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DC Power Supply Systems

TMS1221

Standard Technical Specification



REVISION CONTROL

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Contents

REVISION CONTROL	2
1 SCOPE.....	6
1.1 DEFINITIONS	6
1.2 ACRONYMS AND ABBREVIATIONS	6
1.3 REFERENCE DOCUMENTS	7
2 STANDARDS & REGULATIONS	9
2.1 AUSTRALIAN STANDARDS	9
2.2 INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC) STANDARDS	11
2.3 REGULATIONS	11
2.4 UNITS AND LANGUAGE	11
2.5 SUB-CONTRACTORS	11
2.6 CONTRACTOR EXCEPTIONS	12
2.7 ORDER OF PRECEDENCE.....	12
3 ELECTRICAL DESIGN CRITERIA	13
3.1 OPERATING CONDITIONS AND DESIGN LIFE	13
3.2 SITE CLIMATIC CONDITIONS.....	13
3.3 OPERATING REQUIREMENTS.....	13
3.4 UTILITY DATA	14
3.5 WORKMANSHIP AND PERSONNEL.....	14
3.6 MATERIALS AND EQUIPMENT.....	15
3.7 WEATHER AND INGRESS PROTECTION	16
3.8 CONTROL, TRIPPING AND AUXILIARY POWER SUPPLIES	16
4. TECHNICAL REQUIREMENT	17
4.1 NORMAL OPERATION	17
4.2 AC POWER SUPPLY LOSS OPERATION.....	17
4.3 BATTERY RECHARGE OPERATION	18
4.4 MAINTENANCE OPERATION.....	18
4.5 BATTERY BACK-UP TIME.....	18
4.6 FOUNDATIONS AND SUPPORTING STRUCTURES	18
5 ELECTRICAL REQUIREMENTS	19
5.1 INPUT AC POWER SUPPLY	19
5.2 OUTPUT DC VOLTAGE.....	19
5.3 RECTIFIER / BATTERY CHARGER.....	19
5.4 INVERTER.....	20
5.5 DC-DC CONVERTER	21
5.6 BATTERY	21
5.7 BATTERY MONITORING SYSTEM	22
5.8 INTEGRAL DISTRIBUTION BOARDS.....	22
6 PROTECTION	23
6.1 RECTIFIER / CHARGER.....	23
6.2 INVERTER.....	23
6.3 BATTERY	23
6.4 DISTRIBUTION BOARDS	24
6.4.1 DC Distribution Boards	24
6.4.2 AC Distribution Boards	24
6.5 SAFETY INSTRUMENTED SYSTEM SHUTDOWN.....	24

7	CONSTRUCTION	25
7.1	BATTERY	25
7.2	ENCLOSURES	25
7.3	ACCESSIBILITY	25
7.4	COOLING	26
7.6	COMPONENTS	26
7.7	PANEL WIRING.....	27
7.8	EARTHING	27
8	COMMUNICATIONS	28
8.1	BATTERY MONITORING SYSTEM	28
8.2	BATTERY CHARGER.....	28
8.3	DC-AC INVERTERS	29
8.4	DC-DC CONVERTERS	29
9	MEASUREMENT AND CONTROL	30
9.1	STATUS INDICATIONS	30
9.2	MEASUREMENTS.....	30
9.3	ALARMS AND REMOTE INDICATION.....	30
9.4	CONTROLS.....	31
9.5	DISTRIBUTION BOARDS	31
10	QUALITY ASSURANCE, INSPECTION AND TESTING	32
10.1	QUALITY ASSURANCE.....	32
10.2	ROUTINE TEST AND FACTORY ACCEPTANCE TEST	32
10.3	PERFORMANCE TESTS	33
10.3.1	Load Tests	33
10.3.2	Protection Tests	34
10.3.3	Short Circuit Test.....	34
10.3.4	Heat Run Test.....	34
10.3.5	High Voltage Flash Test	34
10.4	FAT TEST REPORT	34
10.5	INSPECTION AND TEST PLAN.....	35
10.6	FUNCTIONAL CHECKING.....	36
10.7	SITE ACCEPTANCE TESTING AND COMMISSIONING.....	36
10.8	SITE SUPPORT.....	37
11	PROTECTIVE COATINGS.....	38
12	LABELING AND IDENTIFICATION	39
12.1	PRIMARY NAMEPLATE	39
12.2	RATING PLATES.....	39
12.3	DANGER AND WARNING LABELS	40
13	PACKAGING, HANDLING AND SHIPPING	41
14	DOCUMENTATION	42
14.1	PRIOR TO AWARD.....	42
14.2	DOCUMENTATION AFTER CONTRACT AWARD	42
14.3	DRAWINGS	42
14.4	EQUIPMENT LISTS	43
14.5	LABEL SCHEDULE.....	43
14.6	MANUALS	43
14.7	GENERIC MANUALS.....	44
14.8	BATTERY SIZING CALCULATIONS	44
14.9	MAXIMUM DEMAND CALCUALATION.....	44

14.10	ENCLOSURE VENTILATION CALCULATION.....	45
15	SPARE PARTS AND SPECIAL TOOLS.....	46
15.1	SPARES.....	46
15.2	SPECIAL TOOLS.....	46

1 SCOPE

This specification details the minimum technical requirements for design, manufacture and testing of DC power supply systems dedicated to HV Switchboard protection, control and monitoring functions.

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.

1.2 ACRONYMS AND ABBREVIATIONS

ACB	Air Circuit Breaker
AC	Alternating Current
AS	Australian Standard
BMS	Battery Monitoring System
CISPR	Special international committee on radio interference
CT	Current Transformer
DC	Direct Current
ELV	Extra Low Voltage
EMC	Electromagnetic Compatibility
FAT	Factory Acceptance Test
HV	High Voltage
IEC	International Electro-technical Commission
ICSS	Integrated Control and Safety System
ISO	International Organization for Standardization
I/O	Input / Output
IP	Ingress Protection
ITP	Inspection and Test Plan
LCD	Liquid Crystal Display
LED	Light Emitting Diode

LV	Low Voltage
LCP	Local Control Panel
MCC	Motor Control Centre
NC	Normally Closed
NO	Normally Open
MCCB	Moulded Case Circuit Breaker
OEM	Original Equipment Manufacturer
O&M	Operation and Maintenance Manual
PCS	Process Control System
PLC	Programmable Logic Controller
PPE	Personal Protective Equipment
RCD	Residual Current Device
RTU	Remote Telemetry Unit
QUU	Queensland Urban Utilities
SI	International System
SAT	Site Acceptance Test
SLD	Single Line Diagram
TCP	Transmission Control Protocol
UPS	Uninterrupted Power Supply
VT	Voltage Transformer

1.3 REFERENCE DOCUMENTS

Document Number	Title
TMS60	Low Voltage Switchboards and Enclosures
TMS62	Preferred Equipment List – Electrical and Instrumentation
TMS76	Corrosion Protection for Electrical and Mechanical Equipment and Structures
TMS1186	High Voltage Switchboards - Technical Specification
TMS1200	Electrical Installation - Technical Specification
TMS1202	Control System Implementation for Network Assets
TMS1222	Control Panels - Technical Requirements
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 & 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 Supplier 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 1023	Part 2, Thermal Overload Protective Devices
AS 1028	Power Reactors and Earthing Transformers
AS 1029	Part 1, Low Voltage Contactors (Up To and Including 1000 V AC)
AS 1042	Direct Acting Electrical Measuring and Indicating Instruments and their Accessories
AS 1102	Graphical Symbols for Diagrams
AS 1202	Part 1, DOL Motor Starters Part 5, Semiconductor Starters
AS 1242	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
AS1627.4	Metal Finishing – Preparation and Pretreatment of Surfaces – Abrasive blast cleaning of steel
AS 1675	Current Transformers for Measurement and Protection
AS1768	Lightning Protection
AS 1775	Air Break Switches, Isolators and Fuse Combination Units (Up to and Including 1000 V AC and 1200 V DC)
AS 1930	Circuit Breakers for Distribution Circuits

AS 1939	Classification of Degrees of Protection Provided by Enclosures for Electrical Equipment
AS 2005	HRC Cartridge Fuses, up to 1000 V
AS 2067	Substations and High Voltage Installations above 1kV a.c.
AS 2053	Conduits and Fittings for Electrical Installations
AS 2184	Moulded Case Circuit Breakers
AS 2467	Maintenance of Electrical Switchgear
AS 2676.2	Guide to the Installation, Maintenance, Testing and Replacement of Secondary batteries in Buildings – Sealed Cells
AS 2692	Busbars and Busbar Connections
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 3011.2	Electrical installations – Secondary Batteries Installed in Buildings – Sealed Cells
AS 3111	Approval and Test Certification for Miniature Overcurrent Circuit Breakers
AS 3133	Approval and Test Specification – Air Break Switches
AS 3135	Approval and Test Specification – Semi-Enclosed Fuses for a.c. Circuits
AS 3147	PVC Insulated Cables and Flexible Cords
AS 3167	Protective Isolating Transformers
AS 3011.2	Electrical installations – Secondary Batteries Installed in Buildings – Sealed Cells
AS 3808	Insulation and Sheathing Materials for Electric Cables
AS 3439.1	Low Voltage Switchgear and Control Gear Assemblies Part 1 - Type Tested and Partially Type Tested Assemblies
AS 4044	Battery Chargers for Stationary Batteries
AS 4070	Recommended Practices for Protection of Low Voltage Electrical Installation and Equipment in MEN Systems for Transient Over Voltages
AS 4509.1	Stand alone power systems – Safety requirements
AS 60044	Instrument Transformers
AS 60146	Semiconductor Converters – General Requirements and Line Commutated Converters
AS 60269.1	Low Voltage Fuses – General Requirements
AS 60269.4	Low-voltage fuses - Supplementary requirements for fuse-links for the protection of semiconductor devices
AS 60529	Degrees of Protection Provided by Enclosures (IP Code)

AS 60947	Low-voltage Switchgear and Control gear
AS 61000	Electromagnetic Compatibility (EMC)
AS 61558.1	Safety of power transformers, power supplies, reactors and similar products – general requirements and tests
AS/NZS CISPR 11	Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement

2.2 INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC) STANDARDS

IEC 60050	International Electro-technical Vocabulary
IEC 60051	Recommendation for Direct Acting Indicating Analogue Electrical Measuring Instrument and their Accessories
IEC 60228	Conductors of Insulated Cables
IEC 60332 all parts	Flame Test On Single Insulated Wire/Cables and Bunched Wires/Cables
IEC 60445	Basic and Safety Principles for Man-Machine Interface, Marking and Identification - Identification of Equipment Terminals, Conductor Terminations and Conductors

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: Environmental Protection Act - 1994 and Amendment Act - 1997
- Building Code of Australia
- Supply Authority Conditions of Supply and Consumer Metering
- Workplace Health and Safety Regulation (2011)
- Electrical Safety Act 2002 and its latest amendments
- 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 Supplier 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 Supplier are applicable to sub-Suppliers or sub-suppliers. QUU reserves the right to attend the premises or otherwise of any sub-Supplier 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:-

- 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 5 years 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:-

Location	South East Queensland	
Altitude	Above mean sea level.	0-150m
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 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 and assembly of the DC Power Supply electrical 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 electrical enclosures shall be Ingress Protection (IP) rated as specified in the Project Documentation.

Indoor enclosures containing equipment that is susceptible to damage or failure due to moisture and dust ingress shall be rated to IP42 unless otherwise specified. DC Power Supply Systems shall not be located in outdoor areas unless specified otherwise in the Project Documentation.

3.8 CONTROL, TRIPPING AND AUXILIARY POWER SUPPLIES

Unless specified elsewhere, the control, tripping and spring charging supply for circuit breakers and latched contactors is preferred to be 24V DC supplied from an external battery and charger unit. Refer to HV switchboard specification for spring charge requirements. A separate circuit for each function shall be supplied and run the length of the switchboard. Individually circuits with dedicated MCB for each switchboard cubicle will be supplied from this bus. These supply requirements excludes those to process and instrumentation equipment.

4. TECHNICAL REQUIREMENT

Refer to TMS1222 Control Panel Technical Requirements - Section 5 for technical requirements of the DC Power Supply Panels.

The DC Power Supply System can typically consist of:-

- 2 x Rectifiers / Battery Chargers,
- battery banks(parallel string of cells)
- 2 x Inverters,
- 2 x Converters
- Distribution Board for 24 V DC distribution and,
- Distribution Board for 240 V AC distribution

The system shall be arranged in a redundant configuration such that in the event of failure of one of the rectifier/battery units, the total load will be transferred to the healthy unit. The diode configuration shall have a reliable design fit for purpose. The system configuration shall be in accordance with the Project Drawings and the Project Data Sheets.

The design shall offer a common DC power supply system for the installation which excludes the DC power to process, instrumentation and other loads unrelated to the HV switchboards. In addition the Project Documentation may specify the requirement for an LV Distribution Board fed from Inverters. Converters shall be provided where DC voltage other than 24VDC is required.

The DC Power Supply System shall have the following modes of operation;

4.1 NORMAL OPERATION

Incoming normal AC power shall be converted to a regulated DC output by a rectifier / charger, which shall then supply DC power to the batteries and the DC Distribution board that shall then distribute DC power to the individual loads. Where 240VAC or other AC voltage level is specified in the Project Documentation the DC power supply shall feed the inverters that supply AC power to a common single phase LV Distribution Board that shall feed downstream AC loads.

The batteries shall be continuously float charged during normal operation.

4.2 AC POWER SUPPLY LOSS OPERATION

In the event of loss of the incoming normal AC power supply, the batteries shall continue to supply DC power to the load without interruption for the specified battery autonomy time.

4.3 BATTERY RECHARGE OPERATION

Upon restoration of the normal AC power supply, the rectifier / charger shall resume supplying power to the load without interruption. The maximum recharge time shall be stated in the Project Documentation.

4.4 MAINTENANCE OPERATION

It shall be possible to isolate a single rectifier / battery unit for maintenance (or repair) and transfer the total load to the running unit without interruption of power supply.

Access panel/doors shall be adequately sized to allow removal of the batteries for replacement. Large batteries shall not be required to be lifted for removal and preferably placed in separate rack/enclosure or drawers.

4.5 BATTERY BACK-UP TIME

The battery bank shall supply the nominated load current for a back-up time as defined on the Project Data Sheets. A minimum 8 hours back-up time at maximum demand and at end of battery cell design life shall be provided, unless specified otherwise in the Project Documentation.

4.6 FOUNDATIONS AND SUPPORTING STRUCTURES

The Contractor shall design and supply the various frames and support structures associated with the equipment as well as the required hold down bolt details for the racks and enclosures housing the DC Power Supply System. All hold down bolts and specialist fasteners shall be provided by the Contractor.

5 ELECTRICAL REQUIREMENTS

5.1 INPUT AC POWER SUPPLY

The input AC power supply shall be fed from an Essential Services supply at 415VAC, three phase, 4 wire, 50 Hz, for loads in excess of 10kVA and 240VAC 50Hz single phase for other size loads.

The equipment shall be able to withstand, without damage and subsequent malfunction, input voltage depressions of up to 20% for 10 seconds and transient voltage spikes of up to 2 kV. Equipment shall also be able to tolerate +/- 5% frequency variations without interruption.

RCD's shall not be installed on the line side of the power supply.

5.2 OUTPUT DC VOLTAGE

The nominal DC output voltage of the system shall be as nominated on the Project Data Sheets.

The DC output voltage shall be within the limits specified on the Project Data Sheets for all conditions of DC load, battery charge and discharge.

Radio frequency interference of the DC Power Supply System shall be within the limits specified in AS CISPR 11.

5.3 RECTIFIER / BATTERY CHARGER

Battery chargers shall be three phase, phase controlled rectifier type and be classified as Type 4 in accordance with AS4044 unless specified otherwise on the Project Data Sheets.

Each rectifier / charger shall be rated to recharge the battery bank to 90% within 10 hours following a discharge at rated load for the specified autonomy time, whilst at the same time fulfilling the load requirements as specified on the Project Data Sheets.

'Soft-start' capability shall be provided to eliminate overcurrent during starting by gradually accepting load until nominal conditions are reached.

In order to maintain battery life, the rectifier / charger shall limit the charging current to a maximum value, as specified by the battery manufacturer. The rectifier / charger shall also limit the total current drawn to avoid overloading the power supply.

Rectifier / charger voltage regulation shall ensure DC output voltage fluctuations of less than $\pm 2\%$, irrespective of load or input voltage variations (within the limits specified in Section 3.3).

The rectifier / charger shall be provided with automatic float voltage variation to compensate for changes in the battery's ambient temperature.

The rectifier / charger shall have a float charging mode. In this mode, the battery charger output voltage shall be set to a constant value specified by the Contractor and voltage variations shall be controlled to within $\pm 1\%$ of the set value.

5.4 INVERTER

Where specified in the Project Documentation the inverter shall form part of the DC Power Supply System providing 230 V AC derived from the battery backed 24V DC supply.

The inverter shall be sized to supply the load as indicated on the Project Data Sheets.

The variation in the inverter steady-state output voltage shall be limited to $\pm 5\%$ for a balance load between 0% and 100% of the rated power, irrespective of the normal AC input and DC voltage levels (given that they are within the limits specified in Section 5.1 and 5.3 respectively).

Output voltage transients shall not exceed $\pm 5\%$ of the rated voltage at 0% to 100% load step.

The total harmonic distortion of the voltage waveform shall not exceed:

- 5% at the fundamental frequency when supplying a linear load
- 10% at the fundamental frequency when supplying a non-linear load

The output frequency shall be regulated with a tolerance of $\pm 1\%$ rated frequency and maximum rate of change of 0.2 Hz/s.

The inverter shall be capable of operating continuously under the following loading conditions:

- Load variations between 0% and 100% of rated output
- Load power factors ranging between 0.8 and unity
- When delivering maximum continuous rms rated current containing the following harmonic content:
 - 3rd Harmonic – 40% of fundamental
 - 5th Harmonic – 30% of fundamental
 - 7th and higher odd harmonics – 7% of fundamental

The inverter shall be able to supply 150% of the rated load for 60 seconds with all output characteristics within the specified tolerances above for the rated load.

The inverter shall supply sufficient short circuit current to cause operation of the largest output circuit protective device specified within half a cycle.

The redundant inverter outputs shall be synchronised to allow connection to a common LV distribution board.

5.5 DC-DC CONVERTER

The DC-DC converter shall be sized to supply the load as indicated on the Project Drawings and Data Sheets.

The converter shall include a transformer to provide galvanic isolation between input and output. The output voltage transients shall not exceed $\pm 5\%$ of the rated voltage at 10% to 100% load step.

The converter shall be capable of operating continuously under the following loading conditions:

- Load variations between 0% and 100% of rated output

The converter shall supply load with power factors ranging between 0.8 and unity.

5.6 BATTERY

The battery bank shall consist of identical cells (same model numbers) and have sufficient capacity to supply 100% of the design load for the full specified autonomy, at the normal ambient temperature specified in Section 3.2 and on Project Data Sheets, with no rectifier / charger available, whilst maintaining the DC voltage within the tolerances specified. The design load shall include 20% spare capacity for future growth in load.

The battery bank shall have adequate capacity to repeatedly provide the discharge duty based on the load profile and requirements specified in the Project Data Sheets. The Contractor shall state the estimated battery life at the design temperature on the Data Sheet.

The minimum end of discharge voltage shall be as per the value stated in the Project Data Sheets.

Battery terminals shall be shrouded with insulating material to prevent accidental short circuiting of cells during maintenance and installation.

The Contractor shall supply all inter-cell connections, circuit breakers, cabling and shrouds necessary for the battery system. Where batteries are located external to the battery charger enclosure, the Contractor shall supply all DC cabling between the battery charger and batteries.

The nominal ampere-hour capacity of the battery shall include the necessary allowance to compensate for ageing and temperature effects, which result in a progressive loss of capacity. New battery capacity shall not be less than 125% of the nominal ampere-hour capacity required to fulfil the performance criteria specified.

It shall be possible to isolate the battery bank with a double pole MCB for replacement or maintenance of cells without shutting down the battery chargers or disconnecting load.

5.7 BATTERY MONITORING SYSTEM

A Battery Monitoring System (BMS) shall be incorporated into the battery system design capable of monitoring each cell of the battery bank.

As a minimum the BMS shall monitor and measure following information to be displayed on the local HMI and remote SCADA;

- Cell voltage
- Cell temperature
- Cell impedance
- Battery capacity remaining
- Cycle life of battery remaining
- Charge/Discharge current
- Deep discharge level
- Float Voltage Level

Where the BMS cannot monitor/measure the above items directly, the Contractor shall provide a method to calculate the items above based on measured values.

The BMS shall be connected via a communication interface specified in Section 8.1 as well as have a logging system for all data measured.

5.8 INTEGRAL DISTRIBUTION BOARDS

The DC and AC distribution boards shall be integral with the DC power supply panel. The distribution boards shall comply with the requirements in AS 3439.1

Distribution boards shall be of the “dead front” construction type such that live parts are inaccessible while operational adjustments and maintenance is being performed.

Distribution boards shall be designed such that anti-condensation heaters are not required in the environmental conditions specified in Section 3.2.

The distribution boards shall each have at least 20% spare fully equipped circuits for future modifications or expansion with 20% spare poles. All spare slots shall be filled with blanking plates.

Distribution board shall be in accordance with the specifications indicated on the Project Data Sheets and physical segregation provided between AC and DC voltage levels.

6 PROTECTION

Protection systems shall be arranged to provide discrimination throughout the system including the source of supply.

The DC Power Supply System shall include protection against AC power source overvoltage as per AS 60146, earth faults, excessive external temperature rise, excessive internal temperature rise and transport vibrations.

All DC circuit breakers shall be 2 pole and suitably rated as specified on the Project Drawings.

6.1 RECTIFIER / CHARGER

Each rectifier / charger shall have a circuit breaker provided on the AC input.

Each rectifier / charger shall have DC overvoltage protection and shall automatically shut down if the DC voltage reaches the maximum voltage setting.

Each rectifier / charger shall have reverse polarity protection on the output to the battery.

Each rectifier / charger shall provide the following DC protection:

- DC overvoltage disconnection
- DC undervoltage alarm (Low battery voltage)
- DC undervoltage disconnection (End of battery discharge).

The DC undervoltage disconnection shall be fitted with a suitable bypass to allow charging of the batteries.

The Contractor shall specify the current rating of the protection to be installed in the mains supply switchboard for each rectifier / charger.

6.2 INVERTER

The load shall be protected against AC overvoltage that could result from voltage regulation failure at the output of the inverter.

The inverter shall be provided with reverse polarity protection.

6.3 BATTERY

The battery bank shall be supplied with a 2 pole, suitably rated DC circuit breaker. The batteries shall be protected for excessive discharge by limiting the discharge time to three times the backup time at full rated load.

6.4 DISTRIBUTION BOARDS

6.4.1 DC Distribution Boards

The DC distribution board shall be fitted with an incoming 2 pole DC circuit breaker.

All outgoing feeders shall be supplied with a 2 pole, suitably rated DC circuit breakers.

6.4.2 AC Distribution Boards

The AC distribution board shall be fitted with an incoming AC circuit breaker.

All outgoing feeders shall be supplied with suitably rated AC circuit breakers.

Earth leakage CB's or RCD's where applicable shall be installed to all LV circuits unless specified otherwise in the Project Documentation.

6.5 SAFETY INSTRUMENTED SYSTEM SHUTDOWN

QUU will provide a voltage free contact signal to allow disconnection of batteries on the detection of a flammable gas in the vicinity of the switchroom. The Contractor shall provide the contactor to isolate the battery bank and ensure the battery charger controls provide safe shutdown without causing damage to any components. This requirement shall be incorporated with the additional requirement to disconnect the batteries at the end of the autonomy time.

7 CONSTRUCTION

7.1 BATTERY

The battery cells shall be Lithium Ion Phosphate type.

The cells shall be connected in parallel strings so any individual cell failure does not render the entire battery bank unavailable.

Batteries shall be suitable for 10 year design life at the ambient conditions specified for the switchroom or other place of installation.

The Supplier shall provide all inter-cell connectors, bolts, nuts, washers, terminal grease and shrouding to all live components to IP2X.

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

All cabling between cells shall be insulated and uninsulated cables are not accepted in the battery compartment.

7.2 ENCLOSURES

All components of the DC Power Supply System shall be installed in free-standing, self-supporting steel enclosures and suitable to support the weight of internal components.

The enclosures shall be manufactured in accordance with TMS1222 Control Panel Technical Specification. Enclosures shall provide a minimum degree of protection of IP42 with doors closed and IP2X with doors open, as defined in AS 60529.

A separate enclosure is required for the battery bank and charger.

7.3 ACCESSIBILITY

The rear of the enclosures shall be suitable for installation against a wall. The enclosure shall be fully accessible from the front, conducive to servicing, adjustments and component replacement.

All live terminals located within the enclosure shall be suitably protected by barriers or shrouds to IP2X.

Equipment and components shall be arranged in compartments, such that discrete parts of the system can be isolated under full load conditions and made safe for maintenance work to be undertaken with the remainder of the system in service.

Cable entry is from the bottom only of all enclosures and individually glanded through a non-ferrous gland plate unless specified otherwise in the Project Documentation.

7.4 COOLING

Internal cooling of the enclosures shall be by natural or forced air ventilation. If forced air ventilation is provided the power supplies for ventilation fans shall be derived from the main incoming LV power supply and not an auxiliary supply fed from the DC Power supply equipment.

To avoid shutdown of the DC power supply system in the event of a ventilation fan failure, redundant (N+1) fans shall be provided. The enclosure temperature shall be monitored by a thermostat and an over temperature warning alarm and shut down alarm provided to a local PLC.

All enclosures 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 in the switchroom
- Component heat dissipation

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. Forced Ventilation fans shall offer N+1 redundancy

Air intake and exhaust outlets shall be provided with air filters and the filters shall be 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.

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.

7.6 COMPONENTS

Transformers and reactors shall be continuously rated and shall conform to AS 60076 and AS 60289 respectively and shall meet the additional requirements detailed in AS 60146.1.3.

All electronic components shall be subjected to a component quality control system complying with AS 3439.

Fuses shall comply with AS 60269.1 and AS60269.2. Fuse holders shall be self-coloured black. Link holders shall be self-coloured white.

All unearthed poles of supplies shall be fused. Earthed poles shall be connected via a link holder.

Contactor shall comply with AS 60947.

Indicating instruments shall be flush mounted and shall comply with AS 1284.1.

Indicating lights shall be LED cluster flush mounted and shall have a life of not less than 10,000 hours with the operating voltage at its maximum tolerance.

Isolating devices shall comply with the requirements of AS 60947.1 as appropriate for the duty for the device. They shall be padlockable in the off position only. Bypass devices shall be lockable in any position and shall operate without any interruption of the supply to the equipment.

No component mounted on the exterior of the enclosure shall be less than 750mm or more than 1800 mm from the base.

7.7 PANEL WIRING

Panel wiring shall be in accordance with TMS1222 Control Panels – Technical Specification.

In addition the main DC cable should be lugged and be flexible cable type. Hard drawn cables are not accepted to battery banks.

Flexible cables should be of sufficient length to rack out the battery racks or drawers.

7.8 EARTHING

DC Power Supply enclosure shall have an internal earth bar. All metalwork, cable gland plates and component or sub-assembly chassis shall be bonded to the earth bar.

Refer to TMS1222 Control Panels – Technical Specification for further details on enclosure and equipment earthing requirements.

The batteries negative supply shall be earthed unless specified otherwise in the Project Documentation.

8 COMMUNICATIONS

8.1 BATTERY MONITORING SYSTEM

The battery monitoring system shall be designed to connect via a Modbus TCP communications link to a local PLC. The following signals shall be available over the Modbus TCP link:

- Cell Temperature
- Cell Impedance (Average, Minimum and Maximum)
- Depth of Discharge (Average, Minimum and Maximum)
- Estimated Battery Capacity Remaining
- Time Left to Low Voltage
- Discharge Current (Average, Maximum)
- Charge Current (Average, Maximum)
- Deepest Discharge Level
- Counter of Deep Discharge Events
- Average Time Spent in Deep Discharge
- Maximum Time Spent in a Deep Discharge

Where the BMS proposed cannot monitor/measure the above items directly, the Contractor shall provide a method to calculate the items based on available measured values.

Temperature sensor for monitoring battery cells shall be securely mounted and fixing with double sided tape is not accepted.

8.2 BATTERY CHARGER

The battery charger system shall be designed to connect to the local PLC via a Modbus TCP communications link. The following signals shall be available over the Modbus TCP link:

- Mains Fail Alarm
- Charger Fail
- DC High/Low
- Under/Over Voltage Trip
- Earth Fault
- Battery Disconnected
- Charger Voltage
- Charge Current
- Load Voltage
- Load Current
- Battery 1 Charge/Discharge
- Battery 2 Charge/Discharge

8.3 DC-AC INVERTERS

The DC-AC Inverters shall be designed to connect via a Modbus TCP communications link to a local PLC. The following signals shall be available over the Modbus TCP link:

- Inverter Fault
- Inverter Output Voltage
- Inverter Input Voltage
- Inverter Input Failed

8.4 DC-DC CONVERTERS

The DC-DC Converters shall be designed to connect to via a Modbus TCP communications link to a local PLC. The following signals shall be available over the Modbus TCP link:

- Converter Fault
- Converter Output Voltage
- Converter Input Voltage
- Converter Input Failed

9 MEASUREMENT AND CONTROL

The DC Power Supply System shall be supplied with all the necessary equipment to facilitate operation and control of the equipment in accordance with this specification.

The Contractor shall provide, at tender, details of remote access functionality for interrogation of equipment for fault analysis from external locations.

9.1 STATUS INDICATIONS

As a minimum, the following status information shall be monitored by LED lamps located on the exterior of the enclosure front door:-

- System normal (green)
- System fault (red)
- AC input supply A / B available (green)
- Rectifier / charger A / B available (green)
- Battery A / B charging (green)

Indication may be provided within OEM standard products in lieu of panel mounted indicating lights where accepted by QUU.

Facilities shall be provided to enable a system normal running and system general fault status to be remotely monitored by a PLC input by means of voltage free contacts.

Note: Any lamps provided must have a lamp test facility at the enclosure.

9.2 MEASUREMENTS

The battery charger shall be provided with an LCD display for monitoring purpose. As a minimum, the following measurements shall be provided on the equipment front panel:

- AC input supply A / B voltage (per phase)
- DC output supply A / B voltage
- DC output supply A / B current
- Battery enclosure temperature

9.3 ALARMS AND REMOTE INDICATION

Alarms shall be provided for failures which affect the overall integrity of the system.

Alarms shall not be initiated as a result of transient conditions.

As a minimum, the following alarms shall be provided:

- AC input supply A / B failure
- Rectifier / charger A / B failure
- DC overvoltage / under-voltage

- Battery charge failure
- Battery discharging
- Battery disconnected
- DC earth fault
- Rectifier / charger A / B current-limit mode operating
- Control circuit fault
- High cabinet temperature or ventilation fan failure

Alarm initiated LED's shall remain asserted until manually reset.

Facilities shall be provided to enable the following alarms and status signals to be indicated remotely by means of voltage free contacts to a local PLC:-

- Battery charge running
- Common alarm
- Charger fault/failure

Remote alarms shall be automatically reset when the local alarm indication is manually reset. Additionally, there shall be provision and wiring for minimum 6 off voltage free contacts that are configurable should additional status signals be required in future at the local PLC.

9.4 CONTROLS

All control devices for starting, shutdown and testing of the DC Power Supply System shall be provided. As a minimum, the following control facilities shall be provided:

- Rectifier / charger A / B on/off switch
- Rectifier / charger A / B isolation switch
- DC output voltage adjustment
- DC current limit adjustment
- Load transfer initiating control switch
- Battery A / B isolation breakers
- Alarm Reset

9.5 DISTRIBUTION BOARDS

The AC and DC distribution boards provided shall have following signals monitored by the Local PLC using voltage free contacts:-

- Main incomer status – ON/Tripped
- Miniature CB Auxiliary – ON/Tripped (each MCB auxiliary contact connected in series to a common a PLC input, one PLC input per DB)

10 QUALITY ASSURANCE, INSPECTION AND TESTING

10.1 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, Company and 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.

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

10.2 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.

All testing shall be carried out at the manufacturer's test facility. Test equipment shall be supplied by the manufacturer and shall be calibrated within six months of the test date.

Type tests certificates shall be provided in accordance with AS 60146 prior to time of order. Where Type Test certificates cannot be provided, equivalent testing to that stated in relevant Australian Standards may be performed to validate design requirements. Proposed testing shall be outlined in the applicable ITP for approval by QUU prior to manufacture.

Battery banks shall be tested under maximum demand load condition through a complete discharge and recharge cycle prior to delivery.

The routine testing 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
- Battery load test including complete discharge and recharge to demonstrate 125% of design load rating.

LV 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 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.

10.3 PERFORMANCE TESTS

The DC Supply shall be subject to routine tests in accordance with AS 60146.

Type tests shall be conducted in accordance AS 60146 as detailed below unless agreed otherwise at the time prior to contract award.

10.3.1 Load Tests

The following values shall be measured under conditions of no-load, 5% load, 50% load, and 110% load. Ratings and tolerances of the equipment shall conform to the requirements in this specification in order to pass the performance tests.

The Contractor shall provide all equipment necessary to perform load tests.

- Input voltage, frequency, current and power.

- Output voltage and current.
- Battery current and voltage.
- Ripple and spike voltages at output terminals.

10.3.2 Protection Tests

Simulating the following abnormal conditions shall test protection systems.

- AC Mains failure.
- Battery charger/rectifier failure.

10.3.3 Short Circuit Test

A short-circuit test shall be conducted with the battery disconnected. Procedure for conducting the short circuit test shall be as follows.

- A short-circuit of 15 minutes duration shall be applied to the battery charger/rectifier terminals.
- Temperature measurement of the battery charger/rectifier shall be made at the end of the test to ensure that the temperature class of the battery charger/rectifier insulation was not exceeded during the test.

10.3.4 Heat Run Test

A heat run test shall be conducted at full load.

- Test duration shall be 24 hours or until all components have maintained an equilibrium temperature for at least 12 hours, whichever is longer.
- Temperature measurements of all system components shall be made at frequent intervals (at least every 2 hours) to ensure that the temperature class of the component insulation is not exceeded at any time during the test.

10.3.5 High Voltage Flash Test

Immediately following the heat run test the power circuits shall be subject to a HV flash test at $2 \times$ rated voltage + 1000V, minimum. Prior to conducting this test all semiconductor devices shall be shorted or isolated to prevent damage.

10.4 FAT TEST REPORT

The Contractor shall prepare a fully documented and signed FAT Report for submission to QUU. This test report shall contain, but necessarily be limited to, the following:

- Check list showing the results of all checks and inspections.
- A single-line diagram of the system tested shall indicate the points where measurements of the following were taken:-
 - Temperature

- Input supply
 - Battery supply
 - Load banks
 - Switching arrangements
- A brief system description shall be included.
 - Performance curves shall show efficiency, regulation and heat run.
 - Current / voltage recorder chart data and / or oscilloscope photographs shall be included for the ripple at the DC output terminals.

10.5 INSPECTION AND TEST PLAN

The Contractor shall include an Inspection and Test Plan (ITP) in the Tender documents. The ITP shall list all inspections and tests proposed for the equipment by the Contractor, between the date of ordering and the date of delivery.

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.

The Contractor shall be responsible for the planning and execution of all inspections and tests. QUU's representative shall have the right to witness any or all of the manufacturing, inspection or tests.

QUU and the Contractor shall sign off the final version of the ITP, which, thereafter, shall form part of the contract documents.

Certificates of Test shall be provided for each item of equipment to prove it has been satisfactorily tested to meet all requirements of its appropriate manufacturing standards, whether or not witnessed by QUU.

Where appropriate, test certificates shall state values for all test results. Tests for which the results are indicated as pass or fail shall be qualified by the relevant acceptance criteria.

10.6 FUNCTIONAL CHECKING

Each and every wire in the enclosures 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 equipment and discovers inconsistencies with the test records or drawings provided, then the Contractor shall retest all the supplied equipment 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.

10.7 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.

The Contractor, in their Tender, shall identify any special requirements or recommendations for Contractor support during commissioning and start-up of the equipment supplied. QUU's final acceptance of the equipment will be subject to a performance test once the equipment has been installed and commissioned.

10.8 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.

11 PROTECTIVE COATINGS

All enclosure surfaces to be painted shall use the Manufacturer's standard paint specification. The Contractor shall submit the standard paint specification with the Tender for QUU's approval. Where QUU deems the standard painting specification as insufficient, alternative requirements will be negotiated at design proposal stage.

Surfaces of all indoor electrical enclosures shall be finish coated to colours as follows:

External – RAL7035

Internal – White (Contractor Standard)

12 LABELING AND IDENTIFICATION

All items of electrical equipment shall be identified and warning labels shall be fitted where required.

All labels shall be in the English language.

A main nameplate shall be provided on each unit showing the equipment number and title.

Terminals for connection of external cables shall be clearly identified.

Refer to TMS1222 Control Panels- Technical Specification for additional requirements for labelling and equipment identification.

12.1 PRIMARY NAMEPLATE

In addition to any International Code nameplate requirements, each item of equipment shall be equipped with a permanently attached primary nameplate manufactured from 316 stainless steel.

Text and numbering shall be clearly engraved, paint filled and a minimum of 6mm high.

The primary nameplate shall be mounted in a prominent location secured by stainless steel screws or rivets. The nameplate shall contain the following information:

- Client name
- Project name
- Purchase order number
- Equipment title
- Equipment tag number
- Manufacturer's Name
- Serial number
- Year built
- Certified Weight (kg)
- Battery Rated Temperature (min. and max. range)

Major sub equipment shall be provided with individual nameplates in accordance with applicable Project Specifications and/or the Contractor's standard nameplate.

12.2 RATING PLATES

The 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:

- Manufacturer's name and trade mark
- Type, Model and Serial Number
- Standard to which apparatus is manufacture

- Rated output voltage
- AmpHr rating
- Battery type

All technical details required by the relevant standards

12.3 DANGER AND WARNING LABELS

Laminated traffolyte danger and warning labels shall have slotted holes and shall be attached to the equipment where appropriate stainless steel screws or bolts. Danger and warning labels shall have white lettering on a red background and shall comply with AS 1319.

All other removable covers, terminal boxes etc. containing normally live terminals, shall have the following warning label: “DANGER LIVE TERMINALS – ISOLATE ELSEWHERE BEFORE REMOVING COVER”

A label, white background with black text, shall be installed with instructions on how to and when to operate the bypass switch where provided as well as all other isolation devices provided.

13 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.

All equipment 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.

14 DOCUMENTATION

14.1 PRIOR TO AWARD

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

14.2 DOCUMENTATION AFTER CONTRACT AWARD

After the award of the Contract, the Contractor shall supply the documentation specified in the Project Documentation. The equipment procurement and manufacture shall not commence until the design documentation has been accepted by QUU. All design documentation shall be approved by an RPEQ before submission to QUU for acceptance.

14.3 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 enclosure '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 enclosures 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

14.4 EQUIPMENT LISTS

An equipment list shall be provided that details the equipment type, manufacturer, model number and quantity of every item of equipment being installed in the control panel. This shall include all minor equipment such as control relays, lamps and terminals.

14.5 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.

14.6 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,
- 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)

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 control panel 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 and
- List of spare parts provided.

14.7 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.

14.8 BATTERY SIZING CALCULATIONS

The Battery AmpHr sizing Calculation shall be provided by the Contractor.

The battery sizing calculation shall be based on the maximum demand of the DC power supply plus 20% spare for future load growth 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. Design life is 10 years unless stated otherwise in the Project Documentation.

14.9 MAXIMUM DEMAND CALCUALATION

Unless specified otherwise the Contractor shall provide a maximum demand calculation for the power supply.

Refer to TEM336 Power System Analysis Guidelines for the criteria to be considered in a maximum demand calculation.

14.10 ENCLOSURE VENTILATION CALCULATION

The Contractor shall provide a ventilation calculation for all enclosures to be supplied. Refer section 7.4 of this specification for the criteria to be considered in preparing the ventilation calculation.

15 SPARE PARTS AND SPECIAL TOOLS

15.1 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.

15.2 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.