



ABN 86 673 835 011

LOW VOLTAGE DIESEL POWERED GENERATORS

TMS1589

Standard Technical Specification

REVISION CONTROL

Revision Number	Date	Revision Details	Responsible Officer
0	April 2016	First Draft	Kokila Admanathan
1	May 2016	Issued for Use – Stakeholder Comments Updated	Steve Bourke

DOCUMENT CONSULTATION

Revision Number	Date Sent	Name	Comments	
			Received	Incorporated
0	April 2016	Gerard Anderson	Apr 2016	Yes
0	April 2016	Steve Bourke	Apr 2016	Yes
0	April 2016	Mark Davanzo	Apr 2016	Yes
0	April 2016	John Clayton	Apr 2016	Yes
0	April 2016	Scott Adams	Apr 2016	Yes
0	April 2016	John Titmarsh		
0	April 2016	Steve Walton		
0	April 2016	Andy Paranagama		
0	April 2016	Allan Quach		

Contents

REVISION CONTROL	2
DOCUMENT CONSULTATION	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	10
2.3 REGULATIONS	10
2.4 UNITS AND LANGUAGE	10
2.5 SUB-CONTRACTORS	10
2.6 CONTRACTOR EXCEPTIONS	10
2.7 ORDER OF PRECEDENCE.....	11
3 ELECTRICAL TECHNICAL REQUIREMENTS	12
3.1 OPERATING CONDITIONS AND DESIGN LIFE	12
3.2 SITE CLIMATIC CONDITIONS.....	12
3.3 OPERATING REQUIREMENTS.....	13
3.4 UTILITY DATA	13
3.5 WORKMANSHIP AND PERSONNEL.....	13
3.6 MATERIALS AND EQUIPMENT.....	14
3.7 INGRESS PROTECTION	15
4 GENERAL REQUIREMENTS	16
4.1 SCOPE OF SUPPLY.....	16
4.2 RATINGS.....	17
4.3 SAFETY AND MATERIALS.....	17
4.4 MODES OF OPERATION	17
4.5 AUTOMATIC CONTROL MODE	18
4.6 MANUAL CONTROL MODE	18
4.7 MOUNTING	18
4.8 NOISE	18
4.9 VIBRATION	18
4.10 AUTOMATIC TRANSFER SWITCH (ATS)	19
5 ALTERNATOR DESIGN.....	20
5.1 GENERAL.....	20
5.2 COOLING	20
5.3 SHORT CIRCUIT REQUIREMENTS	20
5.4 UNBALANCED LOAD	20
5.5 TRANSIENT REACTANCE	20
5.6 WAVEFORM DEVIATION	20
5.7 WINDING AND INSULATION.....	21
5.8 WINDING THERMAL PROTECTION (WHERE APPLICABLE)	21
5.9 EXCITATION SYSTEM	21
5.10 STATOR CORE	22
5.11 STATOR CONNECTION AND TERMINAL BOX.....	22
5.12 GENERATOR TERMINALS	23

6	ENGINE DESIGN	24
6.1	GENERAL.....	24
6.2	AIR INTAKE SYSTEM.....	26
6.3	FUEL SYSTEM	26
6.4	LUBRICATION SYSTEM.....	27
6.5	COOLING SYSTEM	27
6.6	EXHAUST SYSTEM.....	28
6.7	STARTING SYSTEM	29
6.8	INSTRUMENTS	29
6.9	DIESEL DAY TANK.....	29
6.10	ENGINE GOVERNOR.....	30
6.11	DIRECTION OF ROTATION	30
6.12	LOAD BANK	30
7	CONSTRUCTION.....	31
7.1	FRAME	31
7.2	ENCLOSURE.....	31
7.3	TERMINALS	31
7.4	ANTI- CONDENSATION HEATERS.....	32
7.4	ENGINE CONTROL PANEL COOLING.....	32
7.5	LABELING AND IDENTIFICATION	33
7.6	NAME PLATE	33
7.7	DANGER AND WARNING LABELS	34
7.8	SPARE PARTS & SPECIAL TOOLS	34
7.9	PAINTING AND PROTECTIVE COATINGS	34
8	CONTROL EQUIPMENT	36
8.1	ENGINE CONTROL UNIT (ECU)	36
8.2	INTERNAL WIRING	37
8.3	EARTHING	37
8.4	STATUS MONITORING AND ALARMS	38
8.5	MANUAL CONTROL.....	39
8.6	DC POWER SUPPLY	39
8.7	BATTERY CHARGERS.....	39
8.8	BATTERIES	40
9	INSPECTION AND TESTING	41
9.1	GENERAL.....	41
9.2	FACTORY ACCEPTANCE TESTING	41
9.2.1	Generator Testing	41
9.2.2	Engine Testing	42
9.3	SITE TESTING	42
9.4	SITE SUPPORT.....	42
9.5	OPERATION AND MAINTENANCE TRAINING.....	43
10	PACKING AND SHIPMENT.....	44
11	DOCUMENTATION	45
11.1	PRIOR TO AWARD.....	45
11.2	DOCUMENTATION AFTER CONTRACT AWARD	45
11.3	DRAWINGS	45
11.4	EQUIPMENT LISTS	46
11.5	LABEL SCHEDULE.....	46
11.6	MANUALS	46
11.7	GENERIC MANUALS.....	47

11.8	BATTERY SIZING CALCULATIONS	47
11.9	MAXIMUM DEMAND CALCUALATION	47
11.10	ENCLOSURE VENTILATION CALCULATION.....	47
11.11	CONTROL SYSTEM.....	48
11.12	NOISE SURVEY	48
11.13	POWER SYSTEM ANALYSIS.....	48
12	SPARE PARTS AND SPECIAL TOOLS.....	49
12.1	SPARES.....	49
12.2	SPECIAL TOOLS.....	49

1 SCOPE

This specification details the minimum technical requirements for design, manufacture, testing and commissioning of low voltage diesel powered generators to be permanently installed at QUU sites.

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

ANZEx	Australian/NZ Certification Scheme - Explosion Protected Equipment
AS/NZS	Australian/New Zealand Standards
Aus Ex	Australian Certification Scheme for Explosion Protected Equipment
AC	Alternating Current
AS	Australian Standard
ATS	Automatic Transfer Switch
AVR	Automatic Voltage Regulator
CT	Current Transformer
DC	Direct Current
ECP	Engine Control Panel
ECU	Engine Control Unit
ELV	Extra Low Voltage
EMC	Electromagnetic Compatibility
Ex	Explosion Protected Electrical Equipment
FAT	Factory Acceptance Test
IEC	International Electro-technical Commission
ISO	International Organization for Standardization
I/O	Input / Output
IP	Ingress Protection

ITP	Inspection and Test Plan
IEC Ex	International Electrotechnical Committee Certification Scheme for Explosion Protected Equipment
IEC	International Electro-technical Commission
I.S.	Intrinsically Safe
LCD	Liquid Crystal Display
LV	Low Voltage
LCP	Local Control Panel
MCC	Motor Control Centre
NC	Normally Closed
NO	Normally Open
OEM	Original Equipment Manufacturer
O&M	Operation and Maintenance Manual
PCS	Process Control System
PLC	Programmable Logic Controller
PPE	Personal Protective Equipment
PSA	Power System Analysis
QUU	Queensland Urban Utilities
RCD	Residual Current Device
RTU	Remote Telemetry Unit
SAT	Site Acceptance Test
SDRL	Supplier Data Register List
SI	International System
SLD	Single Line Diagram
TCP	Transmission Control Protocol
UPS	Uninterrupted Power Supply
VT	Voltage Transformer

1.3 REFERENCE DOCUMENTS

Document Number	Title
TEM114	Operations - Asset-Equipment List Table Template
TEM336	Power System Analysis Guidelines
TMS60	Low Voltage Switchboards and Enclosures
TMS62	Preferred Equipment List – Electrical and Instrumentation
TMS76	Corrosion Protection for Electrical and Mechanical Equipment and Structures
TMS849	CITECT SCADA Configuration Standard

TMS1151	Preferred Equipment List – Control Systems
TMS1200	Electrical Installation - Technical Specification
TMS1202	Control System Implementation for Network Assets
TMS1222	Control Panels - Technical Requirements
TMS1229	PLC Programming and Configuration Standard
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 60529	Degrees of protection provided by enclosures (IP Code)
AS1019	Internal Combustion Engines - Spark Emission Control Devices
AS 1243	Voltage Transformers for Measurement and Protection
AS1359	Rotating Electrical Machines - General Requirements
AS1692	Steel tanks for Flammable and Combustible Liquids
AS 2768	Electrical Insulating Materials - Evaluation and Classification based on Thermal Endurance
AS 3000	Wiring Rules
AS 3010	Electrical Installations - General Sets
AS/ NZS 3100	Approval and Test Specification - General Requirements for Electrical Equipment
AS 3947.6.1	Multiple Function Equipment - Automatic Transfer Switching Equipment
AS 4100	Steel Structures
AS4024.1.1	Safeguarding of Machinery - General Principles
AS 4509.1	Stand-Alone Power Systems - Safety and Installation
AS 4594	Internal Combustion Engines - Performance
AS 60034	Rotating Electrical Machines
AS 60529	Degrees of Protection Provided by Enclosures (IP Code)
AS 60947.8	Low-Voltage Switchgear and Controlgear - Control Units for Built-in Thermal Protection (PTC) for Rotating Electrical Machines
AS/NZS 61000	Electromagnetic Compatibility (EMC)

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

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

All requirements applicable to the Contractor are applicable to sub-contractors or sub-suppliers. QUU reserves the right to attend the place of manufacturer by any sub-contractor or sub-supplier engaged to undertake the manufacturing works.

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 TECHNICAL REQUIREMENTS

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 2 years normal continuous operation with only minimal routine 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

The Generator shall be installed outdoors unless otherwise specified in the Project Documentation. Where the generator is installed in a weatherproof building, the design environmental conditions shall be as specified on the Project Data Sheets. For all other cases equipment shall be designed for the site conditions as defined below:-

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

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

3.3 OPERATING REQUIREMENTS

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

All 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 3.2 of this specification.

Where a PSA Report - Maximum Demand Calculation has not been provided in accordance with TEM336 PSA Guidelines, the Contractor shall allow the full load continuous rating for motor circuits to be the motor full load current and the continuous operating load 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 Generator and associated 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. All design documentation including drawings shall be approved and signed by an RPEQ of the relevant engineering faculty before submission to QUU for review.

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 supplied items 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
- Lead-based or Isocyanate paints

3.7 INGRESS PROTECTION

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

Equipment enclosures not directly exposed to the weather (inside the generator acoustic enclosure) shall be minimum IP42 where the enclosure contains components susceptible to damage or failure due to moisture and dust ingress. All other outdoor electrical enclosures and equipment shall be minimum IP56.

The Contractor shall provide vermin proofing of the generator skid enclosure, with particular attention to vermin ingress under the base of the skid. The vermin proofing methods must be accepted by QUU and provided in detail design drawings of the generator skid.

4 GENERAL REQUIREMENTS

4.1 SCOPE OF SUPPLY

This specification defines the minimum technical requirements for design, production of materials, fabrication, manufacture, drawings and data, assembly, painting, inspection, testing and commissioning for the Generator. The Generator shall be a complete stand-alone skid mounted units and are expected to be delivered to site ready for installation .

The Generator shall be supplied in accordance with the Project Documentation including this specification, project datasheets, drawings, standards referred to herein and other documents that define QUU's requirements and equipment details.

The Generator(s) extent of supply shall consist of the following:-

- Diesel engine and integral auxiliaries including pumps, fans, radiator, piping, main CB, instrumentation, control system, governor, etc
- Generator and auxiliaries including brushless exciter with permanent magnetic generator (PMG) and automatic voltage regulator (AVR), etc
- Inlet and outlet noise attenuators
- 400V 50Hz IP65 industrial type interlocked outlet for critical MCC connection
- Weather-proof acoustic enclosure
- Industrial grade exhaust system including muffler and silencers
- Electric starting system with batteries (2 x 100%)
- Engine accessory equipment
- Interconnecting cabling for auxiliary equipment and panels
 - Flexible coupling between engine and generator
 - Baseplate with anti-vibration mountings
 - Lifting points
- 45°C ambient cooling package
- Fuel Heater
- Integrated fuel tank and fuel system for 24hours operation at maximum load
- Drip tray with provision for draining
- Special tools required for maintenance of the generator
- Cables and connection plugs and sockets
- Factory Acceptance Testing
- Site Commissioning
- Manuals, drawings and documentation

The following is excluded from the scope of supply unless stated otherwise in the Project Documentation:-

- Critical Equipment MCC and Distribution Board
- Installation of Generator on site

4.2 RATINGS

The generator shall be capable of continuously supplying the load at the rated output at rated voltage, rated frequency and 0.8 lagging power factor for at least 350 hours without the need for offline maintenance. It shall also be capable of running at 110% full load for a minimum period of five minutes, in any 12 hour period.

The diesel engine shall have sufficient capacity to drive the generator at rated speed and output, in ambient conditions as specified on the datasheets. The overall rating of the generator shall exceed the rating of the engine throughout the ambient temperature range.

The rated steady state full load voltage shall be 400V +/- 2%, 3 phase, and 4 wire. The voltage waveform shall be sinusoidal.

The rated steady state frequency shall be 50 Hz +/- 0.5%. The power supply requirements are specified in the Project Documentation.

4.3 SAFETY AND MATERIALS

All equipment shall be designed to minimise any risk due to internal short circuit and to ensure safety to personnel during all operating conditions, inspections and maintenance.

The equipment shall meet approved limits for electromagnetic compatibility for emission and immunity.

The choice of equipment shall be made with due considerations to the fire hazards involved. Halogen free, flame retardant materials shall be used where appropriate.

Toxic materials such as asbestos, polychlorinated biphenyls (PCBs), mercury and the like shall not be used.

4.4 MODES OF OPERATION

The operating mode of the generator shall be determined from an Off/Auto/Manual selector switch located on the generator control panel.

The modes of operation for the generator shall be:

- Automatic Start-up Mode
- Manual Start/Stop Mode

The generator shall be capable of starting and running without an external power source.

The Auto and Manual modes shall be integrated with the plant control system including the operation of the ATS where specified in the Project Documentation. The Contractor shall develop a control system functional specification and obtain QUU acceptance before proceeding with detail design of the generator control system.

4.5 AUTOMATIC CONTROL MODE

The generator control panel shall enable automatic start with cranking control in the event of an external contact closure signal for loss of normal plant power supply.

4.6 MANUAL CONTROL MODE

The generator control panel shall allow a manual start and stop of the generator via local controls mounted on the generator ECP.

4.7 MOUNTING

The engine, generator and engine control panel (ECP), batteries, load bank and fuel tank shall be mounted on a common base frame/plate, which shall be sufficiently rigid to be self-supporting.

The base frame/plate shall include a minimum of four lifting lugs for lifting the entire package as one unit. All skid mounted equipment shall be suitable to withstand any lift and lifting deflection.

4.8 NOISE

An acoustic enclosure is required to be supplied with all generators. Unless specified otherwise in the project documentation the noise limit level at 1m from the generator shall not exceed 85 dBA with the generator operating at its maximum capacity.

The Project Documentation may impose stricter limits on noise emission for certain QUU sites and the noise emission levels includes contribution from background noise external of the site and other noise sources from within the site. A noise survey of the site shall be provided by the Contractor prior to installation of the generator to determine the noise levels at the site perimeter fence. The Contractor shall provide a noise survey after installation of the generator at the site to demonstrate the noise limits for the site are not exceeded with the generator operating at its maximum rated capacity. The noise level survey plans shall be accepted by QUU before site measurements are commenced.

The acoustic enclosure shall be supplied with exhaust silencer and extension pipe of 2.5m, wall transit flange and with rain cap outlet suitable for outdoor duty.

4.9 VIBRATION

The generator skid shall have integral vibration damping engine mounts.

Torsional analysis shall cover normal running conditions and loads when the engine is operating normally.

The GCP shall be provided with wired warning alarms and trips based on high vibration and high-high vibration respectively.

4.10 AUTOMATIC TRANSFER SWITCH (ATS)

The ATS and Distribution Board are generally not located on the generator skid. The generator package of works may include an on-board ATS where specified in the Project Documentation.

In the event of a power failure the ATS will send a start signal to the generator. The generator will run up to speed and provide a stable constant voltage at the generator output terminals. When the ATS senses the voltage at the generator output it will change from Normal supply position to Generator supply position. This will isolate the primary power (utility supply) connection to the site DB which will be now fed from the generator.

The status and alarms produced by the ATS shall be monitored by the site PLC and SCADA control system. Refer section 8.4 and 8.5 of this document for the ATS control and monitoring signals required.

The ATS shall have facility to undertake a remote test of the ATS and generator function. This will be a manual operation from a remote location using the SCADA screens.

Unless specified otherwise in the Project Documentation the generator will not require to be synchronised with the normal power supply to the site.

5 ALTERNATOR DESIGN

5.1 GENERAL

The generator shall be capable of "black starting". It shall be capable of ramping up to full speed within 10 seconds of power failure and accepting 50% of the load immediately after reaching full speed and 100% of the load within further 10 seconds, without exceeding the terminal voltage variation limits of $\pm 5\%$ and frequency limits of $\pm 2.5\%$ of nominal value.

The rated output of the alternator shall exceed the rated output of the diesel engine over the ambient temperature range as specified in the Project Documentation.

5.2 COOLING

The generator shall be designed with self-ventilated drip proof ventilation cooling in accordance with requirements of AS 1359.

5.3 SHORT CIRCUIT REQUIREMENTS

The generator shall be capable of withstanding without damage any type of short circuit at the terminals for a period of 3 seconds when operating at rated speed and with an excitation corresponding to 5% over voltage at no load. It shall also be capable of sustaining a short circuit current of at least 300% of rated current for ten (10) seconds.

5.4 UNBALANCED LOAD

The generator shall be capable of operating continuously at rated voltage and frequency supplying an unbalanced load, at rated current containing 12% negative sequence component.

5.5 TRANSIENT REACTANCE

The transient and sub-transient reactance of the alternator shall be nominated by the Contractor on the datasheet. Tolerances shall be within and prescribed in the applicable standards.

5.6 WAVEFORM DEVIATION

The maximum level of the total harmonic voltage and current distortion produced by the alternator shall not exceed 5% of the fundamental, while the maximum of any individual harmonic voltage or current frequency shall not exceed 3% of the fundamental. The line-to-line voltage waveform generated and the measurement of the deviation shall be obtained in accordance with the requirements of AS 1359. Refer to TEM336 Power System Analysis Guidelines for further details on harmonic analysis.

5.7 WINDING AND INSULATION

The generator winding shall be at minimum of Class F (180°C) insulation with excellent electrical and mechanical properties. The field winding shall be capable of operating at field voltage of 125% of rated load for at least one minute starting from stabilised temperature at rated conditions. The temperature limits and rises shall be based on insulation temperatures of Class B.

Windings and overhangs shall be firmly clamped and secured within the slots. End turns and connections shall be braced to withstand short circuit forces and prevent harmful distortion and chafing of insulation during service conditions.

No resonant vibrations shall occur within or with any part of the windings and connections, at any load between zero and 120% of the rated speed of the generating set.

The complete stator core with the windings shall be resin varnish impregnated and baked. The impregnation method shall ensure that all air is expelled from the winding and the air space is filled with resin. Coating by painting or spraying is not acceptable.

5.8 WINDING THERMAL PROTECTION (WHERE APPLICABLE)

The generator stator windings shall be fitted with built in temperature detection. There shall be at least two (2) temperature detectors per phase and they shall be located at the expected hot spots. The detectors shall be so connected that a high temperature in any one sensor activates an alarm at the GCP.

5.9 EXCITATION SYSTEM

The excitation control system shall include a direct driven rotary brushless exciter, a solid state automatic voltage regulator (AVR), a voltage adjuster and generator trip output contacts on failure of the AVR, auto/manual control features, etc.

The excitation system shall have constant dv/dt characteristic.

The excitation system shall be provided with short-circuit support equipment (series compounding) to maintain three times the rated current for three seconds in case of short-circuit to ensure proper fault clearance in outgoing feeders.

The AVR shall be capable of maintaining the steady state voltage within $\pm 1\%$ of the controlled value over the whole load range of the generator for power factors between 0.8 and 1.0. The AVR shall be of the static type and shall maintain a voltage regulation to AS 1359.

The voltage setting of the AVR shall be minimum $\pm 5\%$ of the rated value.

The rotating rectifier bridge shall preferably be a three-phase, full-wave bridge, using six diodes without fuses, resistors or capacitors. If multiple parallel connected diodes are used, each diode shall be protected by a suitable HRC fuse with blown fuse

indication to the control system. The total capacity shall be such that one or more sections can fail, so that the redundant capacity shall be a minimum of 20%; while retaining full-load excitation with the specified current safety factor. The rectifier bridge full load output shall be rated at 1.2 times the generator nominal excitation current with the maximum excitation voltage applied.

The maximum repetitive reverse voltage rating (VRRM) of the diodes in the rectifier bridge shall be a minimum of eight (8) times full load excitation voltage.

All rotating components shall be proven at values of centrifugal stress of 50% above normal operating levels.

5.10 STATOR CORE

The stator core shall be made of low loss high permeability laminated silicon steel stampings to reduce heat loss and improve electromagnetic efficiency. In addition, cooling air ducts shall be provided at optimum intervals to ensure uniform temperature distribution within the stator winding.

5.11 STATOR CONNECTION AND TERMINAL BOX

The stator windings shall be star connected and shall be brought out to six insulated terminals in a terminal box. All six winding ends brought out to terminals shall be marked U1, V1 and W1 on the line side and U2, V2 and W2 on the star point side. The alphabetical sequence U1, V1 and W1 shall correspond to the time sequence of the phases.

The alternator shall be provided with separate terminal boxes for the generator line and neutral stator connections and for control connections.

The generator terminal boxes shall be of fabricated steel and shall be suitable for withstanding maximum fault current for 3 seconds. Terminal boxes shall also be suitable for nominated power and control cable connections. Necessary clearances/creepage distance shall be provided between live parts and between live parts to earth.

Live terminals shall be thoroughly insulated from the frame with materials resistant to tracking.

Terminal box gland plates shall be non-magnetic and sized to accommodate the required compression glanded cable entries.

The phase ends shall be indelibly marked in the order of their phase sequence i.e. U1 shall be "Red", V1 shall be "White" and W1 shall be "Blue". Star point ends shall all be "Black".

Separate terminal boxes shall be provided for the termination of control wiring and anti-condensation heaters. These terminal boxes shall be assessable during the normal operation of the generator. They shall be marked with the relevant identification labels.

Where gaskets are provided they shall be of neoprene rubber, preferable fixed to the removable part of the box and suitable for occasional breaking of the joint without deterioration.

All cables will enter from below the baseplate, therefore supporting systems will be provided up to each terminal box.

All terminal boxes shall be electrically bonded to the base frame to provide effective earth.

5.12 GENERATOR TERMINALS

The generator LV output terminals and connections shall be continuously rated for 110% of the full load current of the generator.

The generator terminals and connection spacing shall allow for the installation of current transformers used for protection and metering and AVR control purposes.

The generator terminal block shall be suitable for lug type cable connectors and allow for several single core cables for each phase and neutral. The generator terminal box shall be supplied with a non-ferrous gland plate.

Where a load bank is not specified as installed on the generator skid the Contractor shall provide a pre wired terminal block for future connection of a load bank.

6 ENGINE DESIGN

6.1 GENERAL

The Contractor shall be responsible for the detail design engineering, fabrication, testing, preparation for shipment and delivery of the complete diesel powered generator in accordance with this specification.

The generator engine shall be designed and rated for unattended start-up and normal operation. It shall be designed to prevent deterioration during long periods (up to 3 months) of non-operation.

The normal duty for the generator is for standby operation. The engine would be tested at three monthly intervals, taking load for 30 minutes each time. On failure of the Main Power Supply the generator will be expected to start and run for an indefinite period of time or until utility power supply is restored.

Generators shall be fitted with quality grade mufflers.

The generator control system shall ensure that the generator is running at full speed before energising the generator motorised circuit breaker to engage the load.

The generator package shall be equipped with a battery charger. The battery charger shall be powered by a 230V AC utility power supply. This must ensure that the batteries required for starting the generator are always fully charged.

The Contractor shall provide the following information:

- Recommended periods between inspections (checks) and minor overhauls
- Inspection, minor overhaul and major overhaul activities, together with duration and man hours required for each
- Recommended lube oil change frequency
- Engine availability based on scheduled downtime.

It is anticipated that minor overhaul activities will typically include, but not limited to, the following:

- Cleaning or changing air, fuel and lube oil filters
- Checking lube oil/magnetic plugs
- Lubricating as appropriate (e.g. governor linkage).

Engine performance shall be in accordance with AS4594 for site conditions specified. The Contractor shall declare the rated power of the engine corresponding to the specified duty in accordance with AS4594, Part 1, for the outputs described below:

- Standby power as defined by the manufacturer.
- Overload power as defined in AS 4594, Part 1
- Minimum load for the site

The engine and its auxiliary equipment shall be designed and configured to facilitate inspection, maintenance and overhaul activities. Equipment and components of greater than 25 kg weight shall be provided with lifting lugs for terminal installation and maintenance.

The Contractor shall ensure the following:

- Recommended space required around the engine for maintenance and overhaul, including any access platforms,
- Withdrawal distances of components,
- Maximum maintenance lifts

Provision shall be made for turning the engine by hand during maintenance. The engine bar-over facility shall be controlled by an operating procedure provided by the Contractor. Appropriate traffolyte warning labels shall be provided instructing personnel to disable engine starting and affecting necessary safety isolations before taking up such maintenance.

The direction of rotation shall be permanently marked on the engine in a prominent position.

Personnel protection from hot surfaces above 60°C shall be by 316 stainless steel mesh or equivalent method of protection eg. lagging.

Unless otherwise specified, the engine governor and fuel control system shall be designed such that no external power sources are required for their operation; i.e. engine must be capable of starting, running and stopping when the main power supply has failed.

All driving belts and rotating parts shall be adequately guarded. V-belts shall comply with AS 2784. Belt guards shall be designed to accommodate the full belt adjustment and shall be manufactured from a non-sparking material. Aluminium is not considered to be a non-sparking material. Belt guards shall be designed in accordance with AS 4024 (all applicable parts).

Over speed shutdown shall be by fuel cut off and combustion air intake dampers closure. The over speed protection system shall operate without the need for electrical power. Once the over speed protection system has operated, it shall not be possible to restart the engine without resetting the over speed device and air inlet flap.

6.2 AIR INTAKE SYSTEM

The Contractor shall provide a combustion air intake filter designed to preclude ingress of dust or other airborne contaminants in the environment specified. The filter shall include a replaceable media type filter to prevent water ingress.

The air intake filter unit shall be equipped with a differential pressure indicator and alarm and shall meet noise limits as specified on the datasheet. The housing and all structural components of the air filter shall be made of type 316L stainless steel.

The inlet manifold of the engine shall preferably be provided with automatic condensate drain valves, or alternatively, means of automatically preventing the formation of condensate. The Contractor shall provide details of the proposed method.

The air inlet valve shall close automatically in the event of engine over speed or actuation of the emergency stop push button. A label shall be provided warning that the air inlet flap must be manually reset prior to a re-start attempt; else the start batteries may be depleted.

6.3 FUEL SYSTEM

The fuel shall be diesel (automotive distillate) and the Contractor shall state the exact diesel composition and ensure that the supplied filter system is adequate.

An on board self-bunded diesel fuel tank shall be included. The tank capacity to be sufficient to supply fuel to the diesel generator at 100% load for a minimum of 24 hours unless specified otherwise in the Project Documentation.

The tank to be supplied with a local level indicator and low level switch set at 50% of tank level. The Contractor shall state capacity of tank.

The fuel system design shall be a fast start fuel system and shall ensure that flooding of injectors due to gravity feed from tank is not possible.

The fuel system shall include but not be limited to the following equipment:

- Engine driven fuel injection pump(s) fed from the base frame fuel tank
- Water and sediment trap/pre-filter
- Interlocking duplex fuel filter.
- Automatic fuel replenishment system
- First fill facility for fuel tank
- Hrs capacity day tank.
- Valve with plug insert to drain the tank

The filter shall be of replaceable element type and readily accessible for maintenance.

The fuel system components shall be mounted either on the engine or on the base frame/plate. The fuel tank inlet and outlet pipes shall be kept away from hot components (including exhaust), be flange connected and shall terminate at the edge of the base frame. The fuel filling point shall be located for ease of access and shall be provided with secure fuel cap locking mechanism.

6.4 LUBRICATION SYSTEM

All lubrication points in the engine shall be connected to a full flow pressure system with wet sump pump, strainer pump, piping, cooler and full flow duplex oil filter.

The lubrication system pump shall be engine driven.

The lube oil filters shall be of the replaceable element type and the elements shall be readily changeable without dismantling adjacent engine components. The absolute particle size after filtration shall not exceed 10 microns. The filter shall be equipped with a differential pressure indicator and alarm or pressure indicator downstream of the filter and a filter change indicator.

The lube oil cooler shall be sized to dissipate the heat rejected with the engine fully loaded as specified and operating continuously. The coolers shall be cooled by the same medium as the engine cylinders. The lube oil shall be maintained at a higher pressure than the cooling medium to prevent leakage of cooling medium into the oil.

A manually operated lube oil pump shall be supplied for filling and draining the lube oil reservoir and sump.

The preferred means of ensuring suitable lubrication conditions for first-time starting and rapid load acceptance is by use of suitable multi-grade oil. A traffolyte label to be provided at the oil filling point that indicates the grade and type of oil required.

The Contractor shall confirm that continuous pre-lubrication of the engine to ensure first-time starting and rapid load acceptance is not required.

6.5 COOLING SYSTEM

The cooling system shall be common to both engine and its lube oil system.

The engine cooling system shall be a closed circuit system fitted with an expansion tank and pressure relieving cap and shall be self-venting. An opening shall be provided in the circuit for filling the system, checking coolant level and adding make-up coolant when required. All items shall be fully drainable.

The cooling medium circuit shall be provided with thermostatic control of the engine coolant temperature. The temperature control shall be achieved by by-passing the

radiator to a proportional degree by means of a thermostatic valve. Simple throttling of the coolant circulation is not permissible.

The cooling system shall be equipped with a coolant level and temperature indicator and alarm and an engine mounted temperature indicator shall be provided to show the temperature of engine block

Engine jacket water heater(s) shall be provided to maintain the cooling medium at a suitable temperature for rapid starting and load acceptance. The heater(s) shall preferably not require a circulating pump and shall be thermostatically controlled and arranged to prevent local overheating. The heaters shall be rated suitable for the power supply specified.

The radiator shall be sized to dissipate the engine heat rejected to the coolant at 110% of the rated load. The radiator shall be supplied in accordance with the manufacturer's standards, where such equipment has proven to give satisfactory service in similar applications.

The cooling system shall be supplied complete with an engine driven radiator fan and interconnecting pipe work.

The fan shall be driven from the engine crankshaft. Variations in air volume flow rate due to external wind pressure shall be minimised by using a mixed flow fan such that fan performance is approximately constant from minimum to maximum fan static pressure.

The materials for the fabrication of the radiator shall be selected on the basis of proven long-term performance for the defined environmental conditions per section 3.2. The required design life is defined in Section 3.1.

6.6 EXHAUST SYSTEM

The exhaust system components supplied by the Contractor shall include the engine exhaust manifold(s), extension unit(s) and silencer.

The exhaust system shall include an extension pipe of 2.5m, wall transit flange and rain cap outlet suitable for outside duty. The exhaust system shall be vented to air at adequate height above the floor access area and with adequate clearance from structures and other equipment to prevent damage or fouling of the items from the exhaust fumes.

The exhaust system shall be designed such that there are no exposed hot surfaces accessible to personnel at ground level. This may be achieved via thermal insulation or guards designed in accordance with applicable parts of AS 4024.

6.7 STARTING SYSTEM

The starting system shall be electric. At the minimum ambient temperature, each of the two cranking batteries shall have the capacity to maintain required engine cranking speed through three (3) consecutive cycles of the manufacturer's recommended starting operation.

The automatic cranking cycle shall lock out after three unsuccessful cranking cycles. Upon completion of the cranking cycles, the engine shall accelerate to rated speed within 10 seconds.

The overall start-up of the engine from detection of power failure to attaining full speed shall not exceed 10 seconds and shall be able to supply load within 12 seconds.

6.8 INSTRUMENTS

The following instruments shall be installed on the engine/alternator skid as a minimum:

- Lube oil temperature indicator
- Lube oil filter differential pressure gauge
- Lube oil pressure indicator
- Cooling water temperature gauge and alarm
- Cooling water pressure gauge and alarm
- Air filter differential pressure indicator
- Air filter change indicator
- Fuel bund liquid level sensor
- Fuel tank level gauge and low level sensor

The instruments shall be corrosion resistant by choice of materials. Where this is not possible, they shall be prepared and painted in accordance with manufacturer's standard specification. Corrosion resistant materials shall be selected on the basis of proven, long-term performance in the specified site conditions.

The selection of materials for the wetted parts of instruments, including ancillary equipment shall be type 316L stainless steel unless process conditions dictate otherwise.

6.9 DIESEL DAY TANK

In addition to the fuel tank the diesel day tank capacity shall be sufficient for 10 hours continuous operation at 80% load as a minimum. The generator skid shall be fitted with its own integral diesel day tank unless specified otherwise in the Project Documentation.

Gland connection shall be correctly sealed to maintain the IP rating of the equipment.

Cable entries into any Ex'd enclosures shall utilise a flameproof cable gland incorporating compound filled seals which seal around individual cores or other equivalent sealing arrangement.

The day tank shall incorporate pump control level transmitters as well as high and low level alarms switches and contents gauge. Secondary overfilling protection shall be provided in the form of a suitably sized mechanical float valve fitted with fuel rated seals.

The tank shall be arranged to feed directly into the engine via the fuel filter. The fill line shall include a non-return valve to prevent back flow in the event of diesel system de-pressurization. The outlet shall be positioned to prevent sediment entering the fuel lines. Isolation of the engine fuel tank shall be by the manufacturer's recommendation method. A valve with threaded plug shall be provided for draining the tank. The tank filling point shall be easily accessible with secure locking fuel cap.

6.10 ENGINE GOVERNOR

The engine shall be provided with an electronic governor with load sharing and paralleling capabilities to enable the following operational modes to occur:

- Operation in parallel with the other generating sets and main power supply system
- Operation in isolation from the main power system during emergency operation to supply the main system.

The governor shall meet the requirements of AS 60034, governing accuracy and shall be fitted with speed droop adjustment between 0-5%. The Contractor shall nominate the over speed trip setting which shall not be more than 115% of the synchronous speed. All equipment shall be suitable for the trip speed.

6.11 DIRECTION OF ROTATION

The direction of rotation of the rotor of the machine as viewed from the coupling end, shall be clockwise. A clear indication of the direction of rotation shall be marked on either end of the machine in accordance with AS 60034.

6.12 LOAD BANK

The generator shall be supplied with a load bank to allow testing of the generator with minimum operating load unless specified otherwise in the Project Documentation. The load bank shall be integral to the generator skid. The load bank shall be sized so that the generator engine is adequately loaded at all times to prevent glazing of cylinders.

7 CONSTRUCTION

7.1 FRAME

The engine and alternator shall be mounted on a heavy-duty fully welded common steel base frame/plate including the diesel day tank. The engine/alternator shall be separately and resiliently mounted within an enclosure on a primary base frame/plate that provides direct machine support and alignment.

The base frame shall be a matrix of major steel members combined with fully welded containment floor plate to give rigidity and strength. The longitudinal side members shall incorporate four lifting lugs designed to safely lift the complete assembly with the generator installed.

All steel members and steel plate used in manufacturing the frame/plate floor shall be hot dip galvanized or other accepted corrosion protection coating system.

7.2 ENCLOSURE

An acoustic enclosure shall be installed as the housing of the generator. It shall limit the noise level to less than 85dBA at 1m from the enclosure over the complete operating range and up to the maximum rated output of the generator. The acoustic enclosure specification and materials used shall be from a proven standard design and suitable for continuous exposure to the climatic conditions specified in section 3.2 and meet design life as specified in section 3.1.

7.3 TERMINALS

The terminals on the generator and associated equipment shall be fitted with connectors of size and material to suit the cable. Connectors shall be copper or nickel plated brass for copper conductors.

ELV and LV terminals shall be spaced, separated by barriers/shrouds or otherwise mechanically protected. This shall be done such that the accidental reduction of electrical clearances is not possible during cable installation or subsequently as a result for example of cable tension, vibration and expansion. These requirements include the use of oversized, uninsulated cable lugs.

Adequate means shall be provided to ensure that loosening of connections is not possible during cable installation or due to thermal cycling and vibration.

All terminals shall be clearly and permanently marked as per the electrical design documentation accepted for construction by QUU.

7.4 ANTI- CONDENSATION HEATERS

Suitably rated anti-condensation heaters shall be installed as required. Location and maximum surface temperatures of the heaters shall be such that no damage can be caused to any insulation. Heaters shall be suitable for operation on a single phase 230V, 50 Hz AC supply with 30mA RCD protective device.

The leads of the heater shall be brought out to a separate terminal box without joints or loop through connections inside the generator.

Red labels with white text shall be screwed to terminal boxes that contain heater terminals as follows: "Danger 240VAC, Isolate heater circuit before removing cover."

7.4 ENGINE CONTROL PANEL COOLING

Internal cooling of the ECP 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 overheating of the ECP and shutdown of the generator 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 trip provided to the ECU and site PLC.

The ECP and other electrical equipment enclosures shall have a ventilation design calculation completed before manufacture commences. The calculation shall demonstrate that the maximum temperature inside the enclosures shall not exceed the maximum temperature rating specified by the component manufacturers:

The calculation shall allow for the following criteria:-

- Ambient temperature at the exterior of the enclosure
- 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 equipment contained within the enclosure.

7.5 LABELING AND IDENTIFICATION

All items of electrical equipment associated with the generator shall be identified and warning labels shall be fitted where required.

All labels shall be traffolyte and screwed in position and all text is 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.

7.6 NAME PLATE

An engraved or stamped 316 stainless steel name plate shall be fixed on the generator frame and shall be marked in accordance with AS 1359.4 and with the following additional information :

- Manufacturer's name
- Applicable standard
- Model Number
- Serial Number, type and Frame reference
- Rated output in KVA and KW
- Duty
- Rated power factor
- Overload rating
- Rated frequency
- Rated voltage
- No. of Phase I type of connection
- Rated stator current
- Rated speed in Rev/Min
- Direct axis sub transient, transient and synchronous reactances (in %)
- Class of insulation (Stator)
- Temp. Rise (Stator)
- Phase Rotation (CW or CCW) viewed from DE
- Excitation current and voltage at rated output

- Year of manufacture
- Weights in kg of rotor and stator
- Alternator bearing type/No (DE/NDE)
- IP rating of generator (unprotected by the acoustic enclosure)
- Fuel Capacity in litres
- Overall Weight(with full fuel tanks)

The Contractor's standard plate plus a supplementary plate where necessary will be acceptable.

7.7 DANGER AND WARNING LABELS

Laminated traffolyte danger and warning labels shall have slotted holes and shall be attached to the equipment with 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"

7.8 SPARE PARTS & SPECIAL TOOLS

The Contractor shall nominate any requirements for special tools to aid in proper installation, commissioning and maintenance of all supplied equipment.

The Contractor shall nominate any spare parts required for the first 2 years of operation.

7.9 PAINTING AND PROTECTIVE COATINGS

All equipment 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.

All metal surfaces of electrical enclosures shall be thoroughly cleaned and degreased to remove mill scale, rust, grease and dirt. Fabricated structure shall be pickled and then rinsed to remove any trace of acid. The under surface shall be made free from all imperfections before undertaking finishing coat.

After preparation of the under surface, the panels shall be spray painted with two coats of epoxy based finish paint. The finished panels shall be oven baked in dust free atmosphere. Paint finish shall be free from imperfections like pin holes, orange peel-like finish, run off paint, etc.

The Contractor shall provide a proposed protective coating specification for the approval of QUU at time of tender.

8 CONTROL EQUIPMENT

8.1 ENGINE CONTROL UNIT (ECU)

Each generator shall be provided with a dedicated skid mounted Engine Control Unit (ECU) for local engine management, control and monitoring. The ECU shall be installed in the ECP. The ECP shall be custom manufactured in accordance with TMS1222 Control Panel Specifications.

The ECP shall be mounted on the base frame/plate of the engine to avoid engine vibration. The ECP shall provide local indication of the following engine and generator parameters:

- Coolant temperature reading
- Oil pressure reading
- RPM reading
- Battery Voltage reading
- Jacket Heaters On indication
- Alternator anti-condensation Heaters On indication
- Voltage and Current
- Frequency
- Hours Run
- Generator Load (kW)
- Power Factor
- Fuel Level

The ECU shall be supplied with a Modbus TCP/IP interface or other accepted communications protocol accepted by QUU to allow access to all engine and generator parameters and alarm by the site PLC and SCADA control system. The following data shall be provided at SCADA:-

- Alternator Phase currents Amps
- Alternator Phase voltages Volts
- Alternator Power kVA
- Power Factor
- Alternator Frequency Hz
- Alternator Winding Temperatures
- Essential Engine Data including Running Status
- Phase Failure
- Over/under voltage

Provision of a 12 port FOBOT in the ECP shall be allowed for fibre optic communications link to the ECU.

An Emergency stop pushbutton shall be provided on the external front door of the ECP or other easily accessible location on the generator and location must be accepted by QUU. On unsecured or unfenced sites the ECP and the Emergency Stop Pushbutton shall be located behind a key lockable generator canopy access door.

The Emergency stop pushbutton when activated shall instantaneously disconnect the generator from the LV load when activated and send a controlled stop command to the ECU to shut down the engine safely. The Emergency stop circuit shall be Category 2 as per AS4024 Machine Safety code. The Contractor may reduce the Category rating of the Emergency stop circuit by providing a risk assessment report to AS4024 for QUU acceptance. The generator shall not automatically restart in any mode until the Emergency stop alarm is reset at the ECP.

8.2 INTERNAL WIRING

All cable and wiring run internally on the machine shall be halogen free and run in PVC duct with open slots and removable covers. Cables and wiring within PVC duct shall be secured with plastic ties to prevent spilling when covers are removed.

Power and control wiring shall be copper conductors and de-rated for maximum internal cabinet temperatures. The minimum size of internal wiring conductors shall be 1.5mm^2 , with at least 7 strands, insulated with moisture resistant insulation, except for proprietary wiring within pre-wired equipment modules.

Terminal blocks shall be sized for 2.5mm^2 as a minimum.

All cores including spares shall be terminated in terminals (cutting back and taping of cores is not permitted). No more than one wire shall be connected to the incoming side of any terminal. 20% spare installed terminals shall be installed in the ECP.

AC terminals shall be segregated from DC terminals by means of physical barriers and shall be clearly labelled to indicate the voltage level.

Protective covers shall be provided over all power distribution terminals to minimum IP2X. Appropriate and clear identification and warning labels shall be provided in accordance with AS/NZS 3000.

Panel wiring shall be colour coded as per TMS1222 Control Panel Technical Specification. Alternative panel wiring colour schemes can be considered, however only when advised to QUU prior to Contract award.

8.3 EARTHING

The generator shall be provided with a tinned copper main bar in an accessible location. All equipotential bonds on board the generator shall be continuous to the main earth bar. The earth bar shall have provision to connect maximum 2 off 120mm^2 PVC earth conductors from the site main earth grid.

The ECP shall have an internal tinned copper main earth bar, separate insulated instrument earth bar and a panel M10 earth stud provided.

All non-current carrying parts of mounted equipment on board the generator skid and skid frame shall be earthed by welding, bonding or direct connection to the main earth bar.

Moving parts and door joints shall be earth bonded and have a flexible earth cable installed across the joint to ensure continuity.

8.4 STATUS MONITORING AND ALARMS

The ECP shall be provided with instruments and meters for local indication and annunciation of the following alarms and status as a minimum:

- Voltage deviation - over/under
- Frequency deviation - over/under
- Over temperature
- Circuit breaker tripped
- Engine water temperature - high
- Engine lube oil discharge temperature - high
- Lube oil pressure - low
- Engine overspeed
- Hours run meter
- Low lube oil pressure
- High water temperature
- Over speed
- Cooling Water - Low level
- Fuel Tank - Low fuel level
- Day Tank – Low fuel level
- Lube oil - temperature high
- Lube oil - filter differential pressure high
- Air-filter differential pressure high
- Fuel filter differential pressure high
- Fuel Bund – liquid sensor

Voltage free contacts shall be available for connection to the site PLC and signals shall include, as a minimum:

- Generator general warning alarm
- Generator fault
- Generator Failed to Start (three attempts at starting before failed to start signal is initiated)

- Generator running
- Generator low fuel
- Generator CB closed/tripped
- Battery warning alarm
- Battery Charger fault
- Generator Healthy / Ready to Start
- Generator Enclosure - Access Door(s) open
- Generator Emergency Stop activated
- ATS - Available in AUTO
- ATS - Normal/Generator position

8.5 MANUAL CONTROL

The control system to include digital hard wired contacts for the following manual control signals:-

- ATS manual position selection
- Generator manual stop/start

8.6 DC POWER SUPPLY

The DC power supply unit shall be rated to 24Vdc output with an RCD protected 230VAC single phase input. All DC CB's shall be double pole.

DC power supply shall be provided to charge the batteries and provide supply to the ECP and other ELV equipment on board the generator skid.

The DC power supply system including battery charger and batteries shall be capable of supplying total maximum demand load of the connected equipment plus 20% spare capacity.

The physical size and weight of the components shall be considered in the design and allowance made for adequate space to uninstall and ease of access for maintenance.

8.7 BATTERY CHARGERS

The generator shall be fitted with a battery charger suitable for connection to a 30mA RCD protected 230V, single phase supply. The charger shall be of the constant voltage, self-current-limiting type.

The battery charger shall be sized to restore a fully discharged battery to 100% capacity within 10 hours. Battery charging shall be current limited such that isolation during cranking is not necessary. The battery charger shall incorporate the following controls and indications:

- On/off switch
- DC voltage indication
- Charger output - current indication
- Bi-directional charge indication
- Battery charger voltage high alarm
- Battery voltage low alarm

8.8 BATTERIES

The engine starting/control batteries shall be VRLA type and fully redundant (N+1). Each battery shall be capable of supplying the total load of the generator equipment and control panels for 8 hours including specified crank cycles with the other battery out of service.

The batteries shall be separately housed in suitably rated battery boxes for the site conditions specified. Battery cells can be either rated at 12V or 24V.

It shall be possible to replace a battery cell without disturbing the other battery cell. Each battery string shall have a dedicated double-pole CB between the battery string and the charger. The CB's shall be rated for fault currents generated by the associated battery cell.

9 INSPECTION AND TESTING

9.1 GENERAL

The generator package with all controls must be fully assembled and tested to prove all system operation and ensure minimum commissioning time.

All specified tests shall be carried out at the manufacturer's works and the Contractor shall supply all test equipment.

9.2 FACTORY ACCEPTANCE TESTING

9.2.1 Generator Testing

The generator shall be tested and inspected to verify compliance with the specification and for satisfactory performance. Relevant standards shall be followed as a guideline for testing. All tests shall be witnessed by QUU or other nominated representative.

The commissioning tests shall be carried out at site under normal service conditions.

The following test, as a minimum, shall be carried out prior to delivery in accordance with AS 60034 or equivalent international standards.

- Insulation resistance tests and determination of polarization index value :
- Measurement of open circuit characteristic.
- Measurement of short circuit characteristic.
- Temperature rise at rated voltage, current, frequency and zero power factor.
- Overspeed test at 120% rated speed for 2 minutes.
- Vibration tests.
- Phase sequence/voltage balance/current balance tests.
- Wave form test and harmonic analysis.
- Determination of moment of inertia (Type test results are acceptable).
- Noise measurement test.
- Response of voltage and frequency with step change shedding of 25%, 50%, 75%, 100% rated load.
- Response of voltage and frequency with step change application of 25%, 50%, 75%, 100% rated load respectively to the generator running at no load.
- General dimensional and alignment of windings.
- Measurement of DC resistance of windings.
- Pressure test on heat exchangers (cooling system)
- Measurement of shaft current.
- Determination of exciter response and ceiling voltage of exciter.

9.2.2 Engine Testing

The engine shall receive at minimum a one hour running test at full load prior to shipment which shall be witnessed by QUU or other nominated representative. All major parameters shall be logged intervals and reasons given for significant variations.

The following test shall be in accordance with AS 60034:-

- Dimensional checks and visual inspection for workmanship.
- Over speed protection
- Heat load test under full load conditions
- Speed step change and governor response time

9.3 SITE TESTING

The Contractor shall carry out functional testing and commissioning of the generator with the actual site load connected. All control and communication capabilities to the site PLC and SCADA shall be proven during the testing.

Site testing shall include but not be limited to the following:-

- Calibration, checking and adjustment of all the instruments, meters, alarms, controls, and protection devices.
- Testing of Generator/Engine auxiliary equipment.
- Testing and adjustment of engine over speed protection devices.
- Check battery charge system.
- Functional testing with the LV switchgear.
- Prove all ECU inputs and outputs.
- Prove operation of all ECU programs, operator interface units, alarm logging and reporting.
- Performance of safety systems (shutdowns, alarms etc).
- Generator start, run up to speed, shutdown, stop and trip.
- Prove governor speed control.
- Prove automatic voltage control.
- Simulate all fault conditions in all modes of operation.
- Complete noise measurement in the engine enclosures and at 1 meter from the generator set with generator running at maximum rated capacity.
- Prove operation of all signals to and from the ECP in conjunction with QUU or other nominated representative.

9.4 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.

9.5 OPERATION AND MAINTENANCE TRAINING

The Contractor shall provide operation and maintenance manuals as specified in the (SDRL) Supplier Data Requirements List section of the Project Documentation.

The Contractor shall provide training of site personnel in the operation and maintenance of the generator set. The training format shall include a hands-on component. In particular, the training shall include, but is not limited to:

- General layout and location of equipment
- Maintenance of electrical systems and equipment
- Maintenance of mechanical systems and equipment
- Operation of the generator using the operator interface, including all alarms and faults
- Interfaces with the process plant control system
- Fault finding

Training shall be scheduled to cover all operations and maintenance personnel. Training shall be provided by a person or persons who have the required knowledge of the generator set as well as being experienced trainers.

10 PACKING AND SHIPMENT

The generator shall be completely assembled for transport, unless otherwise agreed by QUU.

The generator shall be suitably packaged to prevent damage during storage, transport, loading and unloading from freight.

All exposed openings shall be suitably sealed for transport. Crates shall be of strong export quality, impregnated solid wood.

The equipment shall fit firmly inside the crate and be restrained from movement by battens firmly fixed to the crate. Where paintwork or prepared metal may come into contact with the crate timbers it shall be protected from abrasion by pads of foam rubber or plastic corrugated cardboard.

The contents of the crate shall be weatherproofed with some non-permeable film, of suitable strength, such as polyethylene sheet or tar paper.

Silica gel or a comparable desiccant shall be provided to absorb moisture within the waterproof sealed package.

All plug-in equipment such as relays and sensitive electronic components shall be unplugged and separately packed. They shall be clearly marked for ease of identification at site.

All fixing screws and bolts shall be equipped with shake-proof washers and shall be lock-nutted or prevented from unscrewing by use of Nylock or similar nuts or, in the case where this may not be possible, by use of such compounds as Loctite on the threads.

Particular attention shall be paid to the fixing of door hinges and panels carrying heavy components. All packages shall be securely labeled with indestructible tags detailing:

- Client order number
- Equipment number
- Destination
- Gross and net weight.

11 DOCUMENTATION

11.1 PRIOR TO AWARD

The Contractor shall provide the documentation specified in the SDRL and the Project Documentation with the bid proposal. The Contractor demonstrates their understanding of the technical documentation required by returning the SDRL with the bid proposal.

11.2 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.

11.3 DRAWINGS

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

- Generator General Arrangements(internal and external)
- ECP and other equipment General Arrangements(internal and external)
- Single Line Diagrams
- Schematics
- Termination Diagrams
- Installation Details
- Cable Block Diagrams(all cables installed on the generator skid)
- Cable Schedule(all cables terminated both ends on the generator skid)

Where equipment 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 equipment 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

11.4 EQUIPMENT LISTS

An equipment list shall be provided that details the equipment type, manufacturer, model number and quantity of every item of equipment being supplied under the generator package. This includes all instrumentation and minor equipment such as control relays, lamps and terminals in the ECP.

11.5 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. Arc Flash labels shall be installed at the ECP and at the generator on-board CB or ATS enclosure. The Arc Flash labels shall be as per the PSA Report for the site.

11.6 MANUALS

The contractor shall provide Operations and Maintenance (O&M) Manuals for all equipment supplied. 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 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.

11.7 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.

11.8 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 load plus 20% spare for future load growth as well as a derating for maximum ambient temperature at the battery box enclosure. The AmpHr rating calculated shall be the battery end of design life AmpHr rating. Battery cell design life is 5 years unless stated otherwise in the Project Documentation.

11.9 MAXIMUM DEMAND CALCUALATION

Unless specified otherwise the Contractor shall provide a maximum demand calculation for the generator LV and ELV loads.

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

11.10 ENCLOSURE VENTILATION CALCULATION

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

11.11 CONTROL SYSTEM

The Contractor shall provide documentation for the generator on-board control system.

This shall include and is not limited to the following items:-

- Functional Specification for the generator control system
- I/O points list(hardwired)
- Communications points list to remote PLC
- Alarms List
- Setpoint List
- Generator Controller HMI screens and operations instructions

The Contractor shall provide the electronic configuration files for all programmable devices installed on the Generator. This shall include the programming software licences and all cables and accessories for QUU to fault find and modify the configuration settings as required.

11.12 NOISE SURVEY

Contractor shall provide site noise surveys and reports before and after the installation of the Generator on site unless specified otherwise in the Project Documentation. Refer section 4.8 of this document for details.

The site noise surveys shall be undertaken by an independent and accredited organisation and must be accepted by QUU before commencing the survey works.

11.13 POWER SYSTEM ANALYSIS

The Contractor shall provide a PSA Report as per TEM336 PSA Guidelines where a PSA report for the site is not provided in the Project Documentation.

The Contractor shall provide an update to the existing site PSA Report to include the new Generator if an existing PSA Report is provided.

Unless specified otherwise in the Project Documentation the PSA Report provided by the Contractor shall include Harmonic Analysis and measurement before and after the generator is installed at the site. Refer TEM336 PSA Guidelines for the requirements of performing Harmonic Analysis.

12 SPARE PARTS AND SPECIAL TOOLS

12.1 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.

12.2 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