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AC Uninterrupted Power Supplies

TMS1187

Standard Technical Specification



REVISION CONTROL

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1 SCOPE

This specification details the minimum technical requirements for design, manufacture, testing and commissioning of AC Uninterruptible Power Supplies (UPS) to be installed at Queensland Urban Utilities facilities.

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.
Operator	The meaning of operator is as referred in AS 60240.1.1, meaning a user or layman who may come into contact with the UPS equipment, and who is not necessarily a service person. Does not refer to the meaning of 'operator' in the sense of field operations for QUU.

1.2 ACRONYMS AND ABBREVIATIONS

AC	Alternating Current
AS	Australian Standard
BMS	Battery Monitoring System
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
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
LSZH	Low Smoke Zero Halogen (cable)
LV	Low Voltage
NC	Normally Closed
NO	Normally Open
OEM	Original Equipment Manufacturer
O&M	Operation and Maintenance
MBP	Maintenance Bypass Switch
PLC	Programmable Logic Controller
PPE	Personal Protective Equipment
RCD	Residual Current Device
QUU	Queensland Urban Utilities
SI	International System
SAT	Site Acceptance Test
SLD	Single Line Diagram
TCP/IP	Transmission Control Protocol / Internet Protocol
THD	Total Harmonic Distortion
UPS	Uninterrupted Power Supply

1.3 REFERENCE DOCUMENTS

Document Number	Title
TEM336	Power System Analysis Guidelines
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
TMS1200	Electrical Installation - Technical Specification
TMS1202	Control System Implementation for Network Assets
TMS1222	Control Panels - Technical Requirements
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 & 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
AS1020	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
AS1627.4	Metal Finishing – Preparation and Pretreatment 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 2467	Maintenance of Electrical Switchgear
AS 2676.2	Guide to the Installation, Maintenance, Testing and Replacement of Secondary batteries in Buildings – Sealed Cells
AS 2700	Colour standards for general purposes
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 3011	Electrical installations – Secondary Batteries Installed in Buildings – All

	Parts
AS 3017	Electrical installations—Verification guidelines
AS/NZS 3100	Approval and test specification - General requirements for electrical Equipment
AS/NZS 3111	Approval and test specification 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 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/NZS 4325.1	Compression and mechanical connectors for Power Cables - Test methods and requirements
AS 4509	Stand alone power systems – All Parts
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 60076	Power Transformers – All Parts
AS 60146	Semiconductor Converters – General Requirements and Line Commutated Converters
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
AS 62040	Uninterruptable Power Systems (UPS) – All Parts

2.2 INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC) STANDARDS

IEC 60038	Standard voltages
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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
IEC 60445	Basic and Safety Principles for Man-Machine Interface, Marking and Identification - Identification of Equipment Terminals, Conductor Terminations and Conductors
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
- Queensland Worker’s Compensation and Rehabilitation Regulation 2014
- 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 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:-

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

3 GENERAL REQUIREMENTS

The UPS shall be designed and constructed in accordance with AS 62040.1.1, AS 602040.2 and AS 602040.3.

3.1 OPERATION AND DESIGN LIFE

The equipment (other than batteries) 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.

Batteries shall be suitable for 15 year design life at the ambient conditions specified for the place of installation.

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 APPLICATION

3.2.1 Operator access

The UPS shall be suitable for installation in an operator accessible area, according to the meaning and requirements of AS 62040.1.1.

3.2.2 Permanent connection

The UPS shall be permanently connected equipment as defined by AS 62040.1.1, intended for connection to building installation wiring. This specification is not applicable to pluggable UPS equipment.

3.2.3 Insulation class

The insulation class of the UPS shall be Class 1 or better as defined by AS 62040.1.1. This specification is written with a view to Class 1 equipment, where connection to the protective earthing conductor in the building wiring is required.

3.2.4 Not for use in fire or emergency systems

The UPS shall not be used to supply power to building emergency and fire systems equipment.

3.3 LOCATION AND ENVIRONMENTAL CONDITIONS

Where electrical equipment is installed in a temperature controlled weatherproof room, 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.	0-300m
External Ambient Temperature	Minimum	-5°C
	Nominal	25°C
	Maximum (dry bulb)	45°C
External Relative Humidity	Minimum	26%
	Maximum	100% condensing
External 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.

3.4 POLLUTION CONDITIONS

The UPS shall be capable of withstanding pollution as specified in the project documentation and according to AS 62040.3.

For UPS mounted in naturally ventilated areas or exposed to outside air the UPS shall be rated to withstand pollution degree 3.

- Pollution degree 3 applies where a local environment within the equipment is subject to conductive pollution, or to dry non-conductive pollution that could become conductive due to expected condensation.

For UPS mounted in air conditioned rooms with filtered air the UPS shall be the UPS shall be rated to withstand pollution degree 2.

- Pollution degree 2 applies where there is only non-conductive pollution that might temporarily become conductive due to occasional condensation.

3.5 OPERATING REQUIREMENTS

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

All equipment 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 3.3 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.

3.6 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 under conditions as specified in section 4.4.

3.7 WORKMANSHIP AND PERSONNEL

Personnel engaged in the manufacture and assembly 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.

3.8 MATERIALS AND EQUIPMENT

All materials shall be new and unused, free of defects and shall be supplied with relevant certification and documentation.

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.

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
- Operating mode
- Physical location
- IP rating

All equipment and materials shall comply with the relevant specifications, regulations, codes and standards. All components and materials supplied by the Contractor shall be free from:

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

3.9 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. AC UPS and Batteries shall not be located in outdoor areas unless specified otherwise in the Project Documentation.

4 TECHNICAL REQUIREMENTS

The AC UPS shall comply with the requirements of AS 602040.1.1, AS 602040.2 and AS 602040.3

4.1 UPS CONFIGURATION

This section refers to definitions and arrangements as described in Section 5.1.1 and Annex A of AS 62040.3.

4.1.1 Configuration for redundancy

The configuration of the AC UPS System shall incorporate redundancy to meet criticality requirements.

The AC UPS system may include redundant rectifier/charger and inverters, Maintenance Bypass Switch, Static Bypass Switches and redundant battery configurations.

4.1.2 Typical UPS configuration for QUU

Typically the UPS system shall comprise:

- 400V AC 3 phase or 230 V AC single phase incoming power distribution
- Single UPS, comprising rectifier/charger and inverters in a redundant (N+1) configuration for rectifiers, inverter and chargers.
- Minimum 2 x battery strings
- Distribution board for 230 V AC or 400 V AC

The system configuration shall be in accordance with the Project Drawings and the Project Data Sheets.

4.1.3 Topology

This section refers to definitions and arrangements as described in Annex B of AS 62040.3.

The AC UPS shall be a static system of the double conversion type and shall be designed for the system as specified in the Project Drawings and Project Data Sheets.

Double-conversion topology comprises an AC to DC converter, generally a rectifier, and a DC to AC converter, generally an inverter. See Figure B.1 from AS 62040.3 below.

In normal mode of operation, the load is continuously supplied by the rectifier/inverter combination.

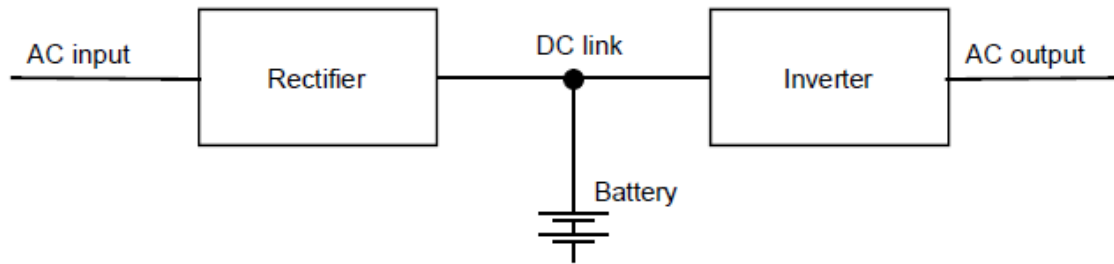


Figure B.1 – Double conversion topology

4.1.4 UPS switches

This section refers to definitions and arrangements as described in Annex C of AS 62040.3.

UPS systems shall be provided with a 3 position maintenance bypass switch (MBP).

The MBP is used to bypass the transfer switch and to ensure the continuity of load power.

4.2 SAFETY

For the purpose of protecting users, operators and service personnel against potential hazards including electric shock; energy related hazards; fire; heat related hazards; mechanical hazards; radiation; chemical hazards, the UPS shall comply with the safety requirements prescribed in AS 62040.1.1

4.3 ELECTROMAGNETIC COMPATIBILITY

The UPS shall conform to the electromagnetic emission and immunity requirements of AS 62040.2.

4.4 OPERATION

4.4.1 Normal operation

Incoming normal (primary) AC power to the AC UPS shall be converted to a regulated DC output by a rectifier / charger, which shall then supply DC power to an inverter and battery.

The inverter shall convert the DC power from the output of the rectifier / charger into regulated AC power for the supply of critical AC load(s).

The batteries shall be continuously float charged during normal operation.

4.4.2 AC power supply loss operation

In the event of loss of the incoming normal AC power supply, the inverter shall continue to supply AC power to the load without interruption for the specified battery

autonomy time. When operating without AC power supply, the inverter output between redundant AC UPS units shall be synchronised.

4.4.3 Battery recharge operation

Upon restoration of the AC power supply, the rectifier / charger shall resume supplying power to the inverter without interruption whilst recharging the battery. The maximum recharge time shall be 90% charge within 10-12 hours unless stated otherwise in the Project Documentation.

4.4.4 Static AC bypass operation

In the event of an overload exceeding system capabilities (short circuit, high inrush currents etc.) or inverter shutdown (malfunction or user-initiated maintenance), a static bypass switch shall instantaneously transfer the critical AC load to the Static Bypass AC source via the static bypass switch without interruption.

When the AC UPS is operating normally, the static bypass switch shall automatically transfer the critical AC load back to the inverter without interruption. There shall be automatic synchronisation of phase and frequency between the inverter and the Static Bypass AC supply.

4.4.5 Maintenance AC bypass operation

A manually operated external maintenance bypass switch shall directly connect the critical AC load(s) to the bypass AC power supply for maintenance purposes.

The maintenance bypass switch shall be padlockable in all positions and designed to completely isolate the rectifier / charger, inverter and static bypass switch for personnel safety during the repair or servicing of the AC UPS, while still providing uninterrupted power to the critical AC load(s).

Interlocks shall be provided to ensure the AC UPS is switched to the Static Bypass AC supply prior to closure of the maintenance bypass switch contacts.

4.5 UPS INPUT SPECIFICATION

This section refers to section 5.2 of AS 62040.3.

4.5.1 Conditions for normal mode operation

The UPS shall be capable of remaining in normal mode of operation when connected to an AC input supply with the following characteristics:

- rated voltage: 230 VAC or 400V AC
- r.m.s voltage variation $\pm 10\%$ of rated voltage rated frequency: 50 Hz
- frequency variation $\pm 2\%$ of rated frequency
- total harmonic distortion (THD) of voltage $\leq 8\%$ with a maximum level of individual harmonic voltages according to the compatibility levels for individual harmonic voltages in low-voltage networks of AS 61000.2.2.
- Transient voltages, superimposed high-frequency voltages and other electrical noise such as that caused by lightning or capacitive or inductive switching; within the electromagnetic immunity levels prescribed in AS 62040.2.

4.5.2 Special requirements

The AC UPS shall be designed to receive power from two independent AC power supplies to be fed into the following inputs:

- Normal AC input – supplies the AC UPS under normal operating conditions
- Static Bypass AC input – supplies the AC UPS DB in the event of UPS shutdown (failure) or an overload (short circuit, high inrush currents etc.)

Unless more onerous conditions are stated on the Project Data Sheets, the equipment shall be suitable for continuous operation at rated load within the supply tolerances stated in section 4.5.1 above.

UPS's with power ratings in excess of 10kVA shall have 400 V AC, three phase input and output unless specified otherwise in the Project Documentation.

The UPS shall be suitable for special conditions as defined on the project datasheet including:

- Protection compatibility with characteristics of upstream electrical protective devices on the incoming AC supply.
- All poles of the UPS, including the neutral, shall be able to be isolated from the incoming supply.
- Supply from a standby emergency generator.
- Connection to an upstream MEN earthing system according to AS 3000, solidly earthed. MEN connection via the neutral shall be maintained for loads when in static AC bypass or maintenance AC bypass operation mode.
- Input protection requirements as described in section 5.1.

Earth leakage protection shall not be installed on the line side supply to the AC UPS.

Prominent marking shall be included at disconnection devices for the normal AC input supply and static bypass AC input supply, giving adequate instructions for removal of all power from the UPS. Refer to 5.5.4 to AS 62040.1.1.

4.6 UPS OUTPUT SPECIFICATION

The AC UPS output shall comply with section 5.3 of AS 62040.3 and special requirements as follows.

4.6.1 Special requirements

The AC UPS is required to continuously supply reliable power of high quality to critical loads comprising control systems, communication equipment, electronic instruments, computers, public address, alarm systems, and process safety systems etc. during normal operations and in event of critical operations.

The output supply of the AC UPS shall have a solidly earthed neutral and a nominal voltage and frequency of either three phase or single phase 50 Hz as detailed on the Project Data Sheets.

Neutral conductors shall be insulated from earth and body throughout the UPS equipment, as if they were a phase conductor. Refer Section 4.4 of AS 62040.1.1.

The AC UPS output shall allow for operation with load circuit breakers incorporating earth leakage protection. If the design of the UPS is such that in any normal or abnormal

operating condition a fault current to earth with DC component is possible, the installation instructions shall define the building residual current devices as type B (IEC/TR 60755/A2) for three-phase UPS and as type A (IEC 61008-1 or IEC 61009-1) for single-phase UPS. (Refer section 4.5.12 of AS 62040.1.1).

The UPS shall be suitable for special conditions as defined on the UPS project datasheet including:

- Any special AC loads or loads generating harmonic currents.
- Compliance to AS 3000.
- Load distribution by an AC distribution board. Refer to section 5.7.
- All-pole isolation of the UPS from the load.
- Connection to an upstream MEN earthing system according to AS 3000, solidly earthed.
- MEN connection via the neutral shall be maintained for loads in all modes of operation.
- Protective devices on-board the UPS and AC DB shall be graded and graded with upstream protective devices.
- Configuration as described in section 4.1.2.
- Topology as described in section 4.1.3
- Performance classification as described in section 4.7
- Operations as described in section 4.4.
- Output protection requirements as described in section 5.5

4.7 PERFORMANCE CLASSIFICATION

This section refers to section 5.3.4 of AS 62040.3.

The AC UPS shall be classified as **VFI SS 111**, where:

- The input dependency characteristic is “VFI”:
A UPS classified VFI is independent of supply (mains) voltage and frequency variations as specified in section 4.5 above and shall protect the load against adverse effects from such variations without depleting the stored energy source.
- The voltage dependency characteristic is “SS”:
The AC output voltage waveform is sinusoidal, presenting total harmonic distortion $\leq 8\%$ and individual harmonic distortion within limits – for both normal mode, bypass mode, or stored energy mode.
- The dynamic output performance is “111”:
The UPS output voltage remains within the limits of curve 1 of subclause 5.3.4 to AS 602040.3, for change of mode of operation, linear load step application, and non-linear load step application.

4.8 BATTERIES

The UPS shall store energy with a battery system.

4.8.1 Requirements for all batteries

The requirements of AS 62040.1.1 shall apply for location, ventilation, marking and protection of batteries.

4.8.2 Battery integration

The battery system shall be integral to the supply. The Contractor shall supply all power cables and battery protection systems for connection of the batteries.

4.8.3 Battery type

The battery banks shall consist of identical cells (same model numbers).

The preferred type of battery cells are Lithium Ion Phosphate.

Valve Regulated Lead Acid (VRLA) batteries are also accepted, but only where the Contractor has proven by calculation that ventilation is adequate. Refer to section 4.8.4.

4.8.4 Battery compartment and battery room ventilation

Refer section 7.6.7 of AS 62040.1.1.

Switchrooms or control rooms with VRLA batteries shall be provided with adequate ventilation to prevent the accumulation of hydrogen gas. The Contractor shall provide hydrogen dissipation calculations for the room to prove adequacy of ventilation.

Proper ventilation ensures that any potential explosive mixtures of hydrogen and oxygen are dispersed safely below hazardous levels.

For battery compartments (separate or combined), the determination method of the necessary airflow to ensure adequate dissolution levels is given in Annex N of AS 62040.1.1.

In combined apparatus of battery and electrical components, attention shall be given to prevent ignition of local concentrations of hydrogen and oxygen by adjacent operational arcing parts, such as contactors and switches close to battery cell vents/valves.

This shall be achieved by the use of fully enclosed components or separation of battery compartments or adequate ventilation dependent upon the technical construction of the UPS and battery.

The adequacy of the distance between battery cell vents/valves and any open arcing component shall be demonstrated by the Contractor with technical data for the construction of the equipment under test.

4.8.5 Battery access and maintenance

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.

4.8.6 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.

4.8.7 Battery capacity

The 100% design load is defined as the load (in Amperes) for the current system configuration.

The UPS system shall allow for up to 20% load growth and shall have sufficient capacity to supply 120% of the design load for the full specified autonomy, at the nominal ambient temperature specified in Section 3.3 and on Project Data Sheets, with no charger available, whilst maintaining the AC output 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 minimum end of discharge voltage shall be as per the value stated in the Project Data Sheets.

4.8.8 Battery age compensation

Batteries shall be suitable for a minimum 15 year design life, see section 3.1. The Contractor shall state the estimated battery life at the nominal design temperature on the Data Sheet.

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, after allowing for 20% load growth.

New battery capacity is:

$$\begin{aligned} &\geq ((120\% \text{ design load (Amps)} \times \text{backup time (hrs)}) \times 125\% \text{ age compensation}) \\ &\quad \geq 150\% \text{ of design capacity (Amp-hrs)} \end{aligned}$$

Refer to section 8.6.2.2 for battery discharge performance tests to prove the new battery system capacity.

4.8.9 Battery connection arrangement

The battery system shall comprise of multiple battery strings in parallel.

The cells shall be connected in parallel strings so any individual cell failure does not render the entire battery bank unavailable. Failure of a single cell shall only affect the associated in-series string.

4.8.10 Battery isolation

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

A double pole MCB shall be fitted between the battery charger and battery bank for the dual purpose of isolation and overcurrent protection. Also see section 5.6.

4.8.11 Battery cables and connections

Internal batteries shall be so arranged as to minimise risk of electric shock from inadvertent contact with terminals and the interconnection method shall be such as to minimize risk of short-circuiting and electric shock during servicing and replacement.

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

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

All cabling between cells shall be by insulated cables. Uninsulated conductors are not accepted in the battery compartment.

Where batteries are located external to the battery charger enclosure, the Contractor shall supply all flexible DC cabling between the battery charger and batteries.

Battery cables shall be lugged, tinned, flexible LSZH cable type. Hard drawn cables are not accepted to battery banks. Main battery cables shall be coloured red for positive and black for negative.

Cable looms shall be adequate to withdraw batteries for disconnection outside of the battery compartment.

4.8.12 Temperature sensors

Temperature sensors for monitoring battery cells shall be securely mounted. Fixing with double sided tape is not accepted.

4.8.13 Battery markings

The requirements of section 4.5.20 of AS 62040.1.1 shall apply. In addition:

- individual batteries shall be clearly labelled with part numbers, volt and amp/hour rating.
- battery cells shall be individually date marked with permanent marker at the date they were installed.

4.8.14 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 information to be displayed locally at the HMI on the equipment, the HMI on the local PLC panel and remote SCADA.

The BMS shall be connected via a communication interface as specified in Section 7.5, as well as have a logging system for all data measured.

4.9 RECTIFIER / CHARGERS

Battery rectifier/chargers shall be single or three phase, phase controlled rectifier type.

Each rectifier/charger shall be rated to recharge the battery bank to 90% within 10-12 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 $\pm 1\%$, irrespective of load or input voltage variations.

The diode configuration shall have a reliable design fit for purpose.

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

The 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.

4.10 INVERTERS

The inverters shall be sized to supply the design load with allowance for minimum 20% future increase in continuous load.

Each inverter shall supply sufficient short circuit current (without transferring to static bypass AC supply) to cause operation of the largest output circuit protective device specified within half a cycle.

Inverter output voltages shall be synchronised with the static bypass AC power supply voltage. During normal operation, the synchronisation system shall limit the phase deviation between the voltages to a maximum of 3° (provided that the static bypass AC supply frequency is within the tolerances specified in section 4.5.1). Upon restoration of the static bypass AC supply, the inverters shall automatically resynchronise.

When operating without AC power supply, the inverter output between redundant AC inverters shall be synchronised.

4.11 SWITCHES

MEN connection via the neutral shall be maintained for loads in all modes of operation.

4.11.1 Disconnect devices

CBs shall be provided to disconnect the UPS from the AC supplies for servicing by qualified personnel.

4.11.2 Static bypass switch

The static bypass switch shall allow instantaneous transfer of the AC load from the inverter to the static bypass AC power supply and transfer back shall occur without any interruption or disturbance in the supply of power to the load.

The static bypass switch shall be four pole for a UPS with three phase primary supply and two pole for a UPS with single phase primary supply.

Transfer of the load from inverter to static bypass AC power supply shall only be possible when:

- The static bypass AC power supply is within the tolerances of the rated voltage and frequency specified in section 4.5.1, and
- The inverter output and the static bypass AC supply are synchronised with respect to voltage, frequency and phase.

Automatic transfer of the load from inverter to static bypass AC power supply shall be initiated when:

- The inverter output voltage falls below 90% of the nominal output voltage, or
- The inverter output voltage exceeds 110% of the nominal output voltage, or
- The inverter output current limit is exceeded

Re-transfer of the load from static bypass AC power supply to inverter shall be initiated automatically when:

- The inverter output voltage is within tolerance of the nominal output voltage for more than 5 seconds, and
- The inverter output and the static bypass AC supply are synchronised with respect to voltage, frequency and phase, and
- The load does not exceed the inverter output capacity

4.11.3 Maintenance bypass switch

Manual bypass of the AC UPS system shall be available by use of an external Maintenance Bypass Switch. The Maintenance Bypass Switch shall allow for an instantaneous transfer of load from the AC UPS to the Maintenance Bypass Switch to allow the AC UPS to be completely isolated for maintenance purposes.

The Maintenance Bypass Switch shall be located in a separate enclosure, near the UPS and shall be rated for the full load of the AC UPS System.

The maintenance bypass switch shall be four pole for a UPS with three phase primary supply and two pole for a UPS with single phase primary supply.

The Maintenance Bypass Switch shall have three positions (labelled), for Normal UPS Operation, Maintenance Bypass Operation and OFF.

The Maintenance Bypass Switch shall be padlockable in all positions.

The switch and enclosure shall comply with AS 60947.3.

An engraved descriptive label shall be fixed on or adjacent to the maintenance bypass switch enclosure providing instructions for operation.

4.12 AC DISTRIBUTION BOARD

The AC distribution board shall be separate to the UPS panel and shall comply with the requirements of AS/NZS 61349 and TMS60.

The distribution board shall be in accordance with the specifications indicated on the Project Data Sheets.

4.13 MOUNTING 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

enclosures housing the AC UPS components and battery bank. All hold down bolts and specialist fasteners shall be provided by the Contractor.

5 PROTECTION

5.1 ELECTRICAL REQUIREMENTS AND SIMULATED ABNORMAL CONDITIONS

The requirements of section 8 of AS 62040.1.1 apply.

5.2 BACKFEED PROTECTION

Backfeed protection shall be provided in accordance with section 5.1.4 of AS 62040.1.1.

The UPS system shall be a fixed installation. Backfeed protection is preferred to be provided internally to the UPS panel.

If backfeed protection is to be provided externally the Contractor shall provide the isolating device and detailed instructions for system integration design and installation. Warning instructions shall be fixed near output terminals warning users that isolation is required before working on remote supplies fed from the UPS. Refer sections 4.5.3 and 5.1.4 of AS 62040.1.1.

5.3 OVERCURRENT AND EARTH FAULT PROTECTION

The UPS system shall be provided with overcurrent and earth fault protection in accordance with section 5.6 of AS 62040.1.1.

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

5.4 RECTIFIER / CHARGERS

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

Each rectifier / charger shall also have the following protection facilities:

- High DC voltage shut-down
- AC power failure
- reverse polarity protection on the output to the battery.
- 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 UPS.

5.5 INVERTERS

Inverters shall be provided with the following protection:

- Input reverse polarity
- Input inrush current limiting
- Input thermal fuse
- Input undervoltage

- Input overvoltage
- Output overload
- Output thermal protection (over temperature)
- Output short circuit

5.6 BATTERIES

The battery bank shall be supplied with a 2 pole, suitably rated DC circuit breaker functioning as a device for isolation and overcurrent protection. Also see section 4.8.10.

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

Batteries shall be protected against excessive voltages in accordance with section 7.6.8 of AS 62040.1.1.

The batteries shall be protected against excessive discharge.

5.7 AC DISTRIBUTION BOARD

The load UPS 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 CBs or RCDs where applicable shall be installed to all outgoing LV circuits unless specified otherwise in the Project Documentation.

6 CONSTRUCTION

6.1 ENCLOSURES

Refer to TMS1222 Control Panel Technical Requirements - Section 5 for technical requirements of the AC UPS enclosure.

The AC UPS enclosure shall also comply with the requirements of AS 62040.1.1 sections 7.1 to 7.7 for:

- Enclosure
- Stability
- Mechanical Strength
- Construction details
- Resistance to fire
- Battery location
- Temperature rise

The AC UPS and battery cell enclosures shall be located in an air conditioned building in non hazardous environments unless specified otherwise in the Project Documentation.

All components of the AC UPS shall be installed in free-standing, self-supporting steel enclosures and suitable to support the weight of internal components.

Enclosures shall be designed for ease of access for maintenance.

Separate standalone enclosure shall be provided for the battery bank and maintenance bypass switch.

The enclosure of the UPS and battery charger shall completely house all live parts other than input and output leads. Enclosures shall provide a minimum degree of protection of IP42 with doors closed and IP2X with doors open, as defined in AS 60529.

The enclosures shall be manufactured in accordance with TMS1222 Control Panel Technical Specification.

6.2 PROTECTION OF PERSONEL AND SAFETY INTERLOCKS

The requirements of section 5.7 to AS 62040.1.1 shall apply.

6.2.1 Interlocks

Safety interlocks shall be provided for areas where operators have access.

6.2.2 Accessibility

Normal operation of the UPS and battery charger shall not require access to the rectifier or to uninsulated live parts. The enclosure shall be constructed to minimize the possibility of adjustment or tampering by unauthorized personnel.

Covers and guards shall be arranged to reduce the likelihood of unintentional contact of live parts by service personnel.

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. AC and DC circuits shall be segregated by spacing or barriers.

Equipment and components shall be arranged in compartments, such that discrete parts of the system can be isolated 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

6.2.3 Capacitive discharge

Capacitors and capacitive components shall be fitted with a means of discharge for protection of service persons. A warning label shall be added if discharge time exceeds 1 sec, stating the time taken to reduce the hazard to a safe level (not greater than 5 min).

6.3 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 AC UPS output.

To avoid shutdown of the AC UPS 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 accepted modelling software shall determine the ventilation methods required. The ventilation methods in order of preference are as follows:-

1. Natural ventilation.
2. Forced ventilation, with N+1 redundant fans.

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.

6.4 COMPONENTS

Transformers and reactors shall be continuously rated and shall conform to AS 60076 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 IEC 60269. Fuse holders shall be self-coloured black. Link holders shall be self-coloured white.

Low voltage switchgear and controlgear shall comply with AS/NZS 60947.

Indicating instruments shall be flush mounted and shall comply with IEC 60051.

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/NZS 60947.1 as appropriate for the duty for the device. They shall be padlockable in the off position only.

No component requiring manual operation shall be less than 750mm or more than 1800 mm from the floor.

6.5 PANEL WIRING

The requirements of section 6 of AS 62040.1.1 shall apply.

The UPS shall be provided with terminals for permanent connection to the power supplies. Separate terminals shall be provided for connection of the normal power supply and standby power supply connections.

All connections shall be by tinned copper wires or cable cores.

Battery bank DC cables shall be manufactured and connected as described in section 4.8.11.

Also refer to TMS1222 Control Panels – Technical Specification.

6.6 EARTHING

AC UPS enclosures 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.

Earthing cable shall be lugged and flexible cable type, with green/yellow PVC coloured insulation.

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

7 MEASUREMENT, CONTROL AND COMMUNICATIONS

The AC UPS shall be supplied with all the necessary equipment to facilitate operation and control of the AC UPS in accordance with this specification.

The AC UPS shall have a Modbus TCP/IP communications interface to QUU's local control system so that all status, measurement, alarms and control information as described in the following clauses can be accessed by the SCADA. Conversion via a separate PLC is not acceptable and reference to QUU's local PLC and network switches shall be included in all design documentation delivered by the Contractor

7.1 STATUS INDICATIONS

As a minimum, the following status information shall be monitored by indicating lights or digital display on the UPS front panel:

- System normal
- System fault
- Normal AC input supply available
- Static Bypass AC input supply available
- Switched to Static Bypass Supply
- Inverter available
- Inverter synchronised to bypass
- Inverter out of synchronism
- Battery charger output failure
- Low DC float voltage
- High DC float voltage.
- Battery discharging

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 local lamp test facility at the enclosure.

7.2 MEASUREMENTS

As a minimum, the following measurement instruments shall be provided on the AC UPS front digital display panel:

- Normal input AC voltage / current (per phase)
- Bypass input AC voltage / current (per phase)
- DC battery voltage / current
- Inverter output AC voltage / current
- System input / output frequency
- Active and apparent power
- Power factor of the load
- Battery capacity remaining
- Battery enclosure temperature

7.3 ALARMS

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.

7.3.1 Hardwired alarms

The following alarms shall be provided by voltage free contacts:

- AC power failure alarm
- UPS fault
- UPS on bypass
- Battery discharging
- Battery disconnected
- Rectifier/charger fault alarm
- Inverter fault alarm
- UPS Common alarm (grouped common alarm including Modbus alarms)

Remote alarms shall be automatically reset when the local alarm indication is manually reset.

All hardwired alarms shall be configured as fail safe.

7.3.2 Alarms via Modbus links

The UPS shall be designed to connect to the local PLC via a Modbus TCP communications link.

The following alarm signals shall be available over the Modbus TCP link:

- Normal input AC power supply failure
- Bypass input AC power supply failure
- Rectifier / charger failure
- DC overvoltage / undervoltage
- Battery disconnected
- Battery charge failure
- DC earth fault
- Rectifier / charger current-limit mode operating
- Inverter failure
- AC output overvoltage / undervoltage
- Inverter overcurrent
- Inverter output frequency out-of-limits
- Synchronisation loss
- Control circuit fault
- AC output supplies lost
- High cabinet temperature

7.3.3 Acknowledgement and resetting of alarms

Remote resetting of critical alarms shall not be permitted.

Alarm initiated LEDs shall remain asserted until manually reset.

Acknowledgement of an alarm locally or remotely shall suppress audible alarm tones, but shall not reset the alarm.

“Local” means at the front panel of the UPS enclosure.

“Remote” means at the PLC panel HMI or using a remote SCADA terminal.

7.4 UPS STATUS SIGNALS

7.4.1 Hardwired status signals

The following status signals shall be provided by voltage free contacts:

- UPS operation healthy

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.

7.4.2 UPS status by Modbus link

The following status signals shall be available over the Modbus TCP link:

- AC input voltage
- AC input current
- Charge voltage
- Charge current
- AC load voltage
- AC load current
- Battery charge/discharge
- Inverter Output Voltage
- Inverter Input Voltage
- Switched to Bypass operation

7.5 BATTERY MONITORING SYSTEM

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

7.6 CONTROLS

All control devices for the starting, shutdown and testing of the UPS shall be provided.

The following control facilities shall be provided.

- DC float voltage adjustment
- DC current limit adjustment
- AC output voltage adjustment
- Battery isolation circuit breakers
- Alarm acknowledge
- Alarm reset
- Shutdown

7.7 DISTRIBUTION BOARDS

The AC distribution board 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)

8 QUALITY ASSURANCE, INSPECTION AND TESTING

8.1 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.

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

8.2 TESTS AND FACTORY ACCEPTANCE TEST

The UPS shall be subjected to type tests and routine tests in accordance with table 3, section 6 of AS 62040.3. These tests shall be performed as Factory Acceptance Tests (FAT).

QUU representative may witness type tests or routine tests.

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 the equipment 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.

All available type tests certificates shall be provided with the tender proposal. Where Type Test certificates are not provided, equivalent testing to that stated in relevant

Australian Standards shall be performed to validate design requirements. Proposed testing shall be outlined in the applicable ITP for approval by QUU prior to manufacture.

Acceptance by QUU of any equipment does not relieve the Contractor from any of their performance guarantees or other obligations under the contract or purchase order.

8.3 TESTS, INSPECTION AND CHECKS

Inspections and checks performed during FAT shall include:

- Completeness check
- Quality of the manufacture
- Checking of rating plates
- Testing of all protection devices as primary or secondary injection test
- Special tests when required and mutually agreed with QUU
- Primary injection to demonstrate correct ratio and polarity of CT's and correct operation of instrument and protection circuits

8.4 INSULATION AND DIELECTRIC TESTS TO AS 62040.1.1

Routine Safety tests to AS 62040.1 are required, including:

- Earth leakage current compliance to section 8.1.1 of AS 62040.1.1
- Insulation and dielectric compliance (see section 8.2 of AS 62040.1.1)
- Automatic backfeed protection

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.

8.5 ELECTROMAGNETIC COMPATIBILITY TESTS TO AS 62040.2

Electromagnetic compatibility compliance is to be verified during the applicable UPS EMC certification as per AS 62040.2.

8.6 TESTS TO AS 62040.3

8.6.1 Routine and type tests

The battery charger and power supply shall be subjected to the following routine and type tests in accordance with Table 3 of AS 62040.3, with changes such that:



- Stored energy time is a routine test.
- Restored energy time is a routine test.

Table 3 – UPS test schedule

Test description	Routine test	Type test	Subclause
Cable and interconnection check	X	X	6.2.2.2
Control device(s)	X	X	6.2.2.3.a
Protective device(s)	X	X	6.2.2.3.b
Auxiliary device(s)	X	X	6.2.2.3.c
Supervisory, monitoring, signalling device(s)	X	X	6.2.2.3.d
Auto transfer to stored energy mode and back to normal	X	X	6.2.2.3.e
Auto transfer to bypass / isolation mode and back to normal	X	X	6.2.2.3.f
Manual transfer to bypass/isolation mode and back to normal	X	X	6.2.2.3.g
No load	X	X	6.2.2.4
Full load	X	X	6.2.2.5

Test description	Routine test	Type test	Subclause
Frequency slew-rate		X	6.2.2.6
AC input failure	X	X	6.2.2.7
AC input return	X	X	6.2.2.8
Parallel redundant UPS fault		X	6.4.2.12
Transfer test to bypass	X	X	6.2.2.9
Input supply compatibility			
Steady-state input voltage tolerance		X	6.4.1.1
Input frequency tolerance		X	6.4.1.2
Input inrush current		X	6.4.1.3
Harmonic distortion of input current		X	6.4.1.4
Power factor		X	6.4.1.5
Efficiency		X	6.4.1.6
Stand-by generator compatibility		X	6.4.1.9

Output – Linear load			
Normal mode – No load		X	6.4.2.1
Normal mode – Full load		X	6.4.2.2
Stored energy mode – No load		X	6.4.2.3
Stored energy mode – Full load		X	6.4.2.4
3-phase voltage unbalance		X	6.4.2.5
DC voltage component		X	6.4.2.6
Current division across paralleled UPS		X	6.4.2.7
Output overvoltage test		X	6.4.2.8
Periodic output voltage variation test (modulation)		X	6.4.2.9
Overload – Normal mode		X	6.4.2.10.1
Overload – Stored energy mode		X	6.4.2.10.2
Fault clearing capability – Normal mode		X	6.4.2.10.3
Fault clearing capability – Stored energy mode		X	6.4.2.10.4
Dynamic performance – Normal to stored energy mode		X	6.4.2.11.1
Dynamic performance – Stored energy to normal mode		X	6.4.2.11.2
Dynamic performance – Normal to bypass mode - overload		X	6.4.2.11.3
Dynamic performance – Step load – Normal mode		X	6.4.2.11.4
Dynamic performance – Step load – Stored energy mode		X	6.4.2.11.5

Output – Non-linear load			
Normal mode – Full load		X	6.4.3.1
Stored energy mode – Full load		X	6.4.3.2
Dynamic performance – Normal to stored energy mode		X	6.4.3.3.1
Dynamic performance – Stored energy to normal mode		X	6.4.3.3.2
Dynamic performance – Step load – Normal mode		X	6.4.3.3.3
Dynamic performance – Step load – Stored energy mode		X	6.4.3.3.4
Stored and restored energy times			
Stored energy time	X		6.4.4.1
Restored energy time	X		6.4.4.2
Battery ripple current		X	6.4.4.3

Test description	Routine test	Type test	Subclause
Restart test		X	6.4.4.4
Environmental			
Repetitive shock during transportation		X	6.5.2.1
Free-fall during transportation		X	6.5.2.2
Storage in dry heat, damp heat and cold environments		X	6.5.3
Operation in dry heat, damp heat and cold environments		X	6.5.4
Acoustic noise		X	6.5.5
Safety		X	Refer IEC 62040-1
Electromagnetic compatibility		X	Refer IEC 62040-2

8.6.2 Notes to routine tests to AS 62040.3

These are notes to specific routine tests by exception. For details of all routine tests refer to Section 6.2 of AS 62040.3.

8.6.2.1 Synchronisation

Since UPS are required to have dual input supplies for normal and static bypass operation, this test applies.

See AS 62040.3 section 6.2.2.6.

8.6.2.2 Stored and restored energy time

The stored energy time and restored energy time tests are to be routine tests (not type tests as listed in AS 62040.3).

The UPS must meet or exceed the minimum battery capacity, including for load growth and age compensation factors, as described in section 4.8.8.

Refer AS 62040.3 section 6.4.4.1 and 6.4.4.2 for the test procedure.

A data logger shall be applied to the battery supply circuit throughout the test to measure battery voltage and current. Time versus voltage and current curves shall be included in the report.

The Ampere-hour capacity of the new battery system must meet or exceed the minimum requirement including for load growth and ageing compensation as specified in the project datasheet.

The time taken to fully recharge the battery shall not exceed the maximum recharge time as stated in the project datasheet.

8.6.3 Notes to type tests to AS 62040.3

These are notes to specific type tests by exception. For details of all type tests refer to Section 6.4 of AS 62040.3

8.6.3.1 Stand-by generator compatibility test

The applicable routine tests listed in Table 3 shall be repeated using the output of the stand-by generator as the source of input supply. The characteristics of the stand-by generator shall be determined by the Contractor.

Where the generator is permanently connected at the QUU site, the generator compatibility test shall be performed at site with the actual generator.

For all other cases, the Contractor shall provide a type test certificate for compatibility with a typical generator.

8.6.3.2 Periodic output voltage variation test (modulation)

This test is required as part of the stored and restored energy tests. Refer to section 8.6.2.2 above.

Also refer section 6.4.2.9 of AS 62040.3.

8.7 OTHER BATTERY AND BATTERY CHARGER TESTS

The following additional routine tests shall be performed:

8.7.1 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.

8.8 GENERAL NOTES TO TESTS

Short circuit faults shall be simulated at the following points of the complete system:

- Beyond the largest fuse on the AC distribution contactor equipment
- On the output of a static bypass switch
- On the output of an inverter
- On the output of a rectifier / charger

Special attention shall be paid to checking that fuses operate when an inverter is operating under current-limit mode, and that there will be coordination between fuses within the apparatus and those specified for the primary power supply.

Where previous type testing has been completed on equipment of identical design, type test documentation may be submitted in lieu of performing each of the listed type tests.

8.9 TEST REPORT

The Contractor shall prepare a fully documented and signed FAT Report for submission to QUU. This test report shall contain, but not necessarily 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 description of each test methodology 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 AC output terminals.

8.10 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. A separate ITP is required for undertaking installation, site testing and commissioning of the AC UPS equipment.

Equipment shall be checked against the QUU accepted design documentation to ensure that the correct type, rating and number of circuits have 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.

8.11 FUNCTIONAL CHECKING

Each and every wire in the AC UPS enclosure 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 enclosure 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.

8.12 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 equipment, 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.

UPS that are delivered as separate functional units intended for final on-site assembly and wiring require their final performance tests to be completed on site. The site test procedure generally consists of the manufacturer's commissioning procedure and of completion of any routine tests of Table 3 that were not completed prior to delivery.

Site tests shall preferably occur under conditions representing those of actual service and shall use the load available on site. The load shall not exceed the rated continuous load of the complete UPS as configured on site.

Where not otherwise prescribed in the relevant test clause, tests shall be performed with reference test load as defined in AS 62040.3 section 3.3.5.

Separate site tests shall be performed with all input supply sources, including mains and on-site generator supplies.

The Contractor shall submit a list of all test records and configuration settings for all parameters associated with the equipment supplied.

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.

8.13 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.

9 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 or Contractor Standard

9.1 CONFORMAL COATINGS FOR ELECTRONICS

All electronic devices installed in potentially corrosive environments as per section 3.3 of this specification require conformal polyurethane based coating or other equivalent harsh environment coating to protect all components from corrosion.

The protective coating should offer a minimum 10 year warranty and shall be tested for compliance with

- EIA364-65A
- IEC 60062-2-60
- IEC 60068-2-1
- IEC 60068-2-7
- IEC 60068-2-30
- IEC 60068-2-14
- IEC 60068-2-38

or other equivalent recognised industry standards.

The Contractor shall consider the maximum operating temperature derating factors contributed by protective coating to the electronic components. The Contractor shall ensure that the derating factor does not impose any operational constraints on the switchboard and especially where the switchboard is not installed in air conditioned switchrooms.

10 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.

10.1 MARKINGS

All UPS equipment shall be marked and supplied with adequate instructions for the installation and operation of the controls and indications. As a minimum such markings and instructions shall be in accordance with the requirements detailed in Subclause 4.5, Markings and instructions, of AS 62040.1.1.

10.2 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
- Total Certified Weight (kg)
- Battery Cell 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.

10.3 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 manufactured
- Rated output voltage
- AmpHr rating
- Battery type, battery cell volts and cell amp-hour rating

All technical details required by the relevant standards

10.4 OTHER 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 maintenance bypass switch where provided as well as all other isolation devices provided.

10.5 MULTIPLE SOURCES OF SUPPLY

Multiple sources of supply shall be identified. Prominent marking shall be included at disconnection devices for:

- the normal AC input supply;
- the static bypass AC input;

giving adequate instructions for removal of all power from the UPS. Refer to 5.5.4 to AS 62040.1.1.

11 SPARE PARTS AND SPECIAL TOOLS

11.1 SPARES

The Contractor shall provide a list of the following spares:

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

The spares lists shall be itemised and priced with the Tender Proposal. QUU will advise the Contractor what spares will be procured.

11.2 SPECIAL TOOLS

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

QUU will advise the Contractor what components will be procured.

12 DOCUMENTATION

12.1 PRIOR TO AWARD

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

12.2 DOCUMENTATION AFTER CONTRACT AWARD

After the award of the Contract, the Contractor shall supply the information specified in the Scope of Work for the Contract. The information shall be supplied in the time specified in the Schedule and in the form detailed below. 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.

12.3 DRAWINGS

The Contractor shall submit design drawings detailing the UPS equipment 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

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.

12.4 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.

12.5 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.

12.6 COMMUNICATION CIRCUITS

The Contractor shall provide adequate instructions for use and installation of any communication and signalling circuits supplied as an integral part of the UPS and intended to be connected to information technology equipment, e.g. programmable logic computers, local area networks (LAN) or to telecommunication networks.

12.7 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 and
- List of spare parts provided.

The Contractor shall supply detailed maintenance procedures in the O&M manual for all routine maintenance, including discharge testing of batteries.

12.8 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.

12.9 BATTERY SIZING CALCULATIONS

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

Refer to section 4.8.8.

12.10 MAXIMUM DEMAND CALCULATION

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.

12.11 ENCLOSURE VENTILATION CALCULATION

The Contractor shall provide a ventilation calculation for all enclosures to be supplied. Refer section 6.2 of this specification for the criteria to be considered in preparing the ventilation calculation.

12.12 ARC FLASH ANALYSIS

The Contractor shall provide an Arc Flash Analysis for the equipment supplied. The calculation shall be performed in accordance with TEM336 Power System Analysis Guidelines. The Arc Flash labels shall be provided by the Contractor to all enclosures supplied.

Note: DC Arc Flash Analysis shall be provided for the UPS Batteries.

13 PACKAGING, HANDLING AND SHIPPING

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

Particular attention shall be given to prevent moisture ingress and physical damage. Small, easily damaged parts shall be removed, tagged and adequately protected from damage during shipment.

All items shipped loose and susceptible to water damage shall first be sealed in suitable water proof plastic with desiccant dryers before being packed.

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.

All equipment shall be manufactured and tested at the factory, and shall be shipped completely assembled. Heavy equipment shall be removed from racks prior to shipment and secured in a manner acceptable to QUU.

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.