Low Voltage Switchboards and Enclosures

TMS60

Standard Technical Specification
# REVISION CONTROL

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<td>Add 24 V AC to colour schedule</td>
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<td>Add angled support brackets for terminal rails in cable zone</td>
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<td>Removal of BCC Logo, Removal a Division of Brisbane City Council, update of QUU Logo with new ABN, update document properties, Document Number corrected from TSM60 to TMS60</td>
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<td>Link to Queensland Urban Utilities ES template</td>
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<td>10</td>
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<td>General Review and Update</td>
<td>Rahim Janfada</td>
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1 SCOPE

This specification details the minimum technical requirements for design, construction and testing of metal clad LV switchboards and enclosures including Motor Control Centres, Distribution Boards and Local Control Panels.

1.1 DEFINITIONS

In this document, the following definitions apply:

<table>
<thead>
<tr>
<th>Project Documentation</th>
<th>Governing technical documents for the specific item(s) for the specific works included or referenced in the Contract</th>
</tr>
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<tr>
<td>Contractor</td>
<td>The entity bound (including sub-contractors appointed by the contractor) to execute the work having responsibility for design, manufacture and supply, delivery, documentation and other functions as further defined in the documents related to the work.</td>
</tr>
<tr>
<td>Contract</td>
<td>The agreement between QUU and the Contractor to which this specification pertains.</td>
</tr>
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1.2 ACRONYMS AND ABBREVIATIONS

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

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<td>TEM336</td>
<td>Power System Analysis Guidelines</td>
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<td>TMS62</td>
<td>Preferred Equipment List – Electrical and Instrumentation</td>
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<td>TMS76</td>
<td>Corrosion Protection for Electrical and Mechanical Equipment and Structures</td>
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<td>TMS78</td>
<td>Typical Switchboard Changeover Commissioning Plan</td>
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<td>TMS1151</td>
<td>Preferred Equipment List – Control Systems</td>
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<td>TMS1200</td>
<td>Electrical Installation - Technical Specification</td>
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<td>TMS1201</td>
<td>Instrumentation Installation - Technical Specification</td>
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<td>TMS1202</td>
<td>Control System Implementation for Network Assets</td>
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<td>TMS1203</td>
<td>General Requirements for Hazardous Area Installation – Technical Specification</td>
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<td>TMS1222</td>
<td>Control Panels - Technical Specification</td>
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<td>TMS1406</td>
<td>LV Variable Speed Drives – Technical Specification</td>
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<tr>
<td>TMS1648</td>
<td>EI&amp;C Design Criteria – Technical Specification</td>
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<td>PRO307</td>
<td>Procedure Drafting Guidelines – Contract Requirements</td>
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2 STANDARDS & REGULATIONS

All equipment and workmanship shall conform to the most recent requirements of the relevant statutory Local, State and Commonwealth Authorities and current applicable Australian Standards. Alternatively, where no Australian Standard exists, work shall conform to the most current and applicable International standard.

Where conflict exists between different Codes, Standards or Regulations, the most onerous conditions of specification shall apply unless accepted otherwise in writing by QUU.

The Contractor shall not deviate from the provisions of the relevant standard without first obtaining agreement in writing from QUU.

Particular standards and regulations relevant to the work include but are not necessarily limited to the following:

2.1 AUSTRALIAN STANDARDS

The equipment shall be designed, manufactured and tested in accordance with the latest edition of all relevant Australian and International Standards, Codes and Regulations except where modified by this specification.

| AS/ISO 1000 | International System of Units (S.I.) and its Applications |
| AS 1243   | Voltage transformers for measurement and protection |
| AS 1275   | Metric Screw Threads for Fasteners |
| AS 1284   | Electricity Meters |
| 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 1768   | Lightning Protection |
| AS 3000   | SAA Wiring Rules |
| AS 3008.1.1 | Electrical Installations – Selection of Cables – Cables for Alternating Voltages up to and Including 0.6/1kV – Typical Australian Installation Conditions |
| AS 3010   | Electrical installations - Generating sets |
| AS 3017   | Electrical Installations - Verification guidelines |
| AS 3111   | Approval and Test Certification for Miniature Overcurrent Circuit Breakers |
| AS 3133   | Approval and Test Specification – Air Break Switches |
### AS Standards

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<tr>
<td>AS 3808</td>
<td>Insulation and Sheathing Materials for Electric Cables</td>
</tr>
<tr>
<td>AS 4024</td>
<td>Safety of Machinery</td>
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<tr>
<td>AS 4070</td>
<td>Recommended Practices for Protection of Low Voltage Electrical Installation and Equipment in MEN Systems for Transient Over Voltages</td>
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<tr>
<td>AS 5000</td>
<td>Electric cables - Polymeric insulated - For working voltages up to and including 0.6/1 (1.2) kV</td>
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<td>AS 60034</td>
<td>Rotating electrical machines</td>
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<td>AS 60044.1</td>
<td>Instrument Transformers - Part 1 Current Transformers</td>
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<td>AS 60529</td>
<td>Degrees of Protection Provided by Enclosures (IP Code)</td>
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<td>AS 60947</td>
<td>Low-voltage Switchgear and Controlgear</td>
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<td>AS 61000</td>
<td>Electromagnetic Compatibility (EMC)</td>
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<td>AS 61386</td>
<td>Conduit systems for cable management</td>
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<td>AS 61439</td>
<td>Low-voltage switchgear and controlgear assemblies</td>
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<tr>
<td>AS 61558.1</td>
<td>Safety of power transformers, power supplies, reactors and similar products – general requirements and tests</td>
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### IEC Standards

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<td>IEC 60050</td>
<td>International Electro-technical Vocabulary</td>
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<tr>
<td>IEC 60051</td>
<td>Recommendation for Direct Acting Indicating Analogue Electrical Measuring Instrument and their Accessories</td>
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<td>IEC 60228</td>
<td>Conductors of Insulated Cables</td>
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<td>IEC 6032 all parts</td>
<td>Flame Test On Single Insulated Wire/Cables and Bunched Wires/Cables</td>
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<tr>
<td>IEC 61439-1</td>
<td>Low-voltage switchgear and controlgear assemblies - Part 1: General rules</td>
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<td>IEC 61439-2</td>
<td>Low-voltage switchgear and controlgear assemblies - Part 2: Power switchgear and controlgear assemblies</td>
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<td>IEC TR 61641</td>
<td>Enclosed low-voltage switchgear and controlgear assemblies - Guide for testing under conditions of arcing due to internal fault</td>
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<tr>
<td>IEC 61643-11</td>
<td>Low-voltage surge protective devices – Part 11: Surge protective devices connected to low-voltage power systems – Requirements and test methods</td>
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2.3 REGULATIONS

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

- Queensland Electricity Act 1994
- Queensland Electricity Regulations 2006
- Queensland Workplace Health and Safety Act 2011
- Queensland: Environmental Protection Act – 1994
  - Environmental Protection Regulation 2008
  - Environmental Protection (Air) Policy 2008
  - Environmental Protection (Noise) Policy 2008
  - Environmental Protection (Water) Policy 2008
- Building Code of Australia Volume 1 and 2
- Supply Authority Conditions of Supply and Consumer Metering
- Workplace Health and Safety Regulation 2011
  - Work Health and Safety (Codes of Practice) Notice 2011
- Electrical Safety Act 2002
  - Electrical Safety (Codes of Practice) Notice 2013
- Electrical Safety Regulations 2013
- Professional Engineers Act 2002

2.4 UNITS AND LANGUAGE

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

2.5 SUB-CONTRACTORS

The Contractor shall disclose, at the tender stage, all sub-Contractors or sub-suppliers they intend to use as part of the equipment package supply. The Contractor shall not sub-contract any work to any party without the prior written consent of QUU. It shall remain the Contractor’s responsibility to audit and co-ordinate the performance of their sub-Contractors with results being disclosed to QUU.

All requirements applicable to the Contractor are applicable to sub-Contractors or sub-suppliers. QUU reserves the right to attend the premises or otherwise of any sub-Contractor or sub-supplier used in the engagement of the equipment package.

2.6 CONTRACTOR EXCEPTIONS

The Contractor shall be responsible to submit, together with the Tender, a list of deviations or exceptions to this Specification. In the absence of any exceptions, it will be construed that the Contractor fully complies with this Specification.
2.7 ORDER OF PRECEDEENCE

In the event of any conflict arising between this Specification and other documents listed herein, refer comments to QUU for clarification before design or fabrication commences.

The order of precedence that applies is as follows:-

- The Contract or Purchase Order Scope or Work
- Project Data Sheets
- This Specification
- Project Drawings
- International Codes and Standards
3  ELECTRICAL DESIGN CRITERIA

3.1 OPERATING CONDITIONS AND 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 Data Sheets. The equipment shall also be suitable for a minimum of 1 year normal continuous operation without maintenance at the duty specified herein and on the Project Data Sheets.

All electrical equipment and instrumentation will be required to operate continuously at full load for 24 hours per day, 365 days per year under the climatic conditions detailed in this specification. All equipment shall be designed to perform this duty safely and without being attended.

3.2 SITE CLIMATIC CONDITIONS

Where electrical equipment is installed in a temperature controlled weatherproof building, the design environmental conditions shall be as specified on the Project Data Sheets. For all other cases electrical equipment shall be designed for the site conditions as defined below:-

<table>
<thead>
<tr>
<th>Location</th>
<th>South East Queensland</th>
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</thead>
<tbody>
<tr>
<td>Altitude</td>
<td>above mean sea level.</td>
</tr>
<tr>
<td></td>
<td>0-300m</td>
</tr>
<tr>
<td>Ambient Temperature</td>
<td>Minimum</td>
</tr>
<tr>
<td></td>
<td>-5°C</td>
</tr>
<tr>
<td></td>
<td>Maximum (dry bulb)</td>
</tr>
<tr>
<td></td>
<td>45°C</td>
</tr>
<tr>
<td>Relative Humidity</td>
<td>Minimum</td>
</tr>
<tr>
<td></td>
<td>26%</td>
</tr>
<tr>
<td></td>
<td>Maximum</td>
</tr>
<tr>
<td></td>
<td>100% condensing</td>
</tr>
<tr>
<td>Solar Radiation</td>
<td>Black bulb design temperature</td>
</tr>
<tr>
<td></td>
<td>minimum mechanical design temperature for equipment exposed to solar radiation</td>
</tr>
<tr>
<td></td>
<td>85°C</td>
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</tbody>
</table>

Notes:
1. Corrosive environments are locations where H₂S gas or other corrosive chemicals and gasses can exist under normal operating conditions and can be both indoor and outdoor areas. This is applicable to all wet wells installations.
2. All areas including inside air conditioned switch rooms at STP sites are considered corrosive environments. All materials installed shall be suitable for the environment.

3.3 OPERATING REQUIREMENTS

The equipment ratings shown on the drawings are the required ratings after all derating factors have been applied.
All components of the switchboard shall be selected and installed so that all circuits can operate at the full load rating shown on the drawings at the worst climatic extreme detailed in Clause 3.2 of this specification.

The full load rating for motor circuits shall be taken as the motor full load current while the rating for other circuits in the switchboard shall be the circuit breaker rating. The maximum demand of DB’s and associated circuits shall be as per TEM336 PSA Guidelines.

3.4 UTILITY DATA

The electrical system may have the following voltage levels:

<table>
<thead>
<tr>
<th>High Voltage Power Supply</th>
<th>33 kV AC, three phase 3 wire, 50 Hz, 11 kV AC three phase 3 wire 50 Hz, 6.6 kV AC, three phase 3 wire, 50 Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Voltage Supplies</td>
<td>3 ph, 4 Wire, 400 Volt +10,-6% 50 Hz ± 2%, MEN System Voltage Unbalance &lt;5%</td>
</tr>
<tr>
<td>Single Phase Power Supplies</td>
<td>230 V AC, +10,-6%, 2 wire, 50Hz ± 2%,</td>
</tr>
<tr>
<td>Control Power Supplies:</td>
<td>UPS 230 V AC, single phase 2 wire, 50 Hz Regulated 24 V DC</td>
</tr>
<tr>
<td>Special Purpose Power Supplies</td>
<td>Regulated 48VDC and 110VDC</td>
</tr>
</tbody>
</table>

The equipment shall be designed to operate continuously under the following conditions:-

- HV Distribution: Steady State Voltage ± 5% nominal voltage
- LV Distribution: Steady State Voltage +10,-6% nominal voltage
- Steady State Frequency ± 2.5% nominal frequency
- Transient Voltage ± 20% nominal voltage
- Transient Frequency ± 5% nominal frequency
- Total harmonic voltage distortion < 5 %

3.5 OPERATING PARAMETERS

Current and Frequency AC 50Hz
Rated Operational Voltage Ue 400 VAC
Rated Insulation Voltage Ui 660 V
Rated Auxiliary Voltage 230 VAC
Control Voltage 24 VDC
Earthing System MEN
3.6 MATERIALS

All materials shall be as detailed on the Project Documentation. When materials are not specified the Contractor may offer standard materials suitable for the environmental and operating design conditions.

All materials shall be new and free of defects.

Asbestos products shall not be used.

3.7 WORKMANSHIP AND PERSONNEL

Personnel engaged in the manufacture of switchboards shall be accredited, suitably experienced, competent and skilled in the particular field of work in which they are engaged. All works shall be completed by or under the direct supervision of fully qualified tradespeople holding trade qualifications and certificates adequate for the work and licensed under the Queensland Electricity Board regulations.

Persons employed in the design, manufacture and testing of the control panel shall be directed by experienced qualified supervisors who shall be responsible for the works and for ensuring that the Contractor’s personnel are conversant with and comply with QUU’s specifications.

Welders shall be suitably qualified and accepted by QUU prior to commencing any welding works.

The Contractor shall execute all works in relation to the design, manufacture and testing of the switchboard in compliance with the quality management system certification accepted by QUU.

3.8 WEATHER AND INGRESS PROTECTION

All enclosures shall have an Ingress Protection (IP) rating as specified in the Project Documentation.

Electrical equipment is susceptible to damage or failure due to moisture and dust ingress into the enclosure. The enclosure shall have IP rating as follows unless otherwise specified:

- For outdoor installation - minimum IP56
- For indoor installation - minimum IP44

All outdoor equipment and installations shall be suitable for un-protected exposure to the weather, direct sunlight, dust and hose-down cleaning. Sloped weather hoods and sun-shades shall be provided to all outdoor switchboards, DB’s and LCP’s enclosures unless specified otherwise in the Project Documentation.

The enclosures shall be designed so as to limit the ingress of corrosive gases where located in corrosive environments.
4 SWITCHBOARD PERFORMANCE AND RATINGS

4.1 GENERAL

Switchgear assemblies shall be designed and constructed in accordance with AS 61439.1 and shall be of a metal-clad, totally enclosed free standing type, unless otherwise agreed in writing by QUU prior to Contract award.

4.2 DESIGN VERIFICATION

The Contractor shall undertake a design verification process that establishes compliance with AS61439.1 of the specific switchboard proposed. Certificates of test for protective devices and other components in accordance with Australian Standard or other recognised equivalent international standard shall be provided.

Test certificates to be provided in the DVR shall include the following:-

- Short time fault current tests on busbars
- Temperature rise tests
- Degree of ingress protection and internal separation of the enclosure
- Type 2 coordination test between contactors and short circuit protection motor starters.
- CB making and breaking capacity
- Mechanical operation of circuit breakers, and isolators
- Enclosure resistance to corrosion
- Enclosure resistance to ultra violet radiation

The test certificates should be held in the name of the company manufacturing or supplying the switchboard and components. Test certificates must be issued by an independent third party with a recognised accredited quality system accepted by QUU.

This specification details performance and construction requirements for switchboards. Should any requirement of this specification require the Contractor to deviate from a tested design, then the Contractor shall specify this in the DVR. It will be assumed that the switchboard being offered is in compliance with this specification and AS61439.1 where no departures are nominated. Where QUU provides design drawings for switchboards it does not exempt the Contractor from providing the relevant design verification documentation for the switchboard supplied.

4.3 ARC FAULT CONTAINMENT PERFORMANCE

4.3.1 Arc Fault Containment

The switchboard supplied shall be a tested design for arc fault containment where the Power System Analysis for the site calculates that the arc flash incident energy at the point of installation of the switchboard in the power network is equal to or exceeds 1.2 cal/cm².
Note: An incident energy greater than or equal to 1.2 cal/cm² requires PPE of Category 2 or higher category as outlined in WI58 Arc Flash Assessment and PPE Selection to access the energised switchboard.

The arc fault containment test certificate shall be to a test fault current the same or higher level than the main bus bar fault current rating and shall have been tested to the line and load side of the protective devices associated with the following:-

- functional units,
- incomers and
- bus bar compartments

The compartments shall each provide 'acceptable protection' for operators in the event of an internal arcing fault occurring on both the line and load side of the protective device in each switchboard compartment. The design being offered shall have been performance tested by a recognised testing authority in accordance with the test procedures detailed in AS 61439.1:2016 Annex ZC and Annex ZD.6 Special tests.

Arc fault containment testing of the switchboard to IEC-TR61641:2008 is also accepted.

The construction methods used for the tested switchboard (eg. IP rating, venting, door bracing, door mounted equipment shrouding, form of segregation, etc.) shall be the same as in the switchboard being supplied under the Contract.

The protective devices (CB’s and fuses) offered under the Contract shall be the same type and manufacturer as those nominated in the arc fault containment test reports, although not every protective device rating need have been tested.

4.3.2 Alternative Arc Fault Containment Ratings

Switchboards that are not a certified as an arc fault contained tested design and do not meet all the conditions outlined in clause 4.3.1 of this specification shall only be accepted where the Power System Analysis for the site calculates that the Arc Flash incident energy at the point of installation of the switchboard in the power network is less than 1.2 cal/cm².

QUU’s preference is for arc fault contained switchboard assemblies as per section 4.3.1 so as to eliminate arc flash hazard to as low as reasonably practicable.

4.4 SHORT CIRCUIT PERFORMANCE

The main circuit shall be constructed to withstand, without thermal or mechanical damage for 1 second, the short circuit stresses generated by the fault level stated on the drawings and other Project Documentation. Current withstand times of less than 1 second can be considered for switchboards with bus load current not greater than 400A rating, and with cable main bus and the withstand time must be nominated in the Project Documentation and accepted by QUU before Contract award.
The switchboard design shall have been tested in accordance with AS61439.1 by a recognised Australian or International testing authority. The design tested shall be applicable to the switchboard being supplied and includes all incomers, functional units and bus bar compartments.

The switchboard being supplied under the Contract shall comply with the parameters specified in the DVR. Particular attention shall be paid to the following parameters:-

- busbar ratings;
- busbar supports shall be identical in material and mounting;
- busbar support spacings;
- busbar phase centres;
- creepage and clearance distances;
- the feeder and motor starting equipment (circuit breakers, switch fuses, contactors, and overloads) shall be the same equipment and in the same combination as detailed in the DVR (however, not every rating need have been tested).

4.5 MAIN CIRCUIT RATING AND TEMPERATURE RISE

The main circuit rating required is indicated in the Project Documentation. The main circuit shall provide this rating with a busbar temperature rise within the temperature rise limits detailed in Table 6 of AS 61439.1.

Cables shall not be used in the main circuit supply except as permitted by clause 8.6 of AS 61439.1. When cables are used in the main circuit, they shall be double insulated.

4.6 EQUIPMENT AND FAULT CO-ORDINATION

It shall be the Contractors responsibility to ensure that every item of equipment in the switchboard is suitable for operation at the fault level shown in the Project Documentation or is protected by upstream fault limiting or co-ordinating devices supplied within the switchboard.

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.

Power and control cable protection shall be such that the energy let through by the protective device does not exceed the level permitted for that cable by AS 3008.1

If fault limiting devices or co-ordinated circuit breakers are proposed, then these shall be specified in the bid proposal. If these are not specified then only equipment which is fully rated for the required fault level shall be installed.

4.7 DESIGN VERIFICATION REPORT

The Contractor shall provide the switchboard DVR signed as approved by an Electrical RPEQ certifying the following with the bid proposal:-
• The proposed switchboard assembly, protective devices, and other equipment are equivalent to the equipment referenced in the arc fault test reports/certificates provided.

• The proposed equipment installation and switchboard assembly will not invalidate the arc fault containment test reports/certificates provided.

• The proposed switchboard and DVR fully complies with section 4.2 and 4.3 of this document

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 can make reference to the relevant test report document numbers. The test reports shall be provided as standalone documents for QUU review prior to Contract award.

The DVR shall also include the following:-

• AS61439.1 Table D.1 List of design verifications to be performed.

• AS61439.1 Table 13 Short Circuit Verification by Comparison with a reference design check list where comparison to a tested design is proposed.

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 QUU. The revised DVR shall include cross references to the document numbers of the switchboard routine test report, FAT report and design drawings. The switchboard shall not be delivered to site until the Final version of the DVR is accepted by QUU.
5 SWITCHBOARD CONSTRUCTION DETAILS

5.1 SWITCHBOARD LAYOUT

Where switchboard 'General Arrangement' drawings are issued with the Project Documentation, the Contractor shall maintain the layout and dimensions specified, and shall be responsible for the complete detail design of the switchboard.

5.2 MODULE DESIGN

The switchboard incomer and functional units shall be fixed or demountable module arrangement.

Individual modules shall have equipment arranged to allow ease of access to each item of equipment within the module. Contactors, Circuit Breakers, fuses, switches, etc. shall be readily accessible for maintenance and inspection purposes.

The module shall be capable of housing all components required for the electrical function of a particular incomer, starter or feeder.

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

The design of the modules shall be as per QUU standard design drawings for network asset switchboards. The Contractor shall propose a switchboard with a fixed or demountable module assembly arrangement were a QUU standard design is not available or module design arrangement is not nominated in the Project Documentation.

5.3 BUSBARS

Busbars shall be formed from hard drawn, high conductivity, solid rectangular copper bar. Main busbars shall have the same current rating for the full length of the switchgear assembly. The temperature rise of busbars and busbar connections shall comply with AS 61439.1 and evidence provided in the DVR.

The current carrying surfaces of busbar joints shall be thoroughly cleaned to remove all traces of dirt and grease, and shall be coated with a layer of corrosion-inhibiting jelly immediately prior to joining. Connections shall be secured with high-tensile steel bolts and washers tensioned in accordance with manufacturer’s instructions. Tension witness marks shall be provided to all bus bar bolts with paint or permanent marker pen. Bolt and washer type and sizes shall be the same as included in the switchboard DVR.

A full size neutral busbar shall extend the complete length of the switchboard and shall have take-off points sufficiently separated from live conductors to allow safe connection of circuit neutrals. Neutral busbars and earth bars shall be completely isolated from each other and shall run the full length of the switchboard. The neutral bar shall be colour-coded using black bands at maximum 300 mm intervals.

All busbars shall be identified at regular intervals (not exceeding 600 mm) in phase colours of red, white and blue. The insulating material shall be non-hygroscopic and not
liable to ‘weeping’ during ageing. Insulation in the form of taping is not accepted. The bus bar colour marking system adopted shall have been tested and certified in excess of the maximum rated temperature rise of the bus bars. Heat shrink coloured bands with minimum width of 30mm is preferred rather than a paint system.

Main busbars shall be completely enclosed except for power take-offs and shall be completely segregated from all other equipment and wiring, including extra-low-voltage busbars and wiring. All wiring passing through busbar chambers shall be double insulated or enclosed in supported conduit and shall not touch the busbars.

Busbar supports shall be fabricated from rigid, non-hygroscopic insulating material. Number, location and method of installation shall be in accordance with the DVR and for the fault level and duration specified.

5.4 EARTHING

The main earth bar and risers shall be provided with suitable termination facilities for the connection of the earth conductors on all incoming and outgoing cables and shall be provided in each vertical terminating zone.

Earth bars shall extend the entire length of the switchboard adjacent to the outgoing cable gland plates. The earth bar shall be colour-coded with green/yellow bands at maximum 300 mm intervals. The earth bar shall be tapped and fitted with bolts, washers and spring washers to accommodate the earth connections for all incoming and outgoing cables, with 20% spare connections. Bolt hole diameters of 10mm and larger shall be drilled through the earth bar and earth cables fixed with suitable nut, bolt and spring washers.

Doors, hinged escutcheons, gear trays and the switchboard chassis shall be provided with a welded M6 thread earth stud and each stud directly connected to the switchboard main earth bar with a minimum 4mm² flexible G/Y insulated earth cable.

All metal cases of instruments, relays, selector switches, etc. shall be connected by a continuous insulated and flexible earth cable of minimum size 4mm² to the earth bar. All earthing connections shall be arranged so that removal of one component shall not affect continuity of the earthing conductor associated with any other component.

All secondaries of current transformers shall have one lead earthed.

For termination of field earth cables 2.5 mm² and smaller, an earth link bar with at least ten terminals shall be mounted on the earth busbar adjacent to each cable zone. Only one earth cable will be terminated at each earth terminal.

Provision shall be made for the entry and termination of 120mm² earth cables at each end of the board, and for suitable terminals for connection to an earth core on all other incoming and outgoing cables. For switchboards that do not contain solid copper bus bars there shall be cable access and termination provisions for 2 off minimum 16mm² earth cables.
An isolated instrument earth bar with 20% spare capacity shall be provided in the PLC marshalling terminal compartment. The instrument earth bar shall be bonded to the main earth bar with a single 4mm² G/Y PVC cable.

5.5 FORM OF SEGREGATION

The form of segregation of the switchboard shall be as per QUU standard design drawings provided in the Project Documentation where the incident energy of the switchboard is less than 1.2 cal/cm².

The Contractor shall detail design a switchboard with Form 3b segregation for the functional units and Form 4a for the main incomer(s) where a standard switchboard design is not provided by QUU.

Form 3bih shall not be accepted under any circumstances.

5.6 DOOR LOCKS AND HANDLES

All doors on the switchboard require only one lockable door handle. Door locks shall be fitted with Abloy Euro Cylinders with part number CY321T single euro cylinder.

For Network site switchboards the keying for the cylinders shall be keyed SA, SB and SC and refer to QUU for exactly where each key type is required on the switchboard.

For STP site switchboards the keying for the cylinders shall be the 92268 key.

5.6.1 Non – Arc Fault Contained Switchboards

5.6.1.1 Form 1 and 2 Segregation

Closetrade - Swing Handle HW-HAND-FLUSH-SS-MS874 with Closetrade - 3 point lock rod set HW-CAM-3PL-SET-3B4500-RG006-1-316SS shall be installed unless specified otherwise in the Project Documentation.

5.6.1.2 Form 3 and 4 Segregation

All doors shall be held closed with 'T' handles. For doors up to 450 mm high, one 'T' handle is sufficient. For doors above 450 mm and up to 1000 mm high, two 'T' handles are sufficient, but doors over 1000 mm high shall have three 'T' handles or a Tri-lock

5.6.2 Arc Fault Contained Switchboards

All door locks and handles shall be as per the switchboard manufacturer’s standard design that has been certified as tested for arc fault containment, access covers and doors shall be key lockable and of material suitable for the installation environment.

5.6.3 Electricity Meter Panel

The electricity meter panel shall be installed with a 45mm brass pin tumbler ENERGEX padlock.
5.7 METAL WORK

The term enclosure for the purpose of this document refers to the sheet metal walls and doors, dividing partitions, structural frame and miscellaneous components such as the escutcheon, gear trays and weather hood of a switchboard, DB or LCP.

5.7.1 Indoor Switchboards (Non-Corrosive Environment)

Switchboards are only considered located indoors where installed in a switchroom or building. All other switchboard installation locations are defined as outdoor for the purpose of this document.

Indoor switchboards shall be a completely self-supporting, modular or fully welded rigid structure, constructed from formed zinc annealed mild sheet steel, of minimum thickness 2.0 mm, free from rust, dents and any surface defects.

Equipment mounting panels shall be a minimum 2.0 mm thick mild sheet steel for those panels up to an area of 500 mm x 500 mm. Where panels are larger, 3 mm thick mounting plates shall be supported by studs of adequate size welded to the enclosure. Large equipment mounting panels, ie. exceeding 1000 mm in any direction, shall be secured by a minimum of six welded studs and nuts.

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

Equipment mounting panels (gear trays) shall be to the manufacturer’s standard surface finish that inhibits corrosion and offers superior earthing continuity.

All nuts, bolts and studs shall be zinc plated mild steel or equivalent and in compliance with the DVR.

5.7.1.1 Doors, Removable Covers and Escutcheons

Doors shall be constructed from formed zinc annealed mild sheet steel, of minimum thickness 1.6 mm, free from rust, dents and any surface defects. Door sealing shall be achieved by 120 degree return on case, sealing against neoprene 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 450 mm wide, or as required. Doors shall open a minimum of 100 degrees for equipment access, and shall be fitted with door stays. The main control compartment door shall have a document holder fitted.

Escutcheons shall be constructed from formed zinc sealed mild sheet steel, of minimum thickness 1.6 mm, free from rust, dents and any surface defects, powder coated gloss white. They shall be hinged and removable in the fully open position. Hinges shall be of the concealed or zinc plated pintle type and equivalent to those specified in the DVR. All escutcheons shall be held closed by means of tool type latches, a minimum of three is required if over 1000 mm in height. All escutcheons shall have 'D' handles.
Covers shall be constructed from formed zinc sealed mild sheet steel, of minimum thickness 1.6 mm, free from rust, dents and any surface defects. All covers shall be secured using acorn nuts or equivalent. A minimum of six fasteners are required if the cover is over 1000 mm in any direction. All covers shall be fitted with 'D' handles or equivalent means of handling.

Acorn nuts or other equivalent fasteners shall only be used for securing covers to busbar zones and horizontal cable zones at the top and bottom of switchboards. Covers for vertical cable zones carrying LV terminations shall have hinged doors and must be secured with coin locks and at least one barrel lock per door. Doors for vertical cable zones with only ELV terminations shall have hinges and can be secured with 'T' handles.

5.7.1.2 Plinth

The switchboard plinth shall be a minimum 75 mm 'U' channel, hot dipped galvanised. The plinth to have M12 clearance holes for bolting to the floor, and 50 mm diameter holes for inserting lifting bars, pipes to be welded between holes to stop the entry of vermin into the base of the board, alternatively, fit galvanised covers over holes after installation. The plinth shall be toe out.

5.7.1.3 Paint Treatment

The surface of the switchboard metalwork shall be degreased and cleaned with solvent, then coated with electro-statically applied powder coat in accordance with paint manufacturers’ recommendations. The Contractor may propose alternative surface preparation techniques and must be accepted by QUU before Contract award.

Internal and external surfaces shall be orange RAL2000 or X15 to AS2700.

Gear trays and escutcheons shall be gloss white or to the manufacture’s standard paint system and colour where accepted by QUU prior to Contract award.

5.7.2 Outdoor Switchboards and Corrosive Environment

Switchboard enclosures shall be a tested design to minimum IP56 for outdoor locations or where switchboard is to be installed in a corrosive environment.

The outdoor switchboard or outdoor enclosure shall be minimum 3mm marine grade aluminium (5251) or 2 mm grade 316 stainless steel. Passivation of steel welds shall be provided throughout.

The switchboard or outdoor enclosure plinth shall be 160x60 channel 6061 T6 grade aluminium.

All panels are to be folded, "Pulse MIG" and "TIG welded with all visible seams and joints fully welded, free from splatter and ground smooth where needed.

External doors and covers shall be fitted with Emka 1011-207 self-grip seal or equivalent.
Door stays and document holders etc shall be provided.

Door stiffeners shall be same material type as the door sheet metal and of sufficient strength to prevent door being deformed when subjected to reasonable loads.

Lift-off covers and mounting panels shall be fixed with M8 studs and stainless steel dome nuts and stainless steel "D" Handles are to be fitted.

The Contractor shall make adequate provisions for joints between dissimilar metals used throughout the enclosure to inhibit galvanic corrosion.

Inspection and Access cover plates shall meet the following requirements:

- Manufactured from same material type, thickness and surface finish as the enclosure.
- Secured with M6 fasteners at 100mm hole centres.
- Fitted with seals attached to the enclosure.
- Maintain a 50mm clearance from section dividers.
- Cover plates are NOT to be split into multiple plates.
- Cover plates are NOT required to be earthed.

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

All equipment is to be removable via the front access doors.

All escutcheons are to open to a minimum of 90°

All sheet metal edging is to be de-burred.

5.7.2.1 Paint Treatment

Aluminium and stainless steel surface preparation shall be:

Finished smooth and all exposed welds are to be cleaned, descaled, and all 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 QUU 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.

5.8 VENTILATION

All switchboards shall have a ventilation design calculation completed before manufacture commences. The calculation shall demonstrate that the maximum temperature inside the panel shall not exceed the maximum temperature rating specified by the switchboard component manufacturers:

The calculation shall allow for the following criteria:-

- Ambient temperature of 45°C unless specified otherwise in Project Documentation
- Black Body Solar Radiation Gain at 85°C
- Component heat dissipation
- Still wind conditions

The ventilation calculation approved by an RPEQ and undertaken using QUU accepted modelling software shall determine the ventilation methods required. The ventilation methods in order of preference are as follows:-

1. Natural ventilation.

2. Solar Heat shield bolted to external walls and shields shall be theft proof.

3. Forced Ventilation. Fans shall be N+1

Air intake and exhaust outlets shall be provided with SS316 mesh screens to prevent vermin ingress with screens removable for cleaning. Steel hoods shall be provided to vents and air intakes to maintain IP rating of the enclosure.

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

5.9 SWITCHBOARD COMPARTMENTS

Switchboard compartments shall have standardised width and depth and an interchangeable standardised set of heights. Compartments shall be designed and sized for ease of access for maintenance.
5.9.1 Modules

Switchboard module doors covering low voltage equipment shall have defeatable door interlocks by the use of a standard flat bladed screwdriver. The interlocking switch shall be pad lockable in the off position. All control circuits shall be housed in the modular compartments.

5.9.2 Cable Zones

Switchboards shall be designed with a separate vertical cable zone for each individual tier, and with a horizontal wiring enclosure running the length of the switchboard unless specified otherwise in the Project Documentation.

Adequate access shall be provided from each vertical zone to the wiring enclosure.

Cable zones shall be adequately sized with minimum 20% spare space for future increase in number of field cables. The compartment shall be designed for ease of installation and maintenance of cables.

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

Bottom entry of cables shall be provided for cable access to the switchboard unless accepted otherwise in writing by QUU.

5.9.3 Distribution Boards

Compartments enclosing CB’s and DB’s boards shall be fitted with a hinged metal escutcheon mounted behind the compartment door, and the operating handles of the devices shall protrude through holes in the escutcheon. The escutcheons shall be latched with zinc plated tool type latches, and the overall door shall be equipped with lockable ‘T’ type handles. The door furniture and locking mechanism shall be as specified for the DVR. The circuit breakers and isolators shall be pad lockable in the off position. The padlock facilities shall not be dependent on the position of the escutcheon, which shall be able to be opened with padlocks present.

Where the DB incoming circuit breaker or switch fuse is mounted behind the escutcheon, the escutcheon shall be interlocked so that the escutcheon cannot be opened unless the incomer is in the off position. A defeat mechanism for this interlock shall be provided so as to gain access to inspect the DB internally without interrupting the service.

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

The neutral bar and earth bar shall have minimum fault current withstand of 10kA/1sec and miniature CB’s shall have minimum 10kA rating unless specified otherwise in the Project Documentation.

The DB enclosure shall have a minimum IP42 test certificate.
5.9.4 Variable Speed Drives and Soft Starters

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

VSD’s mounted inside a switchboard shall have line side protection devices installed, as per the VSD manufacturer’s recommendations.

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 handling method to allow uninstall and replacement of the VSD units.

VSD compartments ventilation shall comply with Section 5.8 of this specification. Cooling fans shall be mounted at the inlet vent. The temperature shall be maintained to less than the VSD manufacturer’s recommended maximum temperature by the use of a temperature thermostat mounted in the switchboard compartment to control the switchboard compartment cooling fans.

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.

The construction and layout of the switchboard shall allow for the segregation needed for input and output power and control cables to limit Electro-magnetic Interference (EMI). Internal 'Layout' drawings of the switchboard shall be submitted to QUU for acceptance prior to switchboard manufacture commencing.

5.9.5 PLC or RTU and Instrument Enclosures

PLC, RTU and instruments shall be located in a separate IP 2X compartment.

A drop down hinged panel with door stay shall be provided suitable for the placement of a laptop on. The panel shall be latched in the upright position on the internal side of the cubicle door and be supported in the 90 degree deployed position. A 10Amp double power outlet shall be installed in the compartment.

Ventilation of the enclosure shall comply with Section 5.8.

5.10 SEALING

All switches, control devices or instruments protruding from a panel shall be sealed to match switchboard degree of protection or mounted behind a sealed perspex window in the panel to achieve higher rating.

Switchboard modules shall be sealed to restrict arc transmission in the event of a fault. Each phase of the connections between the busbars and the line side of functional unit protective devices shall be individually supported and sealed to achieve adequate sealing ie. the three phases shall not be brought through the same hole into the module.
In addition, provision shall be made for sealing switchboard modules after the installation of field cabling. Module cable entry points shall be bushed to prevent cable damage.

5.11 GLAND PLATES

Gland plates shall be 6 mm aluminium plate. A 3mm thick aluminium gland plate can be accepted only where all cables proposed to be installed in the gland plate have hole sizes of less than or equal to 12mm diameter. 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.

The gland plates shall be earthed to the switchboard enclosure. A 25 mm wide neoprene gasket shall be provided to all gland plates and secured with 6 mm bolts at maximum 100 mm centres and accessible from inside the switchboard. Gland plate fixing bolts shall not be used for connection of the earth cable to the gland plate.

Cable glands shall be fitted with the compression side installed within cubicle.

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.

5.12 SHROUDING

All live parts (including terminals, busbars, and control devices and meters mounted on the doors) which are behind hinged non interlocked doors or escutcheons and which carry a voltage higher than 50 VAC shall be shrouded to IP2X to protect against accidental contact when the enclosure doors or escutcheons are open. Provide warning labels on shrouds that state DANGER XXV where XX nominates the maximum voltage of exposed live components behind the shrouds.

5.13 INCOMING FEEDER

Where the size of the incoming feeder is shown on the drawings issued with the Contract, the Contractor shall install busbar flags, cable lugs and cable glands suitable for these cables in the incoming termination area. Cable glands (including those for neutral and earth cable) shall be mounted on the incoming gland plate suitable for the incoming circuit. The distance from cable lugs to the gland plate shall be a minimum of 300 mm, but in any case shall facilitate the ease of installation of large cables.

5.14 EQUIPMENT MOUNTING

No piece of equipment which is to be operated or viewed by an operator (pushbuttons, switches, meters) shall be mounted more than 1900 mm or less than 400 mm above floor level. It shall only be necessary to open the main compartment door, and not required to remove any covers, to operate or reset any item of plant equipment under normal operation.
No item of equipment shall be mounted behind other equipment or in any manner denying free access for removal or maintenance. All equipment within modules shall be mounted on equipment panels. Equipment within small modules (less than 250 mm high opening) shall be mounted within 200 mm of the front of the switchboard to allow better access to terminals.

Items of equipment or terminals shall be no closer than 300 mm measured vertically from outgoing gland plates.

The Contractor shall ensure that the equipment and devices are installed in such a manner that all necessary electrical clearances are observed and that the rating accuracy of devices is not impaired either thermally or electro-magnetically by the proximity of other devices or cables.

When designing switchboard layout and door swing openings the Contractor shall make consideration for access and egress around the switchboard where it will be installed.

5.15 SPARE CAPACITY

Unless otherwise specified by 'Layout' drawings issued with this specification, space shall be provided in the switchboard equivalent to 20% of the total space allocated to starter and supply equipment/modules (excluding cable zones) as detailed on the single line diagrams forming part of this specification. This space shall be placed at one end of the switchboard and provision for future expansion shall be allowed from this end of the switchboard. To facilitate expansion, a removable blanking plate shall be installed over the end of the busbar chamber and cable zone.

Distribution Boards and distribution sections in the switchboard shall be provided with 20% spare installed miniature CB’s and in addition 20% spare unused space for extension of the bus bars or 20% spare poles in the bus bar chassis for future use.

The main bus bars shall be pre-drilled to permit extension in future as required. As-manufactured drawings shall show details of the extension arrangement of the bars. Pre-drilled holes shall be covered with heat shrink or some other mechanical barrier to inhibit corrosion of the copper bars in corrosive environments. Cover plates with WARNING signs shall be provided to prevent access to otherwise exposed equipment.

5.16 SWITCHBOARD INTERNAL WIRING

Wiring insulation shall be non-hygroscopic and fire self-extinguishing. It shall be capable of withstanding the service conditions to which it is subjected.

All wiring is to be PVC V90 HT 0.6/1kV Grade with tinned conductors.

Control, protection, metering, alarm, where subject to movement, eg. across hinged door joints and indication shall be not less than 1.0 mm cross section (unless stated below) tinned copper conductors with a 32/0.20 mm construction.

Hinged joints carrying wiring shall be provided with a flexible earth bonding strap of adequate size.
Wiring carrying 4-20 mA or similar low-level instrumentation signals shall be shielded pair, of not less than 0.5 mm cross section. Shielding shall be grounded at the source only.

Wiring between PLC’s and marshalling terminals within the PLC cubicle or immediately adjacent to the PLC shall be single core 0.5 mm flexible cable or manufacturers recommended pre-formed cable loom.

4-20mA analogue signals (internal & external) wired in shielded pair minimum size 0.5sqmm, and earthed at one end only. (Switchboard end for external signals).

Refer TMS1200, TMS1202 and TMS1222 regarding the design, installation and termination of copper and fibre optic communication cables within the switchboard.

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

Doors and hinged escutcheons are to be bonded with flexible tinned copper braiding.

All 230VAC wiring in the RTU or PLC sections shall be double insulated and all terminals shall be shrouded to a minimum of IP2X and labelled- ‘Danger 230VAC’

The switchboard is to have a dedicated earthing cable bonding directly to main earth bar.

Table of cable core colour and size

<table>
<thead>
<tr>
<th>Service</th>
<th>Colour</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>400 V AC Power Wiring</td>
<td>Red, White, Dark Blue</td>
<td>2.5 sq mm (minimum)</td>
</tr>
<tr>
<td>Potential Metering (240/415 V AC)</td>
<td>Red, White, Dark Blue, Black</td>
<td>1.5 sq mm</td>
</tr>
<tr>
<td>Current Metering (Secondary)</td>
<td>Red, White, Dark Blue, Grey</td>
<td>1.5 sq mm</td>
</tr>
<tr>
<td>230 V AC Active</td>
<td>Red</td>
<td>1.5 sq mm</td>
</tr>
<tr>
<td>230 V AC Neutral</td>
<td>Black</td>
<td>1.5 sq mm</td>
</tr>
<tr>
<td>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.</td>
<td>Orange</td>
<td>1.0 sq mm</td>
</tr>
<tr>
<td>24 V AC Neutral or DC Negative Supply to Distribution Terminals or Fuses and to all negative connections on all devices</td>
<td>Violet</td>
<td>1.0 sq mm</td>
</tr>
<tr>
<td>PLC, RTU &amp; General 24 V AC &amp; DC after Distribution Terminals or Fuses. Both Positive or Negative</td>
<td>Grey</td>
<td>0.5 sq mm</td>
</tr>
</tbody>
</table>
Electrodes | Salmon | 1.0 sq mm
---|---|---
Intrinsically Safe | Light Blue | 1.5 sq mm
Earth | Green/Yellow | 2.5 sq mm (minimum)
Door & Escutcheon Earth Bonds | Green/Yellow | 4.0 sq mm

5.17 WIRING DUCT AND STRAPPING

Where wiring is not run on cable tray in cable zones, wires shall be run in slotted insulated wiring 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 be filled to more than 75% of their full wiring capacity to allow additional wiring to be accommodated in the future.

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.

Plastic duct or cable trays shall also be provided for accommodating the incoming cable cores from the point of cable entry, to the unit terminal block.

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.

Wiring looms shall be supported adequately by a suitable method accepted by QUU.

Ensure minimum clearance of 100mm is maintained between cable ducting & gland plates.

Adhesive backed plastic mounting bases for securing wiring looms with cable ties are not accepted.

5.18 ARRANGEMENT OF WIRING DUCT AND LOOMS

Ducts shall be arranged to allow wiring passing through the slots to be taken as directly to the terminals as possible. Access to terminal studs shall not be impeded by the ducts.

Ducts shall not interfere with the mounting of equipment on any surface and vice versa. Duct fixings shall not have sharp projections inside the duct which could damage cable insulation. Nylon set screws or nylon dome nut duct fixings are preferred.

The weight of wiring looms shall not cause any undue strain on the conductor strands or insulation. In particular, where a wiring loom crosses a door joint, the loom shall be arranged so that flexing across the hinge point is reduced to a minimum, and the wiring is firmly anchored on both sides. Permanent cable fixing supports shall be supplied on all hinged panels.

All groups and bunches of wires shall be run on sections of the cubicle that are free from projections such as small studs, etc., that may damage the conductor insulation.
Where wires pass through holes in panels, suitable bushes or plastic grommets shall be used.

5.19 TERMINATIONS AND CONNECTIONS

5.19.1 Control Wiring Terminations

All conductors shall be terminated with crimping lugs accepted by QUU. Lugs shall be applied using the manufacturer’s approved crimping tool with a ratchet action. Separate lugs shall be used for each conductor. The size of the lug shall be suited to the size of the conductor to be terminated.

Lugs shall be of the type most suited to the device terminal eg. forked tongue for stud terminals, and boot lace type for tunnel type terminals. Only one wire shall be crimped in each lug.

There shall be no jointing or teeing of wires between terminals.

Not more than two wires shall be connected to any terminal. Not more than one wire shall be connected on one side of any tunnel type terminal.

Where multiple connections are required on tunnel terminals, multiple terminals linked with proprietary terminal link bars shall be used. Only when more than one link is required, will wire bridges be permitted.

Screws shall not directly contact the conductors.

Terminals shall be generously spaced to provide easy access to the terminals of any circuit, and to prevent accidental contact with live circuits in the same compartment. Terminals shall be numbered consecutively from top to bottom and left to right. The numbering for each new terminal group shall start at one (1).

Control terminals shall be mounted so that the wire numbers on both sides of the terminal are readable from the front of the switchboard with covers or doors open.

Control terminals in Form 3 switchboards shall be mounted in cable zones (not within the modules), within 150 mm of the front of the switchboard for easy access. The side mounted terminal rails shall be fitted onto angled support brackets for ease of access and to ensure terminal numbers and ferrule numbers are easily viewed.

Control and instrumentation wiring has flexible copper conductors, numbered each end, and terminated by the use of appropriate pre-insulated crimp lugs.

Use proprietary bridging links when required to common up terminals.

Terminal strips are to be mounted 30mm off the equipment panel to aid termination.

The percentage of spare installed unused terminals shall not be less than 20%.
5.19.2 Power Circuit Connections

All power cables within the switchboard shall be connected with a suitably sized lug unless the equipment (circuit breaker or contactor) has tunnel type terminals.

Power circuit connections shall be made with high-tensile, electroplated steel or phosphor bronze bolts, with a large flat washer and spring locking washer under the bolt head.

It shall be possible to check the tightness of all connections, by removing covers if necessary, when the switchboard is completely assembled.

Provision shall be made in the termination area to allow circuits to be checked with clip-on type ammeters.

Power cables to the load shall be terminated directly on their source of supply.

Bolted connections to the main power circuit components such as busbars, ACB’s and MCCB’s etc shall be tightened to the device manufacture’s recommended torque settings using a calibrated torque wrench. Torque settings shall be recorded at the time of connection. Copy of the torque wrench calibration certificates shall be provided with test sheets. The bolt positions shall be marked with paint or other permanent marker at the final torqued position.

5.20 NUMBERING OF WIRES AND CABLES

Wire numbering will be equal to Grafoplast SI2000 system.

Ferrules shall be fitted to each end of all separate lengths of control wire. Ferrules shall have black letters on a background of white insulating material. Circular type, slip-on ferrules, or saddle type clip-on numbers shall not be used.

The same ferrule number shall be used on wires forming connections directly in series or parallel in the same panel.

Wires shall be numbered in accordance with the Contract drawings. Wire numbers on wires which leave the equipment module (in form 3 switchboards), shall be prefixed with the equipment number.

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.

5.21 LABELLING AND IDENTIFICATION

The switchboard and all modules shall be labelled with QUU assigned equipment tag number and title in accordance with the Single Line Diagram. Labels shall be installed as per the label schedule drawing for the switchboard. Switchboards installed in public accessed areas shall have QUU Danger label fixed to the external door.
In addition every exterior and interior device, including terminals, terminal strips, fuses, switches, test blocks, indication lamps, relays and other equipment, shall be identified by a label fixed near the device and oriented so that it is readable from the appropriate access door. The label shall give both the device title or function and a unique alphanumeric identification code. Within a single drive module, the power circuit breaker, contactor and thermal overload shall be labelled as per the circuit diagrams.

All device labels, other than proprietary legend and escutcheon plates on devices, are to be engraved from white/black/white ABS plastic laminated engraving material. External labelling is to be fixed by stainless steel threaded screws. Labels longer than 30 mm shall have clearance fixing holes to allow differential expansion of label and mounting. Where labels are mounted on standoffs they shall be suitably backed to prevent breakage.

Label letter height shall be generally as follows:

- Switchboard Equipment Number: 30 mm
- Switchboard Title: 20 mm
- Module Labels: 10 mm
- Equipment Labels: 5 mm
- Pushbutton Designation: 3.5 mm

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

Label colouring shall be:

- Internal labels W/B engraved ABS PLASTIC to the label schedule.
- Warning labels R/W engraved ABS PLASTIC to the label schedule.
- E/Stop labels R/W engraved ABS PLASTIC to the label schedule.

First letter = Background colour, Second letter = Lettering colour.

Internal labels on gear trays or escutcheon panels shall be secured by M3 zinc plated metal threaded screws or glued into position. Double sided tape shall not be accepted for fixing labels.

CB’s to be identified with individual labels as per the label schedule.

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

External labels shall be 1mm thick 316 grade stainless steel secured by M3 316 grade stainless steel threaded screws.

All internal and external labels are to have bevelled edges.
5.21.1 Danger and Warning Labels

All removable covers and protective shrouds which give access to exposed busbars or live terminals shall be labelled with red/white/red labels marked "DANGER 400VAC ISOLATE ELSEWHERE.

Equipment connected to the line side of a switchboard incoming switch (eg. 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

5.21.2 Primary Nameplate

The primary name plate shall be fitted in a prominent location and secured by stainless steel screws or rivets. The following information shall be given in all cases:

- Queensland Urban Utilities
- Project Name
- Purchase Order or Contract number
- Equipment Title
- Equipment Tagname
- Switchboard Drawing Number Series
- Certified Weight
- Serial Number
- Date of Manufacture

5.21.3 Rating Plates

The switchboard rating plate shall be fitted in a visible position. Entries on the rating plate shall be indelibly marked, by etching, stamping or engraving. The following information shall be given in all cases:

- Manufacturers name and Company Logo
- Type, Model and Serial Number
- Standard to which apparatus is manufactured
- Nominal Operating Voltage
- Nominal Operating Current
- Rated short circuit time withstand current
- Rated peak withstand current
5.22 CURRENT TRANSFORMER WIRING (CT’S)

All CT secondary wiring except motor CT wiring shall be connected to test links which allow testing with 2 mm banana plugs. CT wiring shall be 4 mm² minimum CSA.

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. The voltage connections shall also be made.
6 SWITCHBOARD EQUIPMENT

6.1 GENERAL

The electrical equipment installed in the switchboard shall be new equipment complying with relevant Australian Standards and be suitable for the duty indicated on the drawings issued with this Contract.

The equipment shall be installed so that it has the rating shown on the drawings when the switchboard is in its fully operational and fully loaded condition ie. all covers and doors are closed, all circuits are at full load (as defined in this specification), and ambient temperature is at maximum (as defined in this specification).

All switchboards at STP’s and sewerage pump stations can be exposed to H₂S gas which causes a corrosive environment and as such electronic components and printed circuit boards should be conformal coated to meet the intended design life.

The switchboard equipment shall be installed strictly in accordance with the manufacturer’s instructions in all regards, particularly concerning clearances, enclosure sizes, temperature rise and maximum continuous current rating.

Equipment shall be securely mounted and braced so that movement cannot occur during operation under normal or fault conditions and so that adjacent equipment is unaffected and personnel operating the equipment are not endangered.

The Contractor shall select equipment as per TMS62 Preferred Equipment List – Electrical and Instrumentation. The Contractor may also make an alternative offer based on other equipment if significant advantages exist and the alternative equipment proposed must be accepted in writing by QUU.

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 ie. all moulded case circuit breakers shall be from the one manufacturer and all contactors shall be from the one manufacturer;
• equipment co-ordination shall satisfy the requirements of this specification, eg. type ‘2’ co-ordination between circuit breakers, contactors and backup protection of circuit breakers.

The selected components shall be suitably rated for the application with particular attention given to the following:

• Process conditions
• Power rating
• Voltage rating
• Frequency rating
• Duty rating
• IP rating
All equipment and materials shall be new and comply with the relevant specifications, regulations, codes and standards.

All components and materials supplied by the Contractor shall be free from:

- Asbestos
- Ceramic fibre
- Chlorofluorocarbons
- Polychlorobiphenyls (PCB) and their isomers
- Radioactive materials (unless specified otherwise in Project Documentation)
- Mercury

The Contractor shall maintain an up to date inventory list of all components and consumable and procure additional materials as required well in advance so as not to delay the manufacturing schedule due to shortage of materials.

6.2 AIR CIRCUIT BREAKERS (ACB’S)

ACB’s shall have been tested by a recognised testing authority for compliance with AS 1930. If this testing was not carried out within Australia, then a Certificate of Approval shall be provided from an approved Australian Electrical Distribution Authority.

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 padlockable.

- Have a motorised spring charged, stored energy spring closing mechanism, with manually operated release (i.e. close).

- Have suitable protection relays fitted as shown on the Project Drawings. The following shall be included:
  
  - Separate overcurrent protection in each phase.
  - Earth fault protection.
  - Very inverse (or inverse cubed) IDMT protection.
  - Short time protection.
  - Instantaneous protection

- The current and time settings shall be independently adjustable for each IDMT and instantaneous relay. A single multifunction protection relay forming part of the ACB is preferred.

- The protection relay shall include the main metering where this function is available.

- 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.
• Have interlocks for the prevention of insertion or withdrawal of the circuit breaker truck when the circuit breaker is in the CLOSED position.
• Have a minimum of two NO and two NC auxiliary contacts wired to a terminal strip for use by QUU (in addition to auxiliary contacts required for circuit breaker operation and indication).

Where ACBs are specified as having a spring charged closing mechanism, the following shall apply:

• It shall be necessary for the spring to be fully charged before it can be released to close the circuit breaker.
• 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.

ACBs shall be provided with communications capability with the local control system via the protocol specified in the Project Data Sheets.

ACB’s shall have the following classification characteristics in accordance with AS 1930:

<table>
<thead>
<tr>
<th><strong>Rated Frequency:</strong></th>
<th>50 Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rated Voltage:</strong></td>
<td>400 V AC</td>
</tr>
<tr>
<td><strong>No. of Poles:</strong></td>
<td>3 or 4</td>
</tr>
<tr>
<td><strong>No. of Phases:</strong></td>
<td>3</td>
</tr>
<tr>
<td><strong>Interrupting Medium:</strong></td>
<td>Air</td>
</tr>
<tr>
<td><strong>Mounting:</strong></td>
<td>Withdrawable</td>
</tr>
<tr>
<td><strong>Open/Close Mechanism:</strong></td>
<td>Independent Manual</td>
</tr>
<tr>
<td><strong>Trip Units:</strong></td>
<td>Overcurrent/ Earth Fault</td>
</tr>
<tr>
<td><strong>Rated Continuous Current:</strong></td>
<td>Rating Shown on Drawings or in the Schedule of Technical Requirements</td>
</tr>
<tr>
<td><strong>Interrupting Rating:</strong></td>
<td>Fault Level on Drawings or in the Schedule of Technical Requirements</td>
</tr>
<tr>
<td><strong>Auxiliary Contacts:</strong></td>
<td>1 N/O &amp; 1 N/C</td>
</tr>
<tr>
<td><strong>IEC 947-2 Rated Service</strong></td>
<td>P2 to IEC 947-2</td>
</tr>
<tr>
<td><strong>Short Circuit @ 440 V:</strong></td>
<td></td>
</tr>
</tbody>
</table>

The above general information generally applies unless otherwise specified on the Contract drawings.
6.3 MOULDED CASE CIRCUIT BREAKERS (MCCB’S)

MCCB’s shall have been manufactured in accordance with AS 2184 and tested by a recognised testing authority for compliance with AS 2184. If this testing was not carried out within Australia, then a Certificate of Approval shall be provided from an approved Australian Electrical Distribution Authority.

MCCB’s shall comply with the following requirements:

- Shrouding over incoming terminals to prevent accidental contact.
- MCCBs shall be of the High Interrupting class as defined in AS 2184 and shall have adjustable thermal overload and adjustable magnetic short circuit protection.
- Be fitted with a minimum of 2 NO auxiliary contacts.

MCCB’s shall have the following classification characteristics in accordance with AS 2184:

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Frequency</td>
<td>50 Hz</td>
</tr>
<tr>
<td>Rated Voltage</td>
<td>400 V AC</td>
</tr>
<tr>
<td>No. of Poles</td>
<td>3 or 4</td>
</tr>
<tr>
<td>No. of Phases</td>
<td>3</td>
</tr>
<tr>
<td>Trip Units</td>
<td>Inverse Time, Instantaneous</td>
</tr>
<tr>
<td>Rated Continuous Current</td>
<td>Rating Shown on Drawings</td>
</tr>
<tr>
<td>Interrupting Rating</td>
<td>Fault Level on Drawings</td>
</tr>
<tr>
<td>Auxiliary Contacts</td>
<td>To Suit Circuitry</td>
</tr>
<tr>
<td>Rated Service Short Circuit at 440 V</td>
<td>P1 to IEC 947-2</td>
</tr>
</tbody>
</table>

The above general information applies unless otherwise specified on the Contract drawings.

MCCB’s used in motor power circuits shall be combined with the motor starter specification in Clause 6.4 and shall be selected in accordance with the MCCB 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.

MCCB contacts shall have high resistance to welding with action designed to reduce wear.

MCCB switch mechanisms shall have a positive making/breaking action independent of the operating handle.

MCCB poles shall operate simultaneously.

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

All LV switchboards and DB’s and shall be provided with a main isolator switch that is lockable in the OFF position.

The main switch shall be labelled as specified in AS 3000.

The main switch shall have terminals sized to accommodate the incoming cable.

An oversized CB maybe installed as the main switch instead of an isolator.

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

Isolators are accepted for bus-ties and Automatic Transfer Switches between multiple supplies. Fortress key interlocks or equivalent captive key interlocks shall be provided between incomers and bus ties unless shown otherwise in the Project Documentation.

6.5 CONTACTORS

Contactors shall provide Type 2 co-ordination with their respective circuit breakers under short circuit conditions.

Contactors shall have utilisation category of AC3 in accordance with AS 3947.4.1, a mechanical life of $10 \times 10^6$ operations and be suitable for uninterrupted duty.

All contactor coils shall be continuously rated at 24V DC unless otherwise specified in the Project Data Sheets.

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

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

Contactors shall be fitted with a minimum of two NO auxiliary contacts wired to terminals.

Reversing starters and change-over contactors shall be electrically and mechanically interlocked.

6.6 CONTROL RELAYS

All 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.

All ELV relay coils shall have a maximum operating current of 0.2A and maximum pick-up current of 1A. DC relays shall be provided with suitably rated suppression diodes and an LED.
Control relay coils of different voltage levels shall be keyed differently or other
methods deployed so the coils cannot be installed into bases of the incorrect operating
voltage.

6.7 MOTOR PROTECTION

Thermal overload relays shall be 3 pole, ambient compensated, adjustable type with
single phasing protection and fitted with a minimum of one NC and one NO auxiliary
contact.

Thermal overload relays for motors exceeding 37 kW shall be operated via current
transformers. Thermal overload protection using a PTC thermistor shall be fitted for
motors having a rated output greater than 30 kW.

Where motors are driven by a VSD, a thermistor shall be wired direct to the VSD unless
a type tested VSD and motor combination is provided. The electronic motor protection
and management relays shall be used for all motors as specified on the Project Drawings
and Project Data Sheets.

The MPR’s shall be provided with the following features unless otherwise specified in
the Project Documentation:-

- Programmable inputs and outputs for starting and stopping of the drive, running
and status alarm indications, detecting overcurrent, undervoltage, phase failures,
unbalance, blocking, earth leakage.

- Communications capability with the local control system for indication and
control as well as remote programming of the MPR on the same network
interface port. The communications protocol shall support Ethernet unless other
protocol is specified in the Project Documentation.

- The MPR’s shall have their digital panel installed on the front door of the
switchboard starter functional unit. The MPR shall be remotely controlled and
monitored at a local HMI installed at the PLC Panel and at SCADA. The
digital panel shall be configured to display only the motor starter status. Only
authorised persons using a password access shall be able to control the motor
starter from the digital panel.

- Integrated motor protection CB’s 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.

6.8 MOTOR STARTERS

Motor starters shall have been tested by a recognised testing authority for compliance
with AS 60947. If this testing was not carried out within Australia, then a Certificate of
Approval shall be provided from an approved Australian Electrical Distribution
Authority.
Motor starters shall have the following classification characteristics in accordance with AS 1202:

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Frequency:</td>
<td>50 Hz</td>
</tr>
<tr>
<td>Rated Operating Voltage:</td>
<td>400 V AC</td>
</tr>
<tr>
<td>No. of Poles:</td>
<td>3</td>
</tr>
<tr>
<td>No. of Phases:</td>
<td>3</td>
</tr>
<tr>
<td>Interrupting Medium:</td>
<td>Air</td>
</tr>
<tr>
<td>Control Method:</td>
<td>Electrical</td>
</tr>
<tr>
<td>Type of Release:</td>
<td>Thermal Overload &amp; Under-voltage</td>
</tr>
<tr>
<td>Rated Duty:</td>
<td>Uninterrupted</td>
</tr>
<tr>
<td>Rated Operational Current:</td>
<td>Motor Full Load Current Plus 20%</td>
</tr>
<tr>
<td>Utilisation Category:</td>
<td>AC3</td>
</tr>
<tr>
<td>Mechanical Endurance:</td>
<td>10 Million Operations</td>
</tr>
<tr>
<td>Electrical Endurance:</td>
<td>1 Million Operations</td>
</tr>
<tr>
<td>Co-ordination with Protective Device:</td>
<td>Type ‘2’</td>
</tr>
<tr>
<td>Rated Control Supply Voltage:</td>
<td>24VDC</td>
</tr>
<tr>
<td>Auxiliary Contacts:</td>
<td>1 N/O &amp; 1 N/C (Minimum)</td>
</tr>
</tbody>
</table>

The above general information applies unless otherwise specified on the Contract drawings.

6.9 EARTH LEAKAGE PROTECTION

Unless specified otherwise in the Project Documentation the incomers and feeders including motor starters require earth leakage protection and shall be protected by a toroid type CT and relay having a current sensitivity range of minimum setting 100mA.

Feeder circuits rated 32A and less and with cables that run exterior of the switchboard shall have 30mA RCD provided in the switchboard. The Contractor shall advise QUU where a 30mA RCD is not considered suitable for reliable operation of the load.

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.

All ELR’s provided shall be of the core balance type, with the necessary toroids provided. ELR’s shall comply with Australian Standards and shall be provided with test, reset and status indication facility on the front door of each switchboard module.

CB feeders do not require a dedicated ELR where the VSD is mounted inside the same switchboard as the CB feeder. In this case the VSD shall be configured to provide earth leakage protection of the motor and motor cable.
6.10 CURRENT TRANSFORMERS

Current transformers (CTs) shall be of cast epoxy resin type or self-extinguishing thermo plastic shell encapsulated type.

CT’s shall conform to, and be tested in accordance with Australian Standards. Routine Test Certificates and characteristics shall be provided for each instrument transformer. Polarities of all CTs shall be clearly marked in accordance with Australian Standards, and all secondary windings shall be terminated at accessible separate terminal blocks. CT’s shall be installed so as to be readily accessible and replaceable, taking into account the intended final located / arrangement of the switchboard.

The mechanical and thermal rating of CT’s shall be coordinated with the short circuit rating of the switchgear.

CT’s for protection purposes shall be rated to match the protection relays supplied. CTs for metering purposes shall be rated class 1 and to suit the connected instruments burden + 50%.

Busbar mounted CT’s 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 a mounting 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.

Current Transformers shall comply with the requirements of AS 1675 and shall have the following characteristics in accordance with this standard:

<table>
<thead>
<tr>
<th>Construction:</th>
<th>Window</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Primary Turns:</td>
<td>1</td>
</tr>
<tr>
<td>System Voltage:</td>
<td>400 V</td>
</tr>
<tr>
<td>Rated Frequency:</td>
<td>50 Hz</td>
</tr>
<tr>
<td>Rated Primary Currents:</td>
<td>Refer Drawings</td>
</tr>
<tr>
<td>Rated Secondary Currents:</td>
<td>5A or 1A</td>
</tr>
<tr>
<td>Additional Information - Measurement CT’s Type:</td>
<td>M</td>
</tr>
</tbody>
</table>
Accuracy Class: 1
Rated Burden: 0.6 ohms
Rated Output: 15 VA (minimum)

Additional Information - Protection CT’s

Classification: P
Accuracy Limit Factor: 10
Composite Error: 2.5
Secondary Reference Voltage: 10

Polarity markings shall be marked on each CT along with other information as required by AS 1675.

The CT’s for Power Utility revenue metering shall be specified and installed to meet the Power Utility requirements.

6.11 FUSES AND LINKS

Fuse links shall be HRC type as per AS/NZS 60269.1

Bases for small fuses shall be coloured black and bases for links shall be coloured white.

Bolted links shall be used for circuit neutral, control circuit and current transformer earthing links.

The Power Utility direct metering fuses and circuit components shall be installed as per the Power Utility installation guidelines and circuit included in the Project Documentation.

6.12 SURGE PROTECTION DEVICES

A surge protection device (SPD) shall be provided at the load side of the incoming main switch on all switchboards and DB’s unless specified otherwise in the Project Documentation.

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.

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 Documentation.
6.13 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.

6.14 PANEL METERS

All meters shall be Q96 format.

CT driven ammeters shall be 1A or 5A units.

6.15 PLC AND MARSHALLING PANEL SECTIONS

Outdoor switchboards may include a PLC/RTU compartment. The Contractor shall mount the PLC I/O and associated control system components 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.

The PLC/RTU compartment of the outdoor switchboard shall contain RTU/PLC rack, power supply, marshalling terminal strips, wiring ducts and wiring, as required in the Project Drawings and Project Data Sheets. Any LV supply to the compartment shall be protected by 30mA RCD. The LV components and circuits shall be physically segregated from ELV components and all live LV components shall have IP2X.

Unless specified otherwise in the Project Documentation the PLC/RTU compartment shall contain minimum 20% spare gear tray and 20% spare installed I/O channels (of each type) and marshalling terminals for future use. Equipment shall not be mounted to side walls of the enclosure unless specified otherwise in the Project Documentation.

All external I/O shall be wired to a PLC/RTU marshalling terminal strip for connection of external cabling unless shown otherwise on Project design drawings. The marshalling terminals for field instrument and control cables shall be knife disconnect type. Generally all field control and instrument cable cores shall terminate in consecutive terminals followed by the cable screen. The terminal label marker is assigned the same label as the field cable tag number. The Contractor shall refer to QUU where these termination conventions cannot be strictly followed.

All other switchboards require a separate standalone PLC/RTU control panel with cabling between control panel and the switchboard. The control panel shall be manufactured to TMS1222 Control Panel Technical Specification.

6.16 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. The battery sizing calculation shall be based on the maximum demand of the DC power system as well as
a derating for maximum ambient temperature inside the battery enclosure. The AmpHr rating calculated shall be the battery end of design life AmpHr rating.

Batteries shall be suitable for 10 year design life at the conditions specified in section 3.2 Site Climatic Conditions.

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 AmpHr rating, 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 and prevent battery overheating and reduce the release of hydrogen gas.

Battery terminals shall be insulated with all connections 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.

6.17 INTRINSIC SAFE BARRIERS

Intrinsic safe 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 safe barriers.

6.18 EMERGENCY SHUTDOWN CIRCUITS

Emergency Stop circuits installed in switchboards and LCP’s 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 QUU. The design report shall be approved by an RPEQ Electrical and the risk assessment must be conducted with QUU participation.

Emergency Stop circuits for dry well and wet well submersible pumps have been risk assessed and are accepted by QUU 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.
6.19 ALTERNATIVE SUPPLIES

Alternative supplies such as diesel generator and battery banks with inverters etc shall be connected as shown in the Project Documentation. Generator connection plugs on external of the switchboard shall be provided as shown in design drawings. Refer to TMS62 Preferred Equipment List for the connection components.

A label indicating the switchboard power phase rotation direction shall be located in near vicinity of the generator connection plug.

6.20 THREADED FASTENERS

Threaded fasteners shall be ISO metric.

All 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.

6.21 TOOLS

The Contractor shall supply any special tools necessary for the maintenance or operation of the switchboard equipment.

If the Switchboard includes air circuit breakers, then a lifting trolley for removing and transporting the circuit breaker shall be supplied.

6.22 SPARE PARTS

Spare Parts shall be supplied as specified in the Parent Document.

(3 off) spare fuse cartridges of each size used to be provided on clips mounted inside the switchboard, or in a separate cubicle with a non-lockable door.
7  LOCAL CONTROL PANELS (LCP’S)

The LCP’s shall be constructed and wired in accordance with wiring of this specification.

The supporting structure shall be made of the same material and coating as the LCP enclosure unless specified otherwise. The mounting of the supporting structure shall be at the rear of the enclosure, rather than from the base of the enclosure.

Where LCP’s are to be column mounted, the support column shall be manufactured from 75 x 75 mm RHS and have a 250 x 250 mm base plate with four mounting holes. The height of the column shall be such that the base of the LCP is approximately 1200 mm from the base plate level. The column shall be raised by 50 mm of grout to prevent the collection of water around the base plate.

Where the inside of the RHS is used to protect cables for LCP’s, all machining, forming and drilling for cable entries etc. shall be done prior to surface coating.

LCP’s shall contain the required pushbuttons, switches and indicating lights indicated on the drawings and which are necessary to safely operate the equipment in the field. Where motor LCP’s contain three phase power isolators, the isolating switch shall have an AC23 rating for the motor being isolated. This isolator shall be lockable in the off position and shall be interlocked to prevent the LCP door or escutcheon being opened until the isolator is in the off position. The isolator shall have an auxiliary contact for indication of status to the local control system.

Emergency stopping devices shall be mounted externally on the front of the LCP and readily accessible. All emergency stop devices shall have a normally open contact connected to the local control system for monitoring of status. All other devices such as pushbuttons and selector switches installed at the LCP shall also be connected to the local control system unless specified otherwise in the Project Documentation.

Components mounted to the exterior of the LCP shall be adequately protected from direct UV exposure by suitable means.

Where indicated on schematic drawings, LCP’s shall be fitted externally of the switchboard, with a three phase screwed, weatherproof minimum IP56 decontactor plugged outlet to allow disconnection and removal of the motor by non electrical workers. All line side connections shall be shrouded when the plug is in the disconnected position.

The internal control wiring for LCP shall be ELV and terminated on rail-mounted terminals and ferrules installed in accordance with section 5.19.1

LV live components inside the LCP shall be shrouded to IP2X to protect against accidental contact when the doors or escutcheons are open. These shrouds shall have danger labels nominating voltage level in accordance with this specification. All pushbuttons and lamps shall be connected to ELV circuits only.

A plastic label complying with this specification shall be fitted to the LCP, bearing the equipment number in 7 mm letters and the equipment title in 5 mm letters.
Pushbuttons and selector switches shall be labelled using proprietary legend plates or plastic labels complying with this specification.

Gland plates shall be one piece, manufactured from 6 mm aluminium plate, suitably earthed and sealed using a neoprene gasket. All cable entry to the LCP enclosure is through the pre-drilled gland plate and each cable shall be individually ganded. Bottom cable entry is required for all LCP’s. Conduit glands are not accepted. All unused holes in gland plates shall be sealed with removable bungs.

7.1 LCP’S FOR CORROSIVE AND OUTDOOR LOCATIONS

The LCP enclosures for outdoor and all corrosive areas shall be constructed in accordance with section 5.7.2.

All operating equipment shall be mounted on hinged escutcheons held closed with fasteners detailed in this specification. Push-buttons and isolator handles (if applicable) shall be sealed to IP56, and the exposed parts shall be resistant to corrosion. The push-buttons shall be fitted with protective rubber boots.

All incoming and outgoing control cables shall be terminated on rail mounted tunnel terminals.

These LCP’s shall be fitted with a front access door with a minimum of two off grade 316 stainless steel lift-off pintle hinges, and with a lockable ‘T’ handle with key code 92688. The door shall be sealed using closed-cell neoprene foam stripping glued to the door.

7.2 LCP’S FOR INDOOR LOCATIONS (NON CORROSIVE)

The enclosures shall be generally constructed in accordance with section 5.7.1.

Operating equipment may be mounted on the external door provided the IP rating is maintained.

The LCP’s shall be fitted with an overall door with a minimum of two zinc plated lift-off pintle hinges, and with a lockable ‘T’ handle with key code 92688. The door shall be sealed to maintain the IP rating in the same manner as a switchboard compartment door.
8 INSPECTION AND TESTING

All materials and workmanship will be subject to progressive inspection and testing by QUU at both the Contractor's workshop and site. QUU reserves the right to reject any material, which does not comply with the specifications, set forth herein or which contain defective materials or workmanship. Rejected materials shall be promptly removed at the expense of the Contractor and shall be replaced as soon as practical at no cost to QUU.

The Contractor shall at all times provide QUU with free access to the workshop facility for the safe and convenient inspection, examination, and testing of any part of the Work, including the relevant materials and documentation.

The Contractor shall submit with their Tender, Inspection and Test Plans (ITPs), which shall define the proposed inspection and testing activities. The Contractor shall be responsible for confirmation of conformance to the ITP’s.

8.1 ROUTINE TEST AND FACTORY ACCEPTANCE TEST

Routine tests and a final Factory Acceptance Test (FAT) shall be carried out in accordance with AS3017 and other relevant Australian Standards. The Contractor shall provide written notice to advise QUU, five business days prior to the completion of testing so that specific testing may be witnessed by QUU.

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

Certified test records, consolidated in the FAT Report for each switchboard shall be submitted to QUU 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.

The routine test and FAT shall include the following:

- Completeness check
- Check quality of the manufacture
- Checking of rating plates
- Point to point wiring test
- Testing of all protection devices as primary or secondary injection test
- Insulation resistance tests
- Special tests when required and mutually agreed
- Busbar systems shall be Ductor tested across all individual connections
- Insulation dielectric tests
- Earth continuity tests
- Polarity Test
- Measure the contact resistance of the main current carrying paths including the main busbars, bus-section breakers etc. and verify acceptable values
• Primary injection to demonstrate correct ratio and polarity of CTs and correct operation of instrument and protection circuits
• 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 all interlocking between switches, doors, and earth switches
• Battery load test including complete discharge and recharge unless accepted otherwise by QUU.

Power circuit insulation shall be tested using a 1000 V 'Megger'. Control wiring shall be tested at 500 V only.

Semiconductor equipment such as variable frequency drives, programmable controllers and instruments shall not be voltage tested.

High current micro-ohm resistance tests shall be carried out individually on all joints in the main circuit supply including connections to each outgoing unit. For outgoing units larger than 150 A, all power connections in the outgoing unit shall be tested. Resistance measurements shall be recorded and examined for inconsistent and unusually high readings.

All motor starters shall be functionally tested with a small motor connected and supplied by the Contractor.

Identical equipment such as withdrawable circuit breakers shall be checked for interchangeability.

Acceptance by QUU of any equipment does not relieve the Contractor from any of their performance guarantees or other obligations under the Contract or Purchase Order.

8.2 INSPECTIONS

Equipment shall be checked against the QUU accepted design documentation to ensure that the correct type, rating and number of circuits has been installed. The design drawings shall be updated to properly reflect the finished switchboard and copies of the drawings forwarded to QUU.

The following items shall be checked:

• busbar configuration and support system for consistency with the DVR design drawings, test certificates and test reports;
• sealing of fully welded seams is satisfactory;
• equipment mounting and cable supports to ensure adequate fixing and bracing;
• operating handles and interlocks for correct functioning;
• withdrawable equipment for free movement, operation of shutters and interlocks;
• clearance and creepage distances and degrees of protection;
• doors and access covers for sealing;
• bolted and screwed connections for tightness and adequate contact;
8.3 FUNCTIONAL CHECKING

The functional testing must be performed with the site specific control system software configuration files loaded into the PLC, RTU and other equipment under test. All control wiring in the switchboard shall be checked for correct function and marked off on the schematic drawings. These drawings shall be amended to reflect the final connections of the switchboard as despatched from the workshop.

If QUU carries out spot checks of the completed switchboard and discovers inconsistencies with the QUU accepted issued for construction drawings, then the Contractor shall retest the entire switchboard in the presence of the QUU Representative.

All control circuits shall be energised at their operating voltage and pushbuttons, and indicating lights and switches installed to fully simulate all field devices. Each feature of the circuit shall then be checked by operation of the switches and pushbuttons.

VSD’s shall be tested by monitoring speed changes of a small three phase motor while the VSD input signal is being varied. The Contractor shall provide the test motor.

Unless specified otherwise in the Project Documentation the switchboard and packaged plant skid equipment shall be connected in the factory so functional tests are performed on an integrated system. All functionality shall be tested and simulated where possible. Refer TMS1202 for additional requirements on executing control system functional testing.

All protection relays shall be tested at three points on their protection curve by secondary injection.

All current transformers and direct connected metering and protection equipment shall be tested by primary injection to prove correct polarity and CT ratios for ratio error and phase angle error.

Each analogue loop shall be injected with a variable input signal equivalent to its specified input and the signal shall be varied over its entire range to test the operation of associated indicators, controllers and recorders. In the case of controllers, outputs shall be monitored and the setpoints checked for correct operation including the operation of any associated process alarms.

The Contractor shall provide marked up red-line drawings and completed test and inspection sheets within five (5) business days of completing the FAT. A complete copy of the red line drawings shall be placed inside the switchboard enclosure and delivered to site with the switchboard.

8.4 SITE ACCEPTANCE TESTING AND COMMISSIONING

Inspection, site acceptance testing (SAT) and commissioning will be carried out 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.
- Perform SAT to the QUU accepted SAT Plan
- 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.

Refer to TMS1200 Electrical Installation Specification, TMS1202 Control System Implementation and PRO396 Control System Change Management Procedure for additional requirements when undertaking SAT and commissioning of LV switchboards, LCP’s and DB’s.

On completion of the site installation of the equipment, and before the equipment has been put into regular use, QUU may repeat selected site tests. Should any equipment fail any tests, then the Contractor will be notified of such failure and the cost of replacements, repairs, and further SAT shall be covered by the Contractor.

The Contractor shall provide all testing of the site installation works to AS3000 and includes circuits to existing equipment labels the new or modified switchboard. The Contractor has an obligation to advise QUU in writing of all existing circuits and equipment that does not meet AS3000 current standard, along with a certificate of conformance for the installation works completed by the Contractor.
9 PACKAGING, HANDLING AND SHIPPING

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

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

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 QUU. QUU 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.

Temporary storage arrangements prior to site delivery shall be provided by the Contractor and included in the contract works. The storage location, preservation and duration of storage allowed shall be agreed prior to contract award with QUU.
10 DOCUMENTATION

10.1 PRIOR TO AWARD

The Contractor shall provide the documentation specified in the Project Documentation with the bid proposal.

The Contractor shall include with the bid proposal the DVR as per section 4.7.

10.2 DOCUMENTATION AFTER CONTRACT AWARD

After the award of the Contract, the Contractor shall supply the information specified in the Scope of Work for the Contract. The information shall be supplied in the time specified in the Schedule and in the form detailed below. Switchboard manufacture shall not commence until all the design documentation related to the switchboard has been accepted by QUU.

All design services shall be performed under the direct supervision of an RPEQ Electrical. All design deliverables shall be approved by an Electrical RPEQ before submission to QUU at all stages of the project delivery.

10.3 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 Details
- Cable Schedule
- Equipment List

The Contractor shall submit documentation which shows that switchboard construction requirements are being met. This shall include:

- Full construction drawings of the switchboards, DB’s and LCP’s. For switchboards, these shall include busbar sizes, busbar support materials, spacing and phase centres, as well as sealing, hinging and fixing details for metalwork fabrication.
- Layouts showing location of all power and control equipment shown on the schematic diagrams as well as cabling and glanding areas.
Where switchboard 'Layout' drawings are issued by QUU 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.

Drawings shall be submitted in accordance with

- PRO307 Procedure Drafting Guidelines – Contract Requirements
- PRO395 SEQ Water Supply and Sewerage- D&C Code Asset Information QUU Addendum

The Contractor shall provide a complete set of red line drawings to QUU within 5 business days of completing the FAT. The red line drawings shall be each signed as approved by an RPEQ before submission to QUU. A complete set of red line drawings shall also be available in the switchboard when delivered to site. The Contractor shall maintain the red line 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 QUU within 5 business days of completing the SAT. The red line drawings shall be signed as approved by an RPEQ before submission to QUU. 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 QUU.

10.4 EQUIPMENT LISTS

Equipment lists shall detail the equipment type and quantity of every item of equipment being installed in the switchboard. This shall include all minor equipment such as control relays, lamps and terminals.

10.5 LABEL LISTS

Label lists shall be provided for all labels indicating label text and text size as well as label overall dimensions, colour, material and fixing method.

10.6 MANUALS

The contractor shall provide Operations and Maintenance (O&M) Manuals for all new equipment. This includes two (2) hard copies and one (1) electronic copy in pdf format on DVD. The O&M manual must be provides within five (5) business days after the switchboard FAT is completed.

The Contractor shall provide the O&M manuals in compliance with SEQ Water Supply and Sewerage Design & Construction Code (SEQ WS&S D&C Code). The hard copy manuals shall be neatly presented in 2 ring binders, where hole punching is not suitable.
or the manual is not provided with supports the manual is to be restrained by use of
document holder similar to Magi-clip DK3660 with annotated dividers separating the
different sections

Loose sheets and drawings not forming part of individually bound booklets within the
manual shall be protected in individual plastic pockets. A maximum of two single sided
sheets shall be placed back to back in each pocket, allowing them to be read without
removal from the pockets.

Each folder shall have the following identifying information on the front cover giving

- Project name,
- Switchboard Asset Tagname and Title
- Contract number and year of installation,
- Contractor’s Company name, address & phone number;

Electronic copy of O&M Manual shall be supplied on CD/DVD and be sorted in
directories that reflect the layout provided in the hard copy manuals.

All files shall be in one of the following formats to allow QUU easily reprint portions or
all of the O&M Manual.

- Adobe Acrobat (*.pdf)
- Microsoft Word (*.doc or *.docx)
- Microsoft Excel (*.xls or *.xlsx)

The following information shall be provided:

The following minimum information shall also be provided in the O&M manuals:-

- Equipment schedule detailing the make, model and number of all separate items
  of equipment within the control panel. This shall describe exactly the equipment
  installed, including which manufacturer’s options and accessories are included;
- Equipment manufacturer’s maintenance information;
- Preventative maintenance schedule;
- Complete description of the switchboard or DB including all information shown
  on the rating plate;
- Details and names of equipment suppliers;
- Drawing list showing number, title and revision;
- Drawings including relevant Contract Drawings;
• List of spare parts provided;

• FAT Report and

• SAT Report if site testing is included in the Contract

10.6.1 **Generic Manuals**

Vendor generic manuals shall be modified with strike thru text or highlighted text by the Contractor to indicate the actual equipment supplied and information contained in the manual must be specific to the equipment supplied.

10.7 **CONFIGURATION FILES**

All configurable electronic devices supplied in the switchboard shall be provided by the Contractor with the as commissioned software configuration files on CD/DVD. Programming software licences and hardware accessories required to fault find and reconfigure the devices shall also be provided by the Contractor.

10.8 **HAZARDOUS AREA DOSSIER**

The Contractor shall provide separate drawings and all other documentation that is typically required for inclusion in the site HA Dossier. The information provided for the HA Dossier shall not be duplicated in any other documentation deliverables provided by the Contractor. Refer TMS1203 General Requirements for Hazardous Area Installation - Technical Specification for documentation required in the HA Dossier.

The Contractor shall update the site HA Dossier with the new information and remove the information from the HA Dossier that is superseded by the any new works delivered by the Contractor.
11 SPARE PARTS AND SPECIAL TOOLS

11.1 SPARES

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. QUU will advise the Contractor what spares will be procured.

11.2 SPECIAL TOOLS

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.

QUU will advise the Contractor what components will be procured.