TMS 60 LOW VOLTAGE SWITCHBOARDS REV17

TMS60 – STANDARD TECHNICAL SPECIFICATION

Revision Table

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DOCUMENT ENDORSEMENT

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1. SCOPE

This specification details the minimum technical requirements for design, construction and testing of LV switchboards and enclosures including motor control centres and distribution boards, including those incorporated within switchboards.

2. DEFINITIONS

All definitions are as per AS/NZS 3000 and AS/NZS 61439.1 unless defined in this clause.

Term	Definition
Arc flash incident energy	Energy released by an arc fault. Refer to TEM336 for determination of arc flash incident energy.
Enclosure	Sheet metal walls and doors, dividing partitions, structural frame and miscellaneous components such as the escutcheon, gear trays and weather hood of a switchboard
Switchboard	Low-voltage switchgear and control-gear assembly as defined by AS/NZS 61439

3. ACRONYMS & ABBREVIATIONS

Term	Definition	Term	Definition
AC	Alternating Current	PLC	Programmable Logic Controller
ACB	Air Circuit Breaker	PPE	Personal Protective Equipment
CT	Current Transformer	PSA	Power System Analysis
CSA	Cross Sectional Area	RHS	Rectangular Hollow Section
DB	Distribution Board	RTU	Remote Telemetry Unit
DC	Direct Current	SAT	Site Acceptance Test
DVR	Design Verification Report	SLD	Single Line Diagram
ELR	Earth Leakage Relay	SCADA	Supervisory Control and Data Acquisition
ELV	Extra Low Voltage	SPD	Surge Protection Device
FAT	Factory Acceptance Test	STP	Sewerage Treatment Plant
IEC	International Electro-technical Commission	VRLA	Valve Regulated Lead Acid
I/O	Input / Output	VT	Voltage Transformer
IP	Ingress Protection		
ITP	Inspection and Test Plan		
LED	Light Emitting Diode		
LV	Low Voltage		
LCP	Local Control Panel		
MCC	Motor Control Centre		
NC	Normally Closed		
NO	Normally Open		
MCCB	Moulded Case Circuit Breaker		
MPR	Motor Protection Relay		

4. REFERENCE DOCUMENTS

4.1 Urban Utilities Specifications

Doc No.	Title
TEM336	Power System Analysis Guidelines
TMS62	Preferred Equipment List – Electrical and Instrumentation
TMS76	Corrosion Protection for Electrical and Mechanical Equipment and Structures
TMS78	Typical Switchboard Changeover Commissioning Plan
TMS1151	Preferred Equipment List – Control Systems
TMS1200	Electrical Installation - Technical Specification
TMS1202	Control System Implementation for Network Assets
TMS1203	General Requirements for Hazardous Area Installation – Technical Specification
TMS1222	Control Panels - Technical Specification
TMS1406	LV Variable Speed Drives – Technical Specification
TMS1647	Plant and Equipment Tag Numbering - Technical Specification
TMS1648	EI&C Design Criteria – Technical Specification
PRO307	Procedure Drafting Guidelines – Contract Requirements
PRO395	SEQ Water Supply and Sewerage- D&C Code Asset Information Urban Utilities Addendum
PRO396	Control System Change Management Procedure
WI58	Arc Flash Assessment and PPE Selection

5. STANDARDS & REGULATIONS

All equipment supplied, works performed, and modifications to the existing equipment shall comply with the relevant statutory Local, State and Commonwealth Authorities and current applicable Australian Standards or, in their absence, the latest IEC standards.

5.1 Australian Standards

Document Number	Title
AS/ISO 1000	International System of Units (S.I.) and its Applications
AS 1275	Metric Screw Threads for Fasteners
AS 1319	Safety Signs for the occupational environment
AS 1627.4	Metal Finishing – Preparation and Pre-treatment of Surfaces – Abrasive blast cleaning of steel
AS/NZS 3000	SAA Wiring Rules
AS/NZS 3008.1.1	Electrical Installations – Selection of Cables – Cables for Alternating Voltages up to and Including 0.6/1kV – Typical Australian Installation Conditions
AS/NZS 3010	Electrical installations - Generating sets
AS/NZS 3017	Electrical Installations - Verification guidelines
AS/NZS 3111	Approval and Test Certification for Miniature Overcurrent Circuit Breakers
AS/NZS 3808	Insulation and Sheathing Materials for Electric Cables

AS 4024	Safety of Machinery
AS 4070	Recommended Practices for Protection of Low Voltage Electrical Installation and Equipment in MEN Systems for Transient Over Voltages
AS/NZS 5000	Electric cables - Polymeric insulated - For working voltages up to and including 0.6/1 (1.2) kV
AS 60044.1	Instrument Transformers - Part 1 Current Transformers
AS 60529	Degrees of Protection Provided by Enclosures (IP Code)
AS/NZS 60947	Low-voltage Switchgear and Control gear
AS/NZS 61000	Electromagnetic Compatibility (EMC)
AS/NZS 61386	Conduit systems for cable management
AS/NZS 61439	Low-voltage switchgear and control gear assemblies
AS/NZS 61558.1	Safety of power transformers, power supplies, reactors and similar products – general requirements and tests

5.2International Standards

Document Number	Title
IEC 60050	International Electro-technical Vocabulary
IEC 60051	Recommendation for Direct Acting Indicating Analogue Electrical Measuring Instrument and their Accessories
IEC 60228	Conductors of Insulated Cables
IEC 60332 ALL PARTS	Flame Test On Single Insulated Wire/Cables and Bunched Wires/Cables
IEC TR 61641	Enclosed low-voltage switchgear and control gear assemblies - Guide for testing under conditions of arcing due to internal fault
IEC 61643-11	Low-voltage surge protective devices – Part 11: Surge protective devices connected to low-voltage power systems – Requirements and test methods

5.3Regulations

The current regulations and statutory requirements of the State of Queensland, Australia, shall be complied with, including:

- Workplace Health and Safety Act 2011
- Workplace Health and Safety Regulation 2011
- Work Health and Safety (Codes of Practice) Notice 2011
- Electrical Safety Act 2002
- Electrical Safety Regulation 2013
- Electrical Safety (Codes of Practice) Notice 2013
- Professional Engineers Act 2002
- Professional Engineers Regulation 2019

5.4 Units & Language

AS/ISO 1000 (metric SI system) shall be used. All documentation and correspondence shall be in the English language.

6. GENERAL SWITCHBOARD REQUIREMENTS

The requirements of this section are applicable to all switchboard types. Switchboards shall be designed and constructed in accordance with AS/NZS 61439.1. Final design and fabrication details shall be agreed in writing by Urban Utilities prior to manufacturing.

6.1 Design Life

The equipment shall be designed for minimum life duration of 20 years in the environment and for the duty specified herein and on the Project Datasheets. The equipment shall also be suitable for a minimum of one (1) year normal continuous operation without maintenance at the duty specified herein and on the Project Datasheets.

6.2 Site Climatic Conditions

Electrical equipment shall be designed and rated for the climatic conditions shall be as specified on the Project Datasheet.

Where specified on the Project Datasheet, electrical equipment shall be suitably protected for use in a location where low concentration H_2S gas is continually present.

6.3 Operating Conditions

Equipment shall be designed to operate continuously in the AS/NZS 61000.2.4 environment specified in the Project Datasheet.

The equipment ratings shown on the drawings are the required ratings after all derating factors have been applied.

Switchboard components shall be rated for the circuit or sub-circuit maximum demand at the climatic conditions stated on the Project Datasheet.

6.4 Operating Parameters

Parameter	Value
System voltage	400/ 230 V +10, -6%
Rated insulation voltage	660 V
Frequency	50 Hz ± 2%
System earthing	TN-C-S (AS/NZS 3000 MEN)
Control Power	Regulated 24 VDC
Special purpose power supplies	Regulated 48VDC and 110VDC

6.5 Quality

The Contractor shall execute all works in relation to the design, manufacture and testing of the switchboard in compliance with an AS/NZS ISO 9001 quality management system certification accepted by Urban Utilities.

6.6 Design Verification

The test certificates shall be held in the name of the Original Manufacturer or Assembly Manufacturer. Test certificates must be issued by an ISO 9001 certified testing laboratory, type tests conducted within Australia shall be undertaken by a NATA certified testing laboratory.

A device may be substituted with a similar device to that used in the verification test if the substitution complies with the conditions of AS/NZS 61439.1.

The Assembly Manufacturer shall provide the switchboard DVR signed as approved by an Electrical RPEQ prior to contract award and on completion of manufacture as detailedbelow.

The DVR shall outline in detail how the assessment was undertaken and shall cross reference to all documents reviewed to make the assessment including design drawings. All relevant third-party test certificates must be provided in the DVR. The DVR may make reference to the relevant test report document numbers. The test reports shall be provided as standalone documents for Urban Utilities review prior to Contract award.

The DVR shall also include the following-

- AS/NZS 61439.1 Table D.1 List of design verifications to be performed.
- AS/NZS 61439.1 Table 13 Short Circuit Verification by Comparison with a reference design check list where comparison to a tested design is proposed.

Design verification shall include testing for the containment of internal arc faults where required by the following table.

Criteria	Internal Arcing Fault Tests
Arc flash incident energy load side of incoming over-current protection device less than 1.2 cal/cm^2	None required
Arc flash incident energy load side of incoming over-current protection device equal to or greater than 1.2 cal/cm^2	Internal arcing fault tests to AS/NZS 61439.1 Appendix ZD
Arc flash incident energy on the line side of incoming over-current protection device equal to or greater than 8 cal/cm^2 OR Rated load current equal to or greater than 800 A	Internal arcing fault tests to AS/NZS 61439.1 Appendix ZD including ZD6 Special Tests

At the completion of the switchboard manufacture and before delivery to site the DVR shall be updated to Final status and signed as approved by an Electrical RPEQ and then issued to Urban Utilities. The revised DVR shall include cross references to the document numbers of the switchboard routine test report, FAT report and design drawings. The switchboardshall not be delivered to site until the Final version of the DVR is accepted by Urban Utilities.

6.7 Fasteners

Threaded fasters shall be ISO metric.
Exposed bolts, screws, washers and other fasteners shall be stainless steel, brass or zinc annealed steel. Self-tapping screws are not accepted to be installed in any application.

6.8 Shrouding

Protection against contact with live parts at greater than ELV shall be at least IP2X

6.9 Equipment Mounting Height

Operating devices shall be located within a zone between 0.4 m and 1.9 m above the base of the assembly. This shall include door mounted interface modules for protection relays and meters.

6.10 Short Circuit Performance

The switchboard main circuit shall be constructed and tested to withstand short circuit current magnitude and duration as determined by the PSA (refer to TEM336).

Assemblies which are exempted from verification of short-circuit withstand strength are detailed in clause 10.11.2 of AS/NZS 61439.1. Cable bus systems shall be accepted where detailed in the Project Datasheet and in accordance with the requirements of AS/NZS 61439.1.

6.11 Over-Current Protection

Protective equipment shall be fully co-ordinated so that no item is called upon to break a fault current in excess of its fault current rating. This shall include control circuit breakers. The control circuit shall be fault limited to less than 5 kA.

6.12 Earth Leakage Protection

RCD protection shall be provided mandated in AS/NZS 3000 sections 1.5.6 and 2.6.3, and in areas subject to hose down (AS/NZS 3000 section 6.7)

The following fixed applications have been assessed by Urban Utilities to not present a significant earth leakage risk and therefore do not require RCD protection -

- VSD feeders
- UPS feeders
- Control circuits within a switchboard
- Fixed installation submersible pumps and mixers
- Valve actuators
- Motors
- Ventilation/HVAC equipment (excluding split system air conditioning equipment)

Where earth leakage protection is provided, independent test facilities shall be provided for each earth leakage protection device. All earth leakage devices shall be capable of being tested and reset without isolating the switchboard to gain access to the switchboard interior. The ELR relay shall be DIN rail mounted inside the functional unit and shall not be accessible with the escutcheon door closed.

Residual current devices (RCD) on final sub-circuits shall be suitable for the application as defined in AS/NZS 3000.

6.13 Motor Protection

Refer to typical schematic diagrams and project datasheet for motor protection requirements.
Motor protection relays shall be selected from TMS62.
Motor overload protection shall be as follows;

Motor Criteria	Switchboard Form of Internal Separation	Overload Protection
<30kW	Form 1	Bi-metal thermal overload relay
<30kW	Form 3b	Electronic overload relay
>=30kW	All	Electronic overload relay with 1 thermistor or PT100 RTD per winding
VSD	All	Overload protection provided by VSD with 1 thermistor or PT100 RTD per winding

Electronic overload relays have the following features-

- Programmable inputs and outputs for starting and stopping of the drive, running and status alarm indications, detecting overcurrent, undercurrent, phase failures, unbalance, blocking, earth leakage.
- Communications capability with the local control system for indication and control as well as remote programming of the relay on the same network interface port. The

communications protocol shall support Ethernet unless other protocol is specified in the Project Documentation.

- Digital panel installed on the front door of the switchboard starter functional unit. The digital panel shall be configured to display only the motor starter status. Motor control will be via an HMI installed at the PLC Panel and at SCADA. Only authorised persons using a password access shall be able to control the motor starter from the digital panel.

Integrated motor protection circuit breakers shall only be provided for motor circuits rated less than or equal to 10 Amps and where the motors are not critical to plant operation.

Circuit breakers used in motor power circuits shall be selected in accordance with the circuit breaker manufacturer's recommendations for the motor size. Instantaneous only trip units may be used for motor power circuits. Instantaneous trip units shall have a maximum setting of at least 15 times the motor full load current.

6.14 Emergency Shutdown Circuits

Emergency stop circuits installed in switchboards shall be Category 2 in accordance with AS4024 Machinery Safety code standard. The Contractor may reduce the category of the emergency stop circuit where the Contractor has provided a risk assessment to AS4024 and a design report to validate the reduction in Category is accepted by Urban Utilities. The design report shall be approved by an RPEQ Electrical and the risk assessment must be conducted with Urban Utilities participation.

Emergency Stop circuits for dry well and wet well submersible pumps have been risk assessed and are accepted by Urban Utilities as Category 1. There is no requirement for further risk assessment and design report for Category 1 Emergency stop circuits on these pump station sites.

Refer to TMS1651 for further machine safety requirements.

6.15 Line Side Insulation

Current-carrying parts on the line side of the incoming over-current protection device shall be insulated to IP XXB.

6.16 Cable Entries

Bottom entry of cables shall be provided for cable access to the switchboard unless specified otherwise in the Project Datasheet.

6.17 Ventilation

Where ventilation is required to limit temperature rise, ventilation methods in order of preference are

1. Natural ventilation
2. Forced ventilation with N+1 fan redundancy

Air intake and exhaust outlets shall be provided with removable SS316 mesh screen. Where vent hoods are required to achieve the specified IP rating, they shall be of the same material and finish as the enclosure.

Where forced ventilation is proposed, a thermostat shall be provided inside the enclosureto provide an over temperature warning alarm to the local PLC/RTU and control the operation of the ventilation fans. The thermostat warning temperature shall be set to below the maximum design temperature for the enclosure.

6.18 Switchboard Layout

Where switchboard 'General Arrangement' drawings are issued with the Project Documentation, the Contractor shall use these drawings as a guide only but where possible maintain the indicative arrangements. The final layout and fabrication dimensions shall be confirmed by the switchboard manufacturer and reviewed by Urban Utilities prior to fabrication.

Devices enclosed within the switchboard shall arranged to allow ease of access to each device. Contactors, circuit breakers, fuses, switches, etc. shall be readily accessible for maintenance and inspection purposes

6.19 Earthing & Bonding

Earth bar shall be located adjacent to the cable gland plate. Only one cable shall beterminated at each connection. The earth bar shall have 20% spare connections.

Switchboard earth bar shall be provision for the connection of the following main earth cables-

- Load current rating <=250A, single earth cable sized in accordance with AS/NZS3000.
- Load current rating >250A, two earth cables, each sized in accordance with AS/NZS 3000. An earth cable shall be connected to each end of the earth bar

Doors, hinged escutcheons, gear trays and the switchboard enclosure shall be provided with a welded M6 thread earth stud. Minimum 4mm^2 flexible G/Y insulated earth cable.

Current transformers shall have one secondary winding lead earthed.

Earthing connections shall be arranged so that removal of one component shall not affect continuity of the earthing conductor associated with any other component.

An isolated instrument earth bar with 20% spare capacity shall be provided in the control system marshalling terminal compartment. The instrument earth bar shall be bonded to the main earth bar with a single 4mm^2 G/Y PVC cable.

6.20 Doors

Doors shall be same material type, thickness and surface finish as the enclosure. Doors shall open a minimum of 100 degrees and shall be fitted with door stays.

Door sealing shall be achieved by 120 degree return on case, sealing against neoprene or polyurethane gasket secured (not glued) to the inside of the door.

Stiffeners shall be fitted to all doors with dimensions in excess of 1000 mm high and 450mm wide.

The main control compartment door shall have a document holder fitted.

6.21 Doors & Handles

Doors shall be held closed with the following handles (at least one lockable handle shall be provided on each compartment):

- Quarter turn 'T' handles.
- Padlockable swing handle (pump stations and outdoor switchboards)
- Manufacturer's standard (only where a specific lock is required to meet arc fault containment performance)

Door Quantity	Quantity of Handles
Up to 450 mm	1
Above 450 mm and up to 1000 mm	2
Over 1000 mm	3 (or a Tri-lock)

6.22 Door Lock Cylinders & Keys

Doors shall be fitted with at least one door lock. Door locks shall be fitted with - AbloyProtec 2 - System No. 8JBA663

Location	Cylinders
Sewage treatment plants	Cylinders shall be the 92268 key
Water and sewage sites	Cylinders shall be keyed SA, SB and SC (refer to Urban Utilities for key type)

Electricity meter panels shall be fitted with a 45mm brass pin tumbler Energex padlock.

6.23 Escutcheons

Escutcheons shall be hinged, open to a minimum of 90°, and removable in the fully open position. Hinges shall be of the concealed or zinc plated pintle type. Escutcheons shall be held closed by means of tool type, quarter turn latches.

Escutcheon Height	Quantity of Latches (minimum)
up to 1000 mm	2
over 1000 mm	3

Escutcheons shall have a 'D' handle.
Escutcheons shall be gloss white.

6.24 Mounting Panels

Equipment mounting panels shall be support by studs welded to the enclosure, or using the approved manufacturer's type tested arrangement.

Panel Dimensions	Metal Thickness	Qty of Supporting Studs
Up to 500mm width or height	2mm	4
Between 500mm and 1000mm width or height	2mm	4
Greater than 1000mm width or height	3mm	6

Heavy equipment shall be supported by separate independent framework and shall not rely on the enclosure sheeting.

Mounting panels shall be gloss white.

6.25 Covers

Covers shall be same material type, thickness and surface finish as the enclosure.

Covers shall be secured using dome nuts. A minimum of six fasteners are required if the cover is over 1000 mm in any direction.

6.26 Gland Plates

Gland plates shall be minimum 3 mm aluminium plate. Gland plates shall not to be split and are to be maintained a minimum 50mm clearance from section dividers and the complete gland plate area must be accessible to install cable glands.

Gland plates shall be bonded to the switchboard enclosure. Gland plate fixing bolts shall not be used for connection of the earth cable to the gland plate.

Cable glands shall be installed in accordance with the manufacturer's instructions.

Gland plates shall be sized with minimum 20% spare space for future increase in number of cables. All unused holes in gland plates shall be sealed with removable bungs.

6.27 Busbars

Busbars shall be formed from hard drawn, high conductivity, solid rectangular tin-plated copper bar. Main busbars shall have the same current rating for the full length of the switchboard assembly.

Busbar assemblies shall be installed in accordance with the manufacturer's instructions.

Where specified in the Project Datasheet a neutral bar shall run the full length of the switchboard. An earth bar shall run the full length of the switchboard.

Busbars shall be identified at regular intervals not exceeding 300 mm. Phase colours shall be red, white and blue. The busbar colour marking system shall have been tested and certified to the maximum rated temperature of the busbars. Insulation in the form of taping is not accepted.

Busbar supports shall be fabricated from non-hygroscopic material.

6.28 Wiring

Switchboard wiring shall be protected from damage in accordance with AS/NZS 3000 section 3.3.

All wiring is to be PVC V90 HT 0.6/1kV Grade with tinned conductors.Wiring to hinged doors shall be flexible.

Where wiring is not run on cable tray in cable zones, wires shall be run in slotted insulatedwiring duct fitted with a snap-on lid. The slots shall be of the 'open' type so that it is possible to install or remove a wire without threading it through a slot. Ducts shall not tobe filled to more than 75%.

Where ducts are mounted upside down, the wiring shall be tied or supported to prevent the duct lid being forced open by the weight of wiring upon it.

Where it is not practicable to run the wiring in ducts, wires shall be run in looms using flexible plastic spiral and cable ties at suitable intervals.

Earth cables are to be a minimum of 2.5sqmm flexible.

Low voltage wiring within a control section shall be insulated and sheathed to AS/NZS 5000.2.

Service	Colour	Size
400 V AC Power Wiring	Red, White, Dark Blue	2.5 mm^2 (minimum)
Potential Metering (240/415 V AC)	Red, White, Dark Blue, Black	1.5 mm^2
Current Metering (Secondary)	Red, White, Dark Blue, Grey	1.5 mm^2
230 V AC Active	Red	1.5 mm^2
230 V AC Neutral	Black	1.5 mm^2
24 V AC or DC Positive Supply to Distribution Terminals or Fuses and up to the first point where the circuit activates a contact or device.	Orange	1.0 mm^2
24 V AC or DC after the first point where the circuit activates a contact or device.	Grey	1.0 mm^2
24 V AC Neutral or DC Negative Supply to Distribution Terminals or Fuses and to all negative connections on all devices	Violet	1.0 mm^2
PLC, RTU & General 24 V AC & DC after Distribution Terminals or Fuses. Both Positive or Negative	Grey	0.5 mm^2
Electrodes	Salmon	1.0 mm^2
Intrinsically Safe	Light Blue	1.5 mm^2
Earth	Green/Yellow	2.5 mm^2 (minimum)
Door & Escutcheon Earth Bonds	Green/Yellow	4.0 mm^2

Conductors shall be terminated with tinned copper crimping lugs applied using the manufacturer's approved crimping tool. Lugs shall be of the type most suited to the device terminal e.g. forked tongue for stud terminals, and boot lace type for tunnel typeterminals.

LV and earthing wiring shall not use pre-insulated lugs but shall be insulated with heatshrink of the colour stated in the table above.

Control terminals in Form 3b switchboards shall be mounted in cable zones (not within the modules), within 150 mm of the front of the switchboard.

Provision shall be made in the termination area to allow circuits to be checked with clip on type ammeters. CT secondary wiring except motor CT wiring shall be connected to test links which allow testing with 2 mm banana plugs.

CT's for tariff metering on switchboard incoming supplies shall be connected to a test block as detailed in Supply Authorities Conditions of Supply and Customer Metering.

6.29 Wire & Cable Numbers

Wire numbering will be equal to Grafoplast SI2000 system with black text on white background. Wires shall be numbered in accordance with the Contract drawings. Ferrules shall be arranged to read from left to right and from bottom to top.

Cable numbers in accordance with the Project Documentation shall be provided for each cable that terminates both ends inside the switchboard.

6.30 Communication Systems

6.30.1 Communication Hardware

Networking devices including FOBOTs and network switches shall be mounted in the separate control cabinet or in a dedicated ELV section.

Device level Ethernet ring(s) shall be utilised for networking between smart devices within the switchboard. If the devices to be connected are not compatible with a ring topology, a star network can be implemented with the switch to be installed within a dedicated ELV section of the switchboard.

Category 6a (Cat6a) copper ethernet cable with RJ45 quick connectors shall be used to connect Ethernet capable devices located within the switchboard. Alternatively, for devices that are or can be fitted with fibre optic ports suitable fibre optic patch leads can be used.

6.30.2 Copper Cabling

Ethernet cables shall be individually glanded into each cubicle, cabinet, panel orequipment.

Ethernet cables within switchboards shall be Category 6a (Cat6a) shielded.

Standard RJ45 quick connectors shall be provided to connect to LAN devices. RJ45 connectors shall meet class E characteristics and have moulded snagless boots.

6.30.3 Optical Cabling

Fibre optic cabling shall be terminated in FOBOTs fitted with plug in fibre opticconnectors. Connectors shall be LC type.

Where FOBOT are required in switchboards, they shall be mounted as close to the top of the control section of the switchboard as practical.

All spare fibre optic cores shall be terminated and identified.

Each connector that is unused shall be fitted with a plastic dust cap at the completion of the fibre termination.

6.31 Labelling

A label list shall be submitted and accepted by Urban Utilities prior to label manufacture commencing. Labels manufactured and not accepted by Urban Utilities shall be replaced at no cost to Urban Utilities.

The switchboard and modules shall be labelled with equipment names and tag numbers shown on the switchboard single Line diagram. Labels shall be installed as per the label schedule drawing for the switchboard. Switchboards installed in public accessed areas shall have Urban Utilities Danger label fixed to the external door.

Devices and terminal strips shall be identified by a label fixed near the device and orientedso that it is readable from the front of the switchboard. The label shall give both the devicetitle or function and a unique alphanumeric identification code in accordance with the schematic diagrams.

Labels for indoor switchboards are to be engraved ABS plastic laminated material.

External labels for outdoor switchboards shall be 1mm thick 316 grade stainless steel.

External labelling shall be fixed by M3 316 stainless steel threaded screws. Internal labelsshall be secured by M3 zinc plated metal threaded screws or glued into position. Doublesided tape is not to be used for fixing labels. Labels longer than 30mm shall have clearance fixing holes to allow differential expansion of label and mounting.

Internal labels shall be located so as not to be obstructed from clear sight by switchboard wiring.

The primary name plate shall be fitted in a prominent location and include the following information:

- Urban Utilities
- Project name
- Purchase order or contract number
- Equipment title
- Equipment tag name
- Switchboard drawing number series
- Certified weight
- Serial number
- Date of manufacture

The rating plate shall be fitted in a visible position and include the following information:

- Manufacturers name and Company Logo
- Type, Model and Serial Number
- Standard to which switchboard is manufactured
- Nominal Operating Voltage
- Nominal Operating Current
- Rated short circuit time withstand current
- Rated peak withstand current

Doors, escutcheons, covers or protective shrouds which give access to low voltage conductive parts shall be labelled with red/white/red labels marked "DANGER 400 V AC ISOLATE ELSEWHERE". Equipment connected to the line side of a switchboard incoming switch (e.g. voltmeters) shall be marked "DANGER - LINE SIDE CONNECTION – ISOLATE ELSEWHERE"

Arc Flash Labels shall be installed by the Contractor as per TEM336 PSA Guidelines. Refer standard drawings for arc flash labels:

- 486/1/25-0005-002 Arc Flash & Shock Hazard Sign-Type 2 Standard Detail
- 486/1/25-0005-003 Arc Flash & Shock Hazard Sign-Type 3 Standard Detail
- 486/1/25-0005-004 Arc Flash & Shock Hazard Sign-Type 4 & 5 Standard Detail

Label Type	Text Colour	Background Colour
Equipment/Device Labels	Black	White
Warning Labels	White	Red
E-Stop	White	Red

Label text height shall be generally as follows:

Label Type	Text Height
Switchboard equipment number	30 mm
Switchboard title	20 mm
Module labels	10 mm
Equipment labels	5 mm
Pushbutton designation	3.5 mm

7. SPECIFIC REQUIREMENTS BY SWITCHBOARD TYPE

Switchboards have been categorised by the following types-

Switchboard Type	Main Circuit Load Current Rating	Application	Acceptable Location
Modular indoor switchboard	No limit	Power distribution, control of process plant and equipment	Indoors where there is no possibility of being sprayed with water
Form 1 indoor switchboard	Not greater than 250 A	Control of process plant and equipment	Indoors where there is no possibility of being sprayed with water
Custom built outdoor switchboard	Not greater than 400 A (No limit on network sites)	Control of process plant and equipment	Outdoors or indoors where there is risk of being sprayed with water
Power and lighting distribution board – indoor	Not greater than 250 A	Small power distribution and lighting control	Indoors where there is no possibility of being sprayed with water
Power and lighting distribution board – outdoor	Not greater than 250 A	Small power distribution and lighting control	Outdoors or indoors where there is risk of being sprayed with water

Urban Utilities are to be consulted where a switchboard application or location does not suit the defined types.

The following table specifies the requirements for each switchboard type.

Switchboard Type	Modular indoor switchboard (MCC)	Form 1 indoor switchboard	Custom switchboard	Power and lighting distribution board – indoor	Power and lighting distribution board – outdoor
Main Circuit Type	Busbar	Cable	Cable	Distribution chassis	Distribution chassis
Minimum IP Rating	IP44	IP44	IP56	IP44	IP56
Form of Separation	Incomer Form 4a Functional units 3b (not 3bih)	Form 1	Form 1 or Form 3b	Form 1	Form 1
Enclosure Material and Minimum Thickness	Powered coated 1.6mm (min) zinc plated steel	Powered coated 1.6mm (min) zinc plated steel	2.5mm (min) marine grade aluminium or 1.5mm (min) grade 316 stainless steel.	Powered coated 1.6mm (min) zinc plated steel	2.5mm (min) marine grade aluminium or 1.5mm (min) grade 316 stainless steel.
Fasteners	Zinc plated mild steel	Zinc plated mild steel	Stainless steel	Zinc plated mild steel	Stainless steel

Switchboard Type	Modular indoor switchboard (MCC)	Form 1 indoor switchboard	Custom switchboard	Power and lighting distribution board – indoor	Power and lighting distribution board – outdoor
Spare Space/ Capacity	20% spare space and main busbars pre-drilled for extension	20% spare space	20% spare poles on enclosed distribution board	20% spare poles	20% spare poles
Internal Labelling	Engraved ABS laminate	Engraved ABS laminate	Engraved ABS laminate	Engraved ABS laminate	Engraved ABS laminate
External Labelling	Engraved ABS laminate	Engraved ABS laminate	Laser etched SS with SS fasteners	Engraved ABS laminate	Laser etched SS with SS fasteners
Colour	Orange RAL 2000 or AS2700 X15.	Orange RAL 2000 or AS2700 X15.	Refer to Project Datasheet	Orange RAL 2000 or AS2700 X15.	Refer to Project Datasheet
Additional Requirements	Refer to section 7.1	Refer to Project Datasheet	Refer to section 7.3	Refer to section 7.2	Refer to section 7.2

7.1 Modular Indoor Switchboards

Switchboard must be in a building or enclosure.

Switchboard shall consist of one module per functional unit. Each module shall containall control circuits for the functional unit.

Control system hardware shall not be installed in a modular indoor switchboard. Refer toTMS1222 for control panel requirements.

7.1.1 Modules

Modules shall be constructed of standard cell heights and shall be of standard depth and width.

7.1.2 Module Doors

Doors for modules containing LV circuits shall be interlocked with the main circuit switching device for that functional unit. The interlock shall be defeatable using a standard flat bladed screwdriver. The main circuit switching device shall be pad lockable in the off position.

7.1.3 Cable Zones

Switchboards shall have separate vertical cable zone for each tier, (unless specified in the project datasheet) and with a horizontal wiring enclosure running the length of the switchboard.

Vertical cable zones shall be a minimum of 300mm wide. Cable zones

shall have 20% spare capacity.

Cable tray shall be mounted over the full length of all cable zones for fastening of cables.

7.1.4 Plinth

Plinth shall be a minimum 75 mm 'U' channel, hot dipped galvanised. The plinth to have M12 clearance

holes for bolting to the floor. Where the plinth is used for lifting, 50 mm diameter holes for inserting lifting bars. Lifting holes shall be sealed to prevent the entry of vermin.

7.1.5 Paint

Switchboard metalwork shall be degreased and cleaned with solvent, then coated with electro-statically applied powder coat in accordance with paint manufacturers' recommendations. Alternative preparation and coating system must be accepted by Urban Utilities before Contract award.

7.2 Power & Lighting Distribution Boards

This section specifies the requirements for power and lighting distribution boards including distribution chassis incorporated into modular switchboards.

Distribution boards shall be fitted with an escutcheon requiring a tool to open.

The DB busbar chassis shall have test certification for minimum fault current withstand of 25kA/0.1 secs unless specified otherwise in the Project Datasheet.

7.3 Custom Outdoor Switchboards

This section specifies the requirements for custom built, non-modular switchboards. These requirements do not preclude the offering of a modular switchboard where the performance requirements can be met.

Where exposed to unprotected weather, direct sunlight, dust or hose-down cleaning, equipment shall include sloped weather hoods and sun-shades.

Visible seams and joints be shall be fully welded. Welds shall be free from splatter and smooth. Stainless steel welds shall be passivated.

External doors and covers shall be fitted with Emka 1011-207 self-grip seal or equivalent. Provisions shall be made to inhibit galvanic corrosion.

Inspection and access cover plates shall meet the following requirements-

- Maintain a 50mm clearance from section dividers
- Cover plates are NOT to be split into multiple plates

Plinth shall be minimum 80x40 Aluminium channel with high build epoxy protective coating.

Hinges (external) are to be Selectrix HIB650ss-316 stainless steel or equivalent. Stainless steel grade 316 star washers are to be fitted under all hinge screws.

Hinged escutcheons are to be fixed with Emka 1/4 turn 1000-U142 or equivalent. Equipment is to be removable via the front access doors.

Sheet metal edging is to be de-burred.

7.3.1 Cable Zones

Where vertical cable zones are necessary, they shall be provided for each tier (unless specified in the project datasheet), and with a horizontal wiring enclosure running the length of the switchboard.

Vertical cable zones shall be a minimum of 300mm wide.

Cable zones shall have 20% spare capacity. Cable tray shall be mounted over the full length of all cable zones for fastening of cables.

7.3.2 PLC / RTU Compartment

Outdoor switchboards may include a PLC/RTU compartment. PLC I/O and associated control system components shall be in a separate segregated compartment of the switchboard. The PLC/RTU compartment shall be an integral part of the outdoor switchboard at one end, with all internal wiring between the switchboard and PLC/RTU fully installed and factory tested.

External I/O shall be wired to a PLC/RTU marshalling terminal strip for connection of external cabling.

Refer to TMS1222 for further requirements.

7.3.3 Batteries

Battery cells shall be lithium ion phosphate or VRLA batteries for RTU and PLC backup power supply. The cells shall be connected in parallel strings, so any individual cell failure does not render the entire battery bank unavailable.

Batteries shall be suitable for 10 year design life at the conditions specified in the Project Datasheet.

Battery compartments in control panels shall be naturally ventilated and segregated from other compartments in the panel. Where Lithium Ion battery cells are provided the battery compartment shall have physical space to accommodate VRLA battery cells of the equivalent storage capacity, in the future if required.

The battery compartment shall be provided with a temperature sensor wired direct to the battery charger to enable temperature compensation during charging.

Battery terminals and live parts between the batteries and the short circuit protection device shall be shrouded to IP2X. The battery main isolator shall be a DC double pole CB located in close proximity to the positive terminal.

The battery cells shall be installed on slide out shelves for ease of access. Where battery cells exceed 20kg the Contractor shall allow to provide a trolley for manual handling of the cells.

Battery cells shall be individually date stamped at the date they were installed.

7.3.4 Paint

Finished smooth and exposed welds are to be cleaned, descaled, and surfaces are to be degreased.

Surfaces pre-treatment is to be in accordance with AS 1580 and AS 3715 using Novox LF acid etch cleaner, Novacoat 12 conversion coating, & clean water rinses.

Apply Dulux Alphatech 3000 powder coat to manufacturer's recommendations.

Alternative surface preparation and paint coating systems will only be accepted where Urban Utilities has provided written permission to deviate from this specification prior to Contract award.

Cubicle enclosure and external components shall be coloured Dulux ‘Pale Eucalypt’ (2606303M) matt finish, from Duralloy range.

Interior items (mounting panels, escutcheons, etc.) can be coloured Dulux ‘Bright White’ (27284636) from Duralloy range or to same colour as the cubicle enclosure.

Minimum Dry Film Thickness on all surfaces is to be 50 microns.

Stainless steel enclosures shall be Grade 316 with a No. 4 finish, external painting shall not be provided unless specifically detailed in the project datasheet. All enclosures shall be mechanically or chemically cleaned and passivated following fabrication.

8. SWITCHBOARD EQUIPMENT REQUIREMENTS

Equipment in the switchboard shall be new and tested to their respective product standards.

Where protection from H_2S is specified on the Project Datasheet, printed circuit boards shall have conformal coating.

Equipment shall be selected from TMS62 Preferred Equipment List – Electrical and Instrumentation. Alternative equipment may be offered if advantages exist and the alternative equipment proposed must be accepted in writing by Urban Utilities. When considering device substitution to the type-tested ASSEMBLY, all other performance criteria shouldbe considered and satisfied, in accordance with the standard, before an ASSEMBLY is deemed to be verified. Devices that were not in the original type-tested ASSEMBLY, those in TMS62 or proposed, shall be indicated in the DVR.

Equipment offered shall satisfy the following requirements:

- meet the requirements of this specification
- all equipment to be supplied shall be sourced from local OEM (Original Equipment Manufacturer) Authorised Distributors within Australia.
- shall be consistent i.e. all moulded case circuit breakers shall be from the one manufacturer and all contactors shall be from the one manufacturer;

Components and materials supplied by the Contractor shall be free from:

- Ceramic fibre
- Radioactive materials (unless specified otherwise in Project Documentation)
- Mercury

8.1 Air Circuit Breakers (ACB)

ACB's shall have been tested by a recognised testing authority for compliance with AS/NZS 60947.2 (IEC 60947.2).

ACB's shall be assembled on withdrawable carriages and arranged to automatically align within the switchgear cubicle without joggling. Interlocking mechanisms shall be provided for selection of SERVICE, TEST, and ISOLATED positions.

ACB's shall have the following features:

- Automatic shutters to protect both line and load side fixed portion of plug-in contacts. The shutters shall be pad-lockable.
- Have a motorised spring charged, stored energy spring closing mechanism, with manually operated release (i.e. close).
- Have a protection relay fitted as shown on the Project Drawings. The protection relay shall incorporate the following functionality-
    - Separate overcurrent protection in each phase
    - Earth fault protection
    - Very inverse (or inverse cubed) IDMT protection with independently adjustable current and time settings
    - Short time protection
    - Instantaneous protection
- Tripped indication for each element, and a manual reset facility.

- Have a manual open pushbutton and have provision for remote opening via communications through the local PLC.
- Have mechanical indication devices for closed, open, tripped, spring charged, and spring discharged.
- It shall be possible to charge the spring when the circuit breaker is open or closed.
- A limit switch shall be provided for remote spring charged indication.

A lifting trolley for removing and transporting the circuit breaker shall be supplied, where specified in the Project Datasheet.

8.2 Moulded Case Circuit Breakers (MCCB)

MCCB's shall have been tested by a recognised testing authority for compliance with AS/NZS 60947.2 (IEC 60947.2).

Provision shall be made for padlocking each MCCB in the off position with door interlocking handle and padlock attachment.

8.3 Main Switch

Main switch shall be fitted with a minimum of two NO auxiliary contacts wired to terminals for monitoring of isolator position at the local PLC.

8.4 Contactors

Contactors shall comply with AS/NZS 60947.4.1 with the following requirements-

- Type 2 coordination with short circuit protection device
- AS/NZS 60947.4.1 Table 1 utilisation categories
- Mechanical life of 10 x 106 operations
- 24V DC, continuously rated coils

Contactors shall be of the block type with modular design suitable for vertical mounting. Mounting screws shall be accessible from the front.

Contactors for motors rated over 55kW (Type 2 co-ordination rating) shall have replaceable contacts and removable arc chutes.

8.5 Control Relays

Control relays shall be of the plug-in type with screw or clip retainers.

Control relays shall be supplied with integral push-to-test buttons and LED indicators. Push to test facility shall not be installed on control relays with a safety rated function.

Relay coils shall have a maximum operating current of 0.2A and maximum pick-up current of 1A. DC relays on contactor circuits shall be provided with suitably rated suppression diodes.

8.6 Current Transformers

Current transformers shall comply with the requirements of AS 60044.1 and shall have the following characteristics in accordance with this standard:

- Construction: Window
- Number of Primary Turns: 1
- System Voltage: 400 V

- Rated Frequency: 50 Hz
- Rated Secondary Currents: 5A or 1A
- Additional Information - Measurement CT's
    - Type: M
    - Accuracy Class: 1
- Additional Information - Protection CT's
    - Classification: P
    - Accuracy Limit Factor: 10
    - Composite Error: 2.5

- Busbar mounted CTs shall be installed over a removable section of bar with bolted connections to facilitate changeover. CT's shall be securely clamped to the busbar with proprietary clamps. For cable installations the CT's shall be separately fixed to amounting bracket and the cable shall pass through the centre of the window without imparting any pressure on the body of the CT.
- CT's shall be arranged so that the rating plate and terminal markings are readily visible without the need to dismantle any part of the installation.
- All secondary connections, including unused tappings and test tappings, shall be wired to a terminal block having in-built facilities to allow short circuiting of the CT winding and insertion of test plugs.
- The star point of each set of CT's shall be earthed.

8.7 Surge Protection

A surge protection device (SPD) shall be provided on the incoming supply of all switchboards.

The SPD shall offer protection to Installation Category II in accordance with IEC 61643-

11 and shall have a surge rating as specified in the Project Documentation. The installation of SPD's shall be in accordance with IEC 61643-11 and AS/NZS 3000 Appendix F.

Fuses shall be installed between SPD's and the phase conductors.

The status of SPD's shall be monitored by the local PLC/RTU using a volt free contact unless specified otherwise in Project Datasheet.

8.8 Intrinsic Safety Barriers

Intrinsic safety barriers shall be installed in the control panel where specified in the Project Documentation.

Refer to TMS1203 General Guidelines for Hazardous Area Installation for requirements for intrinsic safety barriers.

8.9 Variable Speed Drives & Soft Starters

The requirements of TMS1406 LV Variable Speed Drives - Technical Specification shall be complied with when providing switchboard compartments for variable speed drives.

The VSD compartments shall provide the clearances around the unit recommended by the manufacturer or supplier. Where VSD units exceed 20kg the Contractor shall provide a safe and efficient manual handing method to allow uninstall and replacement of the VSD units.

VSD compartments ventilation shall comply with Section 6.17.

Control keypad displays for VSD's shall be mounted on the escutcheon panel where fitted or on the external door where the external door acts as an escutcheon panel.

8.10 Indicating Lights

Indicating lights shall be 24 Volt DC LED type provided with a lamp test facility. Colours shall be as indicated on the Contract drawings.

8.11 Panel Meters

Panel meters shall be 96mm x 96mm.

9. INSPECTION & TESTING

Routine verification to AS/NZS 61439.1.

9.1 Factory Acceptance Testing

Tests to be performed to the assembler/manufacturers certified quality assurance processes. The following list of testing are the minimum requirements. The routine tests and FAT shall include the following:

- Completeness check
- Check quality of the manufacture
- Checking of rating plates
- Point to point wiring test
- Primary injection testing of protection devices
- Insulation resistance tests
- Busbar systems shall be Ductor tested across all individual connections
- Earth continuity tests
- Polarity Test
- RCD and ELR tests
- Functional check of circuit breaker and switch operation and control circuits including local and manual controls and simulation of remote controls
- Functional check of circuit breaker trolley for correct and positive operation
- Functional test of interlocking between switches, doors, and earth switches
- Battery load test including discharge test

The Contractor shall provide written notice to advise Urban Utilities, five business days prior to the completion of testing so that specific testing may be witnessed by Urban Utilities.

Urban Utilities will not attend the factory testing until the FAT Plan and supporting check sheets have been accepted by Urban Utilities and the testing is completed in full and all FAT records are available to inspect. On the day of Urban Utilities' attendance, selected tests will be requested to be repeated so they can be witnessed.

Certified test records consolidated in the FAT Report for each switchboard shall be submitted to Urban Utilities for review immediately after completion of the tests. The test records shall clearly describe the details of the tests and the test results. All supporting calculations shall be provided. The full set of schematics and other drawings for the switchboard shall be submitted as part of the FAT Report and not just the tested sheets.

9.2 Site Acceptance Testing

Site acceptance testing (SAT) shall be performed to check the correct installation and prove the operation of each switchboard, in accordance with the Contractor's recommended SAT and commissioning procedures.

The Contractor shall provide a SAT plan as well as supervision of the tests, which shall include but not limited to:

Verification of the installation work e.g. check mechanical installation, check electrical installation including all cables, terminations, identification, check external controls and interfaces.

SAT will be performed to the Urban Utilities accepted SAT Plan which will include-

- Insulation resistance tests
- Earth loop impedance tests to each LV cable
- Polarity test
- Secondary injection tests
- Functional test to prove the operation of each item of switchgear.
- Adjust all necessary settings, e.g. relay settings
- Verify the operation of all (remote) trips, controls and output signals

The Contractor shall submit a list of all test records and settings for all parameters associated with main incomer, motor starters, feeders and control system in the SAT Report.

10.PACKAGING & HANDLING

The Contractor shall be responsible for preparation for shipment including packing, protection, preservation, labelling and marking of all items.

Switchboards shall be fabricated, fully assembled and tested at the factory. Large switchboards shall only be disassembled for shipping where indicated on the accepted design drawings.

All equipment shall have been fully tested and inspected prior to packaging. No packaging activities shall commence without the prior consent of Urban Utilities. Urban Utilities shall be notified of the dates of packaging with sufficient notice to allow attendance for completion of inspection and release certificates without affecting the required delivery schedule.

No equipment shall be allowed to leave the Contractor's premises without such certificate being signed, or a written waiver issued.

All test certificates shall be shipped with all lifting equipment, spreader bars, slings and shackles.

11.DOCUMENTATION

11.1 Drawings

The Contractor shall submit design drawings detailing the switchboard construction. This shall include but not limited to the following-

- General arrangements (internal and external)
- Single line diagrams
- Schematics
- Termination diagrams
- Installation detail

- Equipment schedule including all minor equipment such as control relays, lamps and terminals.
- Label schedule

The Contractor shall provide a complete set of red line drawings to Urban Utilities within 5 business days of completing the FAT. The red line drawings shall be each signed as approved by an RPEQ before submission to Urban Utilities. A complete set of red line drawings shall also be available in the switchboard when delivered to site. The Contractor shall maintain the redline drawings up to date throughout the installation, site testing and commissioning phase of the project. It is not permitted to remove the red line drawings from the site.

The Contractor shall provide a complete set of red line drawings to Urban Utilities within 5 business days of completing the SAT. The red line drawings shall be signed as approved by an RPEQ before submission to Urban Utilities. Unless stated otherwise in the Project Documentation the Contractor is responsible for back drafting the red line drawings and issuing a complete As Built set of drawings to Urban Utilities.

Where typical drawings are issued by Urban Utilities with the Project Documentation, they shall be used as a guide only; the Contractor shall remain responsible for the detail design of the switchboard and shall produce workshop drawings.

11.2 Manuals

Refer to PRO395 for operating and maintenance manual requirements.

11.3 Configuration files

All configurable electronic devices supplied in the switchboard shall be provided by the Contractor with the as-commissioned software configuration files provided in electronicformat.

Programming software licences and hardware accessories required to fault find and reconfigure the devices shall also be provided by the Contractor.

12.SPARE PARTS & SPECIAL TOOLS

The Contractor shall provide a list of the following spares-

- Commissioning and start-up spares
- Recommended spares list for two years operation

The spares lists shall be itemised and priced with the Tender Proposal and include estimated lead times. Urban Utilities will advise the Contractor what spares will be procured.

The Contractor shall list and provide pricing for all necessary special tools, software licences, programming cables, etc that are required to perform routine maintenance, operation and fault finding on the switchboard equipment with the Tender Proposal.

Urban Utilities will advise the Contractor what tool will be procured.