC:	To Be Confirmed
TCB:	Terminal Circuit Breaker
THD:	Total Harmonic Distortion
TW:	TasWater
UPS:	Uninterruptible Power Supply
VESDA:	Very Early Smoke Detection Apparatus
VSD:	Variable Speed Drive
WSAA:	Water Services Association (of Australia)
WTP:	Water Treatment Plant
XLPE:	Cross-linked Polyethylene

3.1.2 Definitions

For the purposes of this standard the following definitions apply:

Asset Operator:	the TasWater officer responsible for the operation of the asset being acquired.
Project Design Brief:	the project-specific instructions and design requirements which the Responsible Designer is required to adhere to in the design of the TasWater asset.
Design Manager:	the TasWater officer appointed to manage the project design process.
Design Reviewer:	the independent reviewer that must ensure that all relevant statutory requirements, standards and the Design Brief have been met.
Electrical Design:	includes all the calculations, drawings and technical specifications produced by the Responsible Designer in fulfilling the requirements of the Design Brief. Electrical Design also includes all SCADA related design requirements.
Electricity Distributor:	the supply authority controlling the operation of the electrical supply authority.
Responsible Designer:	the engineer carrying out the electrical design in fulfilment of the Design Brief.

SCADA Integrator: the entity responsible for the design and implementation of the complete process control software including SCADA, RTU, PLC and communications software for the project as appointed.

TasWater: the Tasmanian Water and Sewerage Corporation Pty. Ltd.

3.1.3 Technical Documents

The technical documents identified in Table 2 below are referenced in this Standard and are deemed to form part of this Standard and shall be utilised in designs.

Technical Documents Table		
Aconex Document No.	**Revision No.**	**Specification Title**
Part 1 – TasWater Standards		
0001-STN-TW-EL-0096	1	TDESTD102 - TasWater Electrical & SCADA Technical Standard – Construction & Application
0001-STN-TW-EL-0010	6	TDESTD21 - Preferred Equipment List Technical Standard
0001-STN-TW-EL-0090	1	TDESTD79 TasWater Standard Motor Circuits - Functional Description
0001-STN-TW-EL-0091	1	TDESTD79 TasWater Standard Motor Circuits - Functional Description Appendix A – Alarm List
0001-STN-TW-EL-0092	1	TDESTD77 TasWater Standard Emergency Stop Circuits - Functional Description
0001-STN-TW-EL-0093	1	TDESTD78 TasWater Standard 24VDC Power Supply Circuits - Functional Description
0001-STN-TW-EL-0051	3	TOMFOR06 - TasWater SCADA Project Handover Checklist
0001-STN-TW-EL-0018	1	TDEFOR10 - Radio Cellular Path Test Form
0001-STN-TW-EL-0043	7	TOMSTD02 - TasWater Alarm Philosophy for SCADA Alarms
0001-STN-TW-EL-0044	2	TOMMAN04 - TasWater StationWare General Users Manual
0001-STN-TW-EL-0045	6	TOMMAN21 - TasWater State-Wide SCADA Head End - User Manual - Integrators
0001-STN-TW-EL-0047	5	TOMPRO03 - TasWater SCADA Change Management Procedure
0001-STN-TW-EL-0050	5	TOMFOR05 - TasWater SCADA Project Change Request Form
0001-STN-TW-EL-0051	3	TOMFOR06 - TasWater SCADA Project Handover Checklist
0001-STN-TW-EL-0031	2	TPMMAN15 - Electrical Project Delivery Requirements Manual
Part 2: Drawings		
	G	TWS-E-0002 – TasWater Standard SPS Type 1 Electrical Drawings
	G	TWS-E-0003 – TasWater Standard SPS Type 2 Electrical Drawings
	1	TWS-E-0038 - SPS Switchboard Design Construction and Installation – Supporting Documentation

Technical Documents Table		
Aconex Document No.	**Revision No.**	**Specification Title**
	1	TWS-E-0014 (01000-09-016) RTU-PLC I-O Wiring Diagram Template
	1	TWS-E-0015 - Telemetry - Standard Topology Overview - Radio Repeater Access Point
	2	TWS-E-0016 - Standard Swivelpole Telemetry Antenna Pole – Design and Installation Drawing
	1	TWS-E-0018 - Standard Radio Repeater Example Layouts & Schematics
	1	TWS-E-0022 - SIEMENS S7-300 PLC TYPICAL SCHEMATIC
	1	TWS-E-0013 - Rack Mount UPS Wiring Schematic Standard Drawing
0001-DST-TW-EL-0067		TWS-E-0019 Sht 1 - Standard Maintenance Hole Overflow Monitor – Example Layouts & Schematics – Schedule
0001-DST-TW-EL-0068		TWS-E-0019 Sht 2 - Standard Maintenance Hole Overflow Monitor – Example Layouts & Schematics – Wiring Diagram
0001-DST-TW-EL-0069		TWS-E-0019 Sht 3 - Standard Maintenance Hole Overflow Monitor – Example Layouts & Schematics – Mounting Bracket
0001-STN-TW-EL-0067	2	TWS-E-0012 Sht E01 TasWater Standard Drawing - Standard DOL Motor Circuits – Cover Page
0001-STN-TW-EL-0068	2	TWS-E-0012 Sht E02 TasWater Standard Drawing - Standard DOL Motor Circuits – Symbol Legend
0001-STN-TW-EL-0069	2	TWS-E-0012 Sht E03 TasWater Standard Drawing - Standard DOL Motor Circuits – Notes
0001-STN-TW-EL-0070	2	TWS-E-0012 Sht ED01 TasWater Standard Drawing - Standard DOL Motor Circuits – Drive Schematic Diagram – Hardwired
0001-STN-TW-EL-0071	2	TWS-E-0012 Sht ED02 TasWater Standard Drawing - Standard DOL Motor Circuits – Drive Schematic Diagram – PLC Manual
0001-STN-TW-EL-0072	2	TWS-E-0012 Sht EL01 TasWater Standard Drawing - Standard DOL Motor Circuits – Typical Controls and Indicators – General
0001-STN-TW-EL-0073	2	TWS-E-0025 Sht E01 TasWater Standard Drawing - Standard ESS Motor Circuits – Cover Page
0001-STN-TW-EL-0074	2	TWS-E-0025 Sht E02 TasWater Standard Drawing - Standard ESS Motor Circuits – Symbol Legend
0001-STN-TW-EL-0075	2	TWS-E-0025 Sht E03 TasWater Standard Drawing - Standard ESS Motor Circuits – Notes
0001-STN-TW-EL-0076	2	TWS-E-0025 Sht ED01 TasWater Standard Drawing - Standard ESS Motor Circuits – Drive Schematic Diagram – Hardwired Manual Control

Technical Documents Table		
Aconex Document No.	**Revision No.**	**Specification Title**
0001-STN-TW-EL-0077	2	TWS-E-0025 Sht ED02 TasWater Standard Drawing - Standard ESS Motor Circuits – Drive Schematic Diagram – PLC Manual Control
0001-STN-TW-EL-0078	2	TWS-E-0025 Sht EL01 TasWater Standard Drawing - Standard ESS Motor Circuits – Typical Controls and Indicators – General Arrangement
0001-DST-TW-EL-0077	1	TWS-E-0032 Sht E01 TasWater Standard Drawing - Standard VSD Motor Circuits – Cover Page
0001-DST-TW-EL-0078	1	TWS-E-0032 Sht E02 TasWater Standard Drawing - Standard VSD Motor Circuits – Symbol Legend
0001-DST-TW-EL-0079	1	TWS-E-0032 Sht E03 TasWater Standard Drawing - Standard VSD Motor Circuits – Notes
0001-DST-TW-EL-0080	1	TWS-E-0032 Sht ED01 TasWater Standard Drawing - Standard VSD Motor Circuits – Drive Schematic Diagram – Hardwired Manual Control
0001-DST-TW-EL-0081	1	TWS-E-0032 Sht ED02 TasWater Standard Drawing - Standard VSD Motor Circuits – Drive Schematic Diagram – PLC Manual Control
0001-DST-TW-EL-0082	1	TWS-E-0032 Sht ED03 TasWater Standard Drawing - Standard VSD Motor Circuits – Drive Schematic Diagram – VSD Connections
0001-DST-TW-EL-0083	1	TWS-E-0032 Sht EL01 TasWater Standard Drawing - Standard ESS Motor Circuits – Typical Controls and Indicators – General Arrangement
0001-STN-TW-EL-0085	0	TWS-E-0030 Sht E01 - TasWater Standard Drawing – Standard Emergency Stop Circuits – Cover Page
0001-STN-TW-EL-0086	0	TWS-E-0030 Sht E02 - TasWater Standard Drawing – Standard Emergency Stop Circuits – Symbol Legend
0001-STN-TW-EL-0087	0	TWS-E-0030 Sht E03 - TasWater Standard Drawing – Standard Emergency Stop Circuits – Notes
0001-STN-TW-EL-0088	0	TWS-E-0030 Sht EC01 - TasWater Standard Drawing – Standard Emergency Stop Circuits – Category 1 Emergency Stop – Schematic Diagram
0001-STN-TW-EL-0089	0	TWS-E-0030 Sht EC02 - TasWater Standard Drawing – Standard Emergency Stop Circuits – Category 2 Emergency Stop – Schematic Diagram
0001-STN-TW-EL-0079	0	TWS-E-0027 Sht E01 - TasWater Standard Drawing – Standard 24VDC Power Supply Circuits – Cover Page
0001-STN-TW-EL-0080	0	TWS-E-0027 Sht E02 - TasWater Standard Drawing – Standard 24VDC Power Supply Circuits – Symbol Legend

Technical Documents Table		
Aconex Document No.	**Revision No.**	**Specification Title**
0001-STN-TW-EL-0081	0	TWS-E-0027 Sht E03 - TasWater Standard Drawing – Standard 24VDC Power Supply Circuits – Notes
0001-STN-TW-EL-0082	0	TWS-E-0027 Sht EP01 - TasWater Standard Drawing – Standard 24VDC Power Supply Circuits – Redundant 24VDC, 10A Supply with Battery Backup – Schematic Diagram
0001-STN-TW-EL-0083	0	TWS-E-0027 Sht EP02 - TasWater Standard Drawing – Standard 24VDC Power Supply Circuits – Single 24VDC, 10A Supply with Battery Backup – Schematic Diagram
0001-STN-TW-EL-0084	0	TWS-E-0027 Sht EP03 - TasWater Standard Drawing – Standard 24VDC Power Supply Circuits – RTU 24VDC, 4A Supply with Battery Backup – Distribution Schematic for RTU Only Sites
0001-DST-TW-EL-0085	1	TWS-E-0033 Sht 1 of 7 - TasWater Standard Drawing - Safe Deployment of LV Generators - Cover Page, Symbols & Notes*
0001-DST-TW-EL-0086	1	TWS-E-0033 Sht 2 of 7 - TasWater Standard Drawing - Safe Deployment of LV Generators on Brownfield Sites - 63A to 125A Connection Power Lock Box Enclosure - General Arrangement and Details*
0001-DST-TW-EL-0087	1	TWS-E-0033 Sht 3 of 7 - TasWater Standard Drawing - Safe Deployment of LV Generators on Brownfield Sites - 125A to 150A Connection Power Lock Box Enclosure - General Arrangement and Details*
0001-DST-TW-EL-0088	1	TWS-E-0033 Sht 4 of 7 - TasWater Standard Drawing - Safe Deployment of LV Generators on Brownfield Sites - 63A to 150A Connection Arrangement – Schematic Diagram*
0001-DST-TW-EL-0089	1	TWS-E-0033 Sht 5 of 7 - TasWater Standard Drawing - Safe Deployment of LV Generators on Brownfield Sites - 150A to 800A Connection Arrangement – Schematic Diagram*
0001-DST-TW-EL-0090	1	TWS-E-0033 Sht 6 of 7 - TasWater Standard Drawing - Safe Deployment of LV Generators - 150A to 800A Connection Power Lock Box Enclosure (Inlet Only) – General Arrangement and Details*
0001-DST-TW-EL-0091	1	TWS-E-0033 Sht 7 of 7 - TasWater Standard Drawing - Safe Deployment of LV Generators - 63A to 150A Connection Power Lock Box Enclosure (Inlet Only) – General Arrangement and Details*
Part 3 – Other Documents		
0001-GUI-DE-0006		Safety in Design Guideline

Technical Documents Table		
Aconex Document No.	**Revision No.**	**Specification Title**
0001-FRM-DE-0015		SiD Register Template
	7.0	TDETEM07 - TasWater Electrical and SCADA Scope of Works Template

Table 2: Referenced Technical Documents

*Documents currently in development

3.2 Engineering Design

3.2.1 Precedence

(a) Australian Standards and National Construction Code (formerly the Building Code of Australia) and relevant legislative or regulatory requirements
(b) Project Specific Requirements and technical specifications – details particular requirements for a project (i.e. electrical scope of work or work scope, functional requirements and delivery requirements) including any departures from the Asset or Electrical design standards
(c) This Standard
(d) TDESTD102 - *TasWater Electrical & SCADA Technical Standard - Construction & Application* and other TasWater electrical documents referenced therein.
(e) Managing Electrical Risks in the Workplace CP117

3.2.2 Design Standards

LV Electrical installations: To Part 2 of AS/NZS 3000 unless otherwise documented.

HV Electrical installations: To AS 2067 and AS/NZS 7000.

LV Electrical systems: To AS/NZS 3000, AS/NZS 3008.1.1 and AS 4024.1 series.

Switchboards: To AS/NZS 61439.1.

Lighting: To AS/NZS 1680 series and AS/NZS 1158 series.

Safety of Machinery: To AS 4024.1 series.

Generating Sets (Electrical Installations): AS/NZS 3010.

Degrees of protection (IP code): To AS 60529.

Earthing: To AS/NZS 3000 and AS 2067.

Lightning protection: To AS/NZS 1768.

EMC: To AS/NZS 61000 series.

Telecommunications and Information Technology Cabling: To AS/CA S008, AS/CA S009 and AS 11801 series.

Emergency Stop and Safety Interlocking Circuits: To AS 4024.1 series.

Explosive gas atmospheres: To AS/NZS 60079 series and other relevant Australian Standards pertaining to Electrical Equipment in Hazardous Areas (EEHA).

Storage and Handling of Flammable and Combustible Liquids: To AS 1940

Storage and Handling of Liquefied Chlorine Gas: AS 2927

Storage and Handling of Corrosive Substances: AS 3780

TasWater requirements: To the various TasWater standards, sections and technical documents referenced herein.

Supply Authority: To TasNetworks' Supply and Installation Rules Manual.

3.2.3 Competencies

3.2.3.1 Responsible Designer

The Electrical Design work must be carried out directly by, or under direct supervision of, the Responsible Designer. The Responsible Designer must be a professionally qualified electrical engineer eligible for membership of Engineers Australia and with at least 10 years' experience in the design of industrial electrical, process control and instrumentation systems, including at least 5 years' experience in the design of industrial plant typical of the size of the proposed TasWater electrical asset.

If any part of the Electrical Design includes High Voltage (HV) electrical systems, a professionally qualified power systems engineer eligible for membership of Engineers Australia and with at least 5 years' experience in the design of HV electrical systems must carry out that part of the design. The Responsible Designer must ensure that the design is technically competent and complies with the relevant statutory requirements, Australian Standards, TasWater's design standards and the relevant terms of the Design Brief.

3.2.3.2 Design Reviewer

The Electrical Design must be reviewed by a Design Reviewer prior to issuing for use. The Design Reviewer must be a professionally qualified electrical engineer eligible for membership of Engineers Australia and with at least 10 years' experience in the design of industrial electrical, process control and instrumentation systems, including at least 5 years' experience in the design of industrial plant typical of the size of the proposed TasWater electrical asset.

The Design Reviewer and the Responsible Designer may be the same person if the design has been completed by another electrical engineer or electrical engineering associate working under direct supervision of the Responsible Designer. If the Responsible Designer personally carried out the electrical design, the Design Reviewer must be a person other than the Responsible Designer. If any part of the design includes High Voltage (HV) electrical systems, this design must be reviewed and certified by a chartered professional engineer (CPEng) with at least 10 years' experience in the design of HV electrical systems. HV system certification and energisation shall be undertaken in accordance with the Tasmanian *Occupational Licensing Act 2005* and the *Occupational Licensing (Private High Voltage Electrical Work – Certification and Energisation) Determination 2016*.

3.2.4 Design Requirements

3.2.4.1 Safety-in-Design

The Responsible Designer needs to demonstrate that risk to property and personnel have been considered in accordance with Tasmanian statutory requirements for the entire life cycle of the Electrical Design. A systematic risk mitigation approach should be followed to reduce all identified risks to as low as reasonably practicable levels. The Responsible Designer must conduct a Safety-in-Design (SiD) risk assessment, which must include a machinery safety risk assessment (based on the requirements of the AS 4024 series of standards) to determine the adequacy (or otherwise) of safety systems (e.g. emergency stop facilities) provided at plant areas that must be supplied by new MCCs to be designed as part of the project brief.

The Safety in Design assessment shall follow TasWater's 0001-GUI-DE-0006 *Safety in Design Guideline* and use TasWater's 0001-FRM-DE-0015 *SiD Register Template.*

3.2.4.2 Design Activities

The Responsible Designer must perform the following design activities, including provision of the results in report(s), as a minimum:

(a) power system design including the site electrical supply and power distribution confirming:
   (i) circuit breaker, contactor, motor overload relay and fuse sizing for each part of the distribution and process power equipment to:
      (A) ensure all equipment and cabling is correctly protected from short circuit and overload
      (B) ensure arc flash energy minimisation
      (C) satisfy earth loop impedance requirements
      (D) determine plant wide circuit breaker and fuse tripping co-ordination and discrimination to restrict effective plant down time
      (E) calculate the prospective bolted 3-phase and arc flash fault currents at each main switchboard (MSB), motor control centre (MCC) and distribution board (DB)
   (ii) power cable sizing including sizing of the consumer mains cable from the Electricity Distributor's supply point
   (iii) Arc flash calculations and label details.
   (iv) earthing design
   (v) lightning protection design (as required)
   (vi) standby generator sizing (as required)
   (vii) uninterruptible power supply (UPS) system sizing (as required)

   TasWater's strong preference is for the first 3 dot points to be carried out using proprietary software packages that take into consideration the requirements of AS/NZS 3000 and AS/NZS 3008.1.1 for LV distribution and earthing design and IEEE 1584 and NFPA 70E for arc flash incident energy calculations. Examples of acceptable software packages include PowerCad-5, SKM PTW, DIgSILENT, PowerFactory, ETAP etc. It might be necessary to use combinations of software packages to obtain the desired outcomes. A copy of the project software configuration file for each site is required as a deliverable.

(b) Design and completion of the following electrical drawings and documentation (as applicable), including but not limited to:
   (i) single line diagrams
   (ii) electrical schematics for all power monitoring, control power distribution and motor starter circuits
   (iii) earthing schematics
   (iv) lightning protection arrangement drawings (where required)
   (v) loop drawings for all field instruments
   (vi) control/telemetry architecture block diagrams
   (vii) power, control, instrumentation & communication cable schedules to TasWater Standards
   (viii) electrical and instrumentation field equipment list to TasWater Standards
   (ix) general arrangement drawings (showing plan and elevation views) of all electrical switchboards, MCCs and control panels
   (x) equipment layout drawings of all electrical switchboard, MCCs and control panels

(xi) typical installation details to illustrate project requirements in more detail, e.g. mounting brackets for radio antennas or cable ladders, stands for local control stations, lightning protection systems, etc.
(xii) electrical installation scope of work, which should include project-specific technical specifications not covered by TasWater Standards
(xiii) display circuit breaker and fuse sizes on drawings.
(xiv) Display motor sizes (KW and FLC) on drawings
(xv) Relays: provide drawing sheet references between Coils and Contacts.

(c) Complete a Safety in Design (SiD) review of the final design and provide a report
(d) Ensure the redundancy levels provided as part of the electrical design align with the overall plant redundancy concepts adopted on the project. These concepts need to be developed by the Responsible Designer and agreed with the Design Manager prior to embarking on detailed design.
(e) Ensure all electrical designs comply with the requirements of AS4024 following a risk assessment that has been incorporated into the SiD design review
(f) Plant, area and equipment emergency stop system design
(g) Hazardous Area electrical equipment and circuit design
(h) Chemical dosing electrical equipment and circuit design
(i) Identify and document the requirements for uninterruptible power supplies (UPS)
(j) Provide detailed Operational and Maintenance (O&M) information (<u>if the electrical design is part of a Design and Construct (D&C) contract</u>) that covers all electrical, process control, instrumentation and SCADA components that were part of the Design Brief
(k) A Process Functional Description will be completed and provided by a Process Engineering. The Electrical Design shall update the Process Functional Description to include relevant Electrical Design details. The SCADA Integrator will add finer details associated with the software to produce the final detailed Functional Description (FD). Refer to the TDESTD102 for details on the difference between a Process and Detailed Functional Description.
(l) Compile an electrical Test and Inspection Plan (ITP)
(m) Compile an electrical Commissioning Plan considering other discipline commissioning requirements (e.g. mechanical commissioning of plant and equipment)
(n) Compile a design report that details the basis of electrical design for this project and the future, design process undertaken, the outcomes and findings of the design work, and recommendations for further investigation, recommended risk mitigation and cost management/control measures.

Further details on technical data submissions are specified in Section 4.1.6 *Submissions* of TDESTD102 - *TasWater Electrical & SCADA Technical Standard - Construction & Application*. The Responsible Designer must provide all electrical design deliverables, including drawings, schedules, calculations, safety reviews etc. to TasWater either when requested or at the conclusion of the project as part of the deliverables.

3.2.4.3 TasNetworks (Electricity Utility) Details

Obtain the following from TasNetworks to facilitate completion of the design:

(a) Supply Transformer Size and Impedance (%Z and X/R ratio)
(b) Existing Supply Fuse Type and Size
(c) Electricity Utility Supply Pole No. / Kiosk No. / Turret No, new points of supply only.
(d) Prospective Fault Current at the point of supply (maximum and minimum and corresponding impedance X/R ratio)
(e) Any running or starting current limitations.

3.2.4.4 TasNetworks: Electrical Protection Co-ordination

The electrical Designer must ensure that the size of the electricity utility supply fuse will be of sufficient rating to allow full electrical discrimination with the switchboard main circuit breaker and still allow full discrimination with the switchboard sub-circuits. To minimise the let-through energy, the circuit breakers must be set to the minimum settings, however, a setting that allows 100% discrimination. The settings required to achieve the above will be recorded next to the circuit breakers on the single line diagram.

The designer may also need to request increase fuse sizes from Electricity Supplier. This will need to be recorded on the For Construction drawings.

3.2.4.5 Circuit Breaker Selection

Use common brands of Circuit Breakers and Contactors. TasWater will accept any brand listed in TDESTD21 Preferred Equipment List but not a combination.

3.2.4.6 Pump Condition Monitoring

Pumps above 11kW will generally be provided with Pump Condition Monitoring Relays which monitor certain aspects of the pump and provide warnings or trip depending on the type of problem occurring. The designer will make sure these circuits are incorporated into the standard motor circuits (see relevant notes) and record all settings and programming requirements.

3.2.4.7 Arc Fault Containment – Low Voltage Switchboards

1. If the installed location fault level is > 8kA or the incoming supply is not protected by HRC fault current limiting fuses rated 100A or less: Switchboards shall be Arc Fault Containment Certified in accordance with AS61439.
2. If the installed location fault level is <= 8kA or the incoming supply is protected by HRC fault current limiting fuses rated 100A or less: Switchboards do not need to be Arc Fault Containment Certified in accordance with AS61439.

This clause is based of WSA 04-2005 Clause 7.3.2.1.

3.2.5 Arc Flash Hazard Calculations and Labelling

3.2.5.1 General

Arcing faults occur when electric current passes through a gas (e.g. air) between two conducting materials. The resulting high arc temperatures, plasma cloud and radiation can cause fatal burns even when standing some distance from the arc. Electric arcs can also shower droplets of molten metal in the surrounding area, causing further hazard.

In his 1985 paper '*The Other Electrical Hazard, Electric Arc Blast Burns*', R. Lee was first to describe the thermal properties of an electric arc and its effects on the human body. He defined the 'curable burn level' of 1.2 calories/cm^2 (5.02 Joules/cm^2) as the maximum level of incident heat energy the unprotected human body can withstand without receiving incurable (2nd degree) burns.

TasWater requires suitable arc flash hazard calculations and labelling for their electrical installations in order to quantify the potential hazard and inform the associated requirements for safe work.

Alignment with the following standards for arc flash hazard calculations and labelling is required;

(a) IEEE Std1584-2018 "*IEEE Guide for Performing Arc-Flash Hazard Calculation*s" for Arc Flash Hazard Calculations.

(b) NFPA 70E - 2021 "Standard for Electrical Safety in the Workplace" for Arc Flash Hazard Labelling.

This purpose of this section is to provide a practical methodology and guidance for consistent arc flash hazard calculations and labelling for TasWater electrical installations.

3.2.5.2 Definitions

arc: A plasma cloud formed in a gap between two electrodes with sufficient potential difference.

arc current: The fault current flowing through an electrical arc plasma (also referred to as arc fault current or arcing current).

arc duration: The interval of time between the instant of the first initiation of the arc and the instant of final arc extinction (usually equivalent to the total clearing time of the first upstream protective device to operate).

arc flash: An electric arc event with thermal energy dissipated as radiant, convective, and conductive heat.

arc flash boundary: The distance from a prospective arc source (energised conductors) at which the incident energy is calculated to be 1.2 cal/cm^2 (5.0 J/cm^2).

arc flash hazard: A dangerous condition associated with an electric arc likely to cause possible injury.

arcing fault current: See 'arc current'.

bolted fault current: Prospective initial symmetrical three-phase rms short-circuit current (assumes zero impedance exists at the point of the fault).

electrode configuration: The orientation and arrangement of the electrodes used in the testing performed for the model development in IEEE 1584-2018. Options are;

(a) VCB: Vertical conductors/electrodes inside a metal box/enclosure
(b) VCBB: Vertical conductors/electrodes terminated in an insulating barrier inside a metal box/enclosure
(c) HCB: Horizontal conductors/electrodes inside a metal box/enclosure
(d) VOA: Vertical conductors/electrodes in open air
(e) HOA: Horizontal conductors/electrodes in open air

fault current: A current that flows from one conductor to ground or to another conductor owing to an abnormal connection (including an arc) between the two conductors.

gap: The spacing between bus bars or conductors where an arc fault may occur.

incident energy: The amount of thermal energy impressed on a surface, a certain distance from the arc source, generated during an electric arc event. The units used to measure incident energy are joules per square centimetre (J/cm^2) or calories per square centimetre (cal/cm^2). Incident energy is normally expressed in cal/cm^2 at the nominated 'working distance'.

working distance: The distance between the potential arc source and the face and chest of the worker performing the task.

3.2.5.3 Methodology

The methodology for performing arc flash hazard calculations for a TasWater electrical installation shall follow the analysis process described in IEEE 1584-2018. This methodology includes the following key steps;

(a) Collection of all required electrical installation data. This includes;
   - (i) Point of supply details including maximum and minimum prospective fault currents and impedance details (e.g. X/R ratio or sequence impedances) and upstream service protective device details and settings – available from TasNetworks.
   - (ii) Detailed Single Line Diagrams.
   - (iii) Specification and nameplate rating details of any transformers, generators and motors involved in the electrical installation.
   - (iv) Details of power cables including conductor size, run lengths and installation details for all electrical circuits between the source of supply and the distribution and control equipment that is part of the study.
   - (v) Details of all protective devices including type, ratings, protection settings and time-current curves.
   - (vi) Details of all electrical equipment that is likely to require inspection, adjustment, servicing or maintenance while energised (including switchgear, switchboards, motor control centres, distribution boards and control panels). This will include switchboard General Arrangement details and dimensions (concept design or "as built"), Form of Separation etc.
   - (vii) Determination of the key locations within the electrical installation requiring arc flash hazard calculations. This shall include the arc fla and load side of any "Main Switch" or "Main Isolator" circuit breaker, the main distribution bus bars (or distribution links) and within distribution modules associated with three phase switchboards, motor control centres or distribution boards.

(b) Determination of Modes of Operation to be considered. Potential configurations which define maximum and minimum fault scenarios shall be considered and at Taswater installations may include;

   - (i) Operation from alternative utility feeders.
   - (ii) Operation from a permanently installed standby generator.
   - (iii) Operation with motors stopped or running.

Note: Unless otherwise directed by TasWater, operation from transportable generators which are not permanently installed on site do not need to be considered in the modes of operation for arc flash hazard calculations. If arc flash hazard calculations for a temporary generator installation is required then all applicable installation details will need to be confirmed with TasWater including, generator specifications (including rating, alternator impedance and transient reactance data), overcurrent protection type and settings and temporary supply cable configuration (including conductor size, run length and installation details).

(c) Determination of the maximum and minimum prospective bolted fault currents at the required key locations in the electrical installation. This shall include suitable short circuit fault calculations for the installation taking into account both the system data and modes of operation to establish the maximum and minimum bolted fault current scenarios.

(d) Selection of the applicable gaps and enclosure sizes to be considered based on nominal system voltages and classes of equipment involved. The values used for the arc flash calculations for TasWater installations shall be in accordance with the requirements of Section 3.2.5.4 below.

(e) Selection of the applicable equipment equivalent electrode configurations in accordance with the requirements of Section 3.2.5.4 below.

(f) Selection of the applicable working distances in accordance with the requirements of Section 3.2.5.4 below.

(g) Calculation of the potential arc fault currents in accordance with IEEE 1584-2018. This will involve calculation of both nominal and "reduced" arcing currents (as applicable) for the maximum and minimum bolted fault current scenarios at each of the key locations considered.

(h) Determination of the potential arc durations based on the total clearing time of the first upstream protective device to operate at the arc fault currents considered at each location.

(i) Calculate the incident energies (at the applicable working distances) for the potential arc fault currents at the required key locations in the electrical installation. These calculations shall be in accordance with IEEE 1584-2018.

(j) For the worst case (largest) incident energies calculated at the required key locations in the electrical installation, calculate the corresponding arc flash boundaries.

3.2.5.4 Modelling Requirements, Parameters and Settings

Arc flash hazard calculations shall be undertaken using a suitable, commercially available power system modelling/simulation software package which has verified capabilities for performing arc flash incident energy calculations in accordance with IEEE 1584-2018 for both HV and LV power systems (e.g. SKM PTW, DIgSILENT PowerFactory, ETAP etc.). TasWater's preference is for arc flash hazard calculations to be undertaken using SKM PTW (Power Tools for Windows - V9 or later) Note: the relevant software model files shall be provided to TasWater as a deliverable for each electrical installation.

The IEEE 1584-2018 model for incident energy calculations is applicable for electrical systems within the following range of parameters;

(a) Voltages in the range of 208 V to 15 000 V, three-phase (line-to-line)

(b) Frequency of 50 Hz or 60 Hz

(c) Bolted fault current (rms symmetrical)

  (i) 208 V to 600 V: 500 A to 106 000 A

  (ii) 601 V to 15 000 V: 200 A to 65 000 A

(d) Gaps between conductors

  (i) 208 V to 600 V: 6.35 mm to 76.2 mm

  (ii) 601 V to 15 000 V: 19.05 mm to 254 mm

(e) Working distances greater than or equal to 305 mm

(f) Enclosure dimension limits:

  (i) Maximum height or width: 1244.6 mm

  (ii) Maximum opening area: 1.549 m^2

  (iii) Minimum width: The width of the enclosure should be larger than four times the gap between conductors (electrodes).

The following parameter values, settings and assumptions shall be used for modelling and arc flash hazard calculations for TasWater electrical installations;

(a) Nominal System Voltage – the nominal system voltage is the nominal phase to phase, rms ac voltage for a three phase electrical system in accordance with AS 60038-2012 (as applicable for the system location being considered). For TasWater electrical installations this will usually be 400 V, 3.3kV, 11 kV or 22 kV (note: above 15 kV, the equations associated with the "Ralph Lee" method are to be used for arc flash incident energy and arc flash boundary calculations). The maximum and minimum fault current details provided by TasNetworks for the point of supply associated with a TasWater electrical installation should already consider the appropriate system voltage tolerances. Where system voltage tolerances need to be considered to calculate maximum and minimum fault current scenarios then the following conservative voltage factor values shall be used;

  (i) voltage factor, c = 0.9 for the minimum fault current scenario

  (ii) voltage factor, c = 1.1 for the maximum fault current scenario

  Note: AS 3851 provides guidance for voltage factor values applicable at different system voltages for the calculation of short circuit currents. Where all supply system and equipment parameters are known for a site electrical installation, these alternative voltage factors may be used to calculate more precise (less conservative) maximum and minimum fault current scenarios.

(b) Motor Load Fault Contributions – the maximum fault current scenario shall include fault current contributions from all large (>37kW) direct on-line and bypassed soft starter connected induction motors. Also, fault contributions from any large motors connected via a four quadrant (regenerative type) variable speed drive shall be included. In electrical installations with a number of concurrently running, small, direct on-line or bypassed soft starter connected induction motors with a combined rating of >37kW, the fault contribution from suitable equivalent lumped motor loads shall be included in the maximum fault current scenario. Motor load fault contributions should be included for 5 cycles unless otherwise advised by TasWater. The minimum fault current scenario shall not include motor load fault contributions.

(c) Working Distance – For TasWater electrical installations, use a working distance of 457mm for any LV equipment (including LV switchgear) and 914mm for any HV equipment.

(d) Gap - For TasWater electrical installations generally use a gap of 25mm for LV equipment, 104mm for HV equipment up to 5kV and 152mm for HV equipment from 5kV to 22kV (note: above 15kV, the equations associated with the "Ralph Lee" method are to be used for arc flash incident energy and arc flash boundary calculations). Where appropriate for larger LV switchgear (e.g. 800A or greater), calculations for a typical gap of 32mm should also be undertaken and the worst case incident energy reported.

(e) Equivalent Electrode Configuration – select the appropriate equivalent electrode configuration for the equipment and locations considered using guidance provided in IEEE 1584-2018 (Table 9 and Annex G.9.7). For enclosed equipment, selection of HCB yields the worst case incident energy results (by a significant factor) but this configuration typically only applies for exposed conductors, termination extensions or bus bars which are directed out towards the worker (this may apply to fuse holders, switch-fuses and bus "stab" connections for rackable circuit breakers or pluggable modules with the circuit breaker or module removed). For locations in LV switchboards (if HCB does not apply) calculate for both VCB and VCBB equivalent electrode configurations and report the worst case.

(f) Enclosure Sizes - Use the actual enclosure dimensions (within +/-10%) where known (up to a maximum of 1244mm for any dimension). For LV switchboards with multiple enclosure sizes, use the smallest enclosure size down to a minimum of 508mm (H) x 508mm (W) x 204mm (D) as this will result in the worst case calculated incident energy. Where enclosure sizes are unknown or cannot be safely determined, an enclosure size of 508mm (H) x 508mm (W) x 204mm (D) may be used to calculate conservative (worst case) incident energies.

(g) Arc Duration – The arc duration in the arc fault calculation shall generally be the worst case total clearing time of the first upstream overcurrent protective device to operate at the arc fault current being considered. The arc duration may be limited to a maximum of 2 seconds except where egress is potentially hampered (as per IEEE 1584-2018 section 6.9.2). Where the arc duration is limited to the 2 second maximum in any arc flash calculation, this shall be clearly indicated in the associated summary report. For LV circuit breakers with integral trip units, the manufacturer's time-current curves usually represent the total clearing time (with maximum and minimum tolerances) and the longest potential clearing time for the calculated arcing current should be used. When a single LV fuse time-current curve for the average pre-arcing (or "melt") time is provided, a conservative +/-10% tolerance with respect to current shall be considered for the maximum and minimum clearing times. For protection relays, all additional delays (including the circuit breaker clearing time) must be added to the relay operation time from the associated time-current curve.

(h) Incident Energy (units and precision) – calculate incident energy in cal/cm^2 at the nominated working distance in accordance with IEEE 1584-2018 and round **up** to 1 decimal place for summary reporting and labelling (e.g. 0.03 cal/cm^2 - round up 0.1 cal/cm^2 ; 1.41 cal/cm^2 - round up 1.5 cal/cm^2 ; 15.14 cal/cm^2 - round up 15.2 cal/cm^2)

(i) Arc Flash Boundary (units and precision) – This is the distance from the potential arc source (energised conductors) at which the incident energy falls to a value of 1.2 cal/cm^2 (which is considered to be the incident energy for the onset of second degree burns). For the system location being considered, the arc flash boundary shall be calculated in mm for the worst case incident energy scenario in accordance with IEEE 1584-2018 (rounded to the nearest whole number).

3.2.5.5 Documentation Requirements

The results of detailed arc flash hazard calculations for an electrical installation shall be documented in an Arc Flash Hazard Calculations Summary Report. As a minimum, the report shall include;

(a) A summary of the system data and modes of operation considered to establish the maximum and minimum bolted fault current scenarios.

(b) Details of the power system modelling/simulation software used to undertake the arc flash hazard calculations in accordance with IEEE 1584-2018.

(c) The modelling assumptions, parameters and settings used. Note: If the calculation results presented are contingent on any protection upgrades or protection setting modification recommendations which have been agreed with TasWater (following suitable protection coordination analysis), this shall be clearly and explicitly stated in the report. Note: TasWater require protection coordination to be verified in a PowerCAD 5 model for an electrical installation and any agreed protection upgrades or protection setting modifications shall be included in an updated PowerCAD 5 model supplied to TasWater.

(d) A summary of the arc flash hazard calculation results at each of the key electrical installation locations considered for the maximum and minimum fault current scenarios. These scenario summaries shall include suitable single line diagrams illustrating the power distribution and protection configuration, the key “bus” locations considered along with all protection settings, fault levels and arc flash hazard calculation results. The following arc flash hazard calculation details shall be shown at each of the power distribution “bus” locations considered on the single line diagram;
   (i) The nominal system voltage
   (ii) The equivalent electrode configuration applied
   (iii) The three phase bolted fault current
   (iv) The calculated arcing fault current which results in the worst case incident energy
   (v) The arc flash boundary
   (vi) The arc flash incident energy and the associated working distance

(e) A summary of the worst case incident energies calculated at each switchboard.

(f) Arc flash hazard label format and details for each switchboard considered in accordance with the requirements detailed in Section 3.1.7 below.

In addition to the Arc Flash Hazard Calculations Summary Report, the software model used for the arc flash hazard calculations (including all required data and reference files) shall be provided to TasWater as a deliverable. In the case of SKM PTW, the software model provided to TasWater shall be in the form of a “Backup” folder of the “project” which is a folder containing all of the necessary project, library and miscellaneous files to restore the project on any other computer with the same or later version of PTW. Note: PTW backup project folders include a library file containing only the library components used in the model and the backup folder can be “zipped up” to further reduce the electronic file size.

3.2.5.6 Special Cases

Where required, arc flash hazard assessment of the special case electrical systems listed below shall be undertaken in accordance with the following requirements;

1. **22kV Systems:**

   System voltages greater than 15kV are outside the scope of the IEEE 1584-2018 model. Where arc flash hazard calculations for parts of an electrical installation operating at a system voltage of 22kV is required, the equations associated with the “Ralph Lee” method are to be used for arc flash incident energy and arc flash boundary calculations. Note: results from applicable alternative calculation methodologies may also be provided for comparison.

2. **Three Phase 400V Switchboards with ≤100A Protected Supplies:**

   For three phase, 400V switchboard installations fed from a suitably fault rated, upstream Type T, gG HRC fuse or a C-curve miniature circuit breaker with a rated current of 100A or less (or an “equivalent” MCCB*) two special cases, 2a) or 2b) can be considered (as detailed below).

   > *Note: an “equivalent” MCCB as referenced above is one with a fixed or adjustable magnetic/instantaneous nominal setting of 800A or less (e.g. an MCCB with a thermal magnetic trip unit set with I_r = 100A and I_m = 800A)

   <u>Case 2a) - Lowest three phase prospective short circuit current at the switchboard ≥ 2kA:</u>

   In this case, provided the minimum three phase prospective fault current at the switchboard under all scenarios is **at least** 2kA then the worst case Arc Flash incident energy (at a working distance of 457mm) when calculated in accordance with IEEE 1584-2018 will be less than 1.2 cal/cm^2.

   In this specific case, unless otherwise directed by TasWater, detailed arc flash hazard calculations are not required and a generic arc flash hazard label may be applied to the switchboard with a format as per the example in Section 3.2.5.9 Figure 5.

   <u>Case 2b) - Lowest three phase prospective short circuit current at the switchboard < 2kA and egress from the switchboard is not hampered:</u>

   In this case, considering a 2 second maximum arc time, the worst case Arc Flash incident energy (at a working distance of 457mm) when calculated in accordance with IEEE 1584-2018 will be less than 8 cal/cm^2 and the associated arc flash boundary will be less than 1200mm.

In this specific case, unless otherwise directed by TasWater, detailed arc flash hazard calculations are not required and a generic arc flash hazard label may be applied to the switchboard with a format as per the example in Section 3.2.5.9 Figure 6.

For either Case 2a) or 2b), TasWater Arc Flash Hazard assessment documentation is still required which shall include;

(i) A summary of the modelling/calculations used to determine the **minimum** three phase prospective fault current at the switchboard under all scenarios. (e.g. from a suitable PowerCAD-5 model).

(ii) A summary of the installation details used to determine compliance with the “special case” conditions. Note: If the “special case” compliance is contingent on any protection upgrades or protection setting modification recommendations which have been agreed with TasWater, this shall be clearly and explicitly stated in the report.

(iii) Confirmation that egress from the switchboard is not hampered (where applicable).

(iv) Details of the generic arc flash hazard label format and content for the switchboard.

Switchboards which may satisfy the conditions for these special cases include TasWater standard small SPS switchboards or small WPS switchboards fed from TasNetworks 100A service fuses or distribution boards fed from a suitable upstream circuit breaker.

3. Three Phase 400V Switchboards with ≤50A Protected Supplies:

For three phase, 400V switchboard installations fed from a suitably fault rated, upstream Type T, gG HRC fuse or a C-curve miniature circuit breaker with a rated current of 50A or less (or an “equivalent” MCCB*) two special cases, 3a) or 3b) can be considered (as detailed below).

> *Note: an “equivalent” MCCB as referenced above is one with a fixed or adjustable magnetic/instantaneous nominal setting of 400A or less.

<u>Case 3a) - Lowest three phase prospective short circuit current at the switchboard ≥ 1kA:</u>

In this case, provided the minimum three phase prospective fault current at the switchboard under all scenarios is **at least** 1kA then the worst case Arc Flash incident energy (at a working distance of 457mm) when calculated in accordance with IEEE 1584-2018 will be less than 1.2 cal/cm^2.

In this specific case, unless otherwise directed by TasWater, detailed arc flash hazard calculations are not required and a generic arc flash hazard label may be applied to the switchboard with a format as per the example in Section 3.2.5.9 Figure 5.

<u>Case 3b) - Lowest three phase prospective short circuit current at the switchboard < 1kA and egress from the switchboard is not hampered:</u>

In this case, considering a 2 second maximum arc time, the worst case Arc Flash incident energy (at a working distance of 457mm) when calculated in accordance with IEEE 1584-

2018 will be less than 8 cal/cm^2 and the associated arc flash boundary will be less than 1200mm.

In this specific case, unless otherwise directed by TasWater, detailed arc flash hazard calculations are not required and a generic arc flash hazard label may be applied to the switchboard with a format as per the example in Section 3.2.5.9 Figure 6.

For either Case 3a) or 3b), TasWater Arc Flash Hazard assessment documentation is still required which shall include;

(i) A summary of the modelling/calculations used to determine the **minimum** three phase prospective fault current at the switchboard under all scenarios. (e.g. from a suitable PowerCAD-5 model).

(ii) A summary of the installation details used to determine compliance with the "special case" conditions. Note: If the "special case" compliance is contingent on any protection upgrades or protection setting modification recommendations which have been agreed with TasWater, this shall be clearly and explicitly stated in the report.

(iii) Confirmation that egress from the switchboard is not hampered (where applicable).

(iv) Details of the generic arc flash hazard label format and content for the switchboard.

Switchboards which may satisfy the conditions for these special cases include small dosing system distribution boards or Local Control Panels.

4. **Single Phase Systems:**

The IEEE 1584-2018 model does not cover single phase systems (as per IEEE 1584-2018 Clause 4.11). However, if arc flash hazard calculations for a single phase system is required by TasWater then the IEEE 1584-2018 three phase equations and methodology shall be employed using the single phase bolted fault current(s) and line to neutral voltage (s). The resulting calculated incident energies and arc flash boundaries are expected to be conservative.

5. **Single Phase 230V Switchboards with ≤80A Protected Supplies:**

For single phase 230V switchboard installations fed from a suitably fault rated, upstream Type T, gG HRC service fuse or a C-curve miniature circuit breaker with a rated current of 80A or less, two special cases, 5a) or 5b), can be considered (as detailed below).

<u>Case 5a) – Lowest single phase prospective short circuit current at the switchboard ≥ 2.5kA:</u>

In this case, provided the minimum single phase prospective fault current at the switchboard under all scenarios is at least 2.5kA then the worst case Arc Flash incident energy (at a working distance of 457mm) when calculated in accordance with the IEEE 1584-2018 three phase equations and methodology, will be less than 1.2 cal/cm^2.

In this specific single phase case, unless otherwise directed by TasWater, detailed arc flash hazard calculations are not required and a generic arc flash hazard label may be applied to the switchboard with a format as per the example in Section 3.2.5.9 Figure 7.

Case 5b) – Lowest single phase prospective short circuit current at the switchboard < 2.5kA and egress from the switchboard is not hampered:

In this case, considering a 2 second maximum arc time, the worst case Arc Flash incident energy (at a working distance of 457mm) when calculated in accordance with the IEEE 1584-2018 three phase equations and methodology will be less than 8 cal/cm^2 and the associated arc flash boundary will be less than 1200mm.

In this specific single phase case, unless otherwise directed by TasWater, detailed arc flash hazard calculations are not required and a generic arc flash hazard label may be applied to the switchboard with a format as per the example in Section 3.2.5.9 Figure 8.

For either Case 5a) or 5b), TasWater Arc Flash Hazard assessment documentation is still required which shall include;

(i) A summary of the modelling/calculations used to determine the minimum single phase prospective fault current at the switchboard under all scenarios. (e.g. from a suitable PowerCAD-5 model).

(ii) A summary of the installation details used to determine compliance with the “special case” conditions. Note: If the “special case” compliance is contingent on any protection upgrades or protection setting modification recommendations which have been agreed with TasWater, this shall be clearly and explicitly stated in the report.

(iii) Confirmation that egress from the switchboard is not hampered (where applicable).

(iv) Details of the generic arc flash hazard label format and content for the switchboard.

Switchboards which may satisfy the conditions for these special cases may include TasWater single phase main switchboards associated with standalone RTU installations.

6. **Single Phase 230V Switchboards with ≤32A Protected Supplies:**

For single phase 230V switchboard installations fed from a suitably fault rated, upstream Type T, gG HRC service fuse or a C-curve miniature circuit breaker with a rated current of 32A or less, two special cases, 6a) or 6b), can be considered (as detailed below).

Case 6a) – Lowest single phase prospective short circuit current at the switchboard ≥ 1kA:

In this case, provided the minimum single phase prospective fault current at the switchboard under all scenarios is at least 1kA then the worst case Arc Flash incident energy (at a working distance of 457mm) when calculated in accordance with the IEEE 1584-2018 three phase equations and methodology, will be less than 1.2 cal/cm^2.

In this specific single phase case, unless otherwise directed by TasWater, detailed arc flash hazard calculations are not required and a generic arc flash hazard label may be applied to the switchboard with a format as per the example in Section 3.2.5.9 Figure 7.

Case 6b) – Lowest single phase prospective short circuit current at the switchboard < 1kA and egress from the switchboard is not hampered:

In this case, considering a 2 second maximum arc time, the worst case Arc Flash incident energy (at a working distance of 457mm) when calculated in accordance with the IEEE 1584-2018 three phase equations and methodology will be less than 8 cal/cm^2 and the associated arc flash boundary will be less than 1200mm.

> Note: IEEE 1584-2018 states that "sustainable arcs are possible but less likely in three phase systems operating at 240V or less with an available short circuit current less than 2000A".

In this specific single phase case, unless otherwise directed by TasWater, detailed arc flash hazard calculations are not required and a generic arc flash hazard label may be applied to the switchboard with a format as per the example in Section 3.2.5.9 Figure 8.

For either Case 6a) or 6b), TasWater Arc Flash Hazard assessment documentation is still required which shall include;

(i) A summary of the modelling/calculations used to determine the minimum single phase prospective fault current at the switchboard under all scenarios. (e.g. from a suitable PowerCAD-5 model).

(ii) A summary of the installation details used to determine compliance with the "special case" conditions. Note: If the "special case" compliance is contingent on any protection upgrades or protection setting modification recommendations which have been agreed with TasWater, this shall be clearly and explicitly stated in the report.

(iii) Confirmation that egress from the switchboard is not hampered (where applicable).

(iv) Details of the generic arc flash hazard label format and content for the switchboard.

Switchboards which may satisfy the conditions for these special cases may include TasWater single phase distribution boards associated with instrumentation systems or RTU enclosures.

A summary of the special cases which may be considered for the application of a generic arc flash hazard label are summarised in Table 3 below;

Special Case Number	Nominal Supply	Upstream Protection Options	Minimum Prospective Fault Current (at the switchboard)	Other Requirements	Incident Energy @ 457mm WD	Arc Flash Boundary (mm)	Generic Label Format
2a)	400V (3-Phase)	≤ 100A gG Fuse ≤ 100A C- curve MCB* *Equivalent MCCB (I_m or I_i ≤800A)	≥ 2kA	None	< 1.2 cal/cm^2	< 457mm	Figure 5
2b)	400V (3-Phase)	≤ 100A gG Fuse ≤ 100A C- curve MCB* *Equivalent MCCB (I_m or I_i ≤800A)	< 2kA	Egress from switchboard is not hampered	< 8 cal/cm^2	< 1200 mm	Figure 6
3a)	400V (3-Phase)	≤ 50A gG Fuse ≤ 50A C- curve MCB* *Equivalent MCCB (I_m or I_i ≤400A)	≥ 1kA	None	< 1.2 cal/cm^2	< 457mm	Figure 5
3b)	400V (3-Phase)	≤ 50A gG Fuse ≤ 50A C- curve MCB* *Equivalent MCCB (I_m or I_i ≤400A)	< 1kA	Egress from switchboard is not hampered	< 8 cal/cm^2	< 1200 mm	Figure 6
5a)	230V (1-Phase)	≤ 80A gG Fuse ≤ 80A C- curve MCB	≥ 2.5kA	None	< 1.2 cal/cm^2	< 457mm	Figure7
5b)	230V (1-Phase)	≤ 80A gG Fuse ≤ 80A C- curve MCB	< 2.5kA	Egress from switchboard is not hampered	< 8 cal/cm^2	< 1200 mm	Figure 8
6a)	230V (1-Phase)	≤ 32A gG Fuse ≤ 32A C- curve MCB	≥ 1kA	None	< 1.2 cal/cm^2	< 457mm	Figure 7
6b)	230V (1-Phase)	≤ 32A gG Fuse ≤ 32A C- curve MCB	< 1kA	Egress from switchboard is not hampered	< 8 cal/cm^2	< 1200 mm	Figure 8

Table 3: Special Cases for Generic Arc Flash Hazard Labels

3.2.5.7 Arc Flash Hazard Labelling General Requirements

Suitable arc flash hazard label details shall be specified for each switchboard considered in the arc flash hazard calculations. In general, one arc flash hazard label shall apply to each switchboard assembly, however, in some cases, separate enclosures may require separate labels (e.g. some incomer or metering enclosures).

Arc flash hazard labels shall contain the minimum information required for equipment labelling specified in NFPA 70E - 2021 “Standard for Electrical Safety in the Workplace” as follows;

(a) Nominal system voltage
(b) Arc flash boundary
(c) Available incident energy and the corresponding working distance

The arc flash hazard label for each switchboard shall specify, the worst case (i.e. largest) calculated incident energy at the applicable working distance and the corresponding arc flash boundary at both the line side and load side of the “Main Switch” or “Main Isolator”. Each switchboard label shall also include the applicable TasWater site and switchboard identification details and the date at which the arc flash hazard calculations were completed.

The Arc Flash Hazard Calculations Summary Report shall include the arc flash hazard label details for each switchboard considered. Label details shall be provided in accordance with the applicable example formats shown below in Section 3.2.5.9.

3.2.5.8 Arc Flash Hazard Label Size and Location Requirements:

Arc flash hazard labels shall be durable, self-adhesive vinyl printed labels with a minimum size of 170mm x 120mm (or 170mm x 90mm for "generic" labels as per the example formats shown in Section 3.2.5.9 Figure 5 to Figure 8). Final label artwork proofs are to be submitted by the Electrical Contractor or the Switchboard Manufacturer for TasWater approval prior to manufacture.

Unless otherwise specified, arc flash hazard labels for switchboards shall be located on the switchboard door or escutcheon adjacent to the "Main Switch" or "Main Isolator" actuator (or on the door or escutcheon behind which the potential arc source exists). Generally, labels are to be applied by the Switchboard Manufacturer prior to Factory Acceptance Testing of new switchboards. If directed by TasWater, labels may be applied by an Electrical Contractor for existing switchboards or prior to energisation of replacement switchboards.

3.2.5.9 Arc Flash Hazard Label Format Requirements:

Where any calculated incident energy (at the applicable working distance) exceeds 40 cal/cm^2, a DANGER label complying with AS 1319 shall be applied to the equipment with a format as per the example shown below in

.

DANGER		
Arc Flash and Shock Hazard **Incident Energy > 40 cal/cm^2**		
OBNST01 - OBAN STP **MAIN SWITCHBOARD**	Date Assessed: 14/12/2020	
Nominal System Voltage:	**400**	**VAC**
INCOMER (Line Side of Main Switch)		
Incident Energy (at 457 mm Working Distance):	**44.8**	**cal/cm^2**
Arc Flash Boundary:	**2721**	**mm**
BUSBARS (Load Side of Main Switch)		
Incident Energy (at 457 mm Working Distance):	**1.8**	**cal/cm^2**
Arc Flash Boundary:	**554**	**mm**

Figure 1: Example Arc Flash DANGER Label Format (Incident Energy > 40 cal/cm^2 - Calculated)

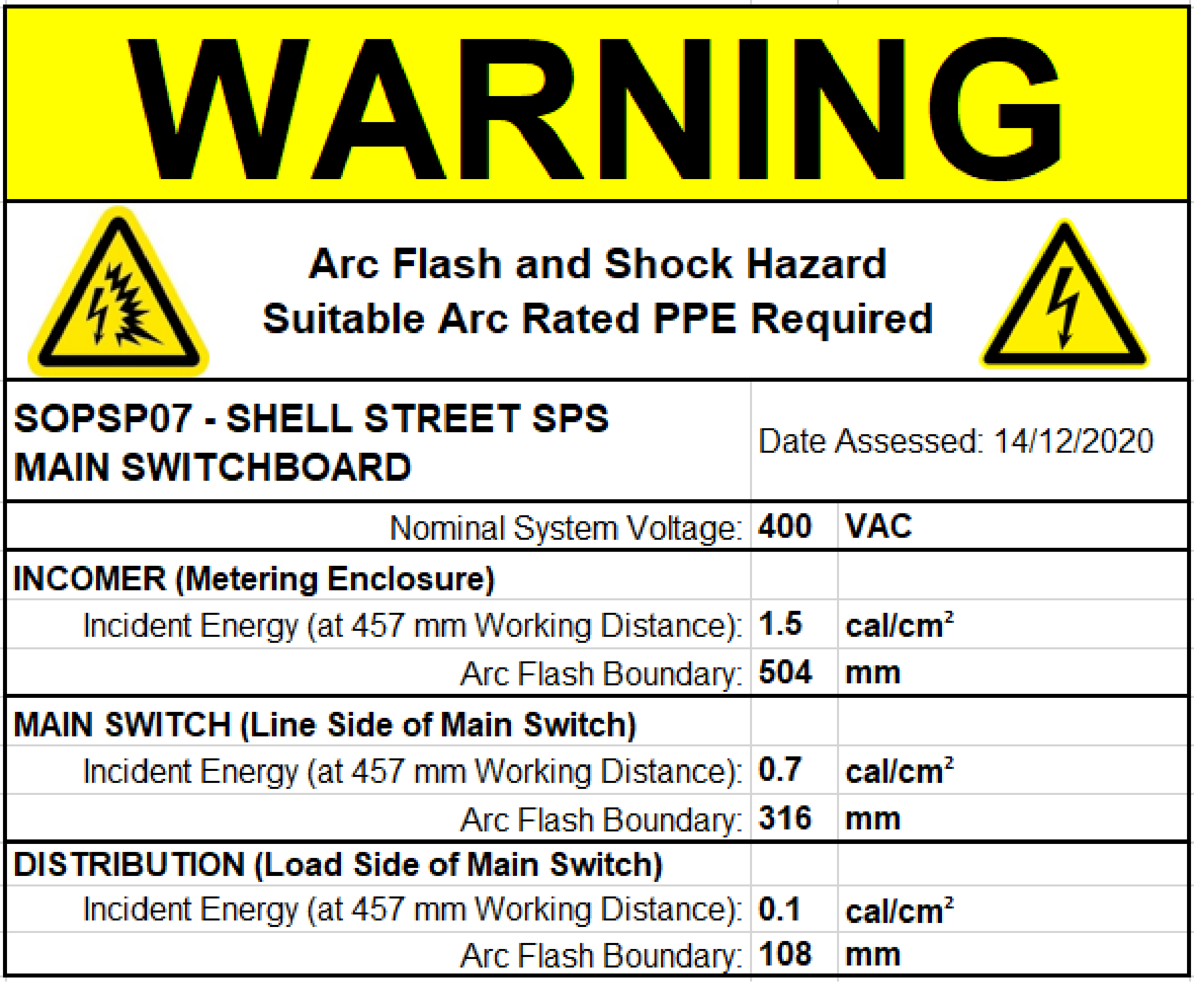
Where the worst case calculated incident energy (at the applicable working distance) is ≥ 1.2 cal/cm^2 and ≤ 40 cal/cm^2, a WARNING label containing the ISO graphical symbols for an electrical shock hazard (ISO 7010 - W012) and an arc flash hazard (ISO 7010 - W042) shall be applied to the equipment with a format as per the examples shown below in Figures 2a) or 2b).

WARNING

Arc Flash and Shock Hazard
Suitable Arc Rated PPE Required

GONWP01 - GONDWANA WPS MAIN SWITCHBOARD	Date Assessed: 14/12/2020	
Nominal System Voltage:	**400**	**VAC**
INCOMER (Line Side of Main Switch)		
Incident Energy (at 457 mm Working Distance):	**15.6**	**cal/cm^2**
Arc Flash Boundary:	**2277**	**mm**
BUSBARS (Load Side of Main Switch)		
Incident Energy (at 457 mm Working Distance):	**1.8**	**cal/cm^2**
Arc Flash Boundary:	**554**	**mm**

Figure 2: Example Arc Flash WARNING Label Format (Incident Energy ≥ 1.2 cal/cm^2 and ≤ 40 cal/cm^2 - Calculated)



WARNING		
Arc Flash and Shock Hazard **Suitable Arc Rated PPE Required**		
SOPSP07 - SHELL STREET SPS **MAIN SWITCHBOARD**	Date Assessed: 14/12/2020	
Nominal System Voltage:	**400**	**VAC**
INCOMER (Metering Enclosure)		
Incident Energy (at 457 mm Working Distance):	**1.5**	**cal/cm²**
Arc Flash Boundary:	**504**	**mm**
MAIN SWITCH (Line Side of Main Switch)		
Incident Energy (at 457 mm Working Distance):	**0.7**	**cal/cm²**
Arc Flash Boundary:	**316**	**mm**
DISTRIBUTION (Load Side of Main Switch)		
Incident Energy (at 457 mm Working Distance):	**0.1**	**cal/cm²**
Arc Flash Boundary:	**108**	**mm**

Figure 3: Example Arc Flash WARNING Label Format (Incident Energy ≥ 1.2 cal/cm^2 and ≤ 40 cal/cm^2 - Calculated)

Where the worst case calculated incident energy (at the applicable working distance) is < 1.2 cal/cm^2 a WARNING label containing the ISO graphical symbols for an electrical shock hazard (ISO 7010 - W012) and an arc flash hazard (ISO 7010 - W042) shall be applied to the equipment with a format as per the example shown below in Figure.

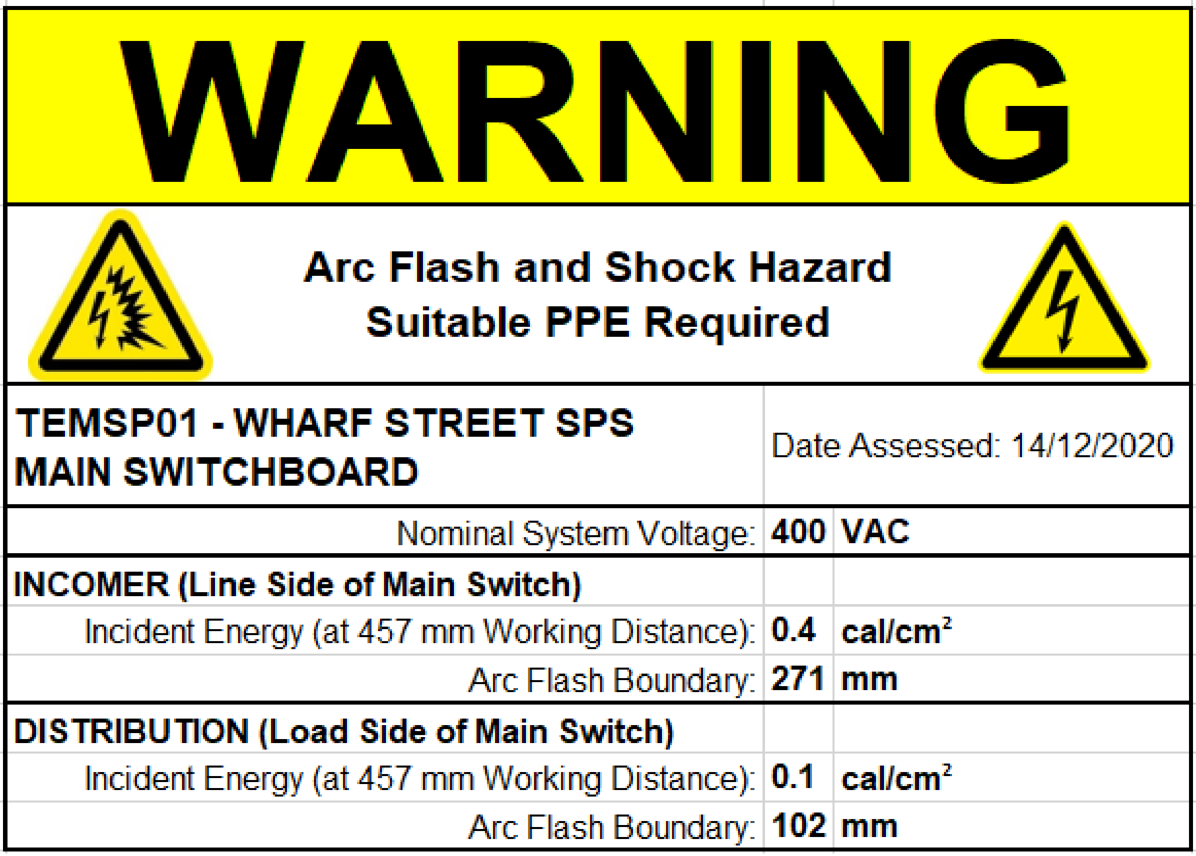


Figure 4: Example Arc Flash WARNING Label Format (Incident Energy < 1.2 cal/cm^2 - Calculated)

For three phase, 400V, 100A protected switchboards complying with the specific requirements of Special Case 2a) above or for 400V, 50A protected switchboards complying with the specific requirements of Special Case 3a) above, a “generic” WARNING label containing the ISO graphical symbols for an electrical shock hazard (ISO 7010 - W012) and an arc flash hazard (ISO 7010 - W042) may be applied to the switchboard with a format as per the example shown below in Figure 4.

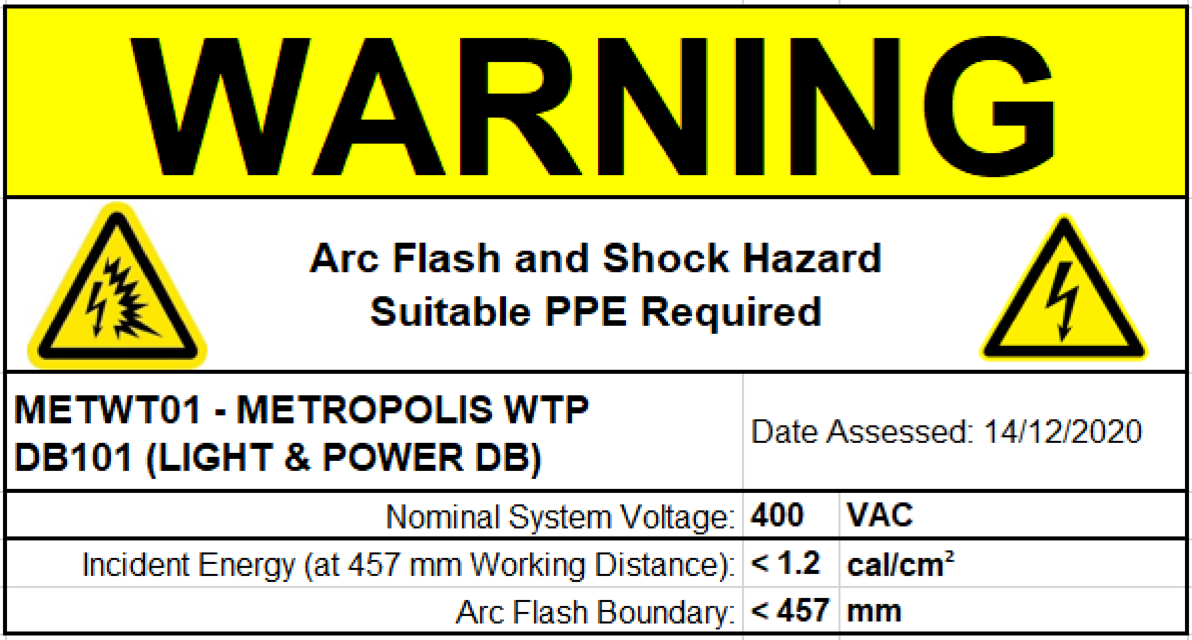


Figure 5: Example Generic 400V, < 1.2 cal/cm^2 Arc Flash WARNING Label Format (Special Case 2a or 3a)

For three phase, 400V, 100A protected switchboards complying with the specific requirements of Special Case 2b) above or for 400V, 50A protected switchboards complying with the specific requirements of Special Case 3b) above, a “generic” WARNING label containing the ISO graphical symbols for an electrical shock hazard (ISO 7010 - W012) and an arc flash hazard (ISO 7010 - W042) may be applied to the switchboard with a format as per the example shown below in Figure 5.

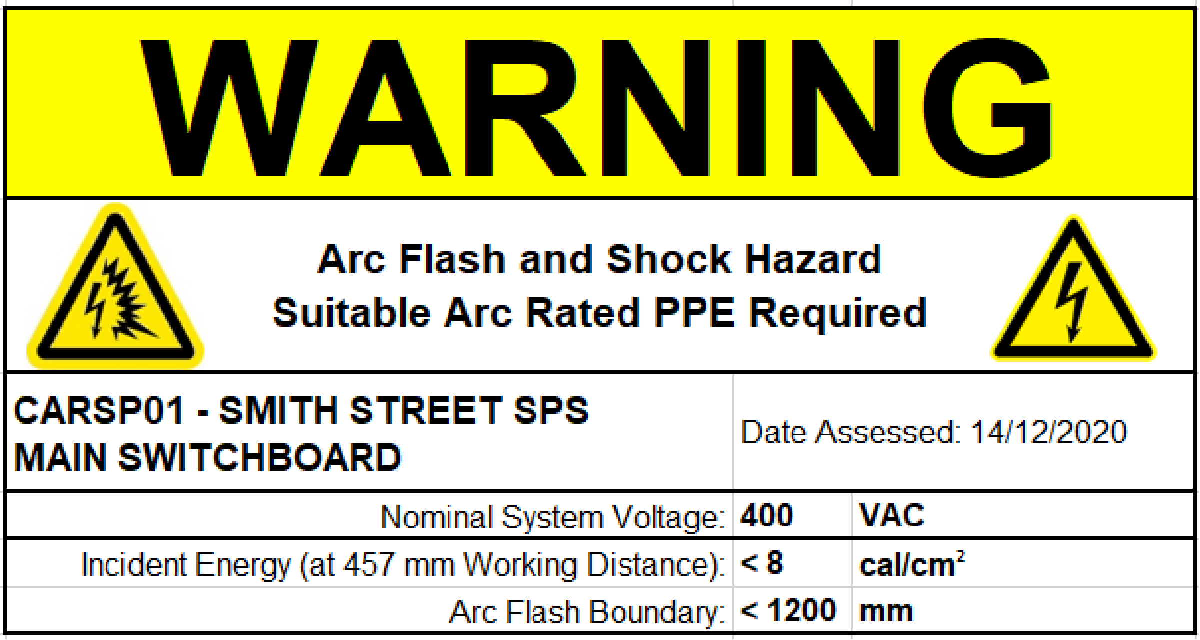


Figure 6: Example Generic 400V, < 8 cal/cm^2 Arc Flash WARNING Label Format (Special Case 2b or 3b)

For single phase, 230V, 80A protected switchboards complying with the specific requirements of Special Case 5a) above or for 230V, 32A protected switchboards complying with the specific requirements of Special Case 6a) above, a “generic” WARNING label containing the ISO graphical symbols for an electrical shock hazard (ISO 7010 - W012) and an arc flash hazard (ISO 7010 - W042) may be applied to the switchboard with a format as per the example shown below in Figure 6.

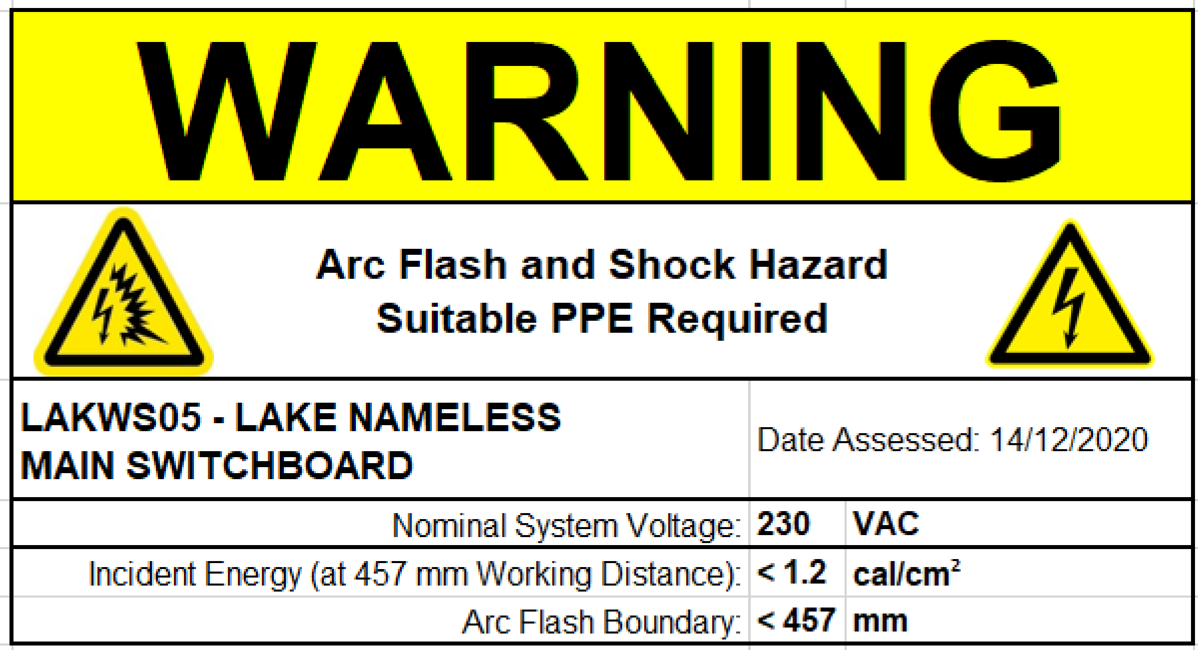


Figure 7: Example Generic 230V, < 1.2 cal/cm^2 Arc Flash WARNING Label Format (Special Case 5a or 6a)

For single phase, 230V, 80A protected switchboards complying with the specific requirements of Special Case 5b) above or for 230V, 32A protected switchboards complying with the specific requirements of Special Case 6b) above, a “generic” WARNING label containing the ISO graphical symbols for an electrical shock hazard (ISO 7010 - W012) and an arc flash hazard (ISO 7010 - W042) may be applied to the switchboard with a format as per the example shown below in Figure 7.

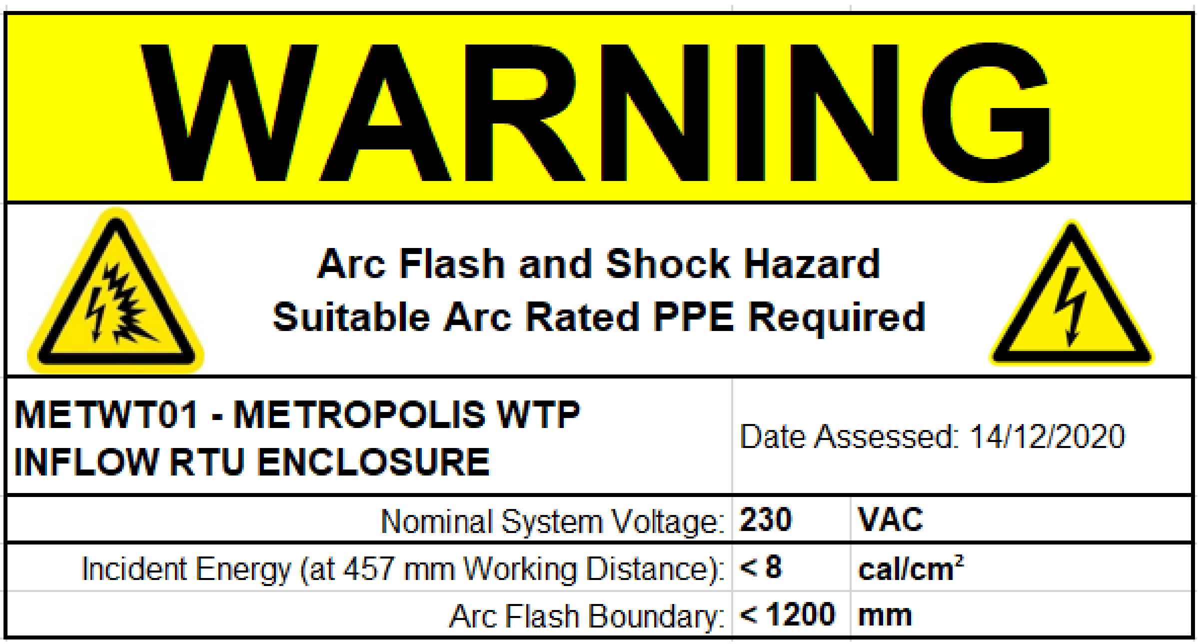


Figure 8: Example Generic 230V, < 8 cal/cm^2 Arc Flash WARNING Label Format (Special Case 5b or 6b)

3.3 Design Considerations

3.3.1 Key Design Factors

The electrical design, which encompasses power distribution, instrumentation, process control and SCADA design must be characterised by the following:

- (a) Compliant with statutory requirements, as well as the requirements of Australian and TasWater Standards
- (b) Safety of operators and maintenance personnel is a main priority
- (c) It features cost-effective, yet reliable solutions that aim to minimise plant downtime
- (d) Aims to maximise environmental sustainability and energy efficiency outcomes throughout a plant's lifetime.

The electrical design, drawings, specifications, installation instructions and commissioning plan must meet all applicable codes, regulations, and standards, and will help mitigate project risks and improved delivery of project outcomes. Electrical installations must be designed to facilitate the safe operation and maintenance of electrical plant. Adequate provisions must be included in the design of all electrical installations to minimize exposure of facility personnel and visitors to safety hazards. Electrical assets must be designed in full compliance with the Tasmanian Work Health and Safety Act 2012, the Tasmanian Work Health and Safety Regulations 2012 (and relevant Codes of Practice), and TasWater's Work Health and Safety Policy, TASPOL13.

All electrical equipment must be adequately rated for the prospective short-circuit fault current so as to prevent injury to personnel in the event of a major electrical fault. This includes the provision of protection against exposure to arc flash incidents. As far as practically possible, specify electrical equipment that are verified for both short circuit withstand and arc flash protection. Include measures in the design which will minimise exposure of people to electric shock hazards. Where exposure cannot be completely eliminated, barriers must be designed that will provide a minimum of IP4X protection against accidental contact with live low voltage (LV) electrical parts. The segregation of LV power and ELV control sections within switchboards and control panels must also be a high priority. Barriers, switchboard or control panel internal arrangement, the use of interposing relays may be used to achieve segregation. The use of ELV as far as practically possible is encouraged.

All switchboards, motor control centres, control panels, marshalling panels etc. which contain electrical equipment shall be positioned and accessed in line with AS/NZS 3000 as a minimum as defined in Section 2.10 *Switchboards*. In particular Section 2.10.2.2 *Accessibility and Emergency Exit Facilities* must be reviewed for all switchboards being new or repositioned. All proprietary modular switchboards and motor control centres shall be fully verified assemblies to Annex ZD, AS/NZS 61439.1 when all doors are correctly closed and secured.

3.3.2 Operating Environment

The electrical design must be based on site environmental conditions determined as follows:

- (a) Maximum ambient temperature – the maximum monthly average daily maximum outside temperature for the site as published by the Commonwealth Bureau of Meteorology
- (b) Maximum humidity – the maximum monthly average index of humidity for the site as published by the Commonwealth Bureau of Meteorology
- (c) Corrosion Environment – the ISO environmental corrosion category for the site as defined in AS/NZS 2312

(d) Airborne dust pollution level – severe, moderate, or low as determined for the site bearing in mind proposed operations and future developments
(e) Altitude – site mean height above sea level.

Except for air-conditioned spaces, the environmental conditions at the various locations around a site may be more severe than the values determined above and must be estimated on the basis of the above values depending on the particular location.
In water treatment plants particular attention must be paid to equipment to be located in areas in which corrosive chemical are found, such as alum, chlorination and fluoridation system.

In sewage treatment plants particular attention must be paid to equipment to be located in areas in which corrosive gases such as hydrogen sulphide (H_2S) is present. Also explosive gases (such as methane) may accumulate in sufficient quantities to present an explosion hazard. Refer to Section 3.3.3 - Electrical Equipment in Hazardous Areas (EEHA) for specific requirements the Responsible Designer must consider and adhere to.

Electrical systems within chemical dosing areas may also be subject to specific legislative requirements. The Responsible Designer must ensure that all legislative and applicable Australian Standards are clearly identified in the design, documented in the Basis of Design and considered during the design phase.

Within treatment plant buildings, switchboards must be installed within dedicated switchrooms which are adequately ventilated and pressurised to ensure that internal room temperatures do not exceed 40°C and all air-borne contaminants are prevented from entering the room. Switchrooms must be pressurised using clean, filtered air.

TW's preference is to have switchrooms which are positively pressurised (10Pa) to keep out harmful dusts and gasses and designed to minimise the maximum temperature within the switchroom to 5 degrees above the external temperature (down to 30 degrees external).

The following design concepts should be considered:

(a) Position and shading of the switchroom to minimise solar heat and process heat gain
(b) Construction of the switchroom to provide thermal mass to lower and delay the higher external heat loads during the day
(c) Increasing the pressurisation fan speed to provide more cooling but maintaining the required pressurisation.
(d) Sourcing clean dry air from the most appropriate position
(e) Only out of necessity and after consultation with TW, use a heat pump to provide the required cooling and in this case size it to limit switchroom temperature to 40 degrees normally but reduce to 30 degrees in 10 minutes in the highest temperature situation. This would be a manual override

3.3.3 Electrical Equipment in Hazardous Areas (EEHA)

3.3.3.1 General

A hazardous area is defined as an area in which an explosive atmosphere is present, or may be expected to be present, in quantities such as to require special precautions for the construction, installation and use of potential ignition sources. The explosive atmosphere may be caused by the presence of a flammable liquid, gas or vapour or by the presence of combustible dust in suspension or in layers or a combination of explosive gas and dust atmospheres.

Sewage treatment plants frequently produce significant quantities of flammable gas either deliberately or accidentally as a by-product of the treatment process. Therefore explosion risks must be considered by the Responsible Designer. The flammables gases produced in sewage treatment consist mainly of methane and tend to be concentrated in particular process areas including anaerobic digesters, digester-gas handling plant, digester-gas fired boilers and generators. However flammable gases may also accumulate in poorly-ventilated areas containing sewage or sludge, such as enclosed air spaces above sewers, inlet channels, screens, primary sedimentation tanks, digested and dewatered sludge storages.

The storage, handling and use of other flammable materials at TW sites may also create hazardous areas which need to be identified, classified and considered as part of the electrical design process.

The Designer shall ensure that area classification, plant design and equipment selection are carried out in accordance with the requirements of the relevant Australian Standards, including but not limited to:

(a) AS/NZS 3000 Electrical Installations
(b) AS/NZS 4761 Competency for Working with Electrical Equipment for Hazardous Areas
(c) AS/NZS 60079.10.1 Explosive atmospheres – Classification of areas - Explosive gas atmospheres
(d) AS/NZS 60079.10.2 Explosive atmospheres – Classification of areas - Explosive dust atmospheres
(e) AS/NZS 60079.14 Explosive atmospheres – Design selection, erection and initial inspection

3.3.3.2 Competency Requirements

The classification of hazardous areas, the selection of electrical equipment to be used in hazardous areas and the design of electrical installations within hazardous areas must only be undertaken by competent persons who satisfy the requirements of AS/NZS 4761, parts 1 and 2.

3.3.3.3 Area Classification

Hazardous Area classification is the first step in designing the electrical installation for hazardous areas. Hazardous Area classification must be carried out in accordance with AS/NZS 60079.10.1 or AS/NZS 60079.10.2 as applicable.

3.3.3.4 Equipment Selection

All electrical equipment used in hazardous areas shall have appropriate certification in accordance with the requirements of AS/NZS 60079.14 and other relevant standards. Only equipment certified under the IECEx or ANZEx certification schemes may be selected. Equipment certified under the ATEX scheme may only be used if also certified under the IECEx or ANZEx scheme. ATEX certification on its own is not accepted in Australia.

Explosion protection techniques (e.g. ‘Ex d’, ‘Ex e’ etc.) selected must be appropriate for the hazard being protected against. Comply with the AS/NZS 60079 series of standards.

3.3.3.5 Installation

Electrical installation design in hazardous areas must conform to the following:

(a) AS/NZS 3000 and
(b) AS/NZS 60079.14

3.3.3.6 Documentation

The Responsible Designer must prepare and maintain during the design process a Hazardous Area Verification Dossier in accordance with AS/NZS 60079.14.
Included in this dossier should be:

(a) Hazardous Area drawings
(b) Certification schedule
(c) Equipment certificates
(d) The engineering calculations pertaining to Intrinsically Safe loops
(e) Cable schedules and Cable routes
(f) Special tests to be carried out upon Installation/Commissioning
(g) Inspection report on installation
(h) Periodic inspection reports
(i) Other items as noted in Clause 4.2 of AS/NZS 60079.14.

The Verification Dossier must be kept up to date at all times during the design process. Any changes to pipework or ducting during design, construction and maintenance may change the hazardous area classification. The dossier must be updated during the design, but also throughout the life of the plant, reflecting any changes which are implemented pertaining to the installation and equipment within the hazardous area.

Following construction and commissioning the Verification Dossier will be used by TasWater, maintenance contractors and future designers for maintenance purposes and for the recording of test results, inspections, equipment overhauls, repairs and modifications and changes to area classifications. The Verification Dossier must be available for inspection by the Design Manager at all times during the design phase.

3.3.4 Work on Existing Plant Electrical Installations

3.3.4.1 General

The design of additions and upgrades to existing plant electrical installations must all follow the same general principles as for new plants. However, the Responsible Designer needs to be aware of a number of issues that are likely to arise when working on existing plants.

3.3.4.2 Site Survey

Before commencing work on additions to or upgrades of an existing plant the Responsible Designer must:

(a) Obtain copies of all available drawings and documentation for the plant from the Design Manager.
(b) Carry out a site survey of the areas affected by the new works in order to confirm the completeness and accuracy of existing documentation and to determine the condition of the existing installation.

Any issues arising from the site survey which may affect the scope or design of the new works must be reported to the Design Manager.

It is strongly recommended that the Responsible Designer meets with plant operations and maintenance personnel on a regular basis during the design phase to brief them on the proposed works and to provide an opportunity for discussion and feedback. Such meetings must be coordinated through the Design Manager and any proposed or requested design changes arising from the meetings must be referred to the Design Manager for approval.

3.3.4.3 Standards and Regulations

All new work must conform to current TasWater, Australian and international standards and to current statutory regulations. Some of the standards and regulations to which existing plants, particularly older plants, have been designed may have been superseded. In many cases this may be of little consequence. However, the Responsible Designer will sometimes encounter compatibility or safety issues when interfacing with equipment or facilities built to superseded standards. This is particularly so when designing additions and upgrades to older plants that have been subject to several previous upgrades. In such cases the Designer must identify the issues and propose solutions for consideration by the Design Manger.

3.3.4.4 Safety and Environmental Issues

The conformance of existing facilities affected by the new works to current statutory requirements must be checked. The Responsible Designer must refer any non-conformances, particularly those which relate to safety or the environment, to the Design Manager with recommendations for resolving them.
If the Responsible Designer becomes aware of any safety or environmental issues relating to existing plant or equipment, even though the plant or equipment may not be directly affected by the new works, the issues must be referred in writing to the Design Manager.

Such issues may include:

(a) Plant or equipment that does not meet current safety or environmental regulations
(b) Existence of hazardous materials (e.g. asbestos) on the site
(c) Plant or equipment in poor or unsafe condition.

3.3.4.5 Electrical Equipment and Cabling

The Design Manager may require that existing electrical equipment and cabling affected by the new works be upgraded or replaced if it has insufficient capacity for the additional loads, does not conform to current TasWater standards, is in poor condition or is nearing the end of its useful life.

3.3.4.6 Process Control and SCADA Systems

All new processes and equipment items must be integrated into the existing process control and SCADA systems, including all necessary updating of displays, graphics, reports, alarms, data logging, trending, programming and documentation.

3.3.4.7 Programmable Controllers

The Design Manager may require that existing programmable controller hardware affected by the new works be upgraded or replaced if it is obsolete or does not conform to current TasWater standards.

3.3.4.8 Data communications

The Deign Manager may require that existing copper or radio communication networks be upgraded to optical fibre as part of the new works.

3.3.4.9 Field Instrumentation

The Design Manager may require that existing field instruments be upgraded or replaced to bring them into conformity with current TasWater standards.

3.3.4.10 Chemical Dosing Areas

The Responsible Designer must carry out a full review of the existence of corrosive chemicals within those areas affected by the new works.

The review must include existing electrical equipment in those areas to ensure they are suitable for the new installations and that both the existing and new electrical systems will comply with the relevant legislative requirements and Australian Standards.
If the Responsible Designer becomes aware of any non-conformance issues relating to existing plant or equipment not affected by the new works, the issues must be referred in writing to the Design Manager.

3.3.4.11 Hazardous Areas

The Responsible Designer must carry out a full review of existing hazardous area classifications for those areas affected by the new works. Existing areas must be reclassified where necessary when the hazardous areas created by the new works overlap existing plant, or the new works are within an area that is already classified as a hazardous area. Re-classification must be undertaken in accordance with Section 3.3.3.3 with the existing site hazardous classification report updated.
When the new works affects the hazardous area classification of existing plant areas, the Responsible Designer must review existing electrical equipment in those areas to ensure they are suitable for the new classification.

If the Responsible Designer becomes aware of any hazardous area non-conformance issues relating to existing plant or equipment not affected by the new works, the issues must be referred in writing to the Design Manager.

The existing Hazardous Area Verification Dossier must be kept up-to-date at all times by the addition of new material from the new works as components and systems are designed, installed and commissioned and brought on line.

3.3.5 Safety and Control Philosophy

3.3.5.1 Emergency Stop System

The electrical designer shall develop an emergency stop system which satisfies the following requirements:

(a) Provides an emergency stopping system for the whole plant which satisfies the requirements of AS/NZS 3000 and the AS 4024.1 series where applicable
(b) The emergency stopping system shall not create further dangerous situations
(c) The locations of emergency stop pushbuttons shall satisfy Australian standards and in addition also provide clear identification of which equipment they will stop if operated and will be easy for personnel to identify in an emergency.
(d) Identify and propose to TasWater the most appropriate type of system for the plant under consideration including whether a plant wide, an area specific, an equipment specific emergency stop system or a combination of these are most appropriate.
(e) Once the system has been activated the following shall occur as a minimum:
    (i) All equipment associated with the emergency stop shall stop in a safe manner as quickly as possible to reduce exposure time to the risk but not produce additional hazards
    (ii) The system shall not restart until the emergency stop which was activated has been physically reset and a system restart has been requested by an operator after they have deemed the plant to be safe. The exception to this is building ancillary equipment such as ventilation fans and other building services type applications where AS/NZS 3000 compliance is deemed acceptable
    (iii) Loss of electrical supply to the plant shall not cause the emergency stop system to trip and the plant will be able to restart automatically on power resumption

(iv) Secondary process alarms which would be created as a result of the emergency stop operation shall be supressed when the emergency stop is active.
(v) The operation of the system shall be reported to the SCADA system which shall create an alarm. The alarm message shall identify either a single estop position or a related group of e-stops, consisting of not more than 5.

3.3.5.2 Documentation

The electrical designer shall complete an emergency stop system design dossier which identifies:

(a) All emergency stops and the associated areas of the plant these emergency stops will shut down
(b) Which standards the emergency stop system is to comply with (e.g. AS 4024.1 or AS/NZS 3000)
(c) If the system is to satisfy AS 4024.1 which Safety Category it is to comply with (CAT B, 1, 2, 3 or 4).

3.3.5.3 Isolation

Each motor and power consuming item of process equipment must be equipped with a primary means of isolation from the electrical supply. This must comprise a lockable disconnector located in the motor control centre or distribution board supplying the equipment.

For all motor driven equipment, a full-current field isolator must also be provided. The isolator must be mounted within sight of and not more than three metres from the motor. The field isolator must be provided with a padlocking facility to secure the isolator in the open position.

Provide field motor isolators to all electric motors in accordance with Section 6 *Motor and Field Isolators* of TDESTD102 - *TasWater Electrical & SCADA Technical Standard - Construction & Application*.

Field isolators must be provided for all single phase circuits up to 10A, and all three phase circuits up to 37kW. For single phase circuits larger than 10A, and for three phase circuits larger than 37kW , a primary isolator within the switchboard, MCC or distribution board supplying the circuit is required as a minimum and field isolators may only be omitted if specifically advised by the TasWater Design manager.

3.3.5.4 Local Control

The Responsible Designer must identify which items of equipment require local control, based on the requirement for the equipment to be run manually for maintenance purposes. Generally, every electric motor or motorised piece of equipment is expected to have a local control station (LCS). It is expected that the LCS controls will be in accordance with the applicable TasWater standard circuits which include;

(a) TWS-E-0012 TasWater Standard DOL Motor Circuits
(b) TWS-E-0025 TasWater Standard ESS Motor Circuits
(c) TWS-E-0032 TasWater Standard VSD Motor Circuits
(d) TDESTD79 TasWater Standard Motor Circuits Functional Description
(e) TWS-E-0032 TasWater Standard Emergency Stop Circuits
(f) TDESTD77 TasWater Standard Emergency Stop Circuits Functional Description

The designer will need to review the above TW standards, establish that these circuits satisfy the requirements of the application, including process and equipment protection during manual operation, and then propose their preferred circuit design for TW acceptance. In the case of clear water pumps which pump potable water from the clear water storage out to the network, a full manual override of the PLC control circuits are required to allow the clear water in the storage to be pumped in the case of a plant control system problem. The LCS must be in sight of and not more than three metres from the associated drive motor or equipment. If appropriate to the plant operation they may be incorporated with the associated field isolator.

3.3.5.5 Machine Hardwired Safety Circuit

Latch off emergency stop pushbuttons, pull wire switches, other personnel safety devices and auxiliary contacts of local disconnect switches must satisfy the requirements of AS 4024.1 and be based on the following TasWater standard circuits:

(a) TWS-E-0012 TasWater Standard DOL Motor Circuits
(b) TWS-E-0025 TasWater Standard ESS Motor Circuits
(c) TWS-E-0032 TasWater Standard VSD Motor Circuits
(d) TDESTD79 TasWater Standard Motor Circuits Functional Description
(e) TWS-E-0032 TasWater Standard Emergency Stop Circuits
(f) TDESTD77 TasWater Standard Emergency Stop Circuits Functional Description

These circuits must be wired to de-energise the motor contactor. Additional contacts, arranged to open before the hard-wired contacts must be provided to signal to the PCS. This must not preclude the provision, in addition to the safety circuit, of non-latching stop buttons operating through the control system. Such controls may be required, for example, for the routine stopping of variable speed drives where a controlled deceleration to standstill is desired. The standard circuits listed above were developed for potential application in a Category 1 or Category 2 safety system. The Responsible Designer must assess for each application the correct safety system classification in accordance with AS 4024.1, and adapt the standard safety circuit if a system is of a different category. The Responsible Designer is responsible for ensuring that a rigorous safety system assessment is carried out in the design phase. The Responsible Designer is also responsible for ensuring the Electrical Design complies with the appropriate safety system category.

3.3.5.6 Modes of Control

In general, there must be three modes of control of equipment. These modes are AUTO, OFF and MANUAL. The functionality associated with each mode is described in TDESTD79 TasWater Standard Motor Circuit Functional Description. Selection between these modes may be from a local selector switch, mounted in the field on a Local Control Station (LCS) or from SCADA depending on the asset specific requirements. The choice between field mounted and/or SCADA/HMI mode selection must be made on a project-by-project basis and in consultation with TasWater's Design Manger.

Modes of control must be based on the following TasWater standards:

(a) TWS-E-0012 TasWater Standard DOL Motor Circuits
(b) TWS-E-0025 TasWater Standard ESS Motor Circuits
(c) TWS-E-0032 TasWater Standard VSD Motor Circuits
(d) TDESTD79 TasWater Standard Motor Circuits Functional Description
(e) TWS-E-0030 TasWater Standard Emergency Stop Circuits
(f) TDESTD77 TasWater Standard Emergency Stop Circuits Functional Description

3.3.6 Design Service Life

All electrical asset components must have a minimum service life as specified below:

(a) Electrical equipment (general): 25 years
(b) Electrical switchboards, MCCs and distribution boards: 40 years
(c) Process control and telemetry: 15 years

3.3.7 Equipment Selections

Unless specified otherwise in the client brief, all equipment selections must be made from TDESTD21 *Preferred Equipment List Technical Standard*. The Responsible Designer must ensure that any equipment specified in the Electrical Design are fit-for-purpose. Where an item of equipment listed in TDESTD21 is not fit-for-purpose, the Responsible Designer must notify the Design Manager and propose an item of equipment that will be fit-for-purpose.

3.3.8 Power Distribution

3.3.8.1 Voltages

All electrical equipment included in the design must be suitable for continuous and safe operation at the following voltages as applicable:

(a) Three phase electrical loads: 400 volt +10%/-6% in accordance with AS/NZS 60038
(b) Single phase electrical loads: 230 volt +10%/-6% in accordance with AS/NZS 60038
(c) Motor starter control voltage: 24V dc
(d) PLC/RTU control voltages: 24 V dc

3.3.8.2 Power Quality

TasWater electrical installations often feature several motor loads (with/without electronic starter drives or VSD's), resulting in greater harmonics and degrading the power factor. The electrical Responsible Designer must consider harmonics and power factor in the design. If harmonics and power factor will fall outside the Electricity Distributor's published limits on harmonics and power factor, the Responsible Designer must include measures in the design to improve the quality of the power supply.

Calculate the level of total harmonic distortion and design mitigating measures as required to comply with the relevant parts of the AS 61000 series and the Electricity Distributor's published requirements. Acceptable forms of harmonic mitigation are: plant-level active harmonic filtering (normally too expensive), drive-level active harmonic filtering or choosing low-harmonic drives (which is the preferable option). Calculate the electrical installation power factor and design mitigating measures as required to meet the Electricity Distributor's published requirements. Passive, capacitive power factor correction is preferred.

Calculate the level of voltage dips (flicker) that will occur at the Electricity Distributor's point of supply due to motor starting and design mitigating measures as required to comply with the relevant parts of the AS 61000 series and the Electricity Distributor's published requirements.

3.3.9 Treatment Plant Building Services – Electrical, Mechanical and Fire

3.3.9.1 General

The Responsible Designer must design all building electrical services in compliance with all relevant Federal and State statutory requirements and Australian Standards.
Tasmanian legislation requires that the building electrical services design be certified by a licenced Building Practitioner.
This section covers all buildings at treatment plants, including control rooms, switchrooms and process buildings.

3.3.9.2 Telephone and Corporate Data Services

A telephone service must be provided to all treatment plants. TasWater will arrange with Telstra for the provision of a lead-in cable and its installation, as well as the provision of the Building Distributor/Main Distribution Frame and termination of the lead-in cable at the Building Distributor/Main Distribution Frame.

The requirements for on-site telecommunications services (including corporate data services) and cabling should be detailed in the Design Brief. If an internal telephone system is required by the Design Brief, the telephone system must comply with Section 17 *Telecommunications Cabling* of TDESTD102 - *TasWater Electrical & SCADA Technical Standard - Construction & Application*.
As a minimum, provide the following at the control room:

(a) A phone service
(b) A facsimile service
(c) A broadband connection.

3.3.9.3 General Light & Power

The general light and power system must comply with the requirements of Section 4 *Low and Extra Low Voltage Power Systems* and Section 7 *Lighting* of TDESTD102 - *TasWater Electrical & SCADA Technical Standard - Construction & Application*.

General light and power distribution must originate at a suitably located General Light and Power (GL&P) distribution board. Each separate building and/or area of the treatment plant must have its own dedicated GL&P distribution board.

All GL&P distribution boards must be located indoors. To mitigate the risk of arc flash and other hazards, the following additional requirements on the placement of the distribution boards must be adhered to:

(a) Suitably rated for the operating environment
(b) Current rating of 100A per phase maximum, which includes a 20% allowance for future growth in the number of circuits and connected load
(c) Must be provided with an escutcheon plate that will provide a minimum of IP4X protection against accidental contact with live electrical parts
(d) Preferably not within any process areas; if unavoidable, the DB must be located a minimum of 5m away from any areas that could be subject to liquid discharges
(e) Not built into switchboards or MCCs
(f) Not within electrical switchrooms, to minimise the need for operators and other non-technical personnel to access switchrooms when resetting circuit breakers or RCDs
(g) Not within areas frequently traversed by personnel, such as hallways (unless installed within a recessed cupboard that complies with the requirements of AS/NZS 3000), walkways etc.
(h) Must be a minimum of 2m away from basins and taps
(i) Must be a minimum of 2m away from any desks, work tables and lunch room tables and
(j) Must not be within any wash-up rooms, water closets or other amenity areas

No equipment associated with the process, or with the process control system, must be supplied from a GL&P distribution board. These must all be supplied from a switchboard/MCC, or from a UPS distribution board. All GL&P distribution boards must fully discriminate with process switchboards/MCCs supplying the distribution board.

Power outlets

The design must include power outlets in convenient locations spread throughout non-process and process areas. If not specified in the Design Brief, the number and placement of outlets to locate within each area must be agreed with the Design Manager. Power outlets (both single phase and three phase types) located within process areas must be weatherproof, switched socket outlets and with a minimum ingress protection (IP) rating of 56, or higher as appropriate for the area. This level of protection must be available with the power outlet in use / not in use. Power outlets must be placed in areas where they will not be subject to sprays caused by floor washing or accidental process liquid discharges. All outlets must be labelled to identify the source of power, i.e. distribution board identification.

Interior lighting

All control rooms, switchrooms, internal process areas and other indoor areas must be provided with adequate lighting to ensure safe and amenable working conditions for building occupants. The lighting design must comply with the minimum lighting levels specified in the AS/NZS 1680 series of standards (for interior and workplace lighting).

Building lighting must comply with Section J6 of the National Construction Code (NCC). This may not be required for certain types of building classes, and should be confirmed at the commencement of the design phase.

Indoor lighting is to be controlled via conveniently placed light switches to allow safe entry to and exit from the areas.

Outdoor lighting

The lighting design must comply with the minimum lighting levels specified in the AS/NZS 1680 and the AS/NZS 1158 series of standards (as applicable for outdoor workplaces, outdoor areas and roadway lighting).

Outdoor lights are to be controlled via AUTO/OFF/MANUAL switches. In MANUAL, the lights remain on permanently unless switched to AUTO or OFF again. In AUTO, the lights must be switched on/off automatically via externally mounted photo-electric sensors wired in series with timers and lighting control contactors (230V ac controlled), located within the GL&P distribution board from which the lights are supplied. As an alternative to photo-electric control of outdoor lights, the use of movement sensors are encouraged in line with the requirement to minimise electricity consumption at the treatment plant. All lighting contactors should be installed behind the distribution board escutcheon plate.

3.3.9.4 Emergency Lighting & Exit Signs

Provide emergency evacuation lighting and exit signs (including illuminated types) in accordance with the requirements of Section 13 *Emergency Evacuation Lighting* of TDESTD102 - *TasWater Electrical & SCADA Technical Standard - Construction & Application*.

3.3.9.5 Electronic Security, Access Control and Security Lighting

The requirements for electronic security, access control and security lighting must be agreed with the Design Manager at the start of the design phase if not otherwise specified in the design brief. Where it is required to provide electronic security and access control systems, their design must comply with Section 15 *Electronic Security and Access Control* of TDESTD102 - *TasWater Electrical & SCADA Technical Standard - Construction & Application* and/or as agreed with the Design Manager.

Provide low level security lighting at doors and other possible building or structure access points, adequate to provide orientation and prevent vandalism. Install vandalism resistant lamp fittings, typically 5-10 lux. Security lighting to be sensor activated.

3.3.9.6 Smoke Detection, Alarming and Fire Suppression

The requirements for smoke detection, alarming and fire suppression must be agreed with the Design Manager at the start of the design phase if not otherwise specified in the design brief.

Where required to provide an electronic smoke detection system and alarming system, their design must comply with Section 14 *Fire Systems* of TDESTD102 - *TasWater Electrical & SCADA Technical Standard - Construction & Application* and/or as agreed with the Design Manager.

As a minimum provide integral smoke detector/alarm units and connect the smoke detection system to SCADA to provide uniquely identifiable smoke alarm(s) for the treatment plant. Provide a minimum of one smoke detector in accordance with NCC requirements for each of the following areas:

(a) Lunch rooms / office areas
(b) Switchrooms
(c) Enclosed plant rooms

The alarms from these different smoke detectors may be paralleled to provide a common treatment plant smoke alarm to SCADA. Provide integral emergency lights in all smoke alarms. Automatic sprinkler or gas flooding systems must not be provided unless there are particular risks that justify their use. The decision of whether or not to install a fire suppression system, should be taken on a case-by-case basis, based on a risk-based assessment and in consultation with the Design Manager. As a minimum provide portable fire extinguishers, with the quantity and location to be designed in accordance with the requirements of the Tasmanian Fire Service.

Should a fire suppression system be required, the design must be carried out by a specialist fire systems engineer. The fire system design must comply with the following:

(a) The National Construction Code
(b) The relevant Australian Standards
(c) State and Federal statutory requirements
(d) Tasmanian Fire Service requirements.

The use of FM200 fire suppression systems is not allowed.

3.3.10 Treatment Plant - Process Electrical Installations

3.3.10.1 Switchrooms

Where practical and cost-effective, TasWater prefers a separate switchboard/MCC supplying each distinct process area. These switchboards/MCCs must in turn be supplied from a central MSB, as per TasWater's stated preferred power distribution architecture
Electrical switchrooms must generally house the following equipment:

(a) Switchgear and control gear assemblies
(b) Special power equipment (e.g. variable speed drives, soft starters, etc.)
(c) Instrument power distribution boards
(d) Uninterruptible power supply
(e) Process control equipment
(f) Marshalling cubicles for field cables
(g) Switchroom fire and safety equipment

Provide measures to ensure that no liquids from the process areas are able to enter the switchroom. Prevent accumulation of run-off around the switchroom by appropriate drainage measures. Each switchroom must be provided with two doors:

(i) A single-leaf door (outward opening) with minimum dimensions 800mm wide by 1,940mm high

(ii) A double-leaf door (both outward opening) with a minimum dimension of 1,600mm wide by 1,940mm high; a higher door size may be required to accommodate the movement of electrical switchboards in/out of the switchroom.

Double doors are to be provided with permanent access ramps to allow easy movement of switchgear into the switchroom.

Switchroom building classification

Switchrooms are generally unoccupied buildings in accordance with the National Construction Code (NCC), and the classification needs to be assessed on a case-by-case basis by a registered building surveyor. Switchroom building design and construction must fully comply with the requirements of the NCC for the selected class of building.

Switchroom layout

Where practical, one or more switchboard/MCC is allowed to be located within the same switchroom, provided the following requirements are met:

(a) The room must be large enough to meet the requirements with AS/NZS 3000 with all electrical and equipment installed, as well as room for future expansion of MCCs.
(b) Enough spare room and wall space for all types of equipment to ensure electrical upgrades required to satisfy the expected mechanical plant upgrade over the next 30 years.
(c) In addition to (a) & (b):
    (i) MCC expansion: allow for future extension of the MCC up to at least 25% of its original length, but not less than one full tier to allow for additional process equipment associated with process changes
    (ii) Provide 50% extra wall space, for mounting of future equipment without hindering exit or entry of additional process equipment associated with process changes.

Equipment mounting

All switchboards, MCCs and other electrical/control panels must be floor mounted, with cable entry from the top. The only exception being distribution boards, which may be wall-mounted with cable entry from the top or bottom. Light and power distribution boards within process areas must be bottom cable entry only.

All VSDs must be mounted on the switchroom wall in such a way that their display panels are visible without the need to stand on a ladder or other such equipment to read and interrogate the VSDs. The VSD display panels should not be any higher than 1,600mm, and not lower than 750mm, above floor level. All cabling to VSDs must be bottom entry via cable tray mounted to the wall. The position of the lower VSDs must ensure they or their cables cannot be easily damaged.

Switchroom lighting

Provide switchroom lighting, including emergency lighting and exit lighting, in accordance with Section 3.3.9.4. Only when it is not practical to provide the switchroom's general light and power from the distribution board in a nearby area, such as would be the case with switchrooms that are within detached buildings not connected to a nearby process building, it is allowable to install a GL&P distribution board within the switchroom.

Ventilation

Switchrooms must generally remain closed during operation and therefore must be provided with adequate ventilation for cooling or heating if required. The Responsible Designer must ensure that if there are any harmful gases or dusts that may affect the operation of the switchboard or other electrical equipment installed within the switchroom, the room will need to be pressurised.

Safety signage and warning labels

All equipment in the switchroom must have warning labels attached to them advising of any hazards associated with opening doors or removing covers of switchboards and electrical panels as per AS/NZS 3000, AS/NZS 61439.1. In addition, if a hazard does exist the doors or covers must only be able to be opened or removed by the use of tools. Locked handles are not acceptable.

Switchrooms must be supplied with all statutory safety signage and signage required by TasWater Standards, including cardiopulmonary resuscitation (CPR) instruction chart and an evacuation plan.

Personnel safety

Hand-held fire extinguishers suitable for electrical fires and of adequate capacity for the size of switchroom must be provided next to doors inside the switchrooms.
The following safety rescue equipment must be provided in each switchroom:

(a) Fire blanket
(b) Electrical rescue kit suitable for the highest voltage present.

Access and egress

Switchrooms must be designed to allow safe access for all employees with access not necessarily restricted to personnel with specific qualifications only. Unless otherwise specified, all switchrooms must have at least two doors for entering / exiting the switchroom. The doors must be outward opening, lockable and able to be opened from the inside at all times without the need for keys or tools. All doors providing external access or access into process areas must be provided with door closers and dust seals. At least one of the doors must be a double leaf door with a push-bar type door release mechanism to enable the future installation of switchboards and electrical panels into the switchroom.

Fire Detection and suppression

The minimum requirement for fire suppression is to provide a portable fire extinguisher suitable for electrical fires inside the main door to the switchroom.

Cable management within switchroom

All cables must enter the switchroom via wall penetrations at a minimum of 2,700mm above finished floor level (AFFL) of the switchroom floor to allow top entry of cables into electrical and control panels. All wall penetrations must be fire sealed to the requirements of Section C *Fire resistance* of the NCC.
Overhead cable ladders must be provided within the switchroom at a minimum height of 2,700mm AFFL. The use of surface-mount conduit on wall surfaces is not preferred.

3.3.10.2 Earthing and Equipotential Bonding

General

The Responsible Designer must design electrical earthing and equipotential bonding in accordance with Section 4 *Low and Extra Low Voltage Power Systems* of TDESTD102 - *TasWater Electrical & SCADA Technical Standard - Construction & Application*.

All low voltage electrical equipment and exposed metal on which electrical equipment is mounted must be earthed. All metallic stands that have electrical equipment mounted on them must be connected to earth using an earth wire.
The earth loop impedance for each system must comply with AS/NZS 3000 at the worst point and installation contractor must be required to carry out earth loop resistance testing in accordance with AS/NZS 3017.
Test earth electrodes must be provided on all earthing systems.

Instrument Earths

At treatment plants all instrument earths must be connected to an insulated earth bar located in the PLC cubicle. This instrument earth bar must be connected to the power earth with a 6mm earth wire in one location only.

3.3.10.3 Lightning Protection

General

The Responsible Designer must design lightning/surge protection in accordance with Section 3 *General Electrical Requirements* of TDESTD102 - *TasWater Electrical & SCADA Technical Standard - Construction & Application*.

Note that lightning strikes are common, especially in the west, northwest and northeast of Tasmania. When the Responsible Designer's AS 1768 risk assessment indicates the need for lightning protection, the protection system must be designed to comply with AS/NZS 3000 and AS 1768. The lightning risk assessment must be included in the Responsible Designer's design report. Transient overvoltage protection must be provided for all consumer mains supplies, as well as for all submains and final sub-circuits that are exposed to open air in outdoor areas. Particular attention needs to be paid to surge protection of communications systems and PLC/RTU connections.

3.3.10.4 Switchboards and other Electrical Cubicles

Provide switchboards and electrical cubicles in accordance with Sections 7 - 11 of TDESTD102 - *TasWater Electrical & SCADA Technical Standard - Construction & Application* and as specified herein.

Switchboards/MCCs must be modular type switchgear assemblies, arranged in tiers and in addition to the technical requirements stated in the TasWater Standards and the Design Brief must have the following minimum features:

(a) Single-sided, dead front arrangement only, and must be suitable for mounting against a wall.
(b) Separate MSB and MCC, allowing one or the other to be replaced without major impact on plant operability.
(c) All switchboards and MCCs are to be fully verified to AS/NZS 61439.1 Annex ZD
(d) Current capacity must be 20% above the maximum demand on the switchboard/MCC at the completion of the design phase.
(e) Form 4A segregation for the following circuits:

(i) Incoming 3-phase circuits
(ii) Outgoing 3-phase circuits supplying loads larger than 4kW (motors and actuators) or 10A (static loads)
(iii) Outgoing loads requiring soft starters
(iv) Outgoing 3-phase circuits supplying duty/standby loads between 300W (0.75A) and 4kW (10A)

(f) Form 2B segregation may be used for:
(i) 3-phase DOL motor starters ≤ 4kW individually
(ii) 3-phase motorised actuators ≤ 4kW individually
(iii) 1-phase process loads less than 300W (0.75A), but NOT light and power circuits, which have to be connected to the GL&P distribution board.

(g) Form 2B cubicles must be provided with both a cubicle door and an inner, hinged metallic escutcheon to provide IP4X protection with the cubicle door open and the escutcheon closed. A warning label on the escutcheon must instruct the MCC to be isolated before the escutcheon is allowed to be opened.

(h) Starter modules must be demountable as far as practically possible. Fully withdrawable starter modules are not allowed.

(i) Full height cable connection chambers (cableways) located between each tier providing ample space for the termination and connection of motor and control cables. Separate wire ways within the chamber for power cables and control wiring must be provided for Form 4 switchboards. No LV control terminals are allowed to be installed within a cableway, and no LV cable terminations are allowed within cableways.

(j) Incoming main switches must be either be withdrawable air circuit breakers (ACB), non-withdrawable moulded case breakers (MCCB) or fault-make, load-break disconnectors as determined during design.

(k) Incoming voltage, current and power transducers. Where required these may be incorporated in the protection relays of the incoming circuit breakers.

(l) Multifunction energy metering required on all switchboards with a Main Switch (In) rated at 400A or greater.

(m) Control power supply to provide 24V dc to contactor coils and motor drive controls.
(i) The 24VDC power supply must be based on TWS-E-0027 TasWater Standard 24VDC Power Supply Circuits and (unless otherwise approved) shall comprise of two power supply units each with 100% redundancy and a proprietary diode/uncoupling/redundancy module in the event of failure of one power supply module.
(ii) The power supplies must feature monitoring/alarming of power supply status and be wired to SCADA for remote alarming and monitoring purpose in accordance with TasWater standards.

(n) Direct on-line (DOL) drive wiring should generally be based on TWS-E-0012 TasWater Standard DOL Motor Circuits.
(i) Control circuit and power wiring must be physically separated within the compartment
(ii) AUTO/OFF/REMOTE selection can be either done via SCADA/HMI, or a hard-wired switch on the MCC door, whichever is more suitable to the required plant operation
(iii) No ammeters are to be provided for motor loads less than 4 kW
(iv) No current monitoring is required on motors < 1kW unless this monitoring is integral in the predictive maintenance of the system.
(v) Manual starting and stopping of drives should be via start/stop buttons on the LCS that drive PLC inputs

(o) Soft Starter motor starter circuits should generally be based on TWS-E-0025 TasWater Standard ESS Motor Circuits
(i) Line contactors must be provided for all Soft Starter motor circuits.

    - (ii) Modbus or Ethernet may be used for monitoring of Soft Starters, but not for control
    - (iii) Soft Starter control must be hard-wired.
- (p) VSD motor starter circuits should generally be based on TWS-E-0032 TasWater Standard VSD Motor Circuits
    - (i) Line contactors must be provided for all VSD motor circuits.
    - (ii) VSDs must incorporate a manual speed setting (via SCADA/local HMI only), i.e. speed setting via potentiometers on the MCC module doors is not required.
    - (iii) Modbus or Ethernet may be used for monitoring of VSDs currents, but not for control
    - (iv) VSD control must be hard-wired
- (q) MANUAL/OFF/AUTO mode selection for motor drives (DOL, VSD or Soft Starter) and actuator drives must be either by hardwired selector switches on the associated MCC cubicle door, or (preferably) via SCADA/HMI selection if the HMI and the control equipment are in close proximity.
    - (i) The choice between hardwired or SCADA/HMI mode selection must be made on a project-by-project basis and in consultation with the TasWater Design Manager.
    - (ii) There may be a need to provide hard-wired interlocks that will prevent motors or actuators to be operated, even when selected in MANUAL mode.
- (r) Power supply feeder modules must comprise a suitably rated moulded case circuit breaker (MCCB) which must be the main switch for that compartment and interlocked with the door.
- (s) Where the design of the MCC incorporates a PLC section, the PLC section must be attached in such a manner that there are no risks from the results of an internal switchboard fault to a person when the PLC section door is open.
    - (i) TasWater prefers all multicore cables to transition via glands from the PLC section to all other areas of the MCC.
    - (ii) In the event that the PLC section cannot be constructed in such a manner a loose-standing PLC cabinet must be provided.
    - (iii) The PLC section must be labelled SCADA/PLC/RTU Section and shall be secured with triangular switchboard latches requiring the specific tool to open them.
    - (iv) All equipment within the PLC section shall Extra low Voltage only with the exception of the 230V ac supply to the 24V dc control supply which must have earth leakage protection and employ IP2X protection to the 230V ac connections at the power supply.
    - (v) All operators and displays shall be mounted >300mm and less than 1900mm from Floor level
- (t) Switchboard and MCC switchboard design and construction must ensure:
    - (i) With all doors closed any person standing in the vicinity of the switchboard/MCC must not be in any danger from any fault or malfunction of any equipment within the switchboard/MCC including short circuit faults and arc flash faults.
    - (ii) Access via module doors to any part of a switchboard/MCC with the module isolator in the OFF position must not provide exposure to any hazards associated with a fault or malfunction occurring at any other module or area of the switchboard/MCC.
    - (iii) If opening of any doors or modules exposes anyone to any form of danger this must be clearly labelled on the switchboard/MCC and the Operating and Maintenance manuals must advise of the precautions to be taken to make access safe.
    - (iv) Each switchboard/MCC to be de-energised to allow safe access for maintenance for a minimum of 4 hour without affecting the required performance of the treatment plant. This may be implemented by employing the use of an emergency mobile generator to power other equipment which has been isolated from the de-energised switchboard/MCC enabling continuation of process control. The generator connection point must be a plug-and-socket type arrangement.

3.3.10.5 Emergency Generators

An emergency generator must be used to supply power to a treatment plant in the event of a mains supply outage. The decision to use a fixed or portable generator is to be made on a project-by-project basis. Fixed generators must be designed to start up automatically and as soon as possible after the mains power supply fails. Fixed generators must be able to run for a minimum of 24 hours without refuelling.

Detailed requirements for emergency generator systems are specified in the following Sections of TDESTD102 *TasWater Electrical & SCADA Technical Standard - Construction & Application*:

(a) Section 8.2.4 *Emergency Generator Module*
(b) Section 9.3.5 *Auto-transfer switches*
(c) Section 23 *Power Generation – Engine Driven*
(d) Section 24 *Liquid Fuels*

3.3.10.6 Uninterruptible Power Supply (UPS)

The electrical Responsible Designer must identify critical plant loads in conjunction with the process designer. The electrical Responsible Designer must then select UPS systems to protect those critical loads from power fluctuations and outages. For larger plants, consideration must be given to dual redundant UPS systems complete with a bypass mechanism to maintain supply when one UPS needs to be taken out of service for maintenance purposes. Each UPS should be capable of supplying 100% of the connected load on its own.

The standard required back-up power time is 4 hours at full load, although longer times may be needed in certain circumstances such as for remote sites where maintenance response times would be longer than 4 hours. Note that "full load" is determined by taking the UPS maximum demand and adding 25% for future growth in maximum demand. For sites where a permanent generator is installed, the back-up time may be reduced to 30 minutes.

Secure power via a UPS system must be provided at the following levels of the WTP's operations:

(a) At a process level, to prevent the loss of control over critical processes. This must typically include the following critical loads:
    (i) Process controllers and downstream distributed I/O modules
    (ii) Process monitoring instruments and local control panels
    (iii) Security systems (fire and access control).
(b) At a control room level, to prevent data loss and allow controlled server shutdown. This must typically include servers, workstations and communications equipment.

(c) Other critical loads, such as:
    (i) Ultraviolet (UV) water disinfection systems, due to their sensitivity to variations in power quality
    (ii) Inlet valves.

The detailed requirements for UPS systems are specified in TDESTD102 *TasWater Electrical & SCADA Technical Standard - Construction & Application* Section 22. These requirements do not cover the SCADA UPS system, which is normally free-issued by TasWater.

3.3.10.7 Emergency Generator Connection

For fixed emergency generators, the generator must be connected directly into the associated switchboard/MCC. The switchboard/MCC must incorporate an automatic transfer switch with interlocking to prevent paralleling of the mains and generator supplies.
For portable generator connections, provide a generator connection as follows:

(a) If the switchboard/MCC requirements is for a generator supply of 150A/phase or less, the portable generator may be connected via a 3-phase socket inlet (Marechal type DS3 or DS9) with permanent cabling to the associated switchboard/MCC. The socket may be mounted onto a bracket or within an enclosure which is mounted externally on the switchroom wall.
(b) If the switchboard/MCC maximum demand is in excess of 150A/phase, the portable generator shall be direct connected to a generator connection panel that must be mounted externally on the switchroom wall.
(c) Provide a manual transfer switch within the switchboard/MCC to enable manual selection between mains and generator supply. Provide a mechanical interlock (cable or captive key) to prevent accidental paralleling of the two supplies. Interlocks that can be defeated, such as door interlocks, are not an acceptable method of interlocking.

3.3.10.8 Electrical Field Equipment

All electrical equipment mounted in the field must be rated for the environment they are intended for and must be installed in line with the manufacturer's requirements to ensure their environmental rating is in no way reduced.

All electrical cables must be bottom entry only via cable glands, and NOT via conduit glands. This includes cables entering into motor terminal boxes, field isolators etc.

3.3.10.9 Power cables, cable ducts and supports

Power cables must generally comply with the requirements of Section 4 *Low and Extra Low Voltage Power Systems* of TDESTD102 - *TasWater Electrical & SCADA Technical Standard - Construction & Application*.

The following are allowed as alternatives to V-75 PVC insulation for power cables:

(a) V-90 PVC insulation
(b) XLPE insulation (rated for 90°C)
(c) Flexible rubber (rated for 90°C or 110°C)

The choice between these different cable types must be made on a project-by-project basis, based on economic and constructability considerations.

The design of power cables must conform to all relevant Australian Standards (including but not limited to AS/NZS 3000 and AS/NZS 3008.1.1), as well as the requirements of Section 4 *Low and Extra Low Voltage Power Systems* of TDESTD102 - *TasWater Electrical & SCADA Technical Standard - Construction & Application*.

The specifics of both underground and aboveground cable design and installation are detailed in Sections 4 and 5 of TDESTD102 - *TasWater Electrical & SCADA Technical Standard - Construction & Application.* Aerial cables are only be allowed by exception, and has to be approved by the Design Manager.

Underground installation of power cables is generally only allowed for:

(i) the consumer mains cable from the Electricity Distributor's point of supply to the site MSB
(ii) cables supplying outdoor loads that cannot be reached via aboveground building/piping structures.

All other cables must be installed aboveground on cable ladder or within surface-mount conduit.

Where underground conduits are to be used to connect various areas of the plant these must be agreed with the Design Manager but must provide 100% redundancy in the number of conduits.

HV, LV and ELV cables must be in different conduits.

The design must make provision for the following spare space requirements:

(A) Main cable runs (i.e. those originating at a switchboard/MCC): 50% spare space
(B) Trunk routes (i.e. those servicing multiple items of equipment): 30% spare space
(C) Reticulation to individual items of equipment: 0% spare space
(D) Where additional spare conduits are provided, these conduits must be run along the same route than the associated occupied conduit
(E) In calculating cable sizes, cable de-rating factors must take the future layering of cables into consideration.

Separation between cables of different voltages (LV and ELV) must be in accordance with Sections 4, 5 and 17 of TDESTD102 - *TasWater Electrical & SCADA Technical Standard - Construction & Application*, AS/CA S009 and AS/NZS 3000, but not be less than 150mm. Separation through the use of dividers on cable ladders is allowable (subject to maintaining a 150mm separation of cables as per above), but physical separation through having different ladders for different types of cable is preferred.
All cable ladders and trays must be electrically bonded to the earth bar at the switchroom from where they originate.

3.3.11 Field Instrumentation

3.3.11.1 Selection and Installation

Unless specified otherwise in the Design Brief, all instruments must be selected from TDESTD 21 *Preferred Equipment List Technical Standard*. For safety reasons, all instrument supplies must only be 24V dc, and all instruments must be selected accordingly. The design and installation of field instruments must also conform to the requirements of TDESTD 16 *Instrumentation Technical Standard*. All outdoor instruments and instruments installed within wet areas must be provided with IP56 or better protection against the ingress of dust and moisture. Outdoor instruments to be positioned out of direct sunlight/weather exposure or as a minimum, must be provided with a sloped sun hood, which must double as a rain hood. Instrument panel layouts need to consider adequate provision for servicing etc. A specific design review of instrument panel layouts is required during design review workshops with TasWater service delivery included as a stakeholder.

3.3.11.2 Instrument Cables

Instrument cables must be PVC insulated, PVC sheathed instrument cables with twisted pairs of conductors. Screening of instrumentation cables must comply with Section 4 *Low and Extra Low Voltage Power Systems* of TDESTD102 - *TasWater Electrical & SCADA Technical Standard - Construction & Application*. The screening of each cable should be terminated at one end of the cable only to an earthed connection.

3.3.11.3 Instrumentation Supplies

Power

Supply to two-wire instruments must be regulated 24V dc and must be backed up by battery and/or UPS for critical equipment. A 24V dc power distribution panel must be provided in each process area for supplying two-wire instruments in that area. Where available, control supplies shall be used for this purpose.
Supply to four-wire instruments must be 24V dc, which is derived from the UPS-backed process control 24V dc supply.

Air

Instrument air supply for process instrumentation, actuated valves and the like must be at a nominal pressure of 700 kPa, filtered and dried. The instrument air system must incorporate air receivers with sufficient capacity to allow limited operation and safe shutdown of the plant in the event of plant air system failure or power failure.

3.3.12 Process Control Architecture

3.3.12.1 General

Treatment plants are usually divided into a number of separate physical and/or operational areas, reflecting the plant's layout and the stages of the treatment process.
The control system design must reflect this division.

3.3.12.2 Definitions

Process Control System (PCS)

For the purposes of this standard, the Process Control System (PCS) will mean the on-site PLC(s) and associated ancillary equipment which control and protect the treatment process against hazardous process conditions. It does this by:

(a) Monitoring inputs from sensors and instruments in the field
(b) Directly controlling equipment and processes in response to field inputs, operator-initiated control signals and logic programmed into its PLC(s).

The term Process Control System will include all communications equipment, instruments and controlling equipment which allow the above functions to be performed.
The requirement of the PCS and its associated components are detailed in Section 3.3.13 - Process Control System (PCS). Additional requirement for packaged proprietary plant are detailed in Section 3.3.14 - Packaged Proprietary Plant.

Supervisory Control and Data Acquisition (SCADA) System

The Supervisory Control and Data Acquisition (SCADA) system monitors the operation of the Process Control System (PCS) and is capable of issuing commands and setpoints to the latter. However all automatic control functions are executed within the PCS.
For the purposes of this standard, PCS and the SCADA system are two distinct but interconnected systems.
The requirements for the upstream telecommunications infrastructure, SCADA server, SCADA client machines and SCADA UPS are further detailed in Section 3.3.15 - Supervisory Control and Data Acquisition (SCADA).

3.3.12.3 Typical System Architecture

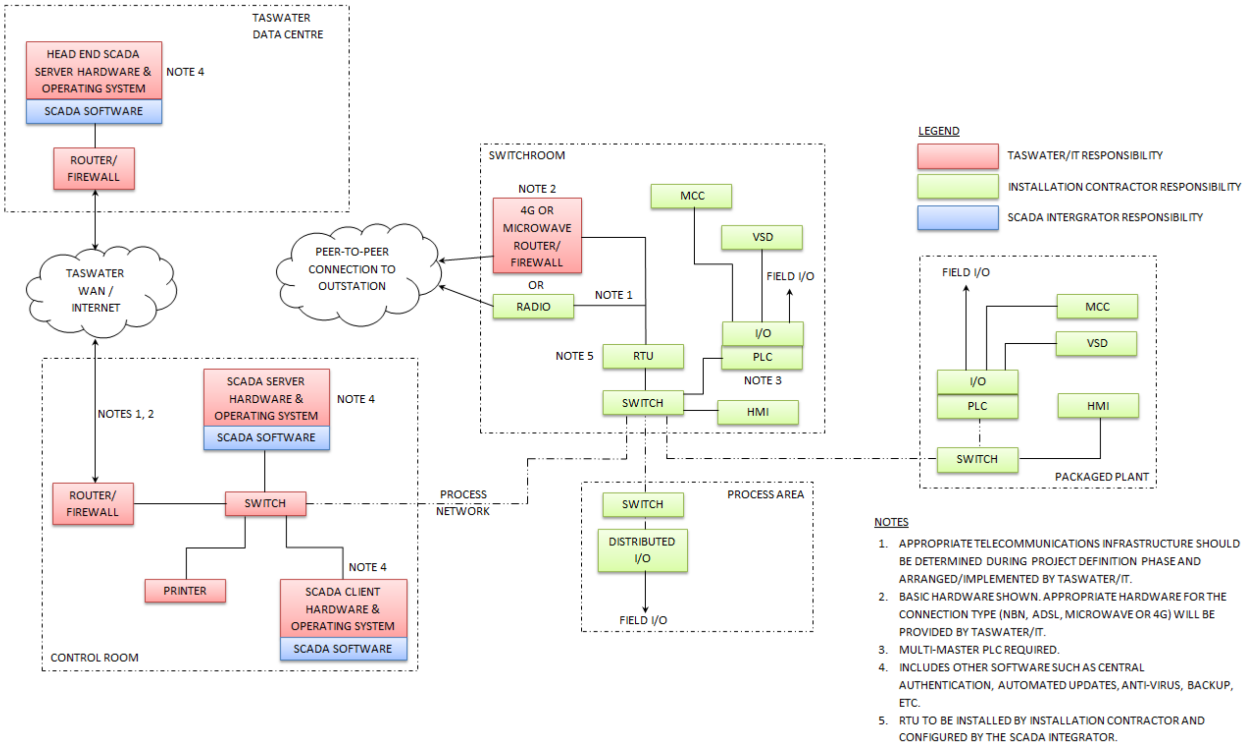


Figure 9: Control System Architecture

Figure 9 shows a typical control system block diagram for a sewerage treatment plant.

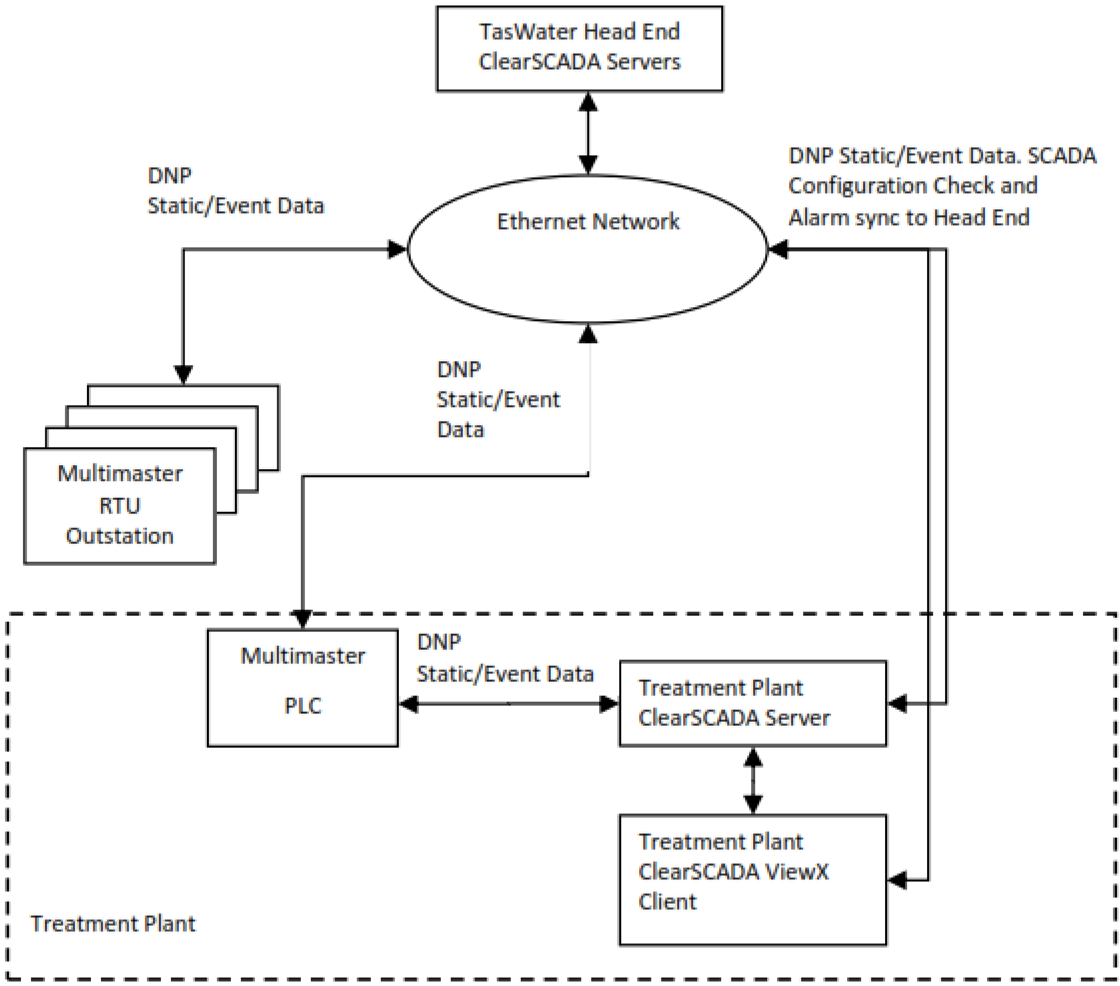


Figure 10: SCADA System Architecture

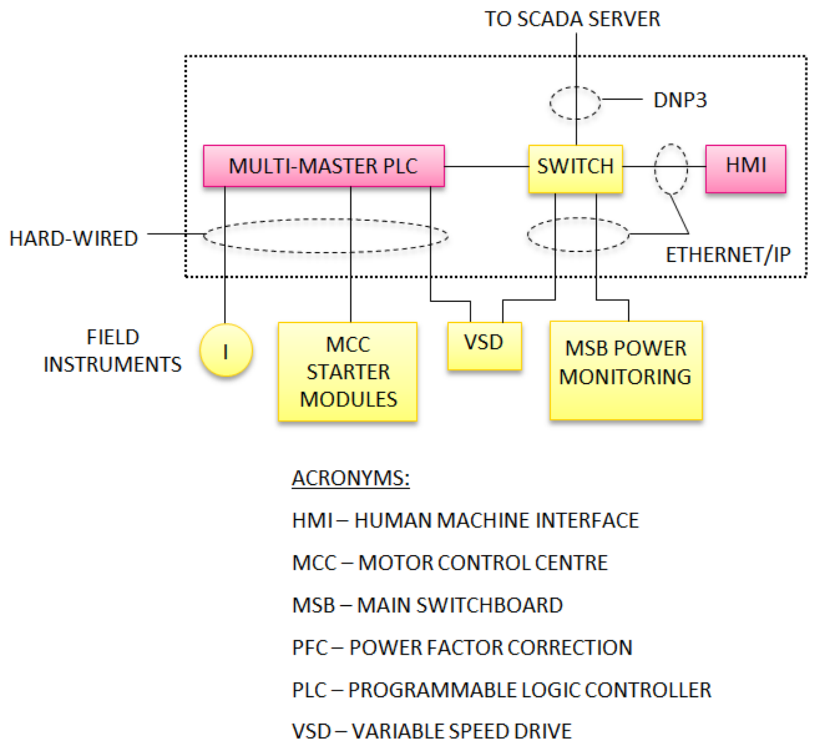


Figure 11: Plant Control System (PCS) Architecture

Figure 10 and Figure 11 show typical block diagrams for the SCADA and process control system (PCS) at a water treatment plant.

The Design Manager will arrange with the TasWater information technology (IT) provider, as well as the TasWater SCADA manager, to provide the following:

(a) Any hardware upgrades required at the TasWater datacentre to accommodate the new treatment plant
(b) Any telecommunications infrastructure required to provide phone, fax and broadband connectivity to the treatment plant
(c) Appropriate hardware for the Corporate Wide Area Network (WAN) connection, which could be an NBN, ADSL, M2M cellular network or microwave connection depending on the location of the treatment plant (this will include all the necessary antennas if used, routers/firewalls, cabling, main distribution frame or 'edge' device as appropriate etc.)
(d) A rack-mount uninterruptible supply (UPS) that will be dedicated to the provision of emergency backup power to the SCADA system devices
(e) 'Cisco' managed network switch
(f) SCADA server, which will include the operating system and other software to make the server functional
(g) One or more SCADA client machines, which will all include the operating system and other software to make the client machines functional, and
(h) Network connected printer/fax/copier.

Some of the above, such as the SCADA server and Cisco network switch will be free-issued to the installation contractor for installation within a communications rack.
The Responsible Designer must document the following as part of the Electrical Design:

(i) desired functionality of the PCS and SCADA system must be documented in a control system functional description

(ii) scope of work for the installation contractor, which could be based on TDETEM07 – TasWater Electrical and SCADA Scope of Works Template
(iii) scope of work for the SCADA integrator, also based on the above template
(iv) all drawings required to make the Electrical Design complete.

Packaged plant will normally feature proprietary control configurations, but the Responsible Designer may have some control over the packaged plant's functionality, as well as 'hand shaking' signals between the packed plant and the treatment plant PLC. All these elements should be clearly documented in the Electrical Design.
The Electrical Design should also document the following responsibilities of the installation contractor with regard to the PCS and SCADA systems:

(A) Supply and install all control panels (fitted out in accordance with the Electrical Design) and network cabling
(B) Supply and install all telemetry equipment required for connecting to outstations, including RTU, antenna and the like
(C) Supply and install a 45 rack unit (RU), 19-inch communications rack within the control room
(D) Install the free-issued rack-mount uninterruptible supply (UPS) within the communications rack
(E) Install the free-issued rack-mount SCADA server within the communications rack
(F) Install the free-issued Cisco network switch within the communications rack
(G) Install the free-issued router/firewall within the communications rack
(H) Supply and install RJ-45 data outlets in accordance with the Electrical Design
(I) Patch the data outlets into the Cisco switch
(J) Patch the SCADA server into the Cisco switch
(K) Patch the router/firewall into the Cisco switch
(L) Patch the process network cabling into the main control panel within the electrical switchroom
(M) Patch the Ethernet connection from the main control panel into the Cisco switch.

The Responsible Designer must document the configuration of the communications rack in accordance with the regional TasWater preference.
The installation contractor will be responsible for providing all Ethernet cabling, connectors and the like to make the process control network complete.
The SCADA integrator will be required to do the following:

I. Install and configure (in accordance with the Electrical Design) the SCADA software on the on-site SCADA server
II. Install and configure (in accordance with the Electrical Design) the SCADA software on the on-site SCADA client machine(s)
III. Reconfigure the SCADA software on Head End SCADA server at TasWater's datacentre to mirror the SCADA configuration of the on-site SCADA server.

3.3.13 Process Control System (PCS)

3.3.13.1 PCS Reliability

Design the PCS to provide extremely high availability percentages for production with 98% uptime being the aim. The system design must provide a Mean-Time-to-Repair (MTTR) of better than (less than) one hour.
Conduct a risk assessment to identify critical plant areas that will require enhances reliability of the PCS.
The following may need to be considered:

(a) Review control system redundancy for critical plant areas and provide dual-redundant PLCs where required.
(b) For complex processes and for packaged proprietary plant, dedicated PLCs may be provided for those process areas.
(c) Identify critical plant areas that will require multiple pathways for the transfer of process data. Consider dual-redundant control network connections for critical plant areas where single-point failures could render that plant area inoperable, or where failure of a single connection may cause loss of monitoring systems that are needed for statutory monitoring of critical plant areas.

3.3.13.2 Process Network

The process network:

(a) connects together the nodes within the PCS (which includes the treatment plant PLCs, RTU (if installed), packaged plant PLCs and distributed I/O modules)
(b) provides connectivity with the TasWater SCADA system, including the on-site SCADA server and client machine(s) as well as the off-site SCADA Head End and
(c) may also provide connectivity via peer-to-peer connections with outstations such as pump stations or reservoirs that are associated with the treatment plant.

Depending on the size of the treatment plant, the physical network connections will consist of Cat 6 cables, optical fibre cables or a combination of these. Where dual-redundant network connections are provided, the network could be configured as a closed or self-healing ring to provide increased security.

The process network must utilise DNP3 or other TasWater-approved communications protocol that is compatible with the brand of PLC and RTU employed in the Electrical Design.

In case multiple (redundant) pathways are provided then failure of any component of the process network must automatically switch the communication over to a redundant pathway in a bumpless manner. A single failure within the process control system may not cause the entire process network to malfunction.

3.3.13.3 Control Power

In the event of mains power supply failure, all the PCS equipment required for monitoring of critical processes must remain operational through employment of uninterruptible power supplies (UPSs). The UPS system dedicated to the process control system must be separate from the SCADA UPS system (Section 3.3.15.6). The requirements for UPS power (including number of UPS systems, positioning, minimum standby time and redundancy) need to be considered on a project-by-project basis. Technical requirements for the process control UPS are defined in Section 22 of TDESTD102 - *TasWater Electrical & SCADA Technical Standard - Construction & Application.* Proprietary, Rack-type UPS systems that house power, control and battery storage systems within a single enclosure are preferred.

Provide a break-before-make bypass switch upstream of the UPS to facilitate maintenance of the UPS. The bypass switch must be within a separate enclosure that complies with Section 10 of TDESTD102 - *TasWater Electrical & SCADA Technical Standard - Construction & Application*. The upstream bypass switch needs to be provided, whether or not the UPS has its own built-in bypass arrangement. Except for the 240V ac supply connection to the control power supply units (which converts 240V ac to regulated 24V dc), no other LV power connections must be made within the control panel.

Areas of the control panel containing different voltage levels (240V ac and 24V dc) must be segregated and clearly labelled. Provide a circuit breaker within the control panel and upstream of the power supply unit for isolating the incoming 240V ac supply. Both the 240V ac circuit breaker and the power supply unit must be positioned within the 240V ac section of the control cubicle. 24V dc must be reticulated to PLCs, RTUs, distributed I/O modules, etc. via miniature circuit breakers that are located within the extra-low voltage (ELV) section of the control panel. The 240V ac wiring must be separated from ELV wiring, i.e. may not be run in the same wiring ducts. In addition, 240V ac power terminals must be covered with a Perspex or similar covering to provide a minimum of IP4X protection to the power terminals.

3.3.13.4 Process Logic Controllers

Process logic controllers (PLCs) must be capable of concurrent analogue and digital control. Redundant controllers are not universally required but must be considered on a case-by-case basis for all critical process areas. The design of the PLC hardware must comply with Section 18 of TDESTD102 - *TasWater Electrical & SCADA Technical Standard - Construction & Application* and with Section 3.3.13.7 - Control Panels in this standard.
Interconnections between PLCs, as well as between PLCs and distributed I/O modules, must be based on the architecture recommended by the manufacturer of the PLC being used in the Electrical Design.

PLC hardware must be selected from TDESTD21 *Preferred Equipment List Technical Standard*.

3.3.13.5 Remote Terminal Units

Remote terminal units (RTUs) must be multi-master units capable of peer-to-peer (via radio or 4G) connections with outstations such as pump stations or reservoirs. The RTU must be connected to the on-site SCADA server (via the process network) to allow data interchange between SCADA and the outstation. The design of the RTU hardware must comply with Section 18 of TDESTD102 - *TasWater Electrical & SCADA Technical Standard - Construction & Application* and with Section 3.3.13.7 - Control Panels in this standard.

RTU hardware must be selected from TDESTD21 *Preferred Equipment List Technical Standard*.

3.3.13.6 Input/Output System

Control and monitoring inputs from, and outputs to, field equipment, motor starters, instruments and the like must be made to input/output (I/O) cards that are connected to a PLC. These I/O cards may be co-located with the associated PLC inside the same control panel, or of the distributed I/O type that are located within a different control panel than the PLC. The design of the I/O system must comply with Section 18 of TDESTD102 - *TasWater Electrical & SCADA Technical Standard - Construction & Application* and with Section 3.3.13.7 - Control Panels in this standard. Use Standard Drawing 01000-09-016 *I/O Wiring Diagram Examples* as a basis to develop detailed I/O wiring diagrams.
Interconnections between PLCs, as well as between PLCs and distributed I/O modules, must be based on the architecture recommended by the manufacturer of the PLC being used in the Electrical Design.

I/O cards must be selected from TDESTD21 *Preferred Equipment List Technical Standard* and must be compatible with the brand(s) of PLC in use.

All signals to the I/O cards must be individually galvanically isolated between the field side and the I/O card side. Interposing relays must be provided on all digital outputs that are used to energise relay coils and other inductive devices, including strobe alarm system. For plant areas which require more than 100 I/O points in total, consider splitting the I/O across multiple I/O panels with a maximum of 100 I/O points each and with the capacity to expand the I/O count up to 8 slots of 16 I/O points (i.e. 128 I/O points total) per panel. All discrete digital inputs and outputs must be 24V DC. All discrete analogue inputs and outputs must be 4-20 mA.

Connections between PLCs, as well as connections between distributed I/O modules and PLCs, must be made via a wire-based communications protocol that is compatible with the brand(s) of PLC and distributed I/O modules being used in the Electrical Design. Control and monitoring connections to soft starters and VSDs must be via hard-wired, point-to-point connections. This includes speed reference signals to VSDs, which must be via analogue outputs from the associated PLC(s).

3.3.13.7 Control Panels

Provide control panels for housing all PLCs, RTUs and distributed I/O modules and associated power supplies etc. within a protected environment. These control panels must either be free-standing cubicles, or be a fully sealed and segregated section of a switchboard/MCC. The design of control panels must comply with Section 10 of TDESTD102 - *TasWater Electrical & SCADA Technical Standard - Construction & Application*.

All control panels must be designed with sufficient measures to prevent accidental contact with live electrical parts. For that purpose include barriers, partitions, separation of LV and ELV sections, etc. are in the design. Control panels (including control panels that are part of packaged plant) are often required to be opened and accessed by SCADA integrators, engineers and other personnel that might not be licenced electrical workers. All LV parts of control panels will be shrouded with Perspex guarding or other appropriate measures to provide a minimum of IP4X protection. The guarding must only be able to be removed by the use of tools.
Provide 100% spare space within each control enclosure. Unless approved by the Design Manager, all control panels must be located within buildings.

3.3.13.8 Future Expansion

The PLC and RTU design must allow minimum 25% spare capacity of all I/O types and these must be fully wired onto proprietary connectors and include any interposing relays ready for connection into control and monitoring circuits.
The PLC/RTU must be installed with 100% spare memory capacity to allow for future expansion and modifications to the process control system.

3.3.13.9 Other PCS Components

Network switches

Provide managed, industrial network switches to provide Ethernet-based connection nodes for the PCS components. Network switches for process control must be selected from TDESTD 21 *Preferred Equipment List Technical Standard.*

Human Machine Interfaces

Local graphic displays (human machine interfaces, HMIs) must be selected to match the brand of PLC being used and must be selected from TDESTD 21 *Preferred Equipment List Technical Standard*. Colour HMIs may be provided where this will assist in making the displayed information clearer. Display and control panels installed in outdoor locations must be weatherproof and protected against deterioration due to high temperatures and ultraviolet radiation. Displayed text and graphics must be clearly readable in direct sunlight.

Panel size must be chosen so that the displayed text and graphics are large enough to be clearly readable from a distance of ±500 mm.
Display and control panels must communicate with the associated PLC via an industry-standard communications link.

3.3.13.10 Process Control Programming

A structured approach to programming PLCs must be followed. The structured program must conform to the requirements of Section 18 of TDESTD102 - *TasWater Electrical & SCADA Technical Standard - Construction & Application*.

Where regional standard PLC and RTU configurations are available, the Electrical Design must specify functionality that is based on these standard configurations.

3.3.13.11 Control Room

Each treatment plant must be provided with a minimum of one control room. The control room will provide space for operators to carry out their duties and house the SCADA and associated communications systems.
Agree with the Design Manager the requirements for the treatment plant. For all control rooms the following minimum requirements apply:

(a) This room shall be separate to functional areas for office facilities, lunch room and ablutions (some WTPs may also require an analytical laboratory area)
(b) The office area must be provided with a minimum of one (1) desk complete with a data connection to the control room network switch, a telephone connection and at least two double 10A GPOs per desk and a 45 rack unit (RU) 19-inch computer rack enclosure
(c) The office area must be large enough to house all of the above, plus room for a large multi-function printer/scanner/copier machine
(d) Smoke detection, smoke alarms, emergency lighting etc. as required by the NCC
(e) Minimum access requirements from outside the building: as required by the NCC but not fewer than one single-leaf door
(f) Minimum access requirement between rooms inside the building: as required by the NCC but not fewer than one single-leaf door from one area into the next
(g) A high-efficiency climate control system (heat pump or similar), which will also maintain the inside of the control room at a slightly higher pressure than the outside to minimise the ingress of the corrosive gases present at the treatment plant into the room.

The above state the minimum requirements for control rooms. The exact requirement should be agreed with the Design Manager on a project-by-project basis.
The following are not allowed inside the control room:

(i) Electrical switchboards other than 63A or less, maximum 32A sub-circuits, general light and power distribution boards
(ii) Any operating process equipment
(iii) Process control panels
(iv) Variable speed drives
(v) Domestic hot water system.
(vi) Any other non-office specific designed pieces of electrical equipment

3.3.14 Packaged Proprietary Plant

3.3.14.1 Definition

A packaged proprietary plant (“packaged plant”) is an assembly of equipment that is manufactured or assembled to order. The Responsible Designer will generally have at least some control over the type of equipment and control interface provided. Examples include filters, chlorinators, chemical batching and dosing plants, aeration blowers, gas flares and the like.

3.3.14.2 General Requirements

Where proprietary items of packaged are included in the design, such plant must comply with the following minimum requirements:

(a) Voltages: in accordance with Section 3.3.8.1 - Voltages
(b) Cabling and wiring: in accordance with AS/NZS 3000
(c) Electronic interface: proprietary or open communications protocol compatible with the PCS
(d) Alarms and fault outputs: preferably via the electronic interface, but hardwiring may be acceptable subject to agreement with the Design Manager.

3.3.14.3 Control System Design

Control panels for packaged proprietary plant must comply with the requirements of Section 3.3.13 - Process Control System (PCS). If the package includes PLCs they should preferably be of the same type as the PCS but must at least communicate with the PCS via a standard data bus.
More complex equipment packages must be provided with graphic display and touch panels communicating by data link with the package PLC. Simple packages may use panel-mounted switches, pushbuttons, indicators, alphanumeric displays and the like.

3.3.14.4 Control Concept

A packaged plant must include a LOCAL-OFF-REMOTE control mode selector and must be specified with a control interface that will allow the PCS to control the packaged plant as a unit. The interface should typically operate as follows:

(a) When power is applied to the package, when all its alarms have been reset, when all its subsystems and equipment items are ready and provided its control mode is not set to OFF it must signal to the PCS that it is available for operation.
(b) If the package’s control mode is set to OFF it must not be possible to start it under either local or remote control. If the package is already running it must shut down. Selection of the OFF mode must immediately signal to the PCS that the package is not available.
(c) If the package’s control mode is set to LOCAL (or MANUAL) it must be under the exclusive control of its local control panel or control stations. PCS commands must have no effect.
(d) If the package’s control mode is set to REMOTE (or AUTO) it must transmit a signal to the PCS to indicate this. Providing the package is available for operation the PCS must then be able to initiate or terminate its operation by issuing or withdrawing a start command.
(e) On receipt of the PCS start command the package’s PLC must manage all start-up sequencing and protection functions for the drives and other equipment that make up the package.
(f) As soon as the package has successfully completed its start-up sequence and is running normally it must transmit a RUNNING signal to the PCS.

(g) The package must continuously monitor itself whether running or not and must transmit information to the PCS indicating the status of its components. The package PLC must automatically and independently take appropriate action in the event of a fault and must transmit detailed alarm and diagnostic information to the PCS.
(h) Local alarm and status indication must be provided for each drive or equipment item and for the package as a whole. Local indication should typically include the status for each drive or equipment item and alarm indication for each fault condition.

TasWater's preference is to have all power circuits for motor starting (i.e. contactors, thermal overload relays etc.) located within the plant area's MCC, even though the control may still be initiated by the packaged plant PLC. Field-mounted motor starters must be approved by the Design Manager. Field-mounted variable speed drives (VSDs) may be used for proprietary equipment where the motor and VSD are integrated into a single unit, but the preference is to have VSDs wall-mounted within a switchroom.

Motor starters for packaged equipment must follow the requirements of the following TasWater standards as closely as possible:

(i) TWS-E-0012 TasWater Standard DOL Motor Circuits
(ii) TWS-E-0025 TasWater Standard ESS Motor Circuits
(iii) TWS-E-0032 TasWater Standard VSD Motor Circuits
(iv) TDESTD79 TasWater Standard Motor Circuit Functional Description
(v) TWS-E-0030 TasWater Standard Emergency Stop Circuits

Any deviations from the TasWater standards must be approved by the Design Manager. All critical handshake signals such as 'start' and 'stop' commands, 'running', 'available' and 'fault' status feedback between the packaged plant PLC and the PCS must be programmed so that they are capable of being transferred by means of a hardwired connection as a minimum. A proprietary communications link may be used for transferring handshake signals, except for safety stop signals which must be hardwired.

In the case that the Proprietary Plant cannot be incorporated into the PCS, the Proprietary Plant electrical control and power system must be submitted to the TasWater Design Manager for review and acceptance. This review will look at such issues as:

(A) Safe Isolation and interlocks
(B) Power equipment segregation to allow safe maintenance activities
(C) Power and control equipment segregation to allow safe maintenance access.
(D) Safe Operation
(E) A full system HAZOP to identify all possible safety issues

The contractor will be required to rectify any issues identified at their cost and TasWater reserves the right to reject the Proprietary Plant if any of the above or other identified issues are unresolved and the contractor will be required.

3.3.15 Supervisory Control and Data Acquisition (SCADA)

3.3.15.1 General

Refer to TDESTD 21 *Preferred Equipment List Technical Standard* for details on the SCADA server and SCADA uninterruptible power supply (UPS) that will be free-issued to the installation contractor, for installation in the communications rack.

3.3.15.2 SCADA Standards

For detailed requirements on SCADA, refer to the following TasWater Standards:

(a) Section 20 *SCADA* of TDESTD102 - *TasWater Electrical & SCADA Technical Standard - Construction & Application*
(b) TOMPRO03 *TasWater SCADA Change Management Procedure*
(c) TOMFOR05 *TasWater SCADA Project Change Request Form*
(d) TOMFOR06 *TasWater SCADA Project Handover Checklist*
(e) TOMSTD01 *TasWater Alarm Management Methodology*
(f) TOMSTD02 *TasWater Alarm Philosophy for SCADA Alarms*

3.3.15.3 SCADA Software

The software licence will be free-issue by TasWater. Other free-issued software will include pre-configured operating system for auto shutdown on the SCADA server and SCADA client machine(s).

3.3.15.4 SCADA Server

Hardware will be free-issued by TasWater for mounting by the installation contractor in the communications rack. The SCADA server will come complete with one LCD display, keyboard and mouse, which also need to be installed inside the communications rack.
All TasWater standard software will be free-issued and pre-installed on the SCADA server. Free-issued software will include pre-configured operating system, antivirus protection, drivers, SCADA server software (ClearSCADA or Citect) and all software licensing.

3.3.15.5 SCADA Client Machines

Hardware will be free-issued by TasWater for installation by the installation contractor on a desk within the control room. The SCADA client machine(s) will each come complete with two LCD displays, keyboard and mouse, which the installation contractor needs to connect to the SCADA client machine.
All TasWater standard software will be free-issued and pre-installed on the SCADA client machine. Free-issued software will include pre-configured operating system, antivirus protection, drivers, SCADA client software (ClearSCADA or Citect) and all software licensing.

3.3.15.6 SCADA UPS

Hardware will be free-issued by TasWater for installation by the installation contractor in the communications rack. All associated operating system shutdown software will be supplied and installed free-issued on both the SCADA server and SCADA client machines.
The UPS must be wired based on TasWater Standard Drawing 01000-09-005, “Rack Mount UPS Wiring Schematic”.

3.3.15.7 SCADA Programming

SCADA integration/programming will be done in accordance with TOMMAN21 - TasWater State-Wide SCADA Head End - User Manual - Integrators to suit the Electrical Design. SCADA projects are to be exported in the correct format and version to match SCADA Head End version.

All SCADA programming is to be provided on the local SCADA server and at the TasWater SCADA Head End, including automatic alarm acknowledgment and configuration checker between local and Head End SCADA databases as per the *SCADA Head End User’s Manual*.

3.3.16 PCS and SCADA Factory Acceptance Tests

The Electrical Design must document the requirements for Factory Acceptance Tests (FATs) to be carried out on all PCS and SCADA equipment at the supplier's premises or other suitable off-site location prior to delivery of any equipment to site. The tests must be carried out with all hardware items (including servers, client machines, network switches, PLCs, distributed I/O racks, communications equipment and the like) interconnected exactly as they are to be connected on site and with all software (including PLC and SCADA software) installed and configured.

The purpose of the tests will be to demonstrate that the PCS and SCADA systems function correctly in accordance with the Electrical Design. Tests must include:

(a) Proving of network communications and (where there are redundant networks) error-free communications transfer from a failed network to the healthy network
(b) Proving of correct communications between all items
(c) PLC-to-PLC communication tests within and between areas
(d) Client machine tests
(e) Correct operation of all software including PLC programs and SCADA system configuration
(f) PLC logic simulation tests
(g) PLC-to-motor control centre tests
(h) PLC-to-equipment package tests
(i) PLC-to-SCADA system communication tests
(j) Proving of inbuilt diagnostic tests
(k) Proving of immunity from electromagnetic interference

Where PCS or SCADA equipment is to be delivered in stages, or where it is impractical to include equipment from other suppliers (e.g. motor control centre switchboards, variable-speed controllers, equipment packages) in the tests, partial tests are acceptable provided that interactions with the missing items are suitably simulated.

4 Water Treatment Plant Asset Design

4.1 Scope

This section outlines TasWater's specific requirements for the electrical and SCADA design of water treatment plants (WTPs). These requirements are in addition to those specified in Section 3 - General Electrical and SCADA Design Requirements.

The design requirements stated herein relate to medium-sized WTPs. Small and large WTPs must be designed as a collaborative effort between TasWater and the Responsible Designer.

For the purpose of this Standard, WTPs are classified according to production rate as follows:

Classification	Production Rate
Small	< 1 ML/d
Medium	1 to 20 ML/d
Large	> 20 ML/d

4.2 Operating Environment

In water treatment plants particular attention must be paid to equipment to be located in areas in which corrosive chemical are found, such as alum, chlorination and fluoridation system.

It is preferred that environmental risks for key items of electrical equipment are eliminated through physical separation e.g. switchrooms/MSBs, transformers etc. to be physically located as far as practicable from any environmental risks (corrosive chemicals). This is in addition to appropriate housing of equipment (switchrooms), IP rating of enclosures, sealing of enclosure penetrations through cable glands etc.

4.3 Power Distribution

4.3.1 Main Design Principles

In order to maximise availability, the Responsible Designer must arrange the power distribution system in a series of separate low-voltage switchboards and MCCs that are supplied from a central site Main Switchboard (MSB). See Figure 4 below.

The concept here is to establish the requirement for duty and standby drives and feeders and determine the allocation of these to redundant MCCs. Generally, MCC 1 would incorporate 'Duty' and 'Individual' (not needing standby function) drives and feeders. MCC 2 would incorporate 'Standby' and 'Assist' drives and feeders.

For smaller treatment plants (<1MLD), it might be practical to have the MSB and MCC co-located in the same switch room. Combining the MSB and MCC into a single switchboard may only be done with approval from the TasWater's Design Manager. The Electrical Design must allow any single switchboard/MCC to be turned off for maintenance purposes for at least 4 hours and still allow the plant to provide full output. This may be achieved by ensuring process critical items are powered by redundant electrical supplies which can be in turn isolated, or with the aid of emergency generators provide power to part of the plant whilst the other part is isolated. The process of isolation must be via in-built operational isolators, and not via requiring electrical power cables to be disconnected. The process of replacing all switchboards at the end of their design life must be considered and clearly stated.

4.3.2 Power Distribution Architecture

The requirements for 400/230V ac and 24V dc Distribution systems for medium WTP's are as follows:

4.3.2.1 400/230V ac Distribution

TasWater prefers the following features in the design of 400/230V ac power distribution for medium WTP's (refer to Figure 12)

(a) A single-line mains supply (grid connection) from the Electricity Distributor's distribution network
(b) A site MSB located indoors within an enclosed switchroom
(c) Electricity Distributor's tariff metering equipment located inside a weatherproof enclosure (typically mounted on the outside of the switchroom within which the MSB is located for easy access of the Electricity Distributor's meter readers)
(d) Radial supplies from the MSB to other switchboards, MCCs and UPS systems
(e) Power factor correction (PFC) equipment and/or harmonic filters (if required) to be located inside the switchroom
(f) An optional backup generator (fixed or mobile) for backing up the mains supply, complete with a generator connection panel for mobile generator connections.
(g) Two separate MCCs:
    (i) MCC 1 – supplies all "duty" drives, individual drives (i.e. those that are not part of duty/assist/standby configurations) and static loads
    (ii) MCC 2 – supplies all "assist" or "standby" drives
(h) Two Uninterruptible Power Supplies (UPSs) to protect critical loads:
    (i) A rack-mounted UPS and 230V ac distribution chassis (housed in the control room) for SCADA and communication systems
    (ii) A rack-mounted or rack-mounted UPS and 230V ac distribution chassis (housed in the switchroom) for process control and instrumentation
(i) Private power meters connected to SCADA via Ethernet or Modbus communication
(j) General lighting and power (GL&P) distribution board separate from the MSB or MCCs, and preferably not installed within the switchroom to minimise the need for operators to enter the switchroom.

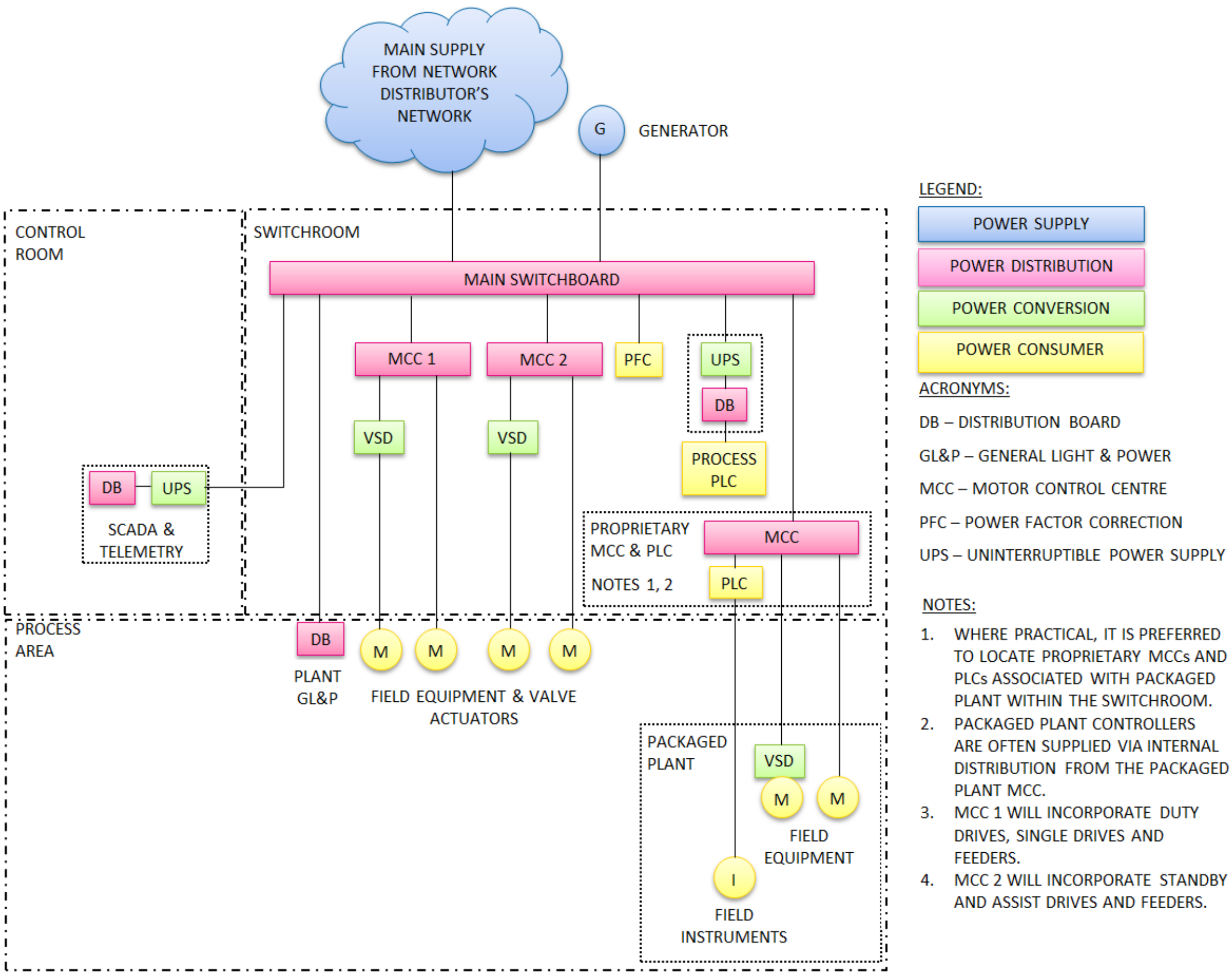


Figure 12: Power System Architecture for WTP 400/230V ac Systems

4.3.2.2 24V dc Distribution

TasWater prefers the following features in the design of 24V dc power distribution for medium WTPs (refer to Figure 13):

(a) Control supplies and non-loop powered instrumentation are supplied from a UPS-backed distribution system
(b) Switchroom mounted single or dual UPS with 400V three-phase/230V single phase input (depending on size of the UPS), 230V ac output and which is supplied from the MSB (in the case of dual 230V single-phase UPS systems the supplies must not come from the same phase of the MSB)
(c) 400/230V ac UPS distribution board wall-mounted within the switchroom
(d) Dual feeds to 24V dc power supplies, each feed being derived from a different phase on the UPS distribution board
(e) A managed redundancy module that will automatically switch the supply when one of the power supplies fail
(f) A 24V dc distribution board from which control supplies are fed, e.g. non-loop powered instruments, PLC/RTU, MSB controls and MCC controls.

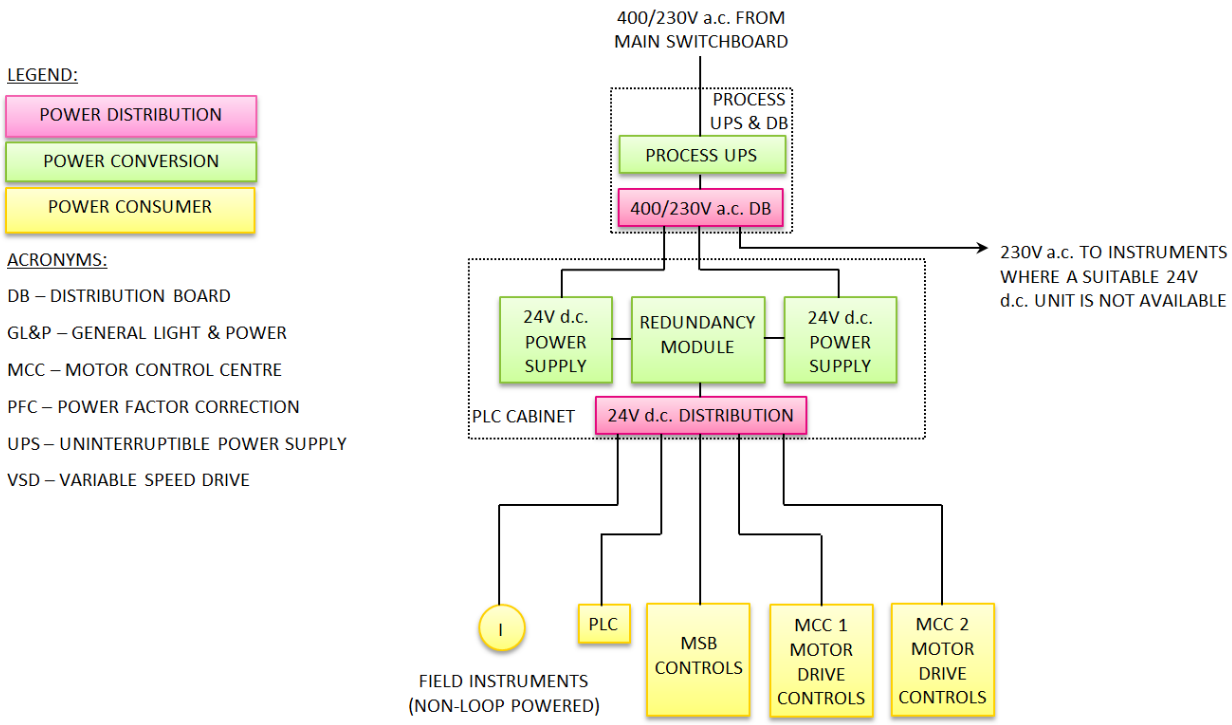


Figure 13: Power System Architecture for medium WTP 24V dc Systems

4.3.2.3 Switchroom Layout

A typical switchroom layout for a medium WTP is shown in Figure 14, which is to be used as the basis for switchroom design. Note that the provided layout is meant to be indicative of TasWater's requirements, and needs to be developed and/or modified to suit each project's requirements.

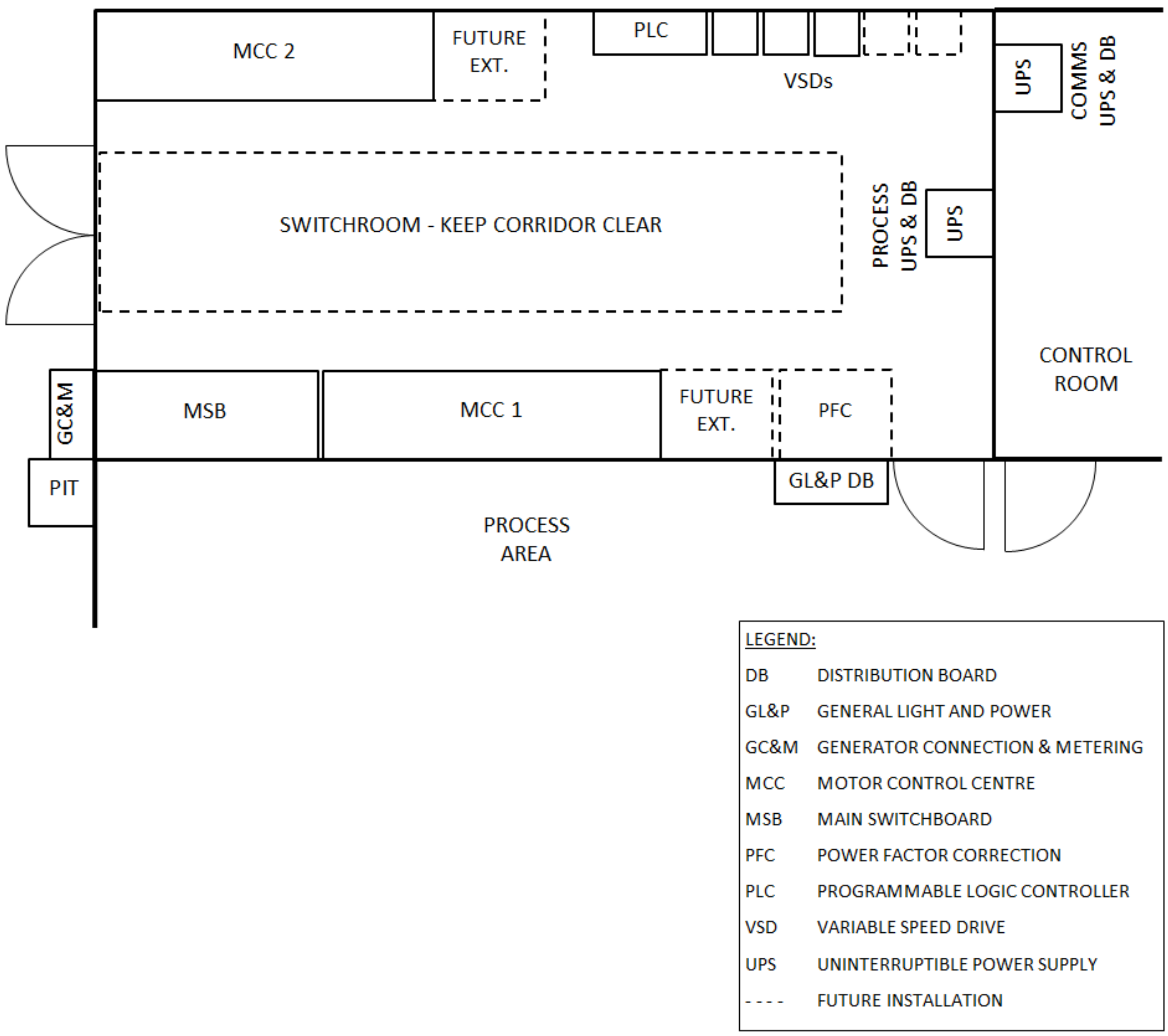


Figure 14: Typical Medium WTP Switchroom Layout

4.3.3 Electrical Redundancy

Electrical power and control redundancy must:

(a) Reflect and be equivalent to any mechanical or process redundancy provided in the plant
(b) Be identified to ensure single-point failures of equipment do not cause total loss of process.

Two separate systems must be provided to meet the above objectives:

(i) Emergency generators (fixed or portable) and
(ii) UPS systems.

4.3.3.1 Emergency Generator Supply

Emergency generator requirements are as detailed in Section 3.3.10.5 - Emergency Generators and Section 3.3.10.7 - Emergency Generator Connection.

4.3.3.2 Uninterruptible Power Supply

UPS system requirements are as detailed in Section 3.3.10.6 - Uninterruptible Power Supply (UPS).

5 Sewerage Treatment Plant Asset Design

5.1 Scope

This section relates to TasWater's requirements for the electrical and SCADA design of sewerage treatment plants (STPs). These requirements are in addition to those specified in Section 3 - General Electrical and SCADA Design Requirements.

5.2 Operating Environment

In sewage treatment plants particular attention must be paid to equipment to be located in areas in which corrosive gases such as hydrogen sulphide (H_2S) is present. Also explosive gases (such as methane) may accumulate in sufficient quantities to present an explosion hazard.

It is preferred that environmental risks for key items of electrical equipment are eliminated through physical separation e.g. switchrooms/MSBs, transformers etc. to be physically located as far as practicable from any environmental risks such as H_2S ingress. This is in addition to appropriate housing of equipment (switchrooms), IP rating of enclosures, sealing of enclosure penetrations through cable glands etc.

5.3 Power Distribution

5.3.1 Main Design Principles

In order to maximise availability, the Responsible Designer must arrange the power distribution system in a series of separate low-voltage switchboards and MCCs that are supplied from a central site Main Switchboard (MSB). See Figure 15 below.

The Electrical Design must allow any single switchboard/MCC to be turned off for maintenance purposes for at least one hour without affecting the plant operation. This may be achieved by ensuring process critical items are powered by redundant electrical supplies which can be in turn isolated, or with the aid of emergency generators provide power to part of the plant whilst the other part is isolated. The process of isolation must be via in-built operational isolators, and not via requiring electrical power cables to be disconnected. The process of replacing all switchboards at the end of their design life must be considered and clearly stated.

5.3.2 Power Distribution Architecture

TasWater prefers the following features in developing a power distribution architecture for a STP (refer to Figure 15 below):

- (a) A single-line mains supply (grid connection) from the Electricity Distributor's distribution network
- (b) A site MSB located indoors within a switchroom or other weatherproof structure
- (c) Electricity Distributor's tariff metering equipment located inside a weatherproof enclosure (typically mounted on the outside of the switchroom within which the MSB is located for easy access of the Electricity Distributor's meter readers)
- (d) Radial supplies from the site MSB to a number of switchboards and MCCs that are located in close proximity to the plant areas they supply.
- (e) Power factor correction equipment
- (f) An optional backup generator (fixed or mobile) for backing up the mains supply
- (g) Two Uninterruptible Power Supplies (UPSs) to protect critical loads:
    - (i) A rack-mounted UPS (housed in the control building) for SCADA and communication systems

(ii) A process control UPS (housed in a switchroom) for process control and instrumentation

(h) Private power meters with communication capabilities to send data to SCADA.

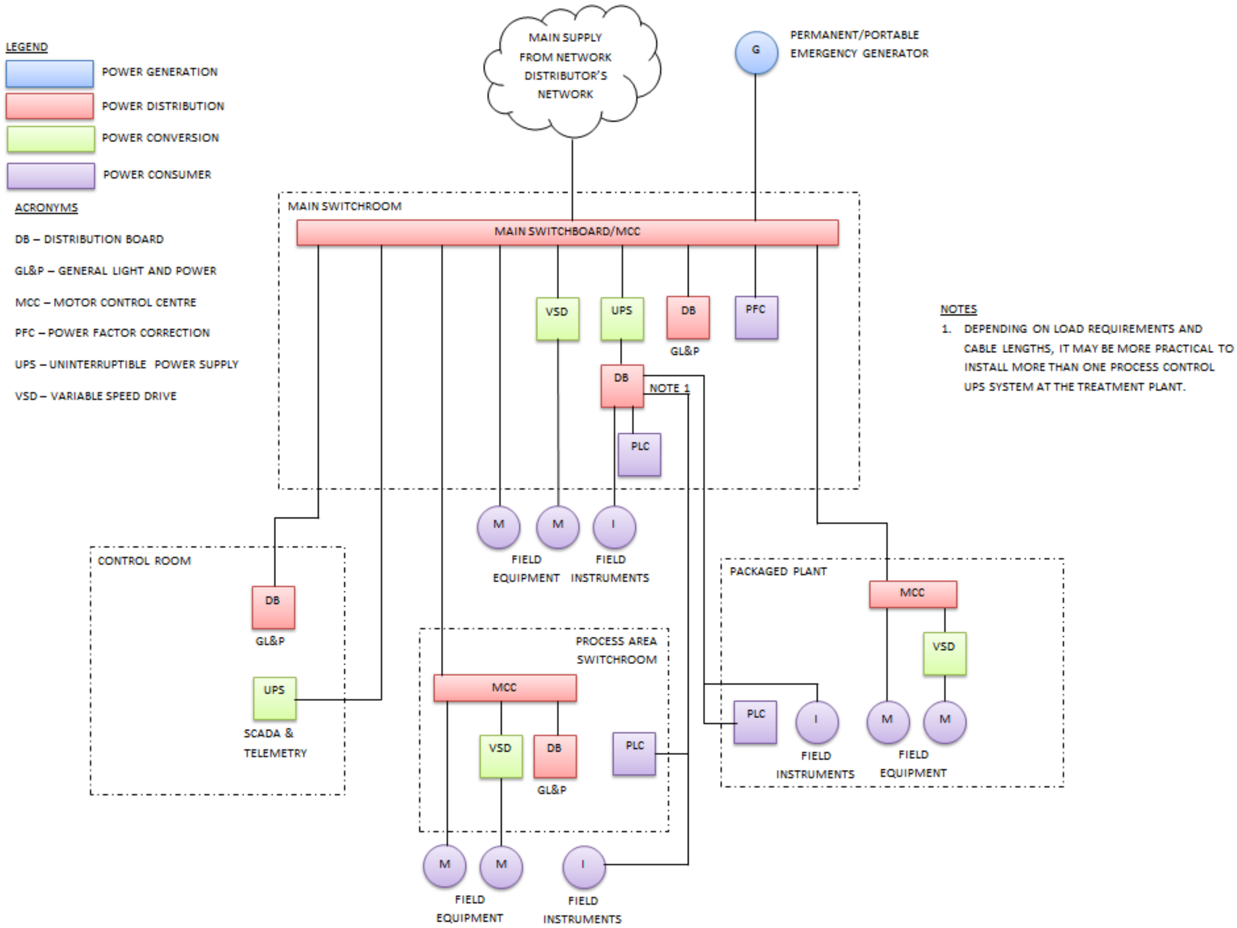


Figure 15: STP Power System Architecture

TasWater prefers the following features in developing a power distribution architecture (refer Figure 15):

(A) A single-line mains supply (grid connection) from the Electricity Distributor's distribution network

(B) A site MSB located indoors within a switchroom or other weatherproof structure

(C) Electricity Distributor's tariff metering equipment located inside a weatherproof enclosure (typically mounted on the outside of the switchroom within which the MSB is located for easy access of the Electricity Distributor's meter readers)

(D) Radial supplies from the site MSB to a number of switchboards and MCCs that are located in close proximity to the plant areas they supply.

(E) Power factor correction equipment

(F) An optional backup generator (fixed or mobile) for backing up the mains supply

(G) Two Uninterruptible Power Supplies (UPSs) to protect critical loads:

I. A rack-mounted UPS (housed in the control building) for SCADA and communication systems

II. A process control UPS (housed in a switchroom) for process control and instrumentation

(H) Private power meters with communication capabilities to send data to SCADA.

5.3.2.1 Switchroom Layout

A typical switchroom layout for a STP is shown in Figure 16, which is to be used as the basis for switchroom design. Note that the provided layout is meant to be indicative of TasWater's requirements and needs to be developed and/or modified to suit each project's requirements.

Where practical, one or more switchboard/MCC is allowed to be located within the same switchroom, provided the following requirements are met:

(a) The room must be large enough to meet the requirements with AS/NZS 3000 with all electrical and equipment installed.
(b) Minimum spare floor space for future expansion:
    (i) Enough space must be allowed for in the design to enable future electrical equipment, such as additional switchboards and wall-mounted VSDs, to be installed within the switchroom without hindering entry or exit.
    (ii) Switchboard/MCC expansion: allow for future extension of the switchboard/MCC up to at least 25% of its original length, but not less than one full tier.
    (iii) Allow for enough space to accommodate the duplication of the largest switchboard/MCC inside the switchroom, plus an allowance to expand the switchboard/MCC by at least 25% of its original length but not less than one full tier.
    (iv) Provide 50% extra wall space, as well as 100% floor space, for mounting of future equipment without hindering exit or entry.

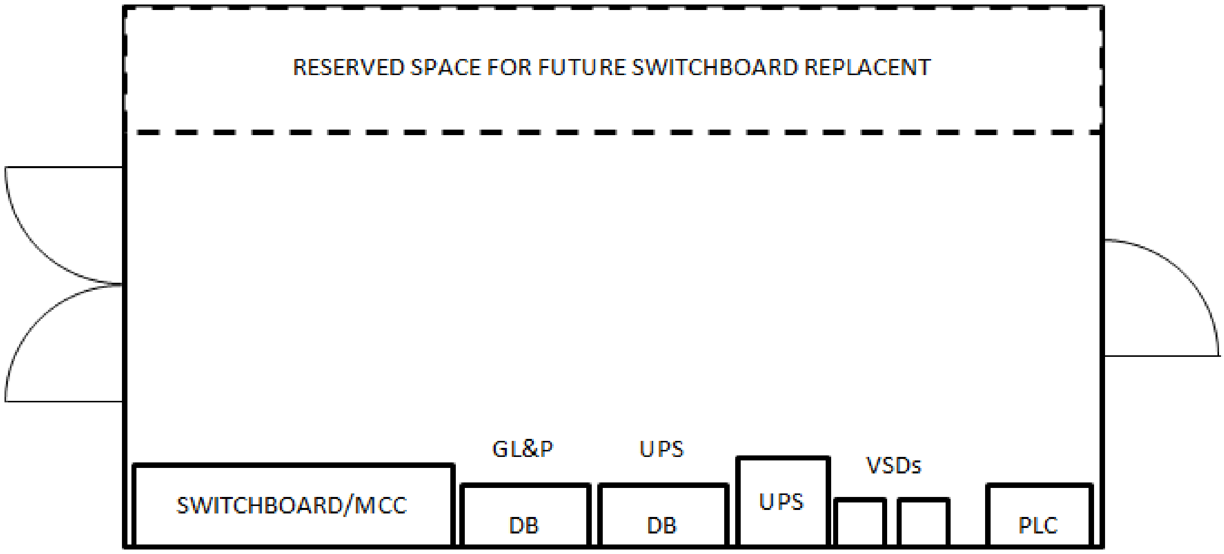


Figure 16: Typical STP Switchroom Layout

5.3.3 Electrical Redundancy

Electrical power and control redundancy must:

(a) Reflect and be equivalent to any mechanical or process redundancy provided in the plant
(b) Be identified to ensure single-point failures of equipment do not cause total loss of process.

Two separate systems must be provided to meet the above objectives:

(i) Emergency generators (fixed or portable) and
(ii) UPS systems.

5.3.3.1 Emergency Generator Supply

Emergency generator requirements are as detailed in Section 3.3.10.5 - Emergency Generators and Section 3.3.10.7 - Emergency Generator Connection.

5.3.3.2 Uninterruptible Power Supply

UPS system requirements are as detailed in Section 3.3.10.6 - Uninterruptible Power Supply (UPS).

6 Sewage Pump Station Asset Design

6.1 Scope

This section relates to TasWater's requirements for the electrical and SCADA design of sewage pump stations. These requirements are in addition to those specified in Section 3 - General Electrical and SCADA Design Requirements.

This section should be read in conjunction with:

- Section 24 Small SPS Asset Class Construction and Application Requirements of the TASTEM102 – TasWater Electrical and SCADA Technical Standard – Construction and Application.
- 6.5.2 Standard Small SPS Electrical and SCADA Design: TasWater has a Standardised SPS electrical and SCADA design for small SPS's which must be used when designing & installing a new or upgraded site-specific small SPS. The standard SPS Electrical and SCADA design fulfills many of the requirements of Section 3 - General Electrical and SCADA Design Requirements and Section 6 Sewage Pump Station Asset Design therefore reducing the work required to complete a design.

6.2 Background

The Sewage Pump Station (SPS) is a common place asset owned and operated by TasWater. The function of the SPS is to collect the gravity fed and pumped catchment sewage in its wet-well and pump it up to a treatment plant or another SPS.

6.3 Sewage Pump Station Categories

Sewage pump stations generally fall into one of the following design categories:

1. One Pump Low Criticality sewerage pump station (Legacy sites only when specifically requested by TasWater): refer to section 6.7)
2. Small sewerage pump stations (refer to Section 6.5)
3. Larger sewerage pump stations (refer to Section 6.6)

6.4 Engineering Design

6.4.1 Design Process

6.4.1.1 General

For all SPS categories generally follow the design process as documented in Section 6.5 Small Sewage Pump Stations as a basis but modify as required depending on the complexity of the proposed pump station.

Any modifications shall be completed in accordance with other standard design documents identified in this document. For example, standard circuits and RTU wiring diagrams.

The SPS is normally operated in Automatic mode where it is controlled locally by the pump station RTU but can be operated manually locally via selector switches and pushbuttons. In both modes the operation of the pump station is monitored by the TasWater SCADA system.

6.4.1.2 Design submissions

The Responsible Designer must make all of the design submissions for TasWater's acceptance as stipulated in Section 6.5.

6.4.1.3 New Sites versus SPS Switchboards renewed at Existing Sites

New sites: Both this design standard and section 24 Small SPS Asset Class Construction and Application Requirements of the TASTEM102 – TasWater Electrical and SCADA Technical Standard – Construction and Application standard are written to provide all required details to complete design, switchboard manufacture, SCADA integration and Electrical Installation at a new greenfield SPS site.

Existing sites (SPS switchboard Renewals): This design standard and section 24 Small SPS Asset Class Construction and Application Requirements of the TASTEM102 – TasWater Electrical and SCADA Technical Standard – Construction and Application standard are supplemented with additional documentation, as identified in section 6.4, to provide all required details to complete design, manufacture, SCADA integration and Electrical Installation at a brownfield site where the SPS switchboard is being renewed.

6.4.2 Operating Environment

The electrical design must be based on site environmental conditions as detailed in Section 3.3.2 - Operating Environment.

In Sewage pump stations, particular attention must be paid to equipment to be located in areas in which corrosive gases such as hydrogen sulphide (H_2S) is present.

Explosive gases (such as methane) may accumulate in sufficient quantities to present an explosion hazard.

6.4.3 Peer to Peer Traffic and Interlocking

It is uncommon to have Peer to Peer traffic between the following sites:

1. SPS to SPS for interlocking.
2. SPS to STP for interlocking.

In the case where interlocking is required Radio telecommunications is the preferred communications medium between the sites. This is typically implemented using Radio Relays (E.g. Elpro radios: Refer to TDESTD21 Preferred Equipment List) located at each site that pass a simple digital interlock signal directly between the two sites. This keeps the interlock traffic off the PTMP radio networks, reduces risk and simplifies the implementation by only involving those sites interlocked. Telecommunications traffic from the SPS to SCADA can still be implement using M2M in this instance.

Refer to the TDESTD25 - Small Sewage Pump Station - Functional Description template for details on how the interlock can be implemented and available options, i.e. hardwired and/or software interlock and what can override the interlock e.g. manual pump control, float control.

Consider local indication on the switchboard escutcheon that an interlock trigged at a remote site is active.

6.5 Small Sewage Pump Stations

6.5.1 Characteristics

Small sewage pump stations are typically characterised by the following:

(a) A single, outdoor electrical switchboard to supply the pumping equipment and other electrical loads

(b) An outdoor wet well
(c) Two pumps in a duty/standby pump configuration. Some legacy sites contain only one pump.
(d) Maximum pump motor size is 37kW per pump (duty/standby)
(e) Electrical maximum Demand <100Amps per phase

6.5.2 Standard Small SPS Electrical and SCADA Design

TasWater has a Standardised Small SPS electrical and SCADA design which must be used when designing & installing a new or upgraded site-specific Small SPS's. The standard small SPS Electrical and SCADA design fulfills many of the requirements of Section 3 - General Electrical and SCADA Design Requirements and Section 6 Sewage Pump Station Asset Design therefore reducing the work required to complete a design.

The small SPS standard design has been developed from TasWaters standard circuits and associated documentation as detailed in this design standard.

The standard design is based around a two pump, Duty/Standby arrangement where both pumps are identical in size and capability. Where specifically required, the pump arrangement can be modified to provide a Duty/Assist function. The SPS can also be used for single pump applications by isolating the second pump.

The standardised SPS design includes the following standard optional features:

1. Flow Meter
2. Wet well washers.
3. Emergency storage washers.
4. External lighting.
5. Odour fan.

When non-standard optional features are required, they will communicated to the designer in the form of a Consultants Brief and the designer shall in turn communicate them to the applicable Contractors in the design documentation.

The following standardised SPS electrical and SCADA design templates shall be used to develop site specific designs. Two tables listing the templates are provided:

1. Table 4 - Standard SPS Design Documents – these documents apply to all sites including new / greenfield sites and brownfield sites.
2. Table 5 - SPS Renewals - Brownfield Sites – these documents only apply to SPS switchboards being renewed at brownfield sites.

Table 4 - Standard SPS Design Documents

Drawing & Document Set	Description
TWS-E-0002 TasWater Standard Sewage Pump Station TYPE 1 Electrical Drawings	Electrical and SCADA drawing set template for DOL started pumps equal to or less than 4.0kW each (Duty/Standby & Duty/Assist). Suitable for sites with 1 or 2 pumps connected. The drawing set covers all required works related to Switchboard Manufacturer including Telemetry and connected field cabling.

TWS-E-0003 TasWater Standard Sewage Pump Station TYPE 2 Electrical Drawings	Electrical and SCADA drawing set template for Soft Started pumps greater than 4.0kW and up to or equal to 37kW each, Duty Standby arrangement. (Duty/Assist arrangement ONLY up to or equal to 18.5kW) Suitable for sites with 1 or 2 pumps connected. The drawing set covers all required works related to Switchboard Manufacturer including Telemetry and connected field cabling.
TWS-M-0002 - SPS Wet Well Level Settings	Details the wet well operating levels for the SPS. It details how to calculate these levels and although not part of the Electrical and SCADA design is included for information as it is an integral part of the design. This document is typically prepared by the Mechanical Designer.
TWS-E-0038 – SPS Switchboard Design, Construction and Installation Supporting Documentation	Provides the following standard documentation to assist with Design, Construction and Installation aspects of a standard SPS for both Greenfield and Brownfield sites as applicable. Drawings include: Sheet 1 Cover Page Sheet 2 Site Plan Layout Considerations – Notes Sheet 3 Site Plan Layout Considerations – 1 of 3 Sheet 4 Site Plan Layout Considerations – 2 of 3 Sheet 5 Site Plan Layout Considerations – 3 of 3 Sheet 6 Civil Work Slab Details Sheet 7 Civil Work Layout and Conduit Details Sheet 8 Cored Hole Mounted Wet Well Layout Sheet 9 Cored hole mounted stilling tube fabrication and installation details. Sheet 10 Cored hole mounted cable support fabrication and installation details. Sheet 11 Cored hole mounted float support fabrication and installation details. Sheet 12 Edge mounted level sensor and float switches installation details Sheet 13 Edge mounted stilling tube fabrication and installation details Sheet 14 Edge mounted float support fabrication and installation details Sheet 15 Edge mounted cable support fabrication and installation details Sheet 16 SPS RPZD Cage and Fabrication Details – 1 of 4 Sheet 17 SPS RPZD Cage and Fabrication Details – 2 of 4 Sheet 18 SPS RPZD Cage and Fabrication Details – 3 of 4 Sheet 19 SPS RPZD Cage and Fabrication Details – 4 of 4 Sheet 20 SPS RPZD Pipework Details Sheet 21 Bollards – Plans and Details Sheet 22 SPS Temporary Supply Single Line Diagram Sheet 23 Site Plan Template Sheet 24 Site Photos and Location Map Template
TDETEM01 - Small Sewage Pump Station - Switchboard Electrical FAT Template	Details the FAT procedures for the Standard SPS Design. Any additional tests required for non standard features should be appended to this document by the Switchboard Manufacturer.

	It's the designers responsibility to identify non standard features.
TDEFOR13 - Small Sewage Pump Station - SCADA Integrator Pre-SAT Form	Details the Pre-SAT procedures for the Standard SPS Design. Any additional tests required for non standard features should be appended to this document by the SCADA Integration Contractor. It's the designers responsibility to identify non standard features.
TDEFOR14 - Small Sewage Pump Station - Electrical and SCADA Integrator SAT Form	Details the SAT procedures for the Standard SPS Design. Any additional tests required for non standard features should be appended to this document by the SCADA Integration Contractor. It's the designers responsibility to identify non standard features.
TDEFOR15 - Switchboard Pre-Energisation Form	Details requirements when energising the Switchboard prior to FAT, Pre-SAT and SAT.
TDETEM19 - Standard 24VDC Circuit Switchboard FAT Template	Details the FAT requirements for the 24VDC circuit and is referenced from the TDETEM01 FAT template.
0001-FRM-QA-0027 - Surface Preparation and Powder Coating – Inspection, Test Plan and Checklist.	Details the required sheet metal work and powder coating tests and inspections required.
TDEFOR10 - Radio Cellular Path Test Form	Details the information to be recorded when Radio or M2M (4G/5G etc…) tests are required. Details required M2M SAT results.
TDEFOR16 – Telemetry Radio SAT Template	Details required SAT results for Radio connected sites.
TDESTD25 - Small Sewage Pump Station - Functional Description	Is a complete detailed functional description that details how the standard SPS operates. Standard optional and non-standard features are added to and detailed in the Appendices by the SCADA Integration Contractor.
TDETEM10 - TDESTD25 - Small Sewage Pump Station - Functional Description - Appendix A Template	Provides standardised alarm categories for sites based on SPS Criticality. SPS Criticality will be advised by TasWaters Asset department (CM A17/6534). Refer to section 24.2.6 SCADA alarm workshop of the TASTEM100 – TasWater Electrical and SCADA Technical Standard – Construction and Application for details on what sheet in the template shall be used for each criticality rating. The SCADA Integration Contractor will create the site specific file. It is the designers responsibility to obtain the Site Criticality and communicate it to the Contractor.
KingFisher CP-35 RTU Code and Configuration Template.	Refer to section 24.2 SCADA Integration of the TASTEM100 – TasWater Electrical and SCADA Technical Standard – Construction and Application for details. The SCADA Integration Contractor will create the site specific file from this template.
ClearSCADA Templates.	Refer to section 24.2 SCADA Integration of the TASTEM100 – TasWater Electrical and SCADA Technical Standard – Construction and Application for details. The SCADA Integration Contractor will create the site specific SCADA mimics from this template.

TDEMAN01 - Small Sewage Pump Station - O&M Manual	Is a complete O&M manual for the standard SPS. Standard optional and non-standard features are added to and detailed in the Appendices by the SCADA Integration Contractor.
PowerCAD Template - 2 Pump SPS Type 1	A PowerCAD model template set up to reflect the Type 1 design. For NHP switchgear.
PowerCAD Template - 2 Pump SPS Type 2 (4kW-11kW)	A PowerCAD model template set up to reflect the Type 2 design for connected pumps 4kW to 11kW. For NHP switchgear.
PowerCAD Template - 2 Pump SPS Type 2 (11kW-22kW)	A PowerCAD model template set up to reflect the Type 2 design for connected pumps 11kW to 22kW. For NHP switchgear.

Table 5 - SPS Renewals - Brownfield Sites

These documents are utilised on SPS Switchboard Renewal Projects only. The documents reference this section of the design standard and detail exemptions that apply to renewal projects. Exceptions include, but are not limited to:

1. Non-standard features
2. The use of Site Specific Scoping Sheets (where multiple sites are renewed in one project).

All are available via the Project Delivery Group (PDG) Intranet Design and Engineering Page.

These documents are not required for new SPS developments on Greenfield sites where this design document covers all Electrical and SCADA requirements.

SPS Renewals - Brownfield Site Templates
SPS Switchboard Renewal Consultants Brief Template
Standard SPS Switchboard - Manufacturing - Work Scope Template
Standard SPS Switchboard Renewal - Civil Works - Work Scope Template
Standard SPS Switchboard Renewal - Electrical Installation - Work Scope Template
Standard SPS Switchboard Renewal - SCADA Integration - Work Scope Template

The design of small Sewage pump stations must conform to TasWater's standard design for small sewage pump stations, as detailed in this section. In all cases the complete design must be reviewed and checked to establish an acceptable level of safety and design conformance in the same manner as if it was designed from new.

6.5.2.1 Standard SPS Switchboard Safety in Design Report

The TW00-160743968-122 - Pitt & Sherry Standard SPS Switchboard Safety in Design Report includes a SiD Hazard Register in Appendix B which identifies hazards associated with the Standard SPS Switchboard Design.

6.5.3 Design Deliverables

Produce the following:

(a) Detailed site specific SPS switchboard electrical design drawings:
   a. Developed using the Standard SPS drawing sets TWS-E-0002 or TWS-E-0003 as applicable to a "For Construction" standard.
   b. Modified to suit the site specific aspects.
   c. Including field cable connections.
   d. Standard optional equipment not installed are to be removed from the drawings.

e. Standard optional equipment installed should have the circuits in solid lines (changed from dotted).

f. Any drawings not used should be noted as "NOT USED" on the cover page EO01 and removed from the drawing set. For example, only ENO1 or EN02 shall be used on any site the other drawing shall be removed. Do not change the sheet numbers.

(b) Detailed and scaled site plan(s):

a. Developed using drawing template TWS-E-0038 – SPS Switchboard Design, Construction and Installation Supporting Documentation Sheet 23 Site Plan Template. The template symbols reference the applicable TasWater standards. Use the provided symbols to identify items on the Site plans and therefore the standards that apply to individual items shown on the Site plan. Those applicable standards are also listed in the Technical Documents Table. Remove unused symbols and notes. Developed to a "For Construction" standard.

b. Brownfield sites: Overlayed on TasWater provided site surveys that include:
   i. Location of inground services at the time of survey.
   ii. Scaled drawings.
   iii. Property boundaries and land ownership.

c. On greenfield sites: Provide a scaled site survey.

d. Showing:
   i. Slab dimensions.
   ii. Switchboard location and orientation considering:
      1. Left or Right Oriented GA.
      2. Complying with the TWS-E-0038 – SPS Switchboard Design, Construction and Installation Supporting Documentation:
         a. Sheet 2 Site Plan Layout Considerations – Notes
         b. Sheet 3 Site Plan Layout Considerations – 1 of 3
         c. Sheet 4 Site Plan Layout Considerations – 2 of 3
         d. Sheet 5 Site Plan Layout Considerations – 3 of 3
         e. Sheet 7 Civil Work Layout and Conduit Details
      3. Allowing safe manual operation of the pumps within viewing distance.
      4. Prevailing weather conditions (controls to face away from prevailing weather)
      5. Access to pits and vehicle locations.
      6. Property boundaries / Land ownership.
      7. Clearances from public walkways and areas.
   iii. Conduits including, but not limited to:
      1. Conduits from the switchboard to wet well. A minimum of 600mm clearance must be provided for each 90 degree change in direction for the 100mm conduits running from the switchboard to the wet well. If the conduits sweep down vertically and also change direction horizontally a minimum 1200mm of clearance between the switchboard and wet well must be provided. Minimum bend radius should be maintained when conduits are shown on the drawings. Conduits should be shown entering the wet well perpendicular to the wet well wall.
      2. Consumer main conduits.
      3. Conduits from the switchboard to flow meters or odour fans.
      4. Conduits from the switchboard to Light/Antenna pole (noting if two conduits are required).

5. Conduits from the switchboard to the RPZD cage for wet well and/or emergency storage washer solenoid control cables.
6. Future conduits from the switchboard to beyond the edge of slabs.
7. Earth stake conduit.
8. Size and location.

iv. Consumer Mains from the Point of Supply to the Switchboard. Where long a Consumer Main run is required a second site plan to a different scale may be required.

(c) Site Photo's and Location Map drawing:
   a. Develop from drawing template TWS-E-0038 – SPS Switchboard Design, Construction and Installation Supporting Documentation Sheet 24 Site Photos and Location Map
   b. Provide the site location map on the drawing in the location provided on the template.
   c. Leave the installation photo place holder for the installation Contractor to populate with as-built photo's

(d) Requirements specified in Section 3 - General Electrical and SCADA Design Requirements. Noting the following:
   a. Arc Flash Calculations and label details: Within the Arc Flash Calculation and Labelling section of this document note the special cases in section 3.2.5.6 Special Cases. This provides a look up table approach based on PowerCAD results too sites which fitting within the category of small SPS.

6.5.4 Civil and Mechanical Design

All aspects of the Civil and Mechanical design associated with a SPS is not covered in the design standard.

However, the following should be noted to help inform the full solution:

1. Wet Well Levels: Standard drawing TWS-M-0002 is required for each site and informs the operating levels of the pump station.

2. Conduits: Conduit installation must integrate with the Civil design and shall comply with the relevant sheets within the following drawing set: TWS-E-0038 – SPS Switchboard Design, Construction and Installation Supporting Documentation.

3. Lighting or Antenna Poles: Poles for this purpose must integrate with the civil design and shall comply with the following standard design drawing set: TWS-E-0016 - Standard Swivelpole Telemetry Antenna Pole – Design and Installation Drawing.

6.5.5 Mechanical Design - Wet Well Level Set Points

Develop a wet well level settings drawing for each site from the provided TWS-M-0002 template.

To assist the following RL levels will be provided by TasWater in the form or survey drawings:

1. Invert level of overflow pipe (drain) line (sometimes not present – i.e. spills out the lid or from upstream manhole).
2. Invert of emergency storage fill (drain) line (if emergency detention is present on site).
3. Invert level of wet well inlet pipe
4. Internal floor of wet well level

5. Wet Well diameter
6. Calculate all remaining values from the values provided. Refer to TWS-M-0002 for details on now to calculate the required values.

Update TWS-M-0002 and include this drawing in the site specific drawing set.

6.5.6 Telecommunications System Selection

Drawing sheets EN01 and EN02 of TWS-E-0002 and TWS-E-0003 provide two options to connect the SPS switchboard to the TasWater SCADA VRF network and therefore SCADA System:

(a) M2M (4G/5G) Modem.
(b) Telemetry Radio.

In addition, the drawings provide several antenna options.

TasWater will select which Telecommunications method will be used at each site including antenna type. The selection process will require testing of one or more available methods to determine the preferred solution and its robustness.

Most SPS switchboards communicate with SCADA via an M2M link.

On the rare occasion Peer to Peer traffic is required refer to section 6.4.3 Peer to Peer Traffic and Interlocking.

6.5.6.1 M2M telemetry links

If TasWater nominates M2M as the preliminary selection an M2M field test will be completed by TasWater's Business Systems and the results will be provided. If the field test is successful, the results should be provided in TDEFOR10 - Radio Cellular Path Test Form format and include details on which antenna to use. M2M antenna types are detailed on sheet EN01. Remove irrelevant details from EN01.

Allow to request and liaise with TasWater's Business Systems group to complete M2M path tests to confirm its robustness. Email: servicecentre@taswater.com.au and provide the following information.

1. Complete an M2M test in accordance with TDEFOR10 - Radio Cellular Path Test Form
2. Site Details: Asset ID and Asset Name.
3. Site Location: GPS coordinates of the Switchboard.
4. Provide antenna type to be used.

When an external pole mounted M2M antenna is selected include the pole location and feeding conduit on the site plans. Note the need for a second conduit it the same pole is used for external lighting.

6.5.6.2 Radio telemetry links

If TasWater nominates Radio as the preliminary selection an initial desktop Radio path test will be completed by TasWater using Pathloss Software to assess viability. If the desktop Radio path field test is successful a Field Test will be required.

Allow to request and liaise with TasWater nominate SCADA Integrator to complete a Radio Path field test in accordance TDEFOR10 - Radio Cellular Path Test Form.

The antenna type used shall be determined in the Radio path test. TasWater will advise and provide the licensed frequency to use. The required ACMA licences are provided and maintained by TasWater.

Radio antenna types are detailed on sheet EN02. Remove irrelevant details from EN02.

When an external pole mounted Radio antenna is selected include the pole location and feeding conduit on the site plans. Note the need for a second conduit it the same pole is used for external lighting.

6.5.7 Wet Well Cable Supports and Stilling Tubes

Drawings are provided for:

1. Stilling tubes and associated cable supports/hanger bracket.
2. Float cable supports (hanger brackets).
3. Pump cables supports (hanger brackets).

Refer to the TWS-E-0038 drawing set sheets 9 to 15.

As a minimum the design shall provide the following:

1. Float cable hanger bracket.
2. Level Transmitter hanger bracket.

The following are optional:

1. Stilling tubes: An assessment shall be completed to determine if a stilling tube, to house the level transmitter, is required or not. They are typically required for wet wells that experience high turbulence.
2. Pump Cable hanger brackets.

Include sufficient cable hanger brackets in the design to ensure cables are supported and kept neat and tidy in the wet well.

Two mounting methods are provided for each bracket and stilling tube, the appropriate type shall be selected and documented on the site plan:

1. Edge Mounted supports: These are typically utilised on new SPS installations where the entry to the wet well is large and the brackets will not imped access or egress from the wet well (Confined Space) in the case of an emergency. E.g. entanglement or catching on the hocks.
2. Core hole mounted supports: These are typically utilised on existing SPS installations where:
    a. The entry to wet well can be small and edge mounted brackets could imped access or egress from the wet well (Confined Space) in the case of an emergency. E.g. entanglement or catching on the hocks.
    b. The wet well is in use and contains sewerage. These brackets can be installed away from the wet well entry without the need to enter the wet well (Confined Space with contamination).

6.5.8 Soft Starters

The pump sizes determine the size of the pump soft starter. Pumps 4kW or less do not require a soft-starter.

The Designer must identify the correct size of soft starter allowing for a minimum of 500% starting current and maximum 12 starts per hour.

The required soft starter settings for standard SPS switchboards are identified in the following:

1. TDETEM01 - Small Sewage Pump Station - Switchboard Electrical FAT Template
2. TDEFOR13 - Small (Two Pump) Sewage Pump Station - SCADA Integrator Pre-SAT Form

If a non standard SPS switchboard is required the design shall modify the required soft starter settings in the following documents to suit the design:

1. TDETEM01 - Small Sewage Pump Station - Switchboard Electrical FAT Template
2. TDEFOR13 - Small (Two Pump) Sewage Pump Station - SCADA Integrator Pre-SAT Form

Operation is verified in during commissioning.

6.5.9 Additional Equipment – Standard Optional and Non Standard Equipment

Depending on the location and the operational requirements of the SPS, additional devices may be required. They fit into two categories:

1. Standard Optional Equipment
2. Non Standard Equipment

This equipment must be taken into account to decide whether the standard switchboard has enough allowance to accommodate the requirements of the equipment in all aspects.

All additional equipment will be included in the “For Construction” drawings showing both physical and electrical requirements.

6.5.9.1 Standard Optional Equipment

Standard optional equipment includes:

1. Flow meter.
2. Emergency generator connection.
3. Wet well washers.
4. Emergency storage washers.
5. External lighting (mounted on standard swivel pole or existing structure).
6. Odour fan.

TasWater has included standard designs for all Standard Optional Equipment in the following:

1. TWS-E-0002 and TWS-E-0003 drawings templates
2. RTU templates and SCADA templates.

The designer is to determine if Standard Optional Equipment is required and either:

(a) Modify the drawings to show that the Standard Optional Equipment is to be installed including drawing the circuits in solid lines (changed from dotted).
(b) If the Standard Optional Equipment is not required, the drawings shall be updated to remove any equipment not installed.

6.5.9.2 Non - Standard Equipment

When non-standard optional features are required, they will communicated to the designer in the form of a Consultants Brief and the designer shall in turn communicate them to the applicable Contractors in the design documentation.

6.5.10 Design Documentation Submission to TasWater

Prior to switchboard manufacture or site construction provide the design to TasWater for approval. This includes documentation detailed in this section and as detailed in Section 3 General Electrical and SCADA Design Requirements.

Once approved documents will be update to a “For Construction” revision.

6.6 Larger Sewage Pump Stations Switchboards

6.6.1 Characteristics

Larger sewage pump stations are typically characterised by the following:

(a) A building which houses an indoor switchboard
(b) An outdoor or indoor wet well. When indoors housed in a separate room to the switchboard.
(c) Two pumps or more in a configuration to suit the needs of the site. Pump motor sizes generally greater than 37kW per pump.
(d) CT metering and an external meter when the switchboard is housed in building.
(e) May contain other ancillary equipment or features such as:
    - Odour Control Systems.
    - Chemical Dosing
    - Flow paced control.
    - Air injection systems.
    - Cranes
    - Automated valves.
    - Building cooling or heating
    - Switchroom pressurisation
    - Emergency lighting
    - Hot Water service

6.6.2 Design guidelines

Larger sewage pump stations are generally pump stations that have the same requirements as small sewage pump stations but with larger pump sizes and sometimes extra functionality such as a third pump, variable speed motor control, chemical dosing systems etc. Therefore the design of larger sewage pump stations must generally follow TasWater’s design guidelines for small Sewage pump stations in Section 6.5 but modified to suit the additional requirements. The design approach must comply with the General Electrical Design Requirements specified in Section 3.

The use of soft starters for pumps larger than 37kW is TasWater’s preferred configuration. Where the use of variable speed drives (VSDs) is unavoidable, for example when volumetric flow control is required, the Electrical Design must be based on the small sewage pump station but adapted for variable speed drive considerations using TWS-E-0032 - TasWater Standard VSD (Variable Speed Drive) Motor Circuits.

A Process Functional Description shall be developed, based on TDESTD25, detailing the site operation.

Generators

If a permanent emergency generator will be included in the Electrical Design, the generator must be wired directly into an automatic change-over switch arrangement which will need designing.

If a portable emergency generator will be included in the Electrical Design, the generator must be connected via a connection box to TasWater Standards. The connection box must be fixed to an external wall of the switchroom building, and cabled into a change-over switch arrangement similar to that specified in Section 6.5.

Indoor switchboards

Thought must be given as to how local control of all the equipment can be carried out by a single operator. Local controls may be required on a local control station (LCS) external to the switchboard appropriately positioned near the wet well.

The building may have an electronic security system meaning the standard SPS switchboard intruder monitoring (refer to TDESTD25) can be simplified to only include SCADA Alarm Enable/Disable. If an electronic security system is not provided move the Access Detection Switches from the switchboard doors to the building access doors and include the standard small SPS functionality (refer to TDESTD25).

Seal conduits between the pump station wet well and the building to prevent entry of sewer gases into the switchroom. TasWater uses standard conduit bung for small sewage pump station installations which should be considered. All cables to the wet well equipment including pumps, floats and level sensors shall be easily removed and replaced (eg within 2 hours) to allow fast replacement in case of equipment failure.

Decontactor sockets (when required: refer to guidance provided on the standard circuits) and float sockets may be better positioned away from the switchboard near the wet well on wall mounts.

Comply with the following:

(a) Buildings must generally remain closed during operation and therefore must be provided with adequate ventilation for cooling or heating if required.
(b) Ensure the building is positively pressurised to prevent the ingress of corrosive sewer gases.
(c) Provide door seals to further improve the efficiency and efficacy of the ventilation system.
(d) Ensure that the internal temperature of the switchroom building will not exceed 40°C. If necessary, provide a passive/active ventilation system to maintain switchroom internal temperature below 40°C.
(e) Inlet and outlet louvres shall be vandal proof to prevent unauthorised access to the switchroom. Heavy duty steel mesh bolted to the internal wall may be needed to prevent access.

(f) Any Fan installation will ensure that it is correctly guarded to AS4024.1 to prevent operator injury and that it is directly wired to the switchboard where it can be isolated if required. The use of a wall mounted socket outlet for the fan is not acceptable

6.7 One Pump Low Criticality sewerage pump station

This applies only to the following:

1. Existing / legacy SPS sites where the existing switchboard is being renewed and TasWater specifically requests this type of switchboard.
2. SPS Criticality Rating of 1 or 2 and less than 50 ET's (Refer to CM A17/6534 for SPS site Criticality and ET's)

Where the above criteria are meet a 2 pump SPS Switchboard, designed in accordance with section 6.5 Small Sewage Pump Stations, can be modified as follows:

1. Generator Connection removed: Transfer switch and decontactor.
2. Second Drive Circuit removed: 1 x decontactor, 1 x drive circuit.
3. Only a single 24VDC power supply and associated batteries to be installed.
4. Switchboard form factor to remain as is.

Kingfisher CP-35 RTU and ClearSCADA templates are available for this scenario.

7 Maintenance Hole Overflow Monitor Electrical Asset Design

7.1 Scope

This section describes the standard equipment design for maintenance hole overflow monitoring. This includes the hardware and software required to implement remote monitoring of sewage overflows at maintenance hole assets. Specific issues covered include;

(a) Remote Terminal Unit (RTU)
(b) Location of RTU standard configuration file
(c) Procedure to obtain a SIM card for connection to TasWater's cellular communications provider
(d) Maintenance hole instrumentation, standard requirements and optional components
(e) Mounting bracket for equipment installed in maintenance holes
(f) TasWater Headend SCADA implementation requirements

7.2 Considerations

This section exists to ensure that maintenance hole overflow monitoring installations are consistent across all of the geographic areas covered by TasWater irrespective of the personnel engaged to provide the installation. The standard design also ensures that the *look and feel* of the SCADA interface remains constant across installations and that costs due to unnecessary duplication of work are eliminated.

Any deviation from this standard design must be approved by TasWater prior to implementation.

7.3 Reference Drawings

TWS-E-0019 Sht 1	Standard Maintenance Hole Overflow Monitor – Example Layouts & Schematics – Schedule
TWS-E-0019 Sht 2	Standard Maintenance Hole Overflow Monitor – Example Layouts & Schematics – Wiring Diagram
TWS-E-0019 Sht 3	Standard Maintenance Hole Overflow Monitor – Example Layouts & Schematics – Mounting Bracket

7.4 Maintenance Hole Overflow Monitoring Installation

A maintenance hole overflow monitoring installation consists of a battery powered RTU, junction box, float switch or switches and hydrostatic level probe mounted on a bracket in a maintenance hole, and covered by the maintenance hole lid. A covert antenna epoxied to the pavement outside of the maintenance hole facilitates connection to the M2M cellular network, by which the RTU can connect and send its data to TasWater's statewide SCADA headend server.

The RTU battery must be replaced periodically. The period varies depending on the number and types of instrumentation connected to the RTU, and the frequency of transmissions to SCADA, however the battery should last at least twelve months.

Figure 17: Typical maintenance hole overflow monitoring installation

7.5 Remote Terminal Unit

7.5.1 RTU Hardware

The Point Orange M2M battery powered RTU has been selected for maintenance hole overflow monitoring. The manufacturer is UK based company Metasphere. The RTU supports IEEE Std 1815-2012 (DNP3 protocol) and connects to the TasWater statewide ClearSCADA headend server.

Configuration software for the Point Orange RTU is *Poco+*. A proprietary USB cable (PN 5-117) is required to connect the configuration software to the RTU.

A typical Point Orange RTU installation will require a covert M2M cellular network antenna to be installed, mounted outside the maintenance hole, and connected to the RTU to provide adequate cellular reception. Antennas are specified in *TDESTD21 Preferred Equipment List Technical Standard* and are typically a pavement mount type, encapsulated in a road marker. See Figure 1.RTU Configuration File

7.5.2 RTU Hardware

The standard generic Point Orange maintenance hole overflow configuration is to be obtained from the Stationware revision management system via the SCADA Group. The file is located in Stationware at:

Standards.Statewide.Manhole.Telemetry SCADA Equipment.RTU Point Orange M2M Battery RTU

When the file has been modified for the particular site it is to be stored in Stationware as described in *TOMMAN04 - TasWater StationWare General Users Manual*.

7.5.3 SIM Card

A SIM card for the RTU is to be ordered from TasWater Business Systems by submitting a standard order form, *TasWater Shared Services SCADA M2M Order Form*, to the Service Centre email address ServiceCentre@taswater.com.au. To enable connection to the TasWater statewide ClearSCADA headend server the correct type of SIM card must be supplied. A Point Orange RTU device must be specified on the order form.

Business Systems typically arranges for a cellular M2M network signal strength survey to be performed as part of the SIM card supply. The site survey will be reported on standard form *TDEFOR10 - Radio Cellular Path Test Form*.

7.6 Maintenance Hole Instrumentation

7.6.1 Standard Instrumentation

The standard monitoring instrumentation set consists of:

(a) One high level float switch (digital output to RTU)
(b) One overflow level float switch (digital output to RTU)
(c) One hydrostatic level transducer (current loop output to RTU)

Standard instrumentation items may be removed from particular installations as required. If the hydrostatic level transducer is not installed it should be removed, or at least disabled, from the RTU configuration so as to prevent unnecessary RTU battery drain.

7.6.2 Optional Instrumentation

Optional instrumentation may be required for a particular installation. The RTU configuration and electrical wiring will need to be modified to suit the installation. Typical optional instruments include:

(a) pH
(b) Dissolved oxygen (DO)
(c) Oxidation-Reduction Potential (ORP)
(d) Temperature

7.7 Maintenance Hole Equipment Mounting

A 316 stainless steel custom manufactured mounting bracket is to be used to support the maintenance hole-mounted equipment including RTU, terminal boxes and cable hangers. Due to the wide variety of maintenance hole shapes and dimensions it is difficult to specify a standard bracket design however a typical field-tested bracket is specified in drawing TWS-E-0019 Sht 3. The design may suit a particular installation as-is or may be modified to suit.

Special consideration needs to be given to the following:

(a) The entire bracket must be removable to facilitate easy maintenance of both equipment and maintenance hole. Drawing TWS-E-0019 Sht 3 demonstrates a lockable pin-and-socket design which accomplishes this requirement.
(b) The bracket must be able to be locked into position to prevent any possibility of it floating off its mount in the case of process water flooding the maintenance hole.
(c) The equipment (RTU, terminal boxes and cable supports) must be able to be locked into position to prevent any possibility of the equipment floating off the bracket in the case of process water flooding the maintenance hole.

7.8 Statewide SCADA Headend Interface

To ensure consistency in design and look-and-feel a template has been developed on the statewide ClearSCADA headend for maintenance hole overflow monitor sites. The template incorporates the standard maintenance hole instrumentation. Optional instrumentation is able to be accommodated by drop-in templated instruments and these can be added as required to match the RTU configuration.

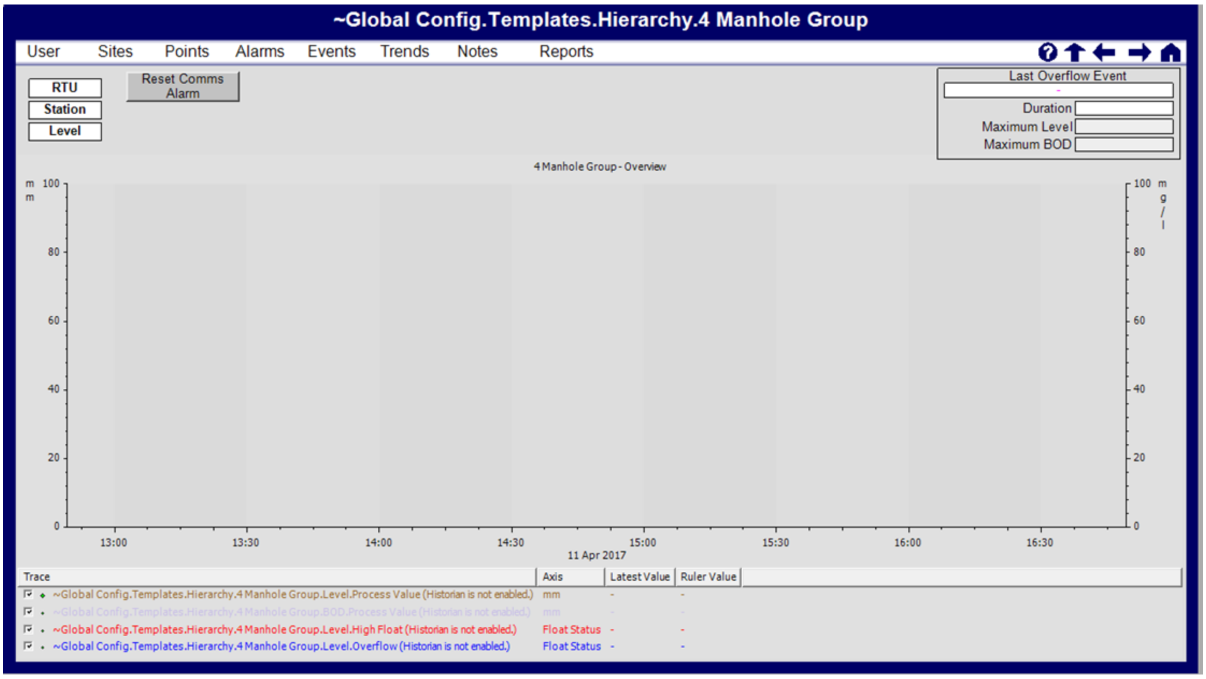


Figure 18: Sample headend SCADA view for maintenance hole monitoring sites

7.8.1 SCADA Alarms and Severities

The alarms (process and outstation RTU) generated by the maintenance hole overflow RTU are detailed in Table 6.

Alarm Type	Alarm Name	SCADA Alarm Severity
Process	Overflow Float	Critical
Process	High Level Float (Optional)	Critical
RTU	Communications Failed	High
RTU	Submersed	High
RTU	Battery Voltage Low Low (6.6 V)	High

Table 6: Maintenance Hole Monitoring SCADA Alarm Severities

8 Reservoirs Electrical Asset Design

8.1 Scope – To Be Developed

9 Water Pump Stations Electrical Asset Design

9.1 Scope – To Be Developed

10 Water Networks Electrical Asset Design

10.1 Scope – To Be Developed

11 Sewerage Networks Electrical Asset Design

11.1 Scope – To Be Developed

12 Supporting Infrastructure Electrical Asset Design

12.1 Scope – To Be Developed