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Control Panels

TMS1222

Standard Technical Specification



REVISION CONTROL

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Contents

REVISION CONTROL	2
DOCUMENT CONSULTATION	2
1. SCOPE.....	5
1.1. DEFINITIONS	5
1.2. ACRONYMS AND ABBREVIATIONS	5
1.3. REFERENCE DOCUMENTS	6
2. STANDARDS AND REGULATIONS	8
2.1. AUSTRALIAN STANDARDS	8
2.2. INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC) STANDARDS	9
2.3. REGULATIONS	10
2.4. UNITS AND LANGUAGE	10
2.5. SUB-CONTRACTORS	10
2.6. CONTRACTOR EXCEPTIONS	10
2.7. ORDER OF PRECEDENCE.....	11
3. GENERAL REQUIREMENTS	12
3.1. OPERATION AND DESIGN LIFE	12
3.2. LOCATION AND ENVIRONMENTAL CONDITIONS.....	12
3.3. OPERATING REQUIREMENTS.....	12
3.4. UTILITY DATA	13
3.5. WORKMANSHIP AND PERSONNEL.....	13
3.6. MATERIALS AND EQUIPMENT.....	14
3.7. WEATHER AND INGRESS PROTECTION	14
4. TECHNICAL REQUIREMENTS.....	16
4.1. CABLING, WIRING AND EQUIPMENT GENERAL ARRANGEMENT.....	16
4.2. CABLING AND WIRING CONTAINMENT	17
4.3. CABLE AND WIRE DETAIL	17
4.4. WIRE INSULATION COLOUR CODING.....	17
4.5. WIRE NUMBERING.....	19
4.6. SEGREGATION AND SHROUDING	19
4.7. PROTECTION OF LINE SIDE CONDUCTORS	20
4.8. DOOR AND ESCUTCHEON WIRING	20
4.9. TRANSPORTABLE SECTIONS	20
4.10. LABELLING AND IDENTIFICATION	20
4.11. DANGER AND WARNING LABELS	22
4.12. PRIMARY NAMEPLATE	22
4.13. EARTHING	22
4.14. LOCKS AND HANDLES.....	22
4.15. LOCKABLE T HANDLES	23
4.16. INDOOR CONTROL PANELS.....	23
4.16.1. Enclosures	23
4.16.2. Doors and Escutcheons.....	23
4.16.3. Plinth.....	24
4.16.4. Paint Treatment.....	24
4.17. OUTDOOR CONTROL PANELS.....	24
4.17.1. Enclosures	24
4.17.2. Doors and Escutcheons.....	24
4.17.3. Plinth.....	25
4.17.4. Paint Treatment.....	25
4.18. INSPECTION AND ACCESS COVERS.....	25

4.19.	VENTILATION	26
4.20.	GLAND PLATES	26
4.21.	EQUIPMENT MOUNTING.....	26
4.22.	SPARE CAPACITY	27
4.23.	SERIAL COMMUNICATIONS AND FIELDBUS CABLING	27
4.24.	TERMINATION OF CONTROL AND INSTRUMENTATION CABLES	27
4.25.	TERMINATION OF POWER WIRING.....	30
4.26.	TERMINATION OF CT AND VT CABLING	31
4.27.	MINIATURE CIRCUIT BREAKERS	31
4.28.	INDICATING LAMPS	32
4.29.	CONTROL, TRIPPING AND AUXILIARY POWER SUPPLIES	33
4.30.	ACTUATORS, PUSH-BUTTONS AND CONTROL SWITCHES.....	33
4.31.	PLC	33
4.32.	BATTERIES	34
4.33.	INTRINSIC SAFE BARRIERS	34
4.34.	EMERGENCY STOP CIRCUITS	34
4.35.	COMMUNICATIONS PANELS	34
4.36.	ETHERNET SWITCHES	35
4.37.	SERIAL TO ETHERNET CONVERTERS	35
4.38.	COPPER TO FIBRE OPTIC CONVERTERS.....	35
4.39.	PROTOCOL CONVERTERS.....	35
4.40.	FIBRE OPTIC BREAK OUT TRAYS (FOBOT).....	36
5.	QUALITY ASSURANCE, INSPECTION AND TESTING	37
5.1.	QUALITY ASSURANCE.....	37
5.2.	ROUTINE TEST AND FACTORY ACCEPTANCE TEST	37
5.3.	INSPECTIONS.....	38
5.4.	FUNCTIONAL CHECKING.....	38
5.5.	SITE ACCEPTANCE TESTING AND COMMISSIONING.....	39
5.6.	SITE SUPPORT.....	39
6.	DOCUMENTATION	40
6.1.	PRIOR TO AWARD.....	40
6.2.	DOCUMENTATION AFTER CONTRACT AWARD	40
6.3.	DRAWINGS	40
6.4.	EQUIPMENT LISTS	41
6.5.	LABEL SCHEDULE.....	41
6.6.	MANUALS	41
6.6.1.	Generic Manuals	42
7.	SPARE PARTS AND SPECIAL TOOLS	43
7.1.	SPARES.....	43
7.2.	SPECIAL TOOLS.....	43
8.	PACKAGING, HANDLING AND SHIPPING	44

1. SCOPE

This specification details the minimum technical requirements for design, manufacture and testing of Control Panels and Communications Panels for Queensland Urban Utilities facilities. This specification shall also apply to control panel compartments of HV and LV switchboards and generally to all other equipment with control panel compartments. This specification is not applicable to local control panels.

1.1. DEFINITIONS

In this document, the following definitions apply:

Project Documentation	Governing technical documents for the specific item(s) for the specific works included or referenced in the Contract
Contractor	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.
Contract:	The agreement between QUU and the Contractor to which this specification pertains.
Local Control Panel	A field mounted electrical enclosure typically containing motor stop/start pushbuttons, motor local isolator and an emergency stop pushbutton, also referred to as a local control station. Refer to TMS60 LV Switchboards and Enclosures -Technical Specification for design and supply of LCP's.

1.2. ACRONYMS AND ABBREVIATIONS

AC	Alternating Current
ACB	Air Circuit Breaker
CT	Current Transformer
DC	Direct Current
ELV	Extra Low Voltage
FAT	Factory Acceptance Test
FOBOT	Fibre Optic Break-out Box
IEC	International Electro-technical Commission
HV	High Voltage
I/O	Input / Output
IP	Ingress Protection
ITP	Inspection and Test Plan
LED	Light Emitting Diode
LV	Low Voltage
LCP	Local Control Panel

NC	Normally Closed
NO	Normally Open
MCCB	Moulded Case Circuit Breaker
O&M	Operation and Maintenance
PLC	Programmable Logic Controller
PPE	Personal Protective Equipment
RCD	Residual Current Device
RTU	Remote Telemetry Unit
QUU	Queensland Urban Utilities
SAT	Site Acceptance Test
SDRL	Supplier Data Register List
SLD	Single Line Diagram
VRLA	Valve Regulated Lead Acid
VT	Voltage Transformer

1.3. REFERENCE DOCUMENTS

Document Number	Title
CHE28	Factory Inspection Checks – Switchboards
CHE73	Standard Fixed Speed Sewage Pumping Station Factory Acceptance Test (FAT) Checklist
CHE135	Pre-factory Inspection Test Checks - Switchboards
TMS60	Low Voltage Switchboards and Enclosures – Technical Specification
TMS62	Preferred Equipment List – Electrical and Instrumentation
TMS76	Corrosion Protection for Electrical and Mechanical Equipment and Structures
TMS1151	Preferred Equipment List – Control Systems
TMS1186	High Voltage Switchboards - Technical Specification
TMS1187	AC Uninterrupted Power Supply - Technical Specification
TMS1221	DC Power Supply Systems - Technical Specification
TMS1200	Electrical Installation - Technical Specification
TMS1201	Instrumentation Installation - Technical Specification
TMS1202	Control System Implementation for Network Assets
TMS1203	General Requirements for Hazardous Area Installation – Technical Requirements
TMS1647	Equipment Naming – Technical Specification
TMS1648	EI&C Design Criteria Technical Specification
PRO307	Procedure Drafting Guidelines – Contract Requirements

PRO395	SEQ Water Supply and Sewerage- D&C Code Asset Information QUU Addendum
	SEQ Water Supply and Sewerage Design & Construction Code (SEQ WS&S D&C Code)
WI58	Arc Flash Assessment and PPE Selection

2. STANDARDS AND 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 Superintendent.

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 1020	Control of undesirable static electricity
AS 1192	Electroplated coatings, nickel and chromium.
AS 1275	Metric Screw Threads for Fasteners
AS 1284	Electricity Meters – All Parts
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 1660	Test methods for electric cables – All Parts
AS 1789	Electroplated zinc (electrogalvanized) coatings on ferrous articles (batch process)
AS 1897	Fasteners – Electroplated coatings
AS 2067	Substations and High Voltage Installations exceeding 1kV A.C.
AS/NZS 3000	Electrical installations (known as the Wiring Rules)
AS/NZS 3008.1.1	Electrical installations – selection of cables – Cables for alternating voltages up to and including 0.6/1kV – Typical Australian installation conditions
AS 3017	Electrical installations—Verification guidelines
AS/NZS 3100	Approval and test specification - General requirements for electrical equipment
AS/NZS 3111	Approval and test certification for miniature overcurrent circuit breakers
AS/NZS 3133	Approval and test specification – Air break switches
AS 3808	Insulation and sheathing materials for electric cables

AS 3894	Site testing of protective coatings – All Parts
AS 4070	Recommended practices for protection of low voltage electrical installation and equipment in MEN Systems for transient over voltages
AS/NZS 4325.1	Compression and mechanical connectors for Power Cables - Test methods and requirements
AS 4024 (all parts)	Safety of machinery
AS/NZS 4534	Zinc and zinc/aluminium-allow coatings on steel wire
AS/NZS 4680	Hot-dip galvanised (zinc) coatings on fabricated ferrous articles
AS/NZS 4792	Hot-dip galvanised (zinc) coatings on ferrous hollow sections, applied by a continuous or specialised process
AS/NZS 5000	Electric Cables- Polymeric insulated – All Parts
AS/NZS 5603	Stand-alone inverters – Performance requirements
AS 60038	Standard voltages
AS 60044	Instrument Transformers – All Parts
AS 60529	Degrees of Protection Provided by Enclosures (IP Code)
AS/NZS IEC 60947	Low-voltage Switchgear and Control gear – All Parts
AS 61000	Electromagnetic Compatibility (EMC)
AS IEC 61131	Programmable controllers – All Parts
AS/NZS 61439	Low-voltage switchgear and control gear assemblies - All Parts
AS 61508	Functional safety of electrical/electronic/programmable electronic safety-related systems
AS 61558.1	Safety of power transformers, power supplies, reactors and similar products – general requirements and tests

2.2. INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC) STANDARDS

IEC 60050	International Electro-technical Vocabulary
IEC 60051	Direct Acting Indicating Analogue Electrical Measuring Instrument and their Accessories – All Parts
IEC 60228	Conductors of Insulated Cables
IEC 60255	Measuring relays and protection equipment – All Parts
IEC 60269	Low voltage fuses – All Parts
IEC 60332	Tests on electric and optical fibre cables under fire conditions – All Parts
AS/NZS 60950.1	Information Technology equipment – Safety , Part 1: General Requirements
IEC TR 61641	Enclosed low-voltage switchgear and controlgear assemblies - Guide for testing under conditions of arcing due to internal fault
IEC 61643	Low-voltage surge protective devices – All Parts
IEEE 519	Recommended practices and requirements for harmonic control in electrical power systems
IEEE 802.3	Ethernet
ISO 9001	Quality Management Systems – Requirements

2.3. REGULATIONS

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

- Queensland Building Act 1975
- Queensland Building Fire Safety Regulation 2008
- Queensland Electrical Safety Act 2002
- Queensland Electrical Safety Regulation 2013
- Queensland Electrical Safety Code of Practice 2013 – Managing electrical risks in the workplace
- Queensland Electrical Safety Code of Practice 2010 – Working near overhead and underground electric lines
- Queensland Electrical Safety Code of Practice 2010 – Works
- Queensland: Environmental Protection Act - 1994 and Amendment Act - 1997
- Queensland Fire Emergency Act 1990
- Queensland Professional Engineers Act 2002
- Queensland Professional Engineers Regulation 2003
- Queensland Work Health and Safety Act 2011
- Queensland Work Health and Safety Regulation 2011
- Queensland current and applicable Work Health and Safety Codes of Practices for design, build, maintain and demolish requirements
- Queensland Workers' Compensation and Rehabilitation Act 2003 and Amendment Act 2015
- National Construction Code 2016, volumes 1, 2, 3 and The Guide
- Queensland Electricity Connection and Metering Manual (QECMM) Version 11

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-contractor or sub-supplier 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 PRECEDENCE

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:-

- Purchase Order or Contract
- Project Data Sheets
- This Specification
- Project Drawings
- Project Specifications
- Australian Standards, Codes and Regulations
- International Codes and Standards

3. GENERAL REQUIREMENTS

3.1. OPERATION 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 contained within the control panel shall also be suitable for a minimum of 5 years normal continuous operation without maintenance at the duty specified herein and on the Project Data Sheets.

All equipment 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.

Control panels will be located both indoor and outdoor depending on the application.

3.2. LOCATION AND ENVIRONMENTAL CONDITIONS

The control panel datasheets and relevant Project Documentation will define the installation location for the control panels.

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

Note: 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. All areas including inside air conditioned switch rooms at Sewerage Treatment Plants 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 control shall be selected and installed so that all circuits can operate simultaneously 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 shall be the circuit breaker rating.

3.4. UTILITY DATA

The electrical system will have the following voltage levels:

High Voltage Power Supply	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
Low Voltage Supplies	3 ph, 4 Wire, 400 Volt +10,-6% 50 Hz \pm 2%, MEN System Voltage Unbalance <5%
Single Phase Power Supplies	230 V AC, +10,-6%, 2 wire, 50Hz \pm 2%,
Control Power Supplies:	UPS 230 V AC, single phase 2 wire, 50 Hz Regulated 24 V DC
Special Purpose Power Supplies	Regulated 48VDC and 110VDC

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

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

3.5. WORKMANSHIP AND PERSONNEL

Personnel engaged in the manufacture of the equipment 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 equipment 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's Representative prior to commencing any welding works.

QUU reserves the right to inspect all works and direct re-work in the case that the works are not in compliance with the project specifications or commensurate with acceptable trade practice.

3.6. MATERIALS AND EQUIPMENT

All materials shall be new and unused, free of defects and shall be supplied with relevant certification and documentation. The defects liability period for all control panel components shall be 12 months from date of commissioning completed to QUU's satisfaction.

All Contractor supplied instruments and equipment shall be of manufacturer, type and model as specified in TMS62 Preferred Equipment List– Electrical and Instrumentation. The Contractor shall not deviate from these requirements without prior written approval from QUU. Where the materials are not specified the Contractor may offer standard materials suitable for the application, environment and operating conditions. Non-specified equipment shall be of the same type, grade and quality as similar items specified in the Project Documentation. Corresponding parts of similar equipment shall where possible be interchangeable.

The contractor shall maintain 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.

All components shall be of standard manufacture and readily available from suppliers unless specified otherwise in the Project Documentation. All equipment to be supplied shall be sourced from local OEM (Original Equipment Manufacturer) Authorised Distributors within Australia.

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

3.7. WEATHER AND INGRESS PROTECTION

All control panels shall be Ingress Protection (IP) rated as specified in the Project Documentation.

Control Panels are susceptible to damage or failure due to moisture and dust ingress and shall be IP rated 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 and hose-down cleaning. Where specified in the Project Documentation weather hoods and/or sun-shades shall be provided for UV and weather protection.

4. TECHNICAL REQUIREMENTS

4.1. CABLING, WIRING AND EQUIPMENT GENERAL ARRANGEMENT

Equipment in the control panel shall be arranged to allow adequate space for the installation and termination of all internal and external wiring. There shall be a suitable amount of space between the internal components to allow easy access for maintenance on the equipment, including the removal of failed equipment without the need to disassemble adjacent equipment.

All cabling and wiring shall be accessible. All wiring shall be one continuous length from terminal to terminal. Splicing, jointing or teeing shall not be permitted.

Common wiring between compartments (i.e 24VDC, 0V etc) shall be configured such that removal of a wire (or loose wiring) within one compartment shall not cause loss of connection to other compartments.

Electronic protection equipment requiring connections to AC supply, current transformers, voltage transformers, baluns and the like, shall wherever possible, be directly connected to such equipment.

A minimum 50mm shall be maintained between each terminal row and any cable ducts to provide sufficient clearance for fanning of conductors for termination and for affixing ferrules for wire identification.

Equipment shall be mounted on a gear tray and not directly to the external metalwork of the enclosure in such a manner so that all equipment can be removed without unbolting the gear tray. Self-tapping screws for fixing equipment to gear trays is not accepted.

All terminals types shall be mounted on DIN rails that are attached to a gear tray, with the open side of the terminals facing upwards.

DIN rails shall be single, continuous lengths extending the full length between wiring ducts.

All outgoing power wiring shall be arranged to allow the use of a clip-on ammeter for testing purposes.

Where practical, all field cables shall be terminated on the same side of the terminal blocks within an enclosure.

Terminal strips shall be mounted vertically to facilitate ease of cable termination and identification of terminals.

Terminals for the connection of field cables shall be located as close as practical to the point of entry of the cable into the enclosure. Where possible, terminals shall be located to prevent field cables (or cores part of) being routed through a compartment for termination into another compartment.

All cabling and wiring between compartments shall be routed through suitably sized holes cleanly punched in the metalwork and protected with grommets or similar to prevent insulation damage.

The bending radius of any cable shall not be less than the minimum bending radius recommended by the cable manufacturer.

4.2. CABLING AND WIRING CONTAINMENT

All cabling and wiring within the enclosures shall be neat, firmly secured and enclosed within PVC cable ducts. Wiring looms or spiral wraps shall not be permitted except for wiring connections to hinged equipment (doors etc). All cable ties shall be installed with an approved tensioning and cutting tool.

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

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

The use of terminations as the only means of wiring support is not permitted.

Self-adhesive wiring supports shall not be used.

Cable ducts shall be side slotted PVC and shall have positive continuous (or clamping) edges on both the wiring channel and the cover.

PVC ducts shall be sized such that their cross-sectional area utilisation factor does not exceed 60%.

All wiring within a cable duct shall be insulated for the highest voltage within the cable duct.

4.3. CABLE AND WIRE DETAIL

All wiring and cabling shall be low smoke emission, halogen free, stranded flexible tinned copper conductor and be flame retardant in accordance with the requirements of IEC60332.

All panel wires shall be multi-stranded single core copper 0.6/1kV V105 grade PVC insulated with a minimum cross sectional area of 1.0mm² for instrumentation, 1.5mm² for control and minimum 2.5mm² for power wiring.

CT wiring shall be sized against the related circuit breaker burden and shall be a minimum cross sectional area of 4.0mm².

Multi-pair cables with multi-strand 0.5mm² conductors shall be permitted for wiring to control system high density I/O modules within enclosures.

For telecommunications applications wiring shall be minimum of 0.4mm² (22AWG).

Plugs and cables supplied with standard equipment items shall not be modified and shall be installed in the control panel as per the manufacture's recommendation.

4.4. WIRE INSULATION COLOUR CODING

Insulation colours for internal wiring shall be as detailed in the following table and in accordance with AS/NZS 3000:

Description	Colour
AC – 3 Phase A	Red
AC – 3 Phase B	White
AC – 3 Phase C	Dark Blue
AC – 3 Phase Neutral	Black
AC – 1 Phase Active (230V)	Red (ferruled '230Vac)
AC – Neutral (230V)	Black (ferruled '230Vn)
AC – CT & VT Phase A	Red
AC – CT & VT Phase B	White
AC – CT & VT Phase C	Dark Blue
AC – CT & VT Neutral	Black
110VAC (active)	TBA
110VAC (neutral)	TBA
12VDC (Positive)	Orange
12VDC (common)	Violet
12VDC (signal)	Grey
24VDC (Positive)	Orange
24VDC (common)	Violet
24VDC (signal)	Grey
48VDC (Positive)	TBA
48VDC (common)	TBA
48VDC (signal)	TBA
110VDC (Positive)	TBA
110VDC (common)	TBA
110VDC (signal)	TBA
Earth	Green/Yellow
Instrumentation, 4-20mA(+)	White (twisted pair)
Instrumentation, 4-20mA(-)	Black (twisted pair)
Instrumentation, Triad – 3 rd Core	Red
Electrode Wiring	Salmon
Intrinsically Safe Wiring	Light Blue

Note: 110VAC, 110VDC and 48VDC voltage level circuits are not generally accepted by QUU. Equipment and circuits operating at these voltage levels shall only be installed where indicated on Project Documentation accepted by QUU.

4.5. WIRE NUMBERING

Panel wiring shall be numbered at each end with the wire numbers as detailed on the schematic and wiring diagrams.

Where practical, wire numbers shall commence within 20mm of the termination.

All alpha-numeric characters used for wire numbering shall be in English.

Wires shall be marked using indelibly printed ferrules in clear plastic push-on ferrule holders and shall be clearly read without moving the ferrule holder.

Wire numbering shall be similar or equal to Grafoplast SI2000 system.

Wires connected directly in series or parallel shall have the same ferrule number, all wires shall be uniquely numbered. Ferrules shall be arranged to read from left to right and from bottom to top.

Wire numbers for wires running external to compartment shall have the appropriate prefix.

Ferrules and holders shall be unaffected by moisture.

Ferrules shall require disconnection of the wire to remove the ferrule.

Ferrule holders shall be sized to suit the wire and shall not rotate freely around the wire.

Hand printed, 'C' type clip-on or adhesive ferrules are not acceptable.

Earth wires connected to the control panel earth bar shall be identified with a dedicated wire number and wire numbers assigned shall be updated to the panel schematics and/or other Project Documentation where not already indicated.

Wire numbers shall not change across terminals for wiring within the control panel.

When wiring numbers change (i.e at connections between equipment) a clear system of coding is to be used at the change point and details shall be clearly marked on the drawings.

The wire number conventions for existing installed control panels at the particular site shall be adopted for all new control panels at the same site, unless specified otherwise in the Project Documentation.

4.6. SEGREGATION AND SHROUDING

Within electrical enclosures segregation of cabling and wiring shall be achieved through the use of either physical distance or slotted PVC cable ducts.

LV power cabling, wiring and terminations shall be physically segregated from ELV wiring and associated equipment.

Wiring and circuit voltages greater than ELV shall be separated from ELV control and instrument signal wiring.

Terminals with circuits operating above ELV shall be segregated using removable shrouding that fully surrounds the terminals.

LV wiring shall be excluded from all I/O marshalling terminal sections.

The shrouds shall be a clear transparent insulating plastic with a fully visible red/white/red warning label. Warning labels on shrouds shall contain the text “Danger XXX Voltage”, where XXX is the maximum voltage level behind the shroud.

Different voltage levels on banks of contacts of individual devices shall be avoided where practical.

4.7. PROTECTION OF LINE SIDE CONDUCTORS

All supply conductors of voltages greater than ELV to the line side of the incomers, switches, circuit breakers and other switching devices shall be fully insulated or provided with IP2X covers or shrouds.

4.8. DOOR AND ESCUTCHEON WIRING

Flexible wiring shall be provided to equipment mounted on doors, escutcheons or similar hinged moving equipment. The wiring loom shall be clamped to retain the loom in position and to prevent any strain or rubbing of the wiring for the full travel of the door or escutcheon.

Spiral wrap, split tubing or similar shall be installed to provide mechanical protection for door and escutcheon wiring looms.

New wiring and new equipment operating at voltage levels exceeding ELV shall not be installed on control panel doors or escutcheons.

4.9. TRANSPORTABLE SECTIONS

Where equipment shall be split for transport, the internal wiring between transport sections shall terminate at a row of dedicated marked terminals located on one side of the break.

The disconnected wiring between transport units shall be crimped (with termination pins/lugs), loomed together and clearly marked for easy identification and on-site connection into the terminal blocks located in the adjacent transport unit.

4.10. LABELLING AND IDENTIFICATION

All equipment within the control panel enclosure shall be clearly labelled for positive identification with the design documentation.

All potential hazards within the electrical enclosures shall have warning labels provided indicating the voltage level.

Equipment identification labels shall be QUU assigned tagnames or as defined on the P&ID, schematic, wiring or general arrangement drawings.

All identification and warning labels shall be in English.

Labels shall not be secured to ducting or electrical equipment items. Labels shall be positioned adjacent to the relevant equipment and to provide unobscured visibility from outside the enclosure.

Each strip of terminals shall be clearly identified with a group label. In addition, each terminal in the strip shall be labelled with a unique number.

All terminals shall be equipped with provision for affixing individual terminal numbers. A non- adhesive, vibration resistant system shall be used for affixing individual terminal numbers.

The control panel shall be labelled with QUU assigned equipment tag number and title in accordance with the Project Documentation. Labels shall be installed as per the label schedule drawing for the control panel. Control Panels 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 include a unique alphanumeric identification code. Equipment labels shall be fixed so as to not be obstructed from view by panel wiring.

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.

Labels shall be provided to indicate the main isolator for each voltage level in the control panel. In addition labels shall be provided on exterior of the control panel front door indicating the voltage levels inside the panel and where each voltage source is isolated upstream of the panel. The label shall indicate the upstream switchboard and circuit breaker number and label shall be engraved black text on white background.

Isolated neutral circuits where present in the panel shall be identified with a warning label.

Label letter height shall be generally as follows:

- Control Panel QUU Equipment Number: 30 mm
- Control Panel Title: 20 mm
- Max Voltage Level and Upstream Isolation: 20 mm
- Equipment Labels: 5 mm
- Pushbutton Designation: 3.5 mm

A label list shall be submitted for approval to QUU prior to manufacture.

Labels not approved by QUU shall be replaced at no cost if required by 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.

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

- Emergency Stop pushbutton labels shall have yellow ring with black lettering.

Internal labels on gear trays or escutcheon panels shall be secured by M3 chrome plated metal threads 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.

External labels are to be 1mm thick 316 grade s/steel secured by M3 316 s/steel metal threads.

All internal and external labels are to have bevelled edges.

4.11. DANGER AND WARNING LABELS

Equipment connected to the line side of the main LV isolating device in the control panel shall be labelled:-

"DANGER - LINE SIDE CONNECTION – ISOLATE ELSEWHERE

4.12. 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

4.13. EARTHING

All parts of the control panel which are required to be earthed shall be effectively connected to the control panel earth bar. All earth conductor connections to the earth bar shall be secured with two screws. Screw holes shall be drilled and tapped. The earth bar 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 terminating zone.

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 2

All metal parts of the control panel shall be bonded to the control panel earth bar.

All doors and escutcheons, fitted with control and/or indicating equipment shall have an independent flexible earth strap with mounting bolt and nut, or stud welded to the door.

All secondaries of current transformers shall have one lead earthed.

All metal cases of instruments, relays, selector switches, etc. shall be connected by an unbroken insulated earth wire of minimum size 2.5mm² to the earth bar. The earthing connections shall be arranged so that removal of one component shall not affect continuity of the earthing conductor associated with any other component. Earth conductor insulation shall be coloured green/yellow.

An isolated instrument earth bar with 20% spare capacity shall be provided in the PLC marshalling terminal section. The instrument earth bar shall be bonded to the main earth bar with a single 4mm² G/Y PVC cable.

4.14. LOCKS AND HANDLES

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.

Lockwood Barrel Locks are to be fitted with Key Codes RC496A, RC496AB, RC496ABC refer to QUU for clarification as to where each is required.

4.15. LOCKABLE T HANDLES

Lockable 'T' handles shall be chrome plated and keyed L & F 92268

4.16. INDOOR CONTROL PANELS

4.16.1. Enclosures

Control panels located indoors in non-corrosive environments shall be minimum IP44 and completely self-supporting 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 gear trays 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 than 500 x500mm a 3 mm thick gear tray shall be provided, supported by studs of adequate size welded to the case.

Large equipment mounting panels, 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.

All nuts, bolts and studs shall be cadmium plated mild steel.

4.16.2. Doors and Escutcheons

Doors and escutcheons 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 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 and escutcheons shall open a minimum of 100 degrees for equipment access, and shall be fitted with door stays.

All doors and escutcheons shall be fitted with chrome plated pintle hinges. A minimum of three hinges shall be fitted if the door or escutcheon is over 900 mm in height.

All doors shall be held closed with chrome plated lockable 'T' handles. For doors up to 450 mm high, one 'T' handle is sufficient. For doors above 450 mm and up to 900 mm high, two 'T' handles are sufficient and doors over 900 mm high shall have three 'T' handles or a Tri-lock. The same rules apply for escutcheons which shall be secured with panel key locks Emka 1/4 turn 1000-U142.

All doors and escutcheons shall be effectively earthed to the control panel case by means of flexible connection not less than 4 mm².

At least one off document holder shall be provided to inside of control panel front door.

4.16.3. Plinth

Plinths shall be a minimum 75 mm 'U' channel, hot dipped galvanised. 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 panel, alternatively fit galvanised covers over holes after installation. The plinth shall be installed with toe facing out.

4.16.4. Paint Treatment

The surface of mild steel control panel metal work shall be degreased and cleaned with solvent, then coated with electrostatically applied powder coat in accordance with paint manufacturers' recommendations.

Internal and external surfaces shall be RAL7035 to AS2700, gear trays and escutcheons shall be gloss white.

4.17. OUTDOOR CONTROL PANELS

4.17.1. Enclosures

Control panel enclosures for all outdoor locations or corrosive environments shall be minimum IP56.

Panel material is to be minimum 3mm Marine grade Aluminium (5251) or 2 mm SS316. Pacified welds shall be provided throughout SS316 cubicles. All sheet metal edging is to be de-burred.

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

All equipment shall be removable via the front access doors.

All control panels located in outdoor locations exposed to the weather shall be provided with a sloped rain hood.

4.17.2. Doors and Escutcheons

External doors and covers are to be fitted with Emka 1011-207 self-grip seal.

M6 Earth studs are to be fixed to the interior of all doors and hinged escutcheons and on adjacent cubicle interior surfaces.

Door stiffeners are to be SS316 and a minimum of 3 mm and of sufficient strength to prevent being deformed when subjected to reasonable loads.

All doors shall be held closed with stainless steel lockable 'T' handles. For doors up to 450 mm high, one 'T' handle is sufficient. For doors above 450 mm and up to 900 mm high, two 'T' handles are sufficient and doors over 900 mm high shall have three 'T' handles or a Tri-lock. The same rules apply for escutcheons which shall be secured with stainless steel panel key locks Emka 1/4 turn 1000-U142.

All doors and escutcheons shall be effectively earthed to the control panel case by means of flexible connection not less than 4 mm².

Hinges shall be Selectrix HIB650ss-316 Stainless steel.

SS316 star washers are to be fitted under all hinge screws.

All escutcheons are to open to a minimum of 90°.

At least one off document holder shall be provided to inside of control panel front door.

4.17.3. Plinth

Plinths for panels installed in non-corrosive areas shall be a minimum 75 mm 'U' steel channel and hot dipped galvanised.

Control panel plinth shall be 160x60 channel T6 Grade Aluminium in corrosive areas. The aluminium plinth paint coat system shall comply with TMS76 Corrosion Protection for Electrical and Mechanical Equipment and Structures.

At installation the control panel plinth shall be levelled using chemical anchors with SS316 threaded rod and jacked high enough to prevent the plinth being contact with water ponding. The spacing between the concrete slab and the plinth shall be filled with a non-hygroscopic, non-shrinkable material to prevent corrosion and ingress of vermin.

Plinths 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 installed with toe facing out.

4.17.4. 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 AS1580 and AS3715 using Novox LF acid etch cleaner, Novacoat 12 conversion coating and 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.

Cubicle and external components are to be coloured Dulux Mist Green (36648) matt finish.

Interior items (mounting panels, escutcheons, etc.) are to be coloured Dulux Bright White (32166).

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

4.18. INSPECTION AND ACCESS COVERS

Inspection and access covers shall be manufactured from the same material as the control panel exterior enclosure. In addition the following shall apply to Inspection and Access covers:-

- Lift-off covers shall be fixed with M8 studs and stainless steel dome nuts and stainless steel "D" Handles are to be fitted.
- Small covers shall be fitted with M6x1.0 flat head closed end rivet nuts.
- Fitted with seals attached to the cubicle.
- Fixings are to be fitted at no more than 100mm spacing.
- Maintain a 50mm clearance from section dividers.
- Shall not be split.
- Shall not be earthed.

4.19. VENTILATION

All control panels 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 component manufacturers:

The calculation shall allow for the following criteria:-

- Ambient temperature of 45degC
- Black Body Solar Radiation Gain at 85 DegC
- Component heat dissipation
- Still wind conditions

The ventilation calculation approved by an RPEQ and undertaken using QUU approved 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 and air filters to prevent vermin ingress with screens and filters removable for cleaning. Screens and vents must be removable from inside the enclosure without need to unbolt the gear tray or remove equipment from the gear tray to gain access. External metal 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 control of the ventilation fans and also provide over temperature warning alarm to the local PLC. The thermostat warning temperature setting shall be set to below the maximum design temperature for the enclosure.

4.20. GLAND PLATES

Gland plates shall be single piece, 5 mm aluminium. A 3mm thick aluminium gland plate can be accepted only where all cables proposed to be installed in the gland plate have less than 32mm diameter glands. Gland plates shall be sized for 50% spare cable access in future.

The gland plate shall be effectively earthed to the control panel earth bar. The Contractor shall fit 25 mm wide neoprene gaskets to all gland plates, secure with 6 mm bolts at maximum 150 mm centres.

Cable glands are to be fitted with the compression side installed inside the cubicle.

4.21. EQUIPMENT MOUNTING

No items of equipment which is to be operated or viewed by an operator (pushbuttons, switches and meters) shall be mounted more than 1900 mm or less than 400 mm above floor level. It shall not be necessary to open any door or remove any cover to operate or reset equipment that is required for normal operation.

No piece of equipment shall be mounted behind other equipment or in any manner denying free access for removal or maintenance.

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

Mounting of equipment on the internal or external walls or installing components on an angle bracket fixed to the control or communications panel wall is not permitted for new panels. These practices may only be considered where accepted by QUU for modifications to existing panels with limited spare space for mounting new equipment.

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 the control panel the Contractor shall make consideration for access and egress around the enclosure at the location it will be installed. The control panel opening door swing shall not obstruct escape routes, walkways or access to plant or equipment.

4.22. SPARE CAPACITY

Unless otherwise specified by 'Layout' drawings issued with the Project Documentation, spare space shall be provided in the control panel equivalent to 20% of the total gear tray space available.

Mounting of equipment on side walls of the control panel is not permitted.

4.23. SERIAL COMMUNICATIONS AND FIELDBUS CABLING

Fieldbus cabling shall be routed directly between fieldbus cards, fieldbus junction boxes and end devices.

Fieldbus cables shall not to be terminated on intermediate terminals.

Equipment such as meters, motor protection relays, circuit breakers and the like which are specified to be part of a serial communications link (whether copper or fibre) shall have communication wiring installed as per the manufacturer's instructions, using the manufacturer's proprietary connectors and cables.

All serial cabling shall be installed in accordance with industry best practice installation guidelines and to reduce EMC disturbances.

4.24. TERMINATION OF CONTROL AND INSTRUMENTATION CABLES

All control and instrumentation wiring shall be terminated at equipment terminals using pre-insulated, crimp type, bootlace pins or lugs.

Terminations relying solely upon solder are not permitted.

No more than one wire shall be terminated in either side of the terminal.

Separate pins or lugs, as applicable, shall be used for each conductor and screen wire. Screen wires of twisted pair instrument cables shall have a clear sleeve fitted before the pin of lug is fitted.

Pins and lugs shall be suitable for copper conductors.

Pins and lugs shall be sized to suit the conductor size.

Sleeves shall be sized so that they are in the manufacturers recommended range of core size and be 15 mm long as standard, unless longer lengths are specifically required.

All 0.5 mm² cores shall be terminated with Weidmuller insulated bootlace ferrules – colour orange.

A method of stripping insulation that does not risk damage to the conductor shall be employed.

Pins and lugs shall only be crimped with the pin or lug manufacturer's approved crimp tool.

Provision shall be made on the length of the wire at each terminal to permit cutting and remaking of the wire termination at least once without interference with the main run of the wire and loom.

Terminals shall be rail mounted, clip-in, tunnel type or spring clamp terminal type, and shall incorporate vibration resistant, captive pressure screws which shall not bear directly on the wire.

Knife gate marshalling terminals with minimum size for 2.5mm² conductors shall be installed for all control and instrument cable cores.

All I/O wiring shall contain fuse(s) to protect the card and individual channels of the card. Where fuse terminals are provided the Contractor shall provide minimum 10 off spare unused fuses inside the panel.

Terminals shall be suitable for copper conductors.

Terminals shall be rated minimum 600V.

Terminal block insulation shall be of a non-grid, non-hygroscopic, non-tracking, non-flammable material.

Terminal shall have minimum ingress protection rating of IP2X to prevent accidental contact during inspection and maintenance.

Terminals shall be sized to suit the conductor size and current rating (minimum of 2.5mm² conductor).

Terminals with hinged components, such as fuse and disconnect terminals, shall be hinged on the right hand side unless advised otherwise.

Single level test/disconnect terminals shall be used for marshalling analogue I/O wiring.

Dual level terminals may only be used for marshalling digital I/O wiring in existing control panels where spare space is limited. The upper level terminals shall be odd numbered and the lower level terminals shall be even numbered. Multiple level or tiered terminals shall not be used for other applications including new control panels unless accepted by QUU in writing.

Push-in clamp type terminals shall not be used unless approved by QUU.

Separately mounted terminal blocks/strips shall be provided for each voltage level.

Separately mounted terminal strips shall be provided for different wiring applications including control, instrumentation and power wiring.

Adjacent groups of terminals shall be separated from each other using space, barriers or earth terminals.

Terminals shall be arranged such that all cores (including spare cores and screens) of multicore and twisted pair cables fan out and terminate in a logical sequence onto consecutive terminals of a common terminal strip. The terminal strip group label in this case is the same as the cable tag number. Terminating screens of instrument cables direct to the instrument earth bar is not accepted.

Terminals for internal wiring shall be arranged such that all 'commons' or 'positives' are grouped together and bridged with a continuous link on consecutive terminals.

Each strip of terminals shall be clearly identified with a group label. In addition, each terminal in the strip shall be labelled with a unique number.

Terminal strip labels and numbers shall be defined on the relevant drawings and Project Documentation.

I/O marshalling terminals shall be grouped per I/O module and the groups of terminals shall be separated by an end bracket which is labelled with the associated controller rack and slot number.

The end terminal with exposed open side in each terminal group shall be blanked off with an end plate.

Only one end bracket shall be used to separate each group of I/O marshalling terminals.

Sufficient terminals shall be provided to terminate all cores (including spare cores and cable screen wires) of multicore cables and instrument cables.

Each terminal strip shall have at least 30% spare terminal space (including provision for field cabling).

All unused ancillary control and monitoring channels on control equipment items within the control panel shall be wired to terminal strips for future use.

Barriers shall be installed on each side of groups of terminals used for termination of spare cores.

All PLC and RTU digital and analogue I/O channels shall be wired to marshalling terminal strips (including installed spare cards) for connection to field cabling.

Field cabling associated with RTD's can be connected directly to the control system analogue input channel.

Where more than one wire is to be connected to one side of a terminal for looping purposes, multiple adjacent terminals and preformed links or combs shall be provided.

Terminal strips shall be arranged such terminal screw slots and terminal numbers are visible from outside the compartment to facilitate ease of wire termination.

All cables entering the control panel shall be individually glanded and only bottom access to the control panel enclosure is accepted unless otherwise accepted by QUU.

Where cables or wiring terminate into plug connectors, such connectors shall be equipped with retaining devices to prevent accidental disconnection.

Surge barriers shall be installed in the control panel for control circuits and instrument loops where indicated in the Project Documentation. The field cables shall connect direct to the surge barrier terminals. Surge barriers shall be provided as per TMS62 Preferred Equipment List – Electrical and Instrumentation. Neutral conductors on load side of the surge barriers shall be identified and isolation maintained from unprotected power supply neutral conductors.

Coaxial antenna cables shall be protected by coaxial surge protectors suitable for the frequency of operation of the antenna system. The surge protector shall be securely bonded to the control panel earth bar. Contractor shall ensure coax connectors are not over tightened which can cause deformation to coax cable and signal attenuation.

Optical fibre terminations and FOBOTs shall be located towards the top of the control panel.

4.25. TERMINATION OF POWER WIRING

Generally, field power cables with conductor size 16mm^2 and above shall be connected directly to the equipment terminals using bolted lugs with space provided to enable the installation and termination of such cables. Provision shall be allowed for termination of neutral conductors with the same cross sectional area as the active conductors.

For instances where intermediate terminals are required for the termination of power cabling with conductor size of 16mm^2 and above then moulded stud type terminals shall be used.

Individual cores of cables up to and including 10mm^2 may be terminated on screw clamp/pressure plate type tunnel terminals where required due to space constraints or other physical limitations. In such cases, raised insulated barriers shall be inserted between terminals for individual phases of a three phase supply. Such terminals shall incorporate vibration resistant captive pressure screws.

Cabling and wiring terminating at stud and screw type terminals shall be fitted with crimp type ring tongue terminals.

In all instances lugs and terminals shall be suitable for copper conductors and shall be sized and rated to suit the conductor size and current rating.

All LV power terminals shall be rated minimum 1000V.

Terminal block insulation shall be of a non-rigid, non-hygroscopic, non-tracking, non-flammable material.

Terminals shall have a minimum ingress protection rating of IP2X to prevent accidental contact during inspection and maintenance.

When more than one wire is to be connected to one side of a terminal for looping purposes, multiple adjacent terminals and preformed links or combs shall be provided.

Wherever crimping is necessary, compression tools recommended by the manufacturer of the crimp type terminals shall be used. Where hand operated, the tools shall be of the type which do not release until full compression is applied.

Power operated crimping tools with hexagonal crimping dies shall be used on conductors in excess of 16mm^2 .

Terminals for neutral circuits shall be sized to suit conductors of the same size as the active conductor.

Polyphase cabling and wiring shall be coloured at the terminations to distinguish phase or polarity. Colours shall be permanent and shall not fade over time.

4.26. TERMINATION OF CT AND VT CABLING

Test terminals and short circuiting disconnect links shall be provided in all on protection secondary circuits to facilitate secondary injection testing for CT circuits. These terminals shall be readily accessible and suitably protected with a removable clear shroud.

CT circuit wiring connected to circuits external to the enclosure shall be provided with captive-type shorting links at the outgoing terminal.

Test terminals shall be provided for VT circuits.

4.27. MINIATURE CIRCUIT BREAKERS

The supply voltage level for all control panels shall be 24VDC unless specified otherwise in Project Documentation.

Where the control panel is fed from an LV supply the main isolator for the panel shall be shrouded and segregated from ELV components. The upstream LV protective device shall include 30mA RCD. RCD's shall not be installed on the line side of UPS's and in this case a range selectable earth leakage relay shall be installed for equipment protection. The fault current rating of CB's and all other equipment shall be suitable for the prospective fault current level at the point of installation in the power network.

Where the LV supply is not fed from an UPS a surge protection device shall be installed at the control panel. The surge diverter shall be fuse protected and rated at 50kA (8/20 micro seconds) and offer bi-directional protection and be current rated for the connected load.

All power supply feed cabling for electrical enclosures shall be connected to a main circuit breaker or main isolator prior to connection with any electrical equipment. The circuit breakers (and/or terminals if required) shall be located in close proximity to the entry point of the cable to alleviate the need for running the cable through the cabinet.

All miniature circuit breakers (MCBs) shall be suitable for copper conductors and rated for uninterrupted duty.

MCBs shall be equipped with both inverse time delayed thermal protection for overcurrent and instantaneous magnetic trip protection for short circuit protection.

LV MCB's shall also incorporate earth leakage protection unless specified otherwise in Project Documentation.

In all instances, the MCBs shall be selected to suit the connected cable and load applications in terms of duty, rated current, short circuit breaking capacity and load characteristics (instantaneous tripping curves to suit resistive loads, motors, fluorescent lighting etc).

A single phase AC or DC main MCB shall be two-pole unless specifically approved otherwise for the application.

The main CB or main isolator, status and operating facility shall be visible and accessible from the front of the panel. MCB's shall be equipped with clear labelling to indicate whether they are ON or OFF.

In all instances main MCB's and main isolators shall be individually pad lockable in the off position. This facility shall be a proprietary proven robust arrangement for accepting standard scissor locks/hasps for group isolation purposes.

MCB's shall include voltage free auxiliary contacts for control system monitoring unless specified otherwise in the Project Documentation.

MCB's shall be mounted on rails that are attached to the gear tray or directly onto busbar chassis assemblies via terminal screws for distribution boards. The distribution of each voltage level shall be in a common area of the control panel and segregation installed between different voltage level distribution sections.

Where more than one wire is to be connected to one side of an MCB for looping purposes to adjacent MCBs, preformed proprietary link bars or combs shall be provided.

MCBs shall have a minimum ingress protection rating of IP2X to prevent inadvertent contact during inspection and maintenance activities.

MCBs shall incorporate captive terminal screws and metal lock dogs provided for each CB and isolator in the panel.

A typed legend in a plastic clear folder shall be provided for all levels of voltage distribution in the panel and fixed to the inside of the control panel front door.

4.28. INDICATING LAMPS

Indicating lamps shall be flush mounted and designed so as not to rotate even if the retaining nut is not fully tightened. The fitting shall be secured to the panel independently of any bezel which needs to be removed for lamp changing.

The status of indication lamps shall be visible from a wide viewing angle.

Lamp holders and lenses shall be designed to dissipate continuously the heat produced by the largest lamp that can be fitted, without deterioration or discoloration.

Lamps shall protrude from the front of the fitting far enough to be readily gripped with the fingers for change-out.

Lamp nominal voltages shall be at least 110% of their supply voltage. LV circuit lamps are not permitted.

Lamps shall be cluster LED type with internal voltage drop resistor.

Colours for indicating lamps shall be:

HV Switchboards:

- Green: CB Open
- Red: CB Closed
- White: Healthy/Lamp Test

Motor Control Centres:

- Green: CB Open / Motor Stopped / off
- Red: CB Closed / Motor Running / On
- White: Healthy/Lamp Test / Ready
- Amber: Fault / Trip/ Alarm/ Caution

Control Stations:

- Green: Running / On
- Red: Stopped / Off
- White: Healthy/Lamp Test / Ready / Status
- Amber: Fault / Trip/ Alarm/ Caution

All lamps operating at the same voltage shall be interchangeable. Lamps operating at different voltages shall not be interchangeable.

Control panels that incorporate indicator lamps shall include a common or integral push-to-test pushbutton to test operation of lamp circuits.

4.29. CONTROL, TRIPPING AND AUXILIARY POWER SUPPLIES

Unless specified elsewhere, the control, tripping and spring charging supply for circuit breakers and latched contactors shall be 24V DC supplied from an external battery and charger unit which is independent of the control system DC power supply. A separate circuit for each function shall be supplied. Refer to TMS1221 for DC Power Supply Systems–Technical Specification.

4.30. ACTUATORS, PUSH-BUTTONS AND CONTROL SWITCHES

The functional requirements of all actuators, push buttons and control switches shall be defined on the relevant projects drawings. All actuators, push-buttons and control switches shall be heavy duty, oil tight and fully rated for the operating conditions and specific application. The device and method of installation shall be selected to maintain the IP rating of the enclosure. Devices shall be selected from TMS62 Preferred Equipment List Electrical and Instrumentation.

All push-button switches, except emergency stop push-buttons shall have a full shroud to prevent inadvertent operation. Emergency stop pushbuttons shall be of the mushroom head, latched type, manually reset and coloured red. Emergency stop push-buttons shall have a guard rings rather than full shrouds.

Colours for actuators and pushbuttons shall be:

HV Switchboards:

- Green: CB Open/trip
- Red: CB Closed

Motor Control Centres:

- Green: CB Open / Trip / Contactor Open
- Red: CB Closed / Contactor Close
- Blue: Reset

Control Stations:

- Green: Start /Jog/ Close /On
- Black: Process Stop / Normal Off
- Red: Emergency Stop/ Emergency Off
- Blue: Reset

4.31. PLC

The PLC and RTU hardware components shall be selected from the TMS1151 Preferred Equipment List – Control Systems.

The control panel shall include 20% spare installed I/O of each type and there shall be at least 20% spare unused slots in PLC racks for future expansion of the I/O count.

All PLC spare I/O shall be terminated to marshalling terminals.

PLC hardware components in corrosive environments shall be conformal coated.

All field cables are terminated to marshalling terminals in the control panel before connecting to the PLC I/O cards.

4.32. 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.

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.

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

4.33. 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.

4.34. EMERGENCY STOP CIRCUITS

Emergency Stop circuits installed in control panels 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. 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.

4.35. COMMUNICATIONS PANELS

Dedicated communication panels shall be Rack Unit type and either wall or floor mounted on a galvanised steel plinth. The enclosure and communication equipment contained within shall be supplied as per the TMS62 Preferred Equipment List – Electrical and Instrumentation.

The supply voltage level for new Communications Panels shall be 24VDC unless specified otherwise in Project Documentation.

New Communications Panels shall have the same panel key lock barrels as that used for Control Panels.

Communication Panels shall be front and rear accessible unless specified otherwise in the Project Documentation.

The same requirements for control panels outlined in this Specification also apply to communication panels with the additional requirements:-

- Fibre cables can be multi-mode or single mode, however fibre cable type must be consistent for the entire installation.
- Dedicated communication panels shall only be installed in indoor areas.
- For small projects the communication equipment such as FIBOTS, Ethernet switches, protocol converters may be installed inside the PLC control panel.
- Communication cable access to the panel shall be individually glanded.

4.36. ETHERNET SWITCHES

Ethernet switches shall be selected from TMS1151 Preferred Equipment List – Control Systems.

All Ethernet switches shall include 25% spare copper port(s) capacity. If the switches contain fibre port(s), then 25% spare or one (1) spare fibre port shall be provided whichever is greater.

4.37. SERIAL TO ETHERNET CONVERTERS

Serial to Ethernet converters shall not be used for any interface requirements of the control systems. The design shall select the equipment (VSD, relays, power meters, flow meters, communication cards of PLC etc.) that support inbuilt Ethernet port connectivity.

Equipment that does not support inbuilt Ethernet connectivity for control systems interfaces shall not be used without prior acceptance by QUU.

4.38. COPPER TO FIBRE OPTIC CONVERTERS

The design shall avoid the use of copper to fibre optic converters wherever possible. This can be done by selecting communication equipment (network switches for example) that support inbuilt fibre optic ports.

Copper to fibre optic converters shall not be used without prior acceptance by QUU.

4.39. PROTOCOL CONVERTERS

Protocol converter(s) shall not be used for any interface between systems. Due diligence shall be made during the selection of transmitting and receiving equipment to ensure that they both support common protocol and their communication interface can be established without the need for protocol converter equipment.

Protocol converters shall not be used without prior acceptance by QUU.

4.40. FIBRE OPTIC BREAK OUT TRAYS (FOBOT)

All fibre optic cabling shall be terminated in FOBOTs fitted with plug in fibre optic connectors.

FOBOT shall be mounted as close to the top of the control or communications panel as practical.

FOBOTs shall be rack mounted in communications panels and DIN rail mounted in control panels.

FOBOTS to have 50% spare unused ports provided for future cable termination

All termination/patch panels shall use SC type connectors.

All spare fibre optic cores shall be terminated and identified.

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

Cable management facilities shall be provided for all patch leads.

A warning notice detailing the hazards associated with optical devices shall be affixed to each termination enclosure in a prominent position.

5. QUALITY ASSURANCE, INSPECTION AND TESTING

5.1. QUALITY ASSURANCE

The Contractor shall demonstrate that they comply with a quality system in accordance with an internationally recognized standard. The effectiveness of the quality system and the Contractor's compliance with it shall be subject to monitoring by QUU and in addition, may be audited following an agreed period of notice.

The Contractor shall submit a quality control program for QUU review at the time of Tender. The Contractor shall provide facilities for, and cooperate with, QUU inspectors during manufacturing, assembly 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.

QUU standard check sheets are the minimum requirements to be prepared by the Contractor.

- CHE28 Factory Inspection Checks – Switchboards
- CHE135 Pre factory inspection test sheets checklist.
- CHE73 Standard Electrical Specification Fixed Speed Sewage Pump Station Factory Acceptance Test (FAT) Check List.

The Contractor may utilise alternative documentation for inspection and testing, however all documents shall be approved by QUU in writing before the inspection and testing tasks commence.

Refer to TMS1202 Control System Implementation Network Assets – Section 8 for minimum requirements for all inspection and testing of control panels and associated control system software.

5.2. ROUTINE TEST AND FACTORY ACCEPTANCE TEST

Routine tests and a final Factory Acceptance Test (FAT) shall be carried out in accordance with the relevant Australian Standards. The Contractor shall provide written notice to advise QUU within 10 business days prior to the commencement of testing so that testing may be witnessed by a representative of QUU. QUU will not attend the factory testing until the FAT Plan and supporting check sheets have been accepted by QUU.

Certified test records, consolidated in the FAT Report for each control panel shall be provided 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 routine and FAT shall include but not limited to the following:

- Completeness check
- Quality of the manufacture
- Checking of rating plates
- Testing of all protection devices as primary or secondary injection test
- Insulation resistance tests
- Special tests when required and mutually agreed with QUU
- Earth continuity tests
- Primary injection to demonstrate correct ratio and polarity of CT's and correct operation of instrument and protection circuits
- Functional check of circuit breaker and switch operation and control circuits including local and manual controls and simulation of remote controls
- Functional test of all interlocking between devices and equipment
- Battery load test including complete discharge and recharge.

Power circuits insulation shall be tested using a 1000 V 'Megger' or approved equivalent voltage test unit. Control wiring shall be tested at 500 V only.

Semiconductor equipment and sensitive electronic components such as PLCs and instruments shall not be voltage tested.

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.

5.3. 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 control panel and copies of the drawings forwarded to QUU.

The following items shall be checked:

- 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;
- clearance and creepage distances and degrees of protection;
- doors and access covers for sealing;
- bolted and screwed connections for tightness and adequate contact;
- label text against relevant schedules.

5.4. FUNCTIONAL CHECKING

Each and every wire in the control panel shall be checked for correct connection and marked off on the schematic drawings. The drawings shall be amended to reflect the final connections of the control panel as despatched from the workshop.

If QUU carries out spot checks of the completed control panel and discovers inconsistencies with the test records or drawings provided, then the Contractor shall retest the entire control panel 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.

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 5 business days of completing the FAT.

5.5. 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 the control panel, in accordance with the Contractor's recommended SAT and commissioning procedures. Where specified in the Project documentation the Contractor shall provide a SAT Plan, Commissioning Plan as well as supervision of the site works, 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
- Secondary injection tests
- Functional test to prove the operation of items.
- 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 configuration settings for all parameters associated with the equipment contained within the control panel.

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

5.6. SITE SUPPORT

The Contractor, in their Tender, shall provide details of their after sales support capability. Contractors shall advise their nearest service representative for the equipment.

6. DOCUMENTATION

6.1. PRIOR TO AWARD

The Contractor shall provide the documentation specified in the Project Documentation with the Tender submission.

6.2. DOCUMENTATION AFTER CONTRACT AWARD

After the award of the Contract, the Contractor shall supply the information specified in the Project Documentation for the Contract. The information shall be supplied in the timeframe as specified in the SDRL and in the format as specified below. Equipment manufacture shall not commence until all the design documentation related to the equipment 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 RPEQ electrical before submission to QUU at all stages of the project delivery.

Fabrication of any equipment shall not commence until QUU has reviewed and accepted calculations, drawings and any other design documentation.

6.3. DRAWINGS

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

- General Arrangements(internal and external)
- Single Line Diagrams
- Schematics
- Termination Diagrams
- Installation Details

Where control panel '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 control panel and shall produce workshop drawings.

Drawings shall be submitted in accordance with

- PRO307 Procedure Drafting Guidelines – Contract Requirements
- SEQ Water Supply and Sewerage Design & Construction Code (SEQ WS&S D&C Code).
- 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 equipment enclosure 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.

6.4. EQUIPMENT LISTS

The equipment list provided by the Contractor shall detail the equipment type, manufacturer, model number and quantity of every item of equipment being supplied. This shall include all minor equipment such as control relays, lamps and terminals.

6.5. LABEL SCHEDULE

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

6.6. 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 provided within 5 business days after the site commissioning 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
- Equipment Asset Tagname and Title
- Contract number and year of installation
- 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)

Original native files saved to PDF shall be used wherever possible. Scans of printed documents shall not be accepted, except for signature and approval pages which may be colour scanned and merged into the rest of the PDF document.

Original PDF files available from high resolution sources such as vendor web sites shall be used otherwise, such as for sub-equipment manuals and data sheets. Original PDFs from these sources shall be merged into the O&M manual master PDF file. Scans of printed documents available as high resolution PDFs shall not be accepted.

Low resolution scans, copies of copies, faxes or otherwise degraded reproductions of documents are not acceptable.

The following minimum information shall 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 equipment 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;
- FAT report
- SAT report (if site testing is included in the Contract)
- List of spare parts provided.

6.6.1. 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.

For PDF file sources use PDF editing tools to strike through text rather than printing, manually marking and rescanning. This will avoid loss of text searching and indexing capability from the PDF file.

7. SPARE PARTS AND SPECIAL TOOLS

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

7.2. 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 control panel equipment with the Tender Proposal.

QUU will advise the Contractor what components will be procured.

8. PACKAGING, HANDLING AND SHIPPING

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

All enclosures will be sealed to their final degree of protection (IP Code) according to AS 60529.

Where required cable entries can be plugged with a suitable gland plug which will provide the same protection as the final gland.

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

Control panels shall be manufactured and tested at the factory, and shall be shipped completely assembled.

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.