Specification

Technical Specification – Permanent Gas Engine Driven Generator

Table of Contents

Revision details

Version No.	Clause	Description of revision
1	All	Complete revision, reformatting and publication.
0	All	Specification created. Not officially published.

Introduction

This Specification is for the design fabrication and supply of a permanent emergency natural gas engine driven generator for Sydney Water assets.

Appendix 3 – Gas Engine Driven Generator Data Sheet of this Specification is site specific and must be completed by the Designer and filled out by the Supplier.

Sydney Water makes no warranties, express or implied, that compliance with the contents of this Specification will be sufficient to ensure safe systems or work or operation.

It is the user's sole responsibility to ensure that the copy of this Specification is the current version as in use by Sydney Water.

Sydney Water accepts no liability whatsoever in relation to the use of this Specification by any party, and Sydney Water excludes any liability which arises in any manner by the use of this Specification.

This document is uncontrolled once printed or downloaded.

Copyright

Acronyms

Acronym	Definition
A	Ampere
AC	Alternating Current
ASTM	American Society for Testing and Materials
ATS	Automatic Transfer Switch
AVR	Automatic Voltage Regulator
CT	Current Transformer
DC	Direct Current
ELCB	Electric Leakage Circuit Breaker
EPA	Environment Protection Authority
FAT	Factor Acceptance Test
GPO	General Power Outlet
Hz	Hertz
I&C	Instrumentation and Control
IICATS	Integrated Instrumentation, Control and Telemetry System

Acronym	Definition
IP	Ingress Protection
ISO	International Organisation for Standardisation
ITP	Inspection and Test Plan
kW	Kilowatt
kWh	Kilowatt Hour
LED	Light-emitting Diode
LEL	Lower Explosive Level
MCCB	Moulded Case Circuit Breaker
MEN	Multiple Earthed Neutral
MJ	Mega Joule
O&M	Operation and Maintenance
PFR	Phase Failure Relay
PLC	Programmable Logic Controller
PMG	Permanent Magnet Generator
PVC	Polyvinyl Chloride
RCD	Residual Current Device
rpm	Revolutions per Minute
SAE	Society of Automotive Engineers
SCADA	Supervisory Control and Data Acquisition
SOC	Systems Operational Centre
SPS	Sewage Pumping Station
THD	Total Harmonic Distortion
TIF	Telephone Influence Factor
TOG	Telemetry Operations Group
USB	Universal Serial Bus
V	Volt
WAC	Work as Constructed
WSAA	Water Services Association of Australia

General Terms & Definitions

Term	Definition
Design life	The period adopted in design for which a product, equipment or component is required to perform its function within the specified parameters with periodic maintenance but without replacement or major overhaul.
Supplier	The person or organisation responsible for the fabrication or manufacture and/or supply of products, materials, equipment and components described herein.
Sydney Water	The nominated person or organisation that has written authority to act on Sydney Water's behalf.
WSAA Codes	Codes of Practice issued by Water Services Association of Australia

1. General

1.1 Scope

This Specification is for the supply of a packaged emergency gas engine driven generator for permanent installation within Sydney Water's facilities. The Specification covers the technical requirements of the generator and the required associated items, including an acoustic enclosure, load bank and control equipment. The specific details are given in Appendix 3 - Gas Engine Driven Generator Data Sheet.

1.2 Drawings

The Supplier must provide a full set of certified construction drawings for the generator for Sydney Water's review prior to fabrication. Detailed equipment list / bill of materials must be supplied prior to performing any work on the project. Additionally, WAC drawings must be supplied for Sydney Water's review prior to delivery to site.

The construction drawings must include plan, elevations and section views with item numbers showing:

- major equipment such as the gas engine, alternator, inlet and exhaust louvres,
- location of all electrical panels and batteries,
- field interface cable entries and access locations
- location of supply gas connection
- acoustic louvre details,
- access doors (in open and closed positions),
- removal arrangement for alternator,
- material list

1.3 Scope of Work

The extent of work covered by this Specification includes the design, manufacture, factory testing and delivery to site of a complete gas engine driven generator unit.

As a minimum, the work must include:

1. Delivery to site.
2. Supply of:
    - complete packaged gas engine driven generator
    - steel skid baseplate,
    - weatherproof acoustic enclosure,
    - anti-vibration mounting pads

    The generator set must be suitable for outdoor installation.
3. Integral closed-circuit radiator.
4. Exhaust system including silencer and flashings.
5. Gas distribution system within the engine compartment including:

a) Gas filters
b) Gas pressure regulators
c) Gas pressure gauges
d) Gas over pressure switch
e) Gas low pressure switch
f) Gas isolating valves
g) Gas leakage detectors
h) Gas emergency automatic shut off valves

6. A 230 V AC single phase load centre with circuit breakers for:
   a) Jacket water heater
   b) Battery chargers
   c) LED lights mounted within the acoustic enclosure with on / off switch
   d) GPO (RCD Protected)
   e) 20A of spare capacity for future use.
7. Local control panel with generator controller, protection devices, alarms, indicators and control switches.
8. Electric starting system (24 V DC) including batteries and battery charger.
9. Batteries and battery charger for generator control circuits (separate to starting system batteries and battery charger).
10. Termination cubicle for termination of outgoing cables from the alternator.
11. Generator circuit breaker for alternator output.
12. External electrical panel for supply isolation.
13. All power wiring and control wiring internal to the package.
14. All programming and configuration of the generator and load bank controllers.
15. Detailed template drawings of skid baseplate and loading information.
16. Detailed drawings of control panel with full equipment list for approval prior to manufacturing.
17. All protective and final finishing painting.
18. Supply of installation, operating and maintenance manuals and other documentation in accordance with Sydney Water Specification: Commissioning – transitioning assets into operation.
19. Supply of all WAC drawings.
20. 12 months servicing and breakdown cover from the date of final commissioning on site.
21. Minimum 12 months warranty from the date of final commissioning on site.

1.4 Ratings

The generator must be rated as per the requirements detailed in the Gas Engine Driven Generator Data Sheet.

The generator must achieve this rating when operating in the ambient temperature range and at an elevation specified in the Gas Engine Driven Generator Data Sheet.

The rating for the generator must be based on standby duty, i.e. continuous service at rated capacity full load during interruption of the normal power supply.

The packaged weatherproof acoustic enclosure must have a minimum degree of protection to IP22 as per AS 60529. The sound pressure level at 7m from the canopy must not exceed the noise level stated in the Gas Engine Driven Generator Data Sheet. Anti-vibration mountings for the package skid baseplate must be provided to achieve the specified acoustic performance.

The package must be fully enclosed with an integrated bund to prevent any oil or coolant spillage to the environment. The bund must be fitted with an alarm signal to warn of any spillages.

1.5 Alternator Generator Electricity Supply

The alternator normal supply must be 400 V / 230 V, 50 Hz, 3 phase, 4 wire power supply system. The star point of the alternator must be connected to the neutral bar of the generator located in the terminal box. The generator assembly must be connected to an earth bar and the earth bar must be connected to the removable MEN link in the terminal box. The neutral and earth cables must be rated to comply with the relevant Australian Standards.

1.6 Operation

Unless otherwise specified the following operation is intended:

- Both normal supply and generator supply will be fed into the ATS located in a separate cubicle in the main switchboard (supplied by others).
- A phase failure relay (PFR) in the ATS panel will continuously monitor the normal supply.
- When the normal supply voltage deviates from nominal for more than a pre-set time (0.1 - 60 seconds adjustable, initially set to 30 seconds), a voltage free contact of the PFR will close and will initiate automatic start-up of the generator (AUTO mode).
- When the ATS controller detects correct voltage on the generator side of the ATS, the ATS controller will open the normal supply circuit breaker/load switch. After opening the normal supply circuit breaker and at the expiry of a pre-set time delay (0.1 - 60 seconds adjustable, initially set to 5 seconds) the ATS controller will close the generator supply circuit breaker/load switch.
- When the normal power supply returns the PFR voltage free contact will open. After a time delay, (0.1 - 240 seconds adjustable, initially set to 240 seconds), provided that the PFR contact has remained open, the ATS controller will initiate the opening of the generator supply circuit breaker.
- After a further time delay (0.1 - 30 seconds adjustable, initially set to 5 seconds) the ATS controller will close the normal supply circuit breaker(s)/load switch.
- Finally, after a further time delay (60 - 600 seconds adjustable, initially set to 480 seconds), the ATS controller will stop the generator.
- Following transfer back to normal supply the generator must continue to run unloaded for a pre-set time after which it must automatically shut down and reset for a future automatic start up.

An auto / test switch will be provided in the ATS controls to override the automatic transfer functions and enable local control for testing purposes or so that the operator may choose the timing of the transfer back

to normal supply. In test position, the ATS will simulate normal supply failure and proceed to complete the power supply changeover to the generator supply. The facility will remain on generator supply until the selector switch is returned to the auto position, at which time the ATS will complete the transfer of supply to the normal supply. The transfer must not occur unless the normal supply is available. During the complete sequence the timing will be identical to automatic operation.

The generator must also be capable of being manually started and stopped from the generator local control panel (MANUAL mode) to cater for special circumstances. Transfer between the generator operating modes must be smooth and must not affect the operation of the generator.

The normal and standby supply circuit breakers / load switches forming the ATS will be mechanically interlocked to prevent the paralleling of the generator supply with the normal supply.

The generator will be regularly operated for maintenance purposes. During such operation the generator may be loaded via the integrated load bank or the plant equipment or both.

The load bank must be controlled automatically by the load bank controller, based on the load of the generator, without any interface with the run status of the plant.

1.7 Gas leakage detection and interlocks

An intrinsically safe gas detector must be mounted inside the enclosure at a location nominated by the manufacturer. The detector must detect the presence of natural gas.

If the gas level reaches 5% LEL, the following actions must take place:

- Gas supply to the gas engine must be switched off by the automatic gas shut-off valve.
- Gas engine operation to be inhibited.
- Except the intrinsically protected control and monitoring signals, all electrical power supplies to the gas engine driven generator enclosure must be isolated at a point external to the acoustic enclosure.
- The sparking mechanism for the gas engine must be disabled.
- Alarm must be sent to Sydney Water SOC and a warning light on the outside the enclosure must go off.

All of the above conditions must remain in place as long as the presence of gas in the enclosure is above its safe limit (5% LEL) and must only be reset manually. Remote or automatic resetting to enable gas engine operation must not be permitted.

With all specified controls in place the gas pump enclosure must be classified and sign posted as Class I Zone 2 hazardous area in accordance to AS 60079.10.1.

1.7.1 Electrical power supply isolation panel

All power supplies to the gas generator including auxiliary power supply, cranking battery supply and the control power battery supply to the gas engine must be automatically isolated when the gas level within the acoustic enclosure reaches 5%LEL. The isolation of power supplies must occur outside the acoustic enclosure to ensure there are no potential power sources within the enclosure.

The auxiliary power supply, cranking power supply batteries, control power supply batteries, battery chargers, and the control equipment required to facilitate the isolation must be housed in an external electrical panel. The electrical panel must be free standing and must not be directly bolted onto the acoustic enclosure. The electrical conduits, channels or ducts between the electrical panel and the gas generator acoustic enclosure must not be terminated directly on the electrical panel.

The electrical panel must be manufactured from 2mm 316 grade stainless steel and must have a minimum ingress protection rating of IP54. The general construction including doors, door seals, door latches, door handles, equipment mounting plates, earthing, internal wiring, labelling, gland plates, surface treatment and painting of the electrical panel must comply with the Sydney Water Technical Specification - Electrical.

All cabling between the electrical panel and the gas engine must be bottom entry.

A typical circuit diagram and electrical panel layout is given in Appendix 2.

1.8 Testing and Commissioning

The Supplier must undertake factory testing of the generator in accordance with Sydney Water's Specification: Commissioning – transitioning assets into operation. If requested, the Supplier must provide site testing and commissioning support.

The Supplier must prepare and submit Inspection and Test Plans (ITPs) and Checklists as part of the Supplier's Project Quality Plan detailing all testing required to satisfactorily complete the factory acceptance testing.

1.9 O&M Manuals and WAC Drawings

The Supplier must provide operation and maintenance (O&M) manuals and WAC drawings in accordance with this Specification and Sydney Water's Specification: Commissioning – transitioning assets into operation.

2. Standards, Codes and Regulations

2.1 General

All equipment, materials and accessories used for the completion of the scope of work must be new. Their design and construction must be in accordance with all legal regulations and latest editions of relevant standards, codes and Sydney Water's specifications including, but not limited to those stated below.

Where no Australian Standard or Code exists, relevant International Standards, subject to Sydney Water acceptance, must apply.

Proof of compliance with a Standard or specified test may be required. Where requested, such proof must comprise a test certificate from an independent Testing Authority.

Where a standard or specification requires reference to another standard or specification and that document has been amended, replaced or superseded or withdrawn, the reference must be taken to apply to the replacement of that standard or specification. If necessary, the author of such document must be consulted for a determination of the appropriate replacement standard or specification.

2.2 Regulations

- Work Health and Safety Act 2011
- Work Health and Safety Regulation 2017
- Dangerous Goods Act 1985 and Regulations
- National (NSW) Gas Act 2008
- NSW Electricity Supply Act 1995
- National Construction Code of Australia
- NSW Environmental Noise Control Manual
- EPA NSW Noise Policy for Industry (NPfI) 2017
- Service and Installation Rules of New South Wales
- Relevant Power Supply Authority Requirements
- Australian Communications and Media Authority Requirements
- Environmental Planning and Assessment Act 1979
- Protection of the Environment Operations Act 1997
- Protection of the Environment Operations (Clean Air) Regulation 2010
- Gas compliance requirements of New South Wales
- Gas and Electricity (Consumer Safety) Act 2017
- Gas and Electricity (Consumer Safety) Regulation 2018

2.3 Standards

- AS 1019: Internal combustion engines – Spark emission control devices

- AS 1055: Acoustics - Description and measurement of environmental noise
- AS 1081.1: Acoustics - Measurement of airborne noise emitted by rotating electrical machinery - Engineering method for free-field conditions over a reflective plane
- AS 1081.2: Acoustics - Measurement of airborne noise emitted by rotating electrical machinery - Survey
- AS/NZS 1269: Occupational noise management
- AS 1359: Rotating electrical machines - General requirements
- AS 1627: Metal finishing – Preparation and pre-treatment of surfaces
- AS/NZS 2373: Electric cables - Twisted pair for control and protection circuits
- AS/NZS 3000: Electrical installations
- AS/NZS 3008.1.1: Electrical installation - Selection of cables
- AS/NZS 3010: Electrical installations - Generating sets
- AS/NZS 3111: Approval and test specification - Miniature overcurrent circuit-breakers
- AS 4041: Pressure piping
- AS 4044: Battery chargers for stationary batteries
- AS 4594: Internal combustion engines – Performance
- AS/NZS 5601.1: Gas installations – General Installations
- AS 60034.1: Rotating electrical machines – Rating and performance
- AS 60034.9: Rotating electrical machines – Noise limits.
- AS 60044.1: Instrument transformers - Inductive voltage transformers
- AS 60079.10.1: Explosive atmospheres – Classification of areas – Explosive gas atmospheres
- AS 60269.1: Low-voltage fuses - General requirements
- AS 60529: Degrees of protection provided by enclosures (IP Code)
- AS/NZS 60947.2: Low-voltage switchgear and control gear - Circuit-breakers
- AS/NZS 60947.6.1: Low-voltage switchgear and control gear - Multiple function equipment - Transfer switching equipment
- AS/NZS 60947.8: Low-voltage switchgear and control gear - Control units for built-in thermal protection (PTC) for rotating electrical machines
- AS/NZS 61000.6.1: Electromagnetic compatibility (EMC) - Generic standards - Immunity standard for residential, commercial and light-industrial environments
- AS/NZS 61439: Low voltage switchgear and control gear assemblies
- AS/NZS CISPR 11: Industrial, scientific and medical equipment - Radio frequency disturbance characteristics - Limits and methods of measurement
- AS/NZS CISPR12: Vehicles, boats and internal combustion engines - Radio disturbance characteristics - Limits and methods of measurement for the protection of off-board receivers

- ISO 8528: Reciprocating internal combustion engine driven alternating current generating sets
- SAE J1349: Engine power test code - Spark ignition and compression ignition - As installed net power rating

2.4 Sydney Water Specifications

- TOG_TS01 Instrumentation and Control Standards (General)
- I&C_SPS SPS Related Instrumentation and Control Standards
- Treatment Plant SCADA Standards
- Sydney Water Specification: Commissioning – transitioning assets into operation
- Technical Specification – Mechanical
- Technical Specification – Electrical

2.5 Codes

- Water Services Association of Australia WSA 201 Manual for Selection and Application of Protective Coatings

3. Technical Requirements

3.1 General

All equipment which is to be provided by the Supplier, and the details of which have not been covered by any specific rating or performance requirements in this Specification, must be of an approved construction and suitable for the duty the equipment has to perform.

For any type of equipment or accessory, the same manufacturer and range must be used throughout the construction to maintain standardisation, unless otherwise specified or approved by Sydney Water. The generator set and all equipment in the control panel must be of a type commonly used within Sydney Water for standardisation purposes.

Any of the works, which would reasonably and obviously be inferred as necessary, for the complete, safe and satisfactory operation of the supplied equipment, whether or not expressly described or specified, must be provided and such work executed as part of the Contract.

The whole of the work must be carried out by skilled qualified tradesmen under qualified supervision.

When designing the enclosure and skid careful consideration must be given to providing suitable access to equipment for operation and maintenance. Access doors must be made large enough and positioned in such a way that additional ladders or platforms are not required. The enclosure must be made wide enough to accommodate any auxiliary equipment associated with the generator.

Auxiliary equipment and accessories must be mounted so as to be free of vibration from the generator unit. Adequate provisions must be made for the attachment of lifting slings and/or jacks for ease of handling.

The general design must provide easy access to all points requiring servicing, maintenance or regular inspection, including batteries, sensors, gas regulators, safety shut off system and isolators. The crankcase oil drain and cooling water system drain must be brought to the side of the unit so that a 200 mm high receptacle may be used to drain the oil or water. Alternatively, if the oil and cooling water spill into a common collection sump, a provision for a suitable portable pump to empty the sump into a container may be considered.

The generator enclosure must be of a vermin proof design. The generator enclosure must carry the necessary labels to indicate the presence of electrical, hot surfaces, noisy, fumes and any other hazardous conditions.

Exposed moving parts must be protected by approved adequate guards. The guards must not interfere with any controls or prevent normal operation or maintenance of the unit. The generator canopy must be painted.

3.2 Acoustic Enclosure

The generator will be installed in such a manner that the transmission of noise and vibration is kept to a minimum. The Supplier must comply with the noise level specified in the Gas Engine Driven Generator Data Sheet.

The generator must be mounted inside an acoustic enclosure as outlined in the Gas Engine Driven Generator Data Sheet. The enclosure must be fabricated from structural steel and be weatherproof with ingress protection rated to a minimum of IP22 as per AS 60529. Each access door must be fitted with Sydney Water locking system to suit CB-Y yellow keying.

The enclosure must be painted as per WSA 201, coating system POW or PUR-A in high exposure class or PUR-B in moderate exposure class. The enclosure colour must be Dulux Ocean Mist 96183250 or European Colour Standard No. RAL9018, unless specified otherwise by Sydney Water (e.g. Environmental Green G66 may be more suitable if installed in parks or bush areas). Sheet metal must be primed for corrosion protection and finish painted to a specified colour. Surfaces of metal parts must be primed and painted to an approved paint system unless they are made from corrosion resistant materials.

Painting of stainless steel and non-metallic service parts such as hoses, clamps, wiring harness and others is not acceptable. Fasteners must be Grade 316 stainless steel, designed to minimise marring of the painted surfaces when removed for normal installation or service work.

The acoustic enclosure must house the generating set, control panel, terminal box, gas supply pipework, ancillary components, any required load banks and harmonic filters. Access to the control panel must be possible without increasing the noise level as per the requirements in the Gas Engine Driven Generator Data Sheet.

Panels for air intake and exhaust must be of adequate size and robust construction such that air induced vibration does not add to the overall noise level generated. If the enclosure consists of a separate exhaust chamber, access must be provided to ensure debris can be cleaned. If no access is provided to this chamber, then the exhaust must be supplied with an appropriate hood to prevent debris or rainwater entering the chamber.

The enclosure must be fully removable from the installed generator assembly to enable major overhauls to be undertaken. The enclosure must be constructed such that it can be removed with minimum disassembly and must retain the acoustic capability when reinstalled. The operation and maintenance manual must provide step by step details of disassembly and re-installation.

The enclosure must reduce the sound level of the generator set while operating at full rated load to the maximum level specified in the Gas Engine Driven Generator Data Sheet. Housing configuration and materials used may be of any suitable design which meets application needs, except that acoustic material used must be oil, water and fire resistant. Foam materials must not be used unless it can be demonstrated that they have the same durability and life span as mineral wool.

The enclosure must include hinged doors for access to both sides of the engine, alternator and the control equipment to provide easy access for routine maintenance and inspection. Door hinges and fasteners must be Grade 316 stainless steel. Each door must be provided with a stainless steel latch to secure the door in the open position. Each door must be provided with a limit switch. The volt free contact must CLOSE when the door is in fully closed position and must OPEN in any other position. Door limit switches must be terminated at the terminal block in the control panel.

The enclosure must be provided with an exhaust silencer, mounted inside the enclosure that allows the generator set to meet specified sound level requirements. The silencer and exhaust must include a rain cap and rain shield, all manufactured from grade 304 or 316 stainless steel. An exhaust guard is to be provided for protection against vandalism.

The Supplier must provide all anticipated noise level information required in the Gas Engine Driven Generator Data Sheet provided in Appendix 3.

The complete generator assembly with enclosure must be factory tested for noise compliance. Equipment operating under normal conditions that does not meet the defined requirements for noise must be rectified and retested.

3.3 Alternator Arrangement

The engine alternator set must be mounted on a separate, fabricated steel sub frame.

Auxiliary equipment and accessories must be mounted to be free of vibration from the alternator unit.

3.4 Engine

3.4.1 General

The engine must be a turbo-charged, after-cooled or normally aspirated 4 stroke, 1500 rpm and gas type of a proven design.

Replaceable cartridge type filters must be provided for lubricating oil and combustion air. The cartridge filters must be positioned in an easy accessible location to allow for a periodic maintenance with no need to disassemble other engine parts within the enclosure.

The engine must be equipped with a radiator and cooling fan.

Crankcase ventilation pipes must be run to a point adjacent to the air intake filter to minimise contamination of the enclosure with oil.

Only engines with a proven track record in Australia of reliability, provisions of local service facilities and local availability of spare parts will be considered. The engine and accessories must comply with AS 4594.

3.4.2 Rating

The power rating of the engine at its minimum tolerance level must be sufficient to drive the alternator and all connected accessories. The engine must be capable of maintaining 100% full load continuously and 110% full load for 1 hour in 12 hours including transients.

The engine rating must be based on the maximum ambient temperature outlined in the Gas Engine Driven Generator Data Sheet. SAE J1349 engine power test code must be used as the baseline for rating the engine. If engine is rated by any other standard, that rating must be converted to SAE J1349 standards by using the correcting formula adopted and published by the SAE Power Test Code Committee under the Engine Group.

3.4.3 Governor

The engine must be provided with an electronic governor of accuracy Class A1 to AS 4594, to maintain an output voltage frequency of 50Hz (nominal) and capable of isochronous operation. Governor regulation class must comply with ISO 8528.

The governor system must be of Woodward or Heinzman manufacture or equivalent and must incorporate an electronic speed and load controller in conjunction with a mechanical governor actuator on the engine.

The electronic governor must include adjustments for speed droop, gain and stability and facilities for rapid stopping under emergency conditions.

3.4.4 Drip Tray

An easily removable drip tray must be provided under the engine.

3.4.5 Jacket Water Heaters

Jacket water heaters must be installed to facilitate rapid starting and loading of the engine. The heaters must accept 230 V AC single-phase power and include thermostatic controls. Hoses to and from the heaters must be of industrial quality, which exhibit long life.

3.4.6 Radiator

The radiator and fan must be included in the package. The jacket water/radiator cooling circuit must be a closed water circuit. Air intakes and outlets must be weather, insect and vermin proof.

3.4.7 Pipework

Pipework and associated components must comply with AS 4041, AS/NZS 5601.1 and AS 1940, as well as requirements of Local Authorities.

Pipework must be carried out using seamless mild steel to ASTM A106 Grade B or BS 3601 Grade 27 or equivalent. The pipes must be pickled, descaled and externally painted or otherwise protected throughout. Grade 316 stainless steel seamless tubes to ASTM A269 must be used where installed in aggressive environment. All ends must be capped or plugged where not terminated at a piece of equipment.

Joints must be butt-welded, and all workmanship must be consistent with the requirements of AS 4041. Joints must be tested to AS 4041 before completion. Press fit (‘crimped’) pipe joints are not acceptable.

Bolted joints must be electrically bonded to protect against the effects of static electricity.

The pipework must be complete with isolation valves, check valves and other fittings necessary for functional operation. Pipe fittings must be malleable iron, steel or bronze.

Valves must be similar to Fire Safe socket weld ball valves.

All pipes must be fixed and supported to prevent rattling or vibration during operation. Where necessary, anti-vibration bellows should be used.

3.5 Alternator

3.5.1 General

The alternator must be excited by a self-regulated exciter, which must be drip proof, screen protected and direct coupled to the engine. The alternator, which must comply with all relevant requirements of AS 60034, must be designed to give an output voltage of 400 V on a 3 phase power supply system when delivering full rated load (at 0.8 lag) at 50Hz.

The alternator must deliver continuously the full rated output plus 10% overload with a voltage regulation of not more than ± 0.5% at any power factor between 0.8 and 1.0.

The alternator must be oversized for any harmonic, voltage distortions and building loads, i.e. pumps, ventilation, variable speed drives etc., if required. See Gas Engine Driven Generator Data Sheet for details.

The engine-alternator set must be capable of single step pick up and drop off of a load equal to the nameplate kW rating (less applicable de-rating factors) of the generator set.

A permanent magnet generator (PMG) must be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls must be capable of sustaining and regulating current supplied to a single phase or three-phase fault at approximately 300% of rated

current for not more than 10 seconds. The sub transient reactance of the alternator must not exceed 12%, based on the standby rating of the alternator set.

An electronic governor system must provide automatic isochronous frequency regulation from steady state no load to steady state rated load. Random frequency variation with any steady load from no load to full load must not exceed ± 0.25%.

The alternator must produce a clean AC voltage waveform, with no more than 5% total harmonic distortion at full linear load, when measured from line to neutral and with not more than 3% in any single harmonic. Total harmonic distortion open circuit voltage waveform in the order of 1.8%. Telephone influence factor (TIF) must be less than 40.

Generator set control interfaces to other system components must be made on a common permanently labelled terminal block assembly mounted within an IP56 enclosure.

The alternator must be brushless rotating field type directly coupled to the engine.

The cooling system must be IC01 to AS 1359.106 and the degree of protection must be not less than IP22 to AS 60529.

The temperature rise of the insulation systems must not exceed the limits set out in AS 60034.1 thermal Class H. In addition, the output voltage THD must not exceed 5% for any load up to rated.

The alternator/exciter/voltage regulator system must be designed for current forcing, i.e. for a three phase short circuit applied at the alternator terminals a current of not less than 3 pu must be sustained for at least 10 seconds.

3.5.2 Terminal Box

The alternator must be designed for star connection and each end of each winding and neutral must be brought out to a terminal box. The box (with suitable rating circuit breaker to protect generator output) gland plate and terminals must be adequately sized and incorporate cable glands to allow easy termination of cables.

The terminal box must be air insulated with copper terminals and brass gland plate for bottom entry cables.

The terminal box must have an IP56 rating and be an integral part of the generator enclosure.

Provision must be made for the installation of protection and measurement CTs in the terminal box or if necessary, in a custom-made extension box to be supplied by the Supplier. Refer to the Gas Engine Driven Generator Data Sheet to confirm if CTs or space for CTs is required in terminal box.

A removable MEN link must be provided inside the terminal box.

3.5.3 Voltage Regulator

The alternator must be provided with a solid-state voltage regulating system. Lockable controls must be provided to allow trim of output voltage and output voltage drop.

The voltage regulation must comply with AS 60034.1.

3.6 Starting System

3.6.1 General

An electric starting system must be used. It must include:

1. 24 V DC.
2. A closely regulated over current protected battery charger.
3. The starting system must include an engagement mechanism incorporating a chamfered ring-gear and self-lubricated pinion. The engagement mechanism must be activated through electromechanical engagement. The starter motor must operate on 24 V DC and must be rated for 30 seconds of continuous cranking.

3.6.2 Battery

Heavy duty battery must be supplied which comply with AS 4044. The selection of battery must consider the risk of explosion and suitability for standby gas engine starting application. The battery must have sufficient capacity to allow a minimum of 5 successive, 15 second starting attempts at 0°C. The number of charge-discharge cycles must not be less than 2400. The batteries are to be mounted within the acoustic enclosure.

Necessary wiring, switches and purpose-made connections must be provided for a complete installation.

A lockable main battery isolator is to be provided and mounted on the engine adjacent to the starter motor. The terminals must be numbered, and DIN rail mounted. All wires are to be numbered and pin connected. 230 V AC terminals are to be segregated by a physical barrier from the 24 V DC and have an appropriate warning label.

The battery must be located so that voltage drop to the starter motor is minimised and that it is unaffected by heat from the engine.

The cells must be mounted in a rigid structure with an electrolyte resistant finish which:

1. Allows easy access to the terminals and vents for maintenance.
2. Protects against falling tools touching the connectors or terminals.

3.6.3 Battery Charger

A constant voltage automatic battery charger, complete with all necessary controls, fuses and alarms must be supplied for charging the battery. The selection of battery charger must be suitable for the type of battery selected and suitable for standby gas engine starting application.

An engine driven automatic type alternator as the sole means for battery charging is not acceptable.

The battery charger must supply 24 V DC battery system for engine starting and the alternator control system. Under normal circumstances when 230 V AC auxiliary power is available the battery charger must charge the batteries ensuring that they are fully charged. Under emergency conditions where normal site power is not available during power failure, the alternator of the gas engine must charge the battery.

The battery charger must be capable of restoring full charge to the battery within 12 hours, following a total of 5 successive start cycles of cranking. The charger must also be adjustable to compensate for the battery self-discharge rate and must be capable of recharging batteries to full potential within 4 hours.

Alarm for DC output / charger failed and low battery voltage are to be provided which are to be wired to the control panel. Alarm circuits must be configured as fail-safe and must have volts free contacts. Alarms must reflect the true battery voltage and not the rectified voltage from the AC supply. The alarms must be wired in series with the alarms for the generator control circuit battery charger alarms so that either will trigger the alarm input.

The charger must include an analogue or digital DC voltmeter and ammeter, 12 h equalise charge timer and AC and DC fuses.

3.6.4 Battery Charger Alarms

The system must include LED type lights to provide local indication for:

1. Supply mains on.
2. Charge fail.
3. Low battery volts.

Provision for remote indication at the control panel of a common fault alarm and a separate "low battery volts" alarm must be made by means of voltage free changeover relay contacts. The "low battery volts" alarm must be initiated if the battery voltage falls below a value required to ensure reliable starting and operation of the generating unit.

3.7 Control Panel

3.7.1 General

The generator local control panel must be located inside the generator package. A separate lockable door to access the controls, indicating instruments and equipment within the control panel must be provided. The generating unit must be capable of operating at maximum capacity with the opened internal and external access doors of the control panel and must comply with the specified noise rating.

The external door of the control panel must be provided with lockable handle to accept Sydney Water key or Sydney Water standard padlock with 10mm shackle. The internal panel door must be provided with 7mm square pin latches. Control panel doors must be fitted with latches that can be used to retain the doors in the fully open position.

In the case of back access to the panels, rear doors or covers must be of the lift off type. Lift off doors or covers must be fitted with lifting handles and must be retained in their position when retaining nuts or bolts are removed. Covers must be held in place with chrome-plated captive knurled fixing nuts or screws.

Cubicles having access from the front only must be provided with lift off covers over cabling compartments.

Doors and covers must be fitted with neoprene type gaskets installed within retaining channels. Gaskets fixed with adhesive only are not acceptable.

Panel components and controls must be identified by engraved traffolyte labels fixed by self-tapping stainless steel screws or an equivalent approved system.

Incoming or outgoing cabling to the control panel must be bottom entry only. Each incoming or outgoing cable must be fitted with suitable glands such that the cables are adequately spaced and allow for required bending radius.

The panel must be a dead front folded sheet metal type and the general arrangement of equipment on the front panel must be such that an ordered and balanced appearance is provided.

The control panel, doors and covers must be manufactured from cold rolled zinc seal steel sheet, free of scale, rust or indentations. Normally a minimum 1.6mm sheet thickness must be used, but lighter sheet may be acceptable if the type of construction meets with the overall requirements of rigidity and robustness.

Special attention must be given to doors, which must be rigid and free from buckling. The sheet metal must be painted white in accordance with WSA 201.

Bolts, nuts and screws used must be cadmium plated or similar approved finish.

The degree of protection must be IP56.

3.7.2 Control Cubicle Layout

The control cubicle layout must comply with the following:

- 230 V AC wiring and control wiring must be suitably segregated within the control cubicle.
- Control relays and timers must be DIN rail mountable grouped and located on the same DIN Rail.
- Control fuses must be DIN rail mountable grouped and located on the same DIN rail.
- Control input terminals to the generator controller must be grouped and located on the same DIN rail.
- Control output terminals from the controller must be grouped and located on the same DIN Rail.
- Remote control signal terminals and remote monitored signals must be grouped and located on the same DIN rail.
- Components that require to be reached for maintenance must not be mounted higher than 2000 mm and panel indicators, operating panels and switches must not be mounted higher than 1600 mm from the mounting floor of the generator unit.
- Equipment, other than the generator controller, unless prior Sydney Water's approval is obtained, must be the type currently used in Sydney Water to ensure standardization. Information will be made available on request. A full equipment list with layout drawings MUST be supplied and approved prior to any manufacturing taking place.

3.7.3 Generator Controller

A generator control panel must be provided in the package. The package and the control panel must be suitable for bottom entry of control cables via the cast-in conduit provided in the foundation. The controller must be fascia mounted on the internal door of the control cubicle.

The generator controller must include but not be limited to the following, however some features such as alarms and indicators may be provided in proprietary integral solid state devices:

1. Ammeter three-phase with phase selection.
2. Voltmeter three-phase with phase selection.
3. Frequency meter.
4. Generator Operation Mode Selection with the following modes:
    a. Manual Mode – generator able to start and run
    b. Auto Mode – started from remote start signal
    c. Off Mode – generator set shutdown and cannot be started.
5. Emergency stop pushbutton (red pushbutton with mushroom head, twist release).
6. Generator Running indication.
7. Not in auto mode indication.

8. Common warning indication.
9. Low oil pressure warning (latched).
10. Low oil pressure shutdown (latched).
11. High engine temperature warning (latched).
12. High engine temperature shutdown (latched).
13. Over-speed shutdown (latched).
14. Under-speed shutdown (latched).
15. Fail to start (latched).
16. Low battery voltage (latched).
17. High battery voltage (latched).
18. Fluid in bund.
19. 5% LEL shutdown, gas supply shut-off, electrical supply disabled, sparking disabled, alarm and warning light.

3.7.4 Telemetry Remote Monitored Status and Alarms

The generating unit must be capable of supplying but not limited to the following alarms and status:

1. Common alarm for all fault/alarm conditions identified by the generator controller / engine management system.
2. Generator unavailable including but not limited to: Alternator overload protection shutdown (MCCB tripped), emergency stop pressed, not in AUTO, circuit breaker off, 5% LEL reached.
3. Generator running.
4. Engine fails to start.
5. Engine cooling system fault including but not limited to low jacket water temperature, high jacket water temperature shutdown, engine low jacket water level.
6. Engine low lubricating oil pressure shutdown.
7. Engine over speed shutdown.
8. Gas leakage detected.
9. Engine high gas pressure.
10. Engine low gas pressure
11. Combined cranking battery charger fault or control circuit battery charger fault including loss of 230 V AC supply.
12. Combined cranking battery voltage fault or control circuit battery voltage fault.
13. Doors open/close status (must be interfaced to existing alarm circuit at the main facility).

See Gas Engine Driven Generator Data Sheet for details.

Volt free alarm contacts must be wired to a set of terminals as shown in Appendix 1. The common for the alarms must be supplied from the generator control voltage to interposing relays in the generator control

panel supplied by the Supplier. This is required to ensure that faults within the generator do not jeopardise the Sydney Water's main switchboard control voltage power supply.

Unless otherwise agreed all alarms MUST be FAIL SAFE. The failsafe alarm circuits must be configured to ensure that failure of any component, including primary devices, arising and/or de-energising of the circuit will OPEN the volt-free contact and generate a remote alarm.

In addition, an engine running status signal is also to be provided which must not be wired as fail safe.

Where the generator controller is not capable of supplying volt free fail safe relay contacts for the required remote monitored alarms as described above, they may be provided by alternative programmable devices or solid state devices. Alternative device/s must have capability to communicate directly with the generator controller to extract all alarm and trip status generated by the generator controller.

Where alternative programmable devices are proposed the following also applies:

1. Equipment must be approved by Sydney Water
2. Delivery of programming software and hardware
3. Delivery of manuals for hardware and software
4. Delivery of software program
5. Easily accessible within the control cubicle
6. Powered by the generator control battery supply
7. Must be able to operate reliably within voltage variation caused during generator cranking at starting or use a separate battery supply system and must have:
    - Separate battery charger that has same alarm capability of the generator battery charger.
    - Alarms wired in series with the alarms of generator battery charger.

3.7.5 Local Generator Alarms

In addition to the remote alarms specified, the engine must be fitted with all protective devices considered necessary by the manufacturer to protect it from damage in event of a malfunction and to provide warning of an impending malfunction. Pre alarms must be capable of being manually cancelled without shutting down the engine once the condition being monitored has returned to the manufacturer's limit.

All alarms must be indicated locally on the generator control panel and be capable of being reset from a remote signal via IICATS or plant SCADA. The remote signal must be a volt free normally open contact.

Alarm wiring must be secured to prevent vibration and must be terminated on the remote control and alarm terminal block mounted in the local control panel.

3.7.6 Control Wiring

Unless otherwise approved control wiring must be carried out in minimum 16/0.2 PVC insulated wire rated at 0.6/1 kV. All ends must be terminated with approved type lugs or ferrules.

Colour coding of wiring must comply with the Sydney Water's Instrumentation and Control Standards.

Wiring within the control cubicle must be enclosed with grey slotted duct. Terminals must be spaced suitably from the ductwork allowing room for neatly separated wiring, identification, and terminations. Wiring must be identified with wire numbers within plastic sleeves at each end of the wire.

Terminals within the control cubicle must be an approved type where wiring is terminated on the top and bottom of the terminal, not into the front. Terminals must be numbered sequentially. Each terminal strip within the control cubicle must also be identified to differentiate between different terminal strips, i.e. X1, X2, etc.

Terminations and terminals exposed on the inside of hinged doors must be appropriately shrouded.

Harness bars or equivalent must be provided for wiring associated with hinged doors to suitably support the weight of the wiring and secured such that it is not affected by any vibration or movement. Wiring across hinged doors must be bound in spiral wrap unless otherwise approved.

3.7.7 Control Circuit Battery

A battery (or batteries) must be supplied, separate to the generator starting system batteries, dedicated to supplying the generator control circuits.

Heavy duty batteries must be supplied which comply with AS 4044. The selection of battery must consider the risk of explosion and suitability for standby gas engine application. The battery must have sufficient capacity to supply the generator control circuits for a period of 12 hours. The batteries are to be mounted within the acoustic enclosure.

All necessary wiring, switches and purpose-made connections must be provided for a complete installation.

A main battery isolator is to be provided. The terminals must be numbered, and DIN rail mounted. All wires are to be numbered and pin connected. 230 V terminals are to be segregated by physical barrier from the 24 V and appropriately warning labelled.

The battery must be located so that voltage drop to the control circuits is minimised and that it is unaffected by heat from the engine.

The cells must be mounted in a rigid structure with an electrolyte resistant finish which:

1. Allows easy access to the terminals and vents for maintenance.
2. Protects against falling tools touching the connectors or terminals.

3.7.8 Control Circuit Battery Charger

A constant voltage automatic battery charger, separate to the generator starting system battery charger, must be supplied, complete with all necessary controls, fuses and alarms for charging the generator control circuit battery. The selection of battery charger must be suitable for the type of batteries selected and for standby gas engine application.

An engine driven automatic type alternator as the sole means for battery charging is not acceptable.

The battery charger must supply 24 V DC battery system for the generator control circuits. Under normal circumstances when 230 V AC auxiliary power supply is available the battery charger will charge the batteries ensuring that they are fully charged. Under emergency conditions where normal site power is not available during power failure, the alternator of the gas engine must charge the battery.

The battery charger must be capable of restoring full charge to the battery within 12 hours, following supplying the control circuits for 12 hours. The charger must also be adjustable to compensate for the battery self-discharge rate and must be capable of recharging batteries to full potential within 4 hours.

Alarm for 24 V DC output power supply failed and low battery voltage are to be provided which are to be wired to the control panel. Alarms must be fail-safe and must have volt free contacts. Alarms must reflect

the true battery voltage and not the rectified voltage from the AC supply. The alarms must be wired in series with the alarms for the starting system battery charger alarms so that either will trigger the alarm input.

The charger must include an analogue or digital DC voltmeter and ammeter, 12 h equalise charge timer and AC and DC fuses.

3.7.9 Control Circuit Battery Charger Alarms

The control circuit battery charger system must include LED type lights to provide indication for:

1. Supply mains on
2. Charge fail
3. Low battery volts

Provision for remote indication at the control panel of a common fault alarm and a separate "low battery volts" alarm must be made by means of voltage free changeover relay contacts. The "low battery volts" alarm must be initiated if the battery voltage falls below a value required to ensure reliable starting and operation of the generating unit.

3.7.10 Labelling

All components within the control cubicle must be physically labelled and identified on the generator WAC drawings. Labels must be traffolyte type with black lettering on white background and to be installed in a clearly viewable position located above the component. Labelling must not be installed directly onto any component nor on any ductwork.

3.7.11 Outgoing Cabling

A number of control and alarm functions on the alternator interface with other systems (e.g. MAIN SWITCHBOARD, ATS control). To facilitate connection to these systems, the wiring associated with these interfaces must be brought to sets of terminals mounted in a single location at the generator. The terminals must be mounted within an IP56 enclosure.

3.7.12 Current Transformers

Current transformers must be encapsulated types complying with AS 60044.1. They must be mounted on easily accessible removable sections of busbar.

Current transformer test and shunt links must be provided and located within the cubicle for easy front access.

Separate current transformers must be used for instrumentation/metering and protection.

A notice must be located adjacent to the links engraved: "Shunt must be closed before removing instruments".

3.7.13 Instruments, Meters and Accessories

Instruments, meters and accessories must be supplied and connected as indicated on the Single Line Diagram or as specified.

Instruments and meters must be flush mounting types. Voltmeters and voltage operated instruments must be protected by potential fuses. All indicating lights must be LED types.

3.8 Baseplate

The engine, alternator and all other ancillary equipment must be mounted on a rigid baseplate, fabricated from mild steel and hot dipped galvanised or painted. The baseplate must be substantial, suitable for installation on a concrete plinth or steel frame and must ensure the engine and alternator are correctly aligned.

Vibration isolator's spring/pad type must be provided between the engine and generator and the baseplate.

The baseplate must be fitted with a minimum of three levelling screws to allow for a minimum 20 mm height adjustment and levelling.

The mounting surfaces for the engine and alternator must be machined so that the mounting locations are in a common plane and the engine mounting locations are in a parallel plane to the alternator mounting locations. The relative dimension of the two planes must provide adequate shimming allowance to achieve final alignment of the engine and alternator after allowing for manufacturers' tolerances of centreline heights.

All holding down bolts must be of stainless steel and must be supplied by the Contractor. Holes drilled for holding down (anchor) bolts must not be obstructed by the equipment on the baseplate.

3.9 Load Bank

3.9.1 General

A fan-cooled resistive load bank must be provided for permanent, on-site installation as a component of the emergency power system. The load bank is to be used for periodic, scheduled, supervised maintenance exercise, testing and proper loading of the generator to avoid cylinder glazing, wet stacking and improper piston ring seating.

A load bank is to exercise and support the generator operation based on the site specific requirement. The permanent installation load bank must be provided as a tool for maintenance to test the generator.

The load bank must be completely self-contained, free standing unit, incorporating all resistive elements with fusing or circuit breaker to protect each load section and control circuit.

The cooling system must be forced air cooled by fans directly driven by electric motor with overload protection and temperature sensor control circuit. Any temperature rise of the enclosure must not exceed 20° above ambient temperature.

3.9.2 Load Bank Rating

Capacity:	See Gas Engine Driven Generator Data Sheet
Power factor:	1.0
Load steps:	10 kW resolution (Supplier to advise)
Voltage:	400 V AC, 3 phase
Frequency:	50 Hz
Ambient temperature:	See Gas Engine Driven Generator Data Sheet
Control Voltage:	230 V AC or 24 V DC
Noise level:	See Gas Engine Driven Generator Data Sheet

3.9.3 Load Bank Enclosure and Load Resistor

The load bank enclosure must be designed and constructed for a long and reliable life in industrial environments. The unit must be constructed from galvanised steel that is primed and painted in accordance with WSA 201. The load bank unit must have fully opening hinged doors to provide full and clear access to resistor connections and switch and control equipment, ensuring that equipment can be accessed safely at all times. Ideally the load bank controller should be located outside the resistor panel.

Where it is not included in the generator acoustic enclosure, the load bank must be designed for outdoor installation on a supporting structure (constructed by others). The load bank must be fully weatherproof including any louvers, etc. There must be sufficient clearance between the cold air intake and the hot air exhaust as recommended by the manufacturer.

The resistor must be designed specifically for high-density application. The resistor value must be accurate to ±2.5% of rated value at full operating temperature. The resistor supports must be constructed from a ceramic material. Plastic, glass or polyester materials must not be used.

3.9.4 Load Bank Control Operation

The load bank must have the facility to be operated automatically by remote control to provide a complete generator operational support system for loading acquisition support, automatic loading/ regenerative operation for light and variable loading application, automatic exercise with alarm monitoring, and basic manual control function for installation commissioning.

The load bank controller must automatically control the switching of the load bank loading steps in response to the instantaneous kW loading of the generator, to maintain generator kW output at or above 40% of the rated value.

The load bank must be able to provide a common alarm for all fault/alarm conditions identified by the controller. A volt free alarm contact must be wired to a set of terminals as shown in Appendix 1.

Equipment earthing connections must be provided for the load bank to ensure permanent and effective grounds to comply with AS 3000.

3.10 Corrosion Protection

Equipment must be protected from the effects of corrosion using systems detailed in WSA 201 and the guidelines below:

1. Fixings, brackets, nuts, bolts etc. for equipment, pipework, cable trays or similar must be hot dip galvanised steel. All other fixings must be grade 316 stainless steel. Where dissimilar materials are used they must be insulated from each other to prevent galvanic corrosion.
2. Pipework, tanks and miscellaneous steelwork must be:
    a. Cleaned and degreased.
    b. Etch primed.
    c. Finished with an undercoat and one coat of gloss enamel of the colour specified.
3. The alternator, pumps, motors and other pre-painted equipment must be:
    a. Cleaned.
    b. Finished with two coats of gloss enamel.

4. The engine manufacturer's standard finish will be acceptable.
5. Battery charger and control panel must be powder coated.
6. The acoustic/ weatherproof canopy must be powder coated in the specified colour.

All of the above systems to be applied are to be approved by Sydney Water. Surface preparation and coatings must be in compliance with WSA 201.

3.11 Earthing

The engine alternator mounting frame must be bonded to earth by flexible conductors. Any component not in effective electrical contact with these components must be appropriately earthed.

The control cubicle, battery charger and oil system must be earthed to the mounting frame.

An earth bar must be provided within the terminal box for EACH required earthing termination as part of the Generator.

Generator set bonding system must comply with AS 3010.

3.12 Motors

Motors for auxiliary plant must be 3 phase induction types.

Motor starters and other equipment necessary for local or automatic control must be provided together with all interconnecting wiring.

3.13 Installation, Operation and Maintenance Manuals

The following must be provided with the generator set:

- One hard copy of an installation, operation and maintenance manuals.
- A copy of the manual in electronic form on a USB drive. The media and data must not be password protected so that it can be transposed into the Sydney Water's database for common usage.

The manuals must be specific only to the equipment specified. They must be complete and include all information necessary for engineers, supervisors and tradesman to install, operate and maintain the unit satisfactorily whether they are electrical or mechanical by discipline.

Electronic versions must contain a table of contents with hyperlinks to the reference sub-sections and drawings, and PLC code if applicable.

As part of the manual, a list of recommended spare parts must be included to cover such items as:

- Filters
- Injector components
- Recommended lubricants
- All consumables
- Critical spares

4. Inspection and tests

4.1 Factory Inspection

A factory inspection of the completed generator unit may be undertaken by Sydney Water. The factory inspection must be carried out at the manufacturer's works when manufacturing is complete. At least one weeks' notice must be given of a proposed factory inspection.

Before commencing tests, the Supplier must provide Sydney Water with details of name, rating, type, manufacturer and serial number for:

1. Engine.
2. Alternator.
3. Voltage regulator.
4. Governor.
5. Control panel.
6. Battery chargers and batteries.

The Supplier must then perform the tests listed in the presence of Sydney Water:

1. Insulation resistance at 1 kV DC and high voltage test at 1.6 kV AC rms for 1 minute before and immediately after the load test.
2. Cold winding resistance immediately before and hot winding resistance immediately after the load test.
3. A transient frequency test with engine cold for the application of 0.6 p.u. load steps to check that governor performance complies with AS 4594.
4. A transient voltage test with engine cold for the application of a 0.6 p.u. load step to check that voltage regulator performance complies with the requirements of AS 60034.
5. A load test at the standby power rating specified for 6 hours. During this test all specified readings must be recorded at 30 minute intervals.
    a. The test must be carried out at unity (1) power factor.
    b. The test must be recommenced if any failure occurs.

Readings must be recorded for the following:

1. All temperatures monitored on engine control panel
2. All pressures monitored on engine control panel
3. AVR output voltage and current
4. Load current and power factor
5. Alternator output voltage
6. Ambient air temperature
7. Cooling water temperature
8. Engine and alternator air inlet temperature
9. Frequency

10. Insulation resistances from Test 1
11. Cold and Hot winding resistance from Test 2
12. Derived alternator winding temperature before and after load tests.
13. Highest LEL level inside the enclosure during the test.
14. A transient voltage rise after rejection of rated load to check that voltage regulator performance complies with the requirements of AS 60034.
15. Harmonic analysis of phase-to-phase and phase-to-neutral voltage waveform at no load and at rated load.
16. Simulated functional tests to prove correct operation of the controls and alarms.
17. Noise ratings
18. Paint thickness
19. Automatic generator synchronisation test with another generator supplied under this Specification.

All temperatures, pressures and voltages must be within the manufacturer's allowable limits.

Document Control

Ownership

Role	Title
Group	Engineering and Technical Support
Owner	Manager, Engineering
Author	Milan Rubcic, Lead Engineer

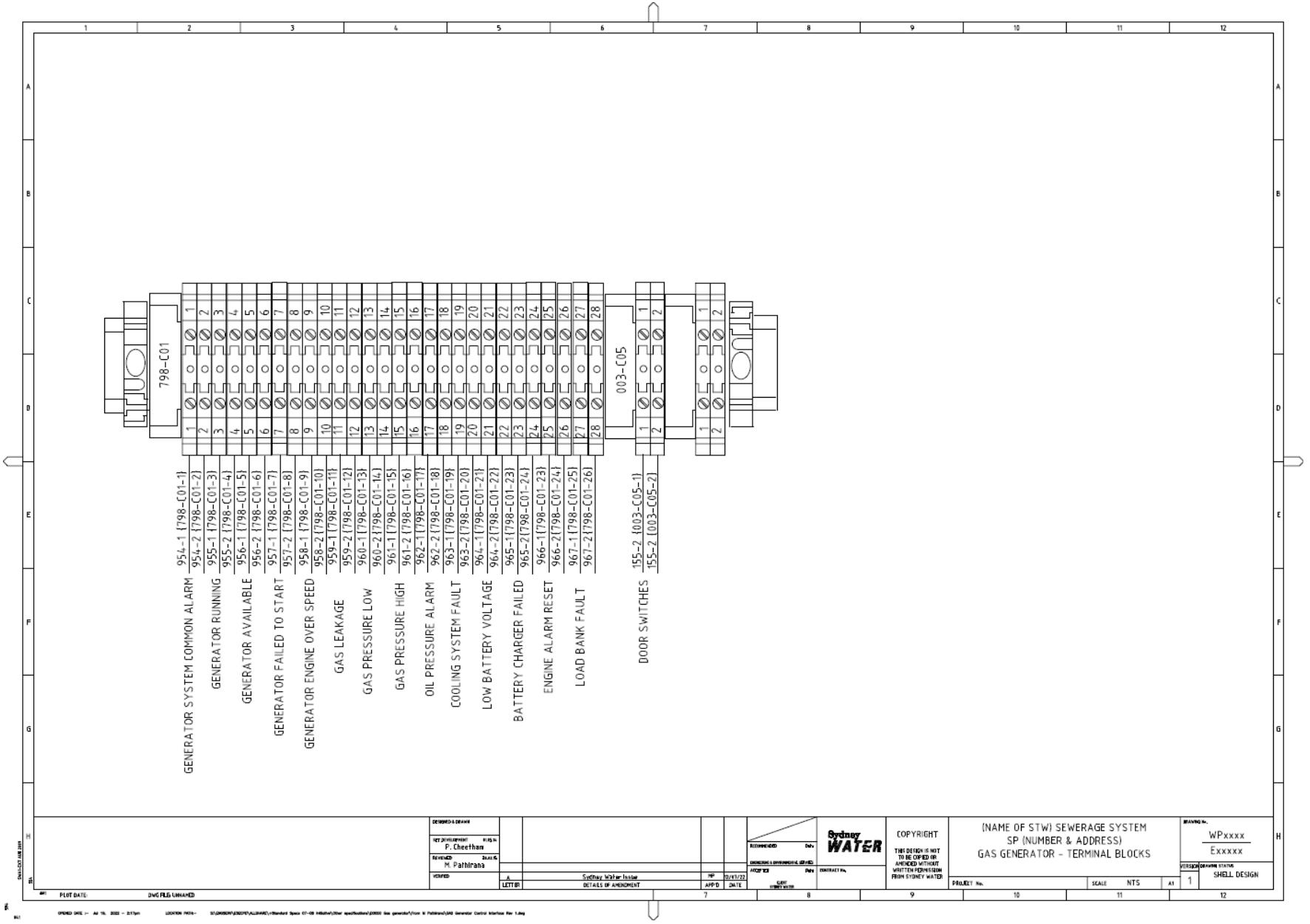
Change history

Version	Prepared by	Date	Reviewed by	Approved by	Issue date
1.0	Milan Rubcic	28/07/2022	M. Pathirana, R. Faure, M Mordini, L. Gupta, K. Ranatunga, A. Kwong. C. Varricchio, N. Majlessi	Norbert Schaeper	1/08/2022

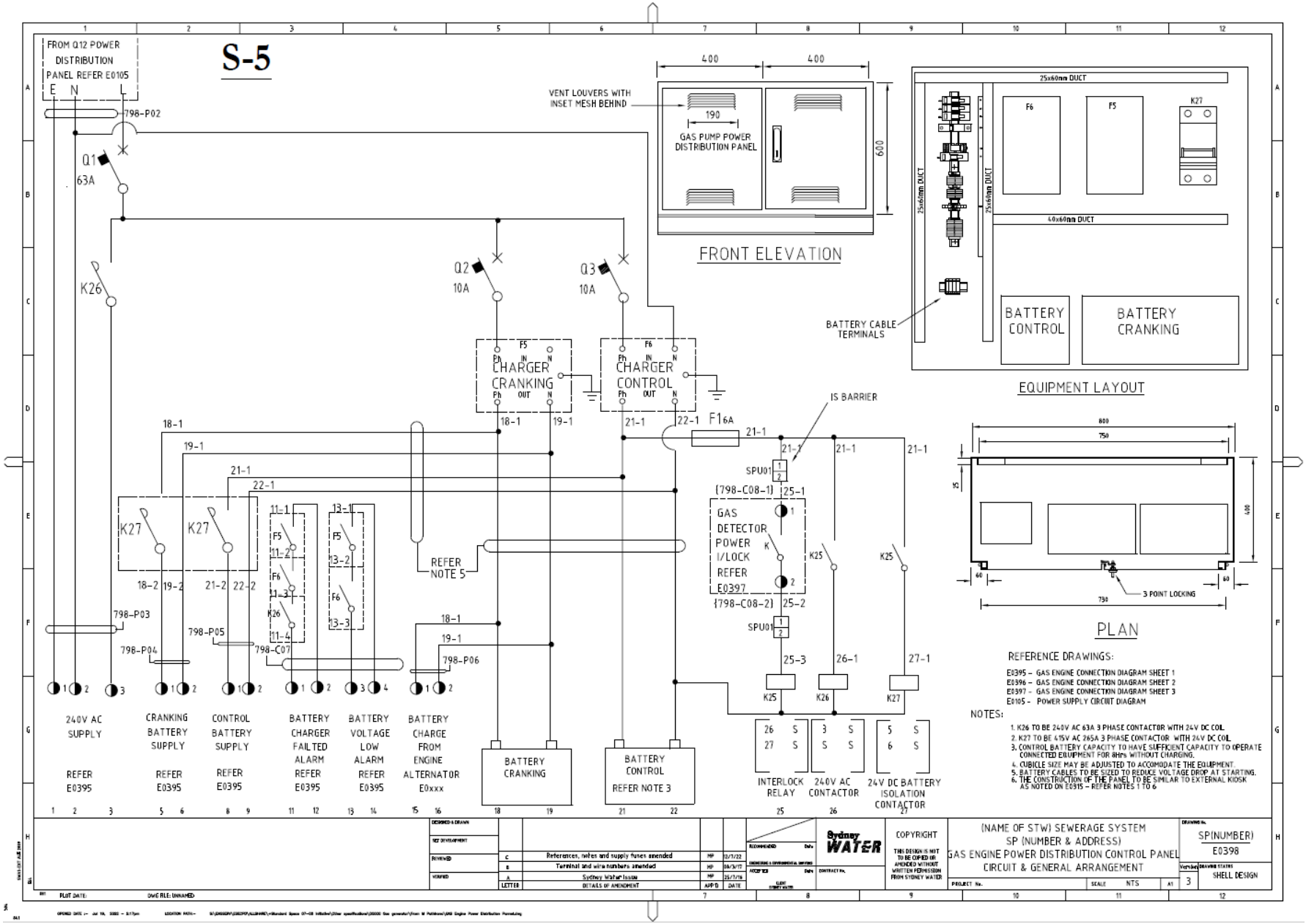
Appendices

Appendix	Title
1	Generator – Terminal Blocks
2	Typical layout and circuit diagram of electrical power supply isolation panel
3	Gas Engine Driven Generator Data Sheet

Appendix 1 Generator – Terminal Blocks



Appendix 2 Typical layout and circuit diagram of power supply isolation panel



Appendix 3 Gas Engine Driven Generator Data Sheet

Project Number	
Site	
Description	
Tag Number (s)	
Qty Required	

SPECIFICATIONS and REFERENCE INFORMATION
• Sydney Water Technical Specification – Permanent Gas Engine Driven Generator

SCOPE OF SUPPLY
• The design, fabrication, supply, assembly, factory testing and delivery to site of a gas engine driven generator. • The unit must be supplied with the necessary electrical control panel, load bank and acoustic enclosure, as per the Technical Specification. • Testing and commissioning of the unit at the factory. • Supply of test documentation, drawings and manuals in accordance with the Technical Specification. **Note:** Civil works, installation, connection of services, site testing and commissioning are excluded from the scope.

Item	**Units**	**Requirement***	**Suppliers offer**
***To be reviewed and completed by the Designer.**			
VENDOR INFORMATION			
Function	-	To provide standby power during a mains power outage.	
Type	-	Natural gas	
Supplier	-	Supplier to advise	
Manufacturer	-	Supplier to advise	
Model	-	Supplier to advise	
Engine Make and Model	-	Supplier to advise	
Generator Make and Model	-	Supplier to advise	
Control Panel Make	-	Supplier to advise	
AMBIENT CONDITIONS			
Location	-	Outdoor	
Ambient Environment	-	Inland	
Ambient Temperature Range	Deg. C	-6 to 50	
Ambient Humidity Range	% RH	30 to 90	
Elevation	m		
Ambient Temperature	Deg. C		
OPERATING CONDITIONS			
Continuous Nominal Rating @ 45 Deg. C Ambient	kVA		
Load Requirements	-		
Power Factor	-		
Set Output Voltage	V		
Operating Speed	rpm	1500	
Overall Dimensions	mm	Supplier to Advise	
Current Transformers	-	Yes	
Harmonic Filter	-	No	

Synchronising Function	-	Yes / No May be required where multiple generators required.	
Maximum Voltage Dip	%	20	
Weatherproof Enclosure Required	-	Yes	
Acoustic Enclosure Required	-	Yes	
Control Panel Installation	-	Separate from the main generator compartment	
Load Bank	-	Yes Load bank should be automatically variable to provide minimum of 40% generator load	
Weight (wet)	kg	Supplier to Advise	
Weight (dry)	kg	Supplier to Advise	
ACOUSTIC ENCLOSURE			
Noise Level Limits – Sound Pressure Level	dB(A)	*xx* @ 7m The noise level limit is required for any position 7m from the perimeter of the enclosure with the generator operating at 100% load	
Manufacturer	-	Supplier to Advise	
Height	mm	Supplier to Advise	
Width	mm	Supplier to Advise	
Length	mm	Supplier to Advise	
Materials	-	Supplier to Advise	
Thickness	mm	Supplier to Advise	
Removable Panels	-	Supplier to Advise	
Mass of Each Panel	kg	Supplier to Advise	
Method of Removal	-	Supplier to Advise	
Locks to SWC Standards	-	Supplier to Advise	
IP Rating	IP	Min. 22	
Design Life	Years	Supplier to Advise	
ALTERNATOR			
Type	-	Supplier to Advise	
Number of Phases	-	Supplier to Advise	
Power Factor	-	Supplier to Advise	
Insulation Class	-	Supplier to Advise	
Temperature Class	-	Supplier to Advise	
Winding Pitch	-	Supplier to Advise	
Winding Type	-	Supplier to Advise	
Protection	-	Supplier to Advise	
IP Rating	IP	Supplier to Advise	
Voltage Regulation	%	Supplier to Advise	
Total Harmonics (TGH/THC)	%	Supplier to Advise	
Wave Form: NEMA = TIF – TGH/THC	%	Supplier to Advise	
Wave Form: CEI = FHT – TGH/THC	%	Supplier to Advise	
Number of Bearings	-	Supplier to Advise	
Number of Poles	-	Supplier to Advise	
Efficiency	%	Supplier to Advise	
Short Circuit Ratio: 50 (kcc)	-	Supplier to Advise	

Direct Axis Synchro Reactance Unsaturated (Xd)	-	Supplier to Advise	
Quadra Axis Synchro Reactance Unsaturated (Xq)	-	Supplier to Advise	
Open Circuit Time Constant; 50 (T'do)	-	Supplier to Advise	
Direct Axis Transient Reactance Saturated (X'd)	-	Supplier to Advise	
Short Circuit Transient Time Constant (T'd)	-	Supplier to Advise	
Direct Axis Sub-Transient Reactance Saturated (X"d)	-	Supplier to Advise	
Sub-Transient Time Constant (T"d)	-	Supplier to Advise	
Quadra Axis Sub-Transient Reactance Saturated (X"q)	-	Supplier to Advise	
Zero Sequence Reactance Unsaturated (Xo)	-	Supplier to Advise	
Negative Sequence Reactance Saturated (X2)	-	Supplier to Advise	
Armature Time Constant (Ta)	-	Supplier to Advise	
No Load Excitation Current (io)	-	Supplier to Advise	
Full Load Excitation Current (ic)	-	Supplier to Advise	
Full Load Excitation Voltage (uc)	-	Supplier to Advise	
Recovery Time	s	Supplier to Advise	
Transient Dip	-	Supplier to Advise	
No Load Losses	-	Supplier to Advise	
Heat Rejection	-	Supplier to Advise	
GAS ENGINE - GENERAL			
Rated Power	kVA	Supplier to Advise	
Rated Speed	rpm	Supplier to Advise	
Rated Torque	Nm	Supplier to Advise	
Cycles	-	Supplier to Advise	
Engine Type	-	Supplier to Advise	
Rated BMEP	kPa	Supplier to Advise	
Minimum Speed	rpm	Supplier to Advise	
Over Speed Trip	rpm	Supplier to Advise	
Turbocharger Speed	rpm	Supplier to Advise	
No. of Cylinders	No.	Supplier to Advise	
Bore	-	Supplier to Advise	
Stroke	-	Supplier to Advise	
Configuration	-	Standard/V Supplier to Advise	
Gas Rate – Rated Load	MJ/kWh	Supplier to Advise	
Gas Rate – 75% Load	MJ/kWh	Supplier to Advise	
Gas Rate – 50% Load	MJ/kWh	Supplier to Advise	
Cylinder Liner Type	-	Wet/Dry Supplier to Advise	
No. of Rings	No.	Supplier to Advise	
Size of Compression	-	Supplier to Advise	
Main Bearings	-	Size, Type and Material Supplier to Advise	

Flywheel Bearing	-	Size, Type and Material Supplier to Advise	
Thrust Bearing	-	Size, Type and Material Supplier to Advise	
Con Rod Bearing	-	Size, Type and Material Supplier to Advise	
Wristpin Bearing	-	Size, Type and Material Supplier to Advise	
Exhaust Valve	-	No., Size, Facing, Seat Supplier to Advise	
Inlet Valve	-	No., Size, Facing, Seat Supplier to Advise	
Exhaust Manifold	-	Wet, Dry, Insulated, Shielded, Cooled Supplier to Advise	
Exhaust Manifold Material	-	Supplier to Advise	
Vibration Dampers	-	Size, Type Supplier to Advise	
Torsional Calculations	-	Supplier to Advise	
Weight (Net)	kg	Supplier to Advise	
Flywheel Weight	kg	Supplier to Advise	
Overall Dimensions	mm	Supplier to Advise	
Exhaust Connection	-	No., Size, Rating Supplier to Advise	
Air Inlet Connection	-	No., Size, Rating Supplier to Advise	
Starting Air Connection	-	No., Size, Rating Supplier to Advise	
Jacket Water Inlet	-	No., Size, Rating Supplier to Advise	
Jacket Water Outlet	-	No., Size, Rating Supplier to Advise	
Oil Inlet	-	No., Size, Rating Supplier to Advise	
Oil Outlet	-	No., Size, Rating Supplier to Advise	
GAS ENGINE – COOLING SYSTEMS			
Jacket Water Pump	-	Yes/No	
Jacket Water Pump Manufacturer	-	Supplier to Advise	
Jacket Water Pump Drive	-	Supplier to Advise	
Jacket Water Pump Head	m	Supplier to Advise	
Jacket Water Pump Speed	rpm	Supplier to Advise	
Jacket Water Pump Impeller Material	-	Supplier to Advise	
Jacket Water Pump Case Material	-	Supplier to Advise	
Jacket Water Capacity	m^3	Supplier to Advise	
Jacket Water Flow	m^3/h	Supplier to Advise	
Jacket Water Pressure	kPa	Supplier to Advise	
Jacket Water Inlet Temperature	Deg. C	Supplier to Advise	
Lube Oil Cooler Type	-	Supplier to Advise	
Lube Oil Cooler Manufacturer	-	Supplier to Advise	
Lube Oil Cooler Duty	kJ/h	Supplier to Advise	
Lube Oil Cooler Surface	m^2	Supplier to Advise	

Lube Oil Cooler Code		Supplier to Advise	
Lube Oil Cooler Shell O.D.	mm	Supplier to Advise	
Lube Oil Cooler Thickness	mm	Supplier to Advise	
Lube Oil Cooler Design Pressure	kPa	Supplier to Advise	
Lube Oil Cooler Tubes O.D.	mm	Supplier to Advise	
Lube Oil Cooler Length	mm	Supplier to Advise	
Lube Oil Cooler BWG	-	Supplier to Advise	
Lube Oil Cooler Water Flow	m^3/h	Supplier to Advise	
Lube Oil Cooler Inlet Temperature	Deg. C	Supplier to Advise	
Lube Oil Cooler Shell Material	-	Supplier to Advise	
Lube Oil Cooler Tube Material	-	Supplier to Advise	
Lube Oil Cooler Channel Material	-	Supplier to Advise	
Lube Oil Cooler Baffle Material	-	Supplier to Advise	
Air Cooler Type	-	Electric Fan/Engine Driven Fan Supplier to Advise	
GAS ENGINE – LUBRICATION SYSTEM			
Lube Oil Pump Type	-	Integral/Separate Supplier to Advise	
Lube Oil Pump Manufacturer	-	Supplier to Advise	
Lube Oil Pump Model	-	Supplier to Advise	
Lube Oil Pump Drive	-	Supplier to Advise	
Lube Oil Pump Capacity	m^3/h	Supplier to Advise	
Lube Oil Pump Pressure	kPa	Supplier to Advise	
Lube Oil Pump Speed	rpm	Supplier to Advise	
Lube Oil Pump Impeller/ Gear Material	-	Supplier to Advise	
Lube Oil Pump Case Material	-	Supplier to Advise	
Pre-Lube Pump Type	-	Supplier to Advise	
Pre-Lube Pump Drive	-	Supplier to Advise	
Pre-Lube Pump Capacity	m^3/h	Supplier to Advise	
Pre-Lube Pump Minimum Pressure	kPa	Supplier to Advise	
Lube Oil Filter Type	-	Supplier to Advise	
Lube Oil Filter	Micron	Supplier to Advise	
Lube Oil Filter Manufacturer	-	Supplier to Advise	
Lube Oil Filter Model	-	Supplier to Advise	
Lube Oil Filter	-	Supplier to Advise	
Lube Oil Filter	-	Supplier to Advise	
Lube Oil Level Controller - Lubricator	-	Yes/No Supplier to Advise	
Lube Oil Level Controller - Crankcase	-	Yes/No Supplier to Advise	
Lube Oil Level Controller Manufacturer	-	Supplier to Advise	
Lube Oil Level Controller Model	-	Supplier to Advise	
Lube Oil Dipstick	-	Yes/No Supplier to Advise	
Lube Oil Dipstick – Magnetic Filter	-	Yes/No Supplier to Advise	

Slow Flow Oil Meter	-	Yes/No Supplier to Advise	
Slow Flow Oil Meter Manufacturer	-	Supplier to Advise	
Slow Flow Oil Meter Model	-	Supplier to Advise	
GAS ENGINE – STARTING SYSTEM			
Type	-	Air, Electric, Hydraulic Supplier to Advise	
Make	-	Supplier to Advise	
Model	-	Supplier to Advise	
Air Pressure	kPa	Supplier to Advise If Applicable, Air Type Only	
No./ Size of Air Tanks	-	Supplier to Advise If Applicable, Air Type Only	
No. of Starts	-	Supplier to Advise	
Voltage	V	Supplier to Advise If Applicable, Electric Type Only	
Battery Capacity	Ah	Supplier to Advise If Applicable, Electric Type Only	
Mains Battery Charger	Ah	Supplier to Advise If Applicable, Electric Type Only	
Generator Charger	Ah	Supplier to Advise If Applicable, Electric Type Only	
Glow Plug Start	-	Yes/No Supplier to Advise	
GAS ENGINE – FUEL SYSTEM			
Fuel Type	-	Natural gas	
Gas Filters Type	-	Supplier to Advise	
Gas Pressure Regulators Type	-	Supplier to Advise	
Gas Pressure Switches Type	-	Supplier to Advise	
Gas Leakage Detectors Model	-	Supplier to Advise	
Gas Shut off Valves Type	-	Pre-Chamber/Direct Injection/Gas Pressure Regulator Supplier to Advise	
GAS ENGINE – GOVENOR			
Type	-	Constant Speed/Variable Speed Supplier to Advise	
Make	-	Supplier to Advise	
Model	-	Supplier to Advise	
Reset By	-	Manual/Pneumatic Signal/Electric Signal/Other Supplier to Advise	
Speed Range	rpm	Maximum and Minimum Supplier to Advise	
Regulation	%	Supplier to Advise	
Signal Range	-	Supplier to Advise	
Tachometer	-	Mechanical/Electrical/Other Supplier to Advise	
Tachometer Make	-	Supplier to Advise	
Tachometer Model	-	Supplier to Advise	
Pyrometer Required	-	Supplier to Advise	
Pyrometer Make	-	Supplier to Advise	
Pyrometer Model	-	Supplier to Advise	

Engine Gauge Board Instruments	-	Pyrometer/Tachometer/Oil Pressure Gauge/Oil Temperature Gauge/Jacket Water Temperature Gauge/Gas Pressure Gauge/Air Pressure Gauge/Hours Run Meter/Other Supplier to Advise	
GAS ENGINE – AUXILLARY EQUIPMENT			
Jacket Water Heater Voltage	V	Supplier to Advise	
Jacket Water Heater Power	W	Supplier to Advise	
Jacket Water Heater Phase	-	Supplier to Advise	
Lube Oil Heater Voltage	V	Supplier to Advise	
Lube Oil Heater Power	W	Supplier to Advise	
Lube Oil Heater Phase	-	Supplier to Advise	
Exhaust Silencer Type	-	Spark Arrestor/Standard/Hospital Supplier to Advise	
Exhaust Silencer Manufacturer	-	Supplier to Advise	
Exhaust Silencer Model	-	Supplier to Advise	
Exhaust Silencer Mounting	-	Horizontal/Vertical/Saddle/Trunnions/ Other Supplier to Advise	
Air Filter Type	-	Dry/Oil Bath Supplier to Advise	
Air Filter Manufacturer	-	Supplier to Advise	
Air Filter Model	-	Supplier to Advise	
Air Filter Connection	-	Side/Top/Bottom Supplier to Advise	
Air Filter Max. Allowable Differential Pressure	mbar	Supplier to Advise	
Flywheel Bearing Type	-	Manual/Air Jack Supplier to Advise	
Flywheel Guard	-	Yes/No Supplier to Advise	
GAS ENGINE – ALARM AND SAFETY SHUT DOWN			
Over Speed	-	Alarm Set, Shut Down Set Supplier to Advise	
Low Oil Pressure	-	Alarm Set, Shut Down Set Supplier to Advise	
High Oil Pressure	-	Alarm Set, Shut Down Set Supplier to Advise	
High Jacket Water Temperature	-	Alarm Set, Shut Down Set Supplier to Advise	
High Fan Vibration	-	Alarm Set, Shut Down Set Supplier to Advise	
Gas Over Pressure	-	Alarm Set, Shut Down Set Supplier to Advise	
Gas Low Pressure	-	Alarm Set, Shut Down Set Supplier to Advise	
Gas Leakage	-	Alarm Set, Shut Down Set, Shut Off Gas Supply, Electrical Supply Disabled, Sparking Mechanism Disabled Supplier to Advise	

GAS ENGINE – ATMOSPHERIC EMISSIONS			
Content O_2 in Combustion	%	Supplier to Advise	
Guaranteed Level NO_x	g/kWh	Supplier to Advise	
Guaranteed Level NO_x	ppm	Supplier to Advise	
Unburnt Hydrocarbons (VOC)	ppm	Supplier to Advise	
Guaranteed Level CO_2	g/kWh	Supplier to Advise	
Guaranteed Level CO_2	ppm	Supplier to Advise	
INSTALLATION			
Foundation Specifications	-	Supplier to Advise	
Mounting Details	-	Supplier to Advise	
EQUIPMENT LABELLING			
Label Material	-	Stainless Steel 316	
Lettering	-	Engraved, Black In Filled	
Information Required	-	As per Technical Specifications – Mechanical	
Fixing Method	-	Oval Head Stainless Steel Screws	
PROTECTIVE COATINGS			
Colour	-	Dulux Ocean Mist 96183250 or RAL9018 All Enclosures/Canopies	
Requirements	-	As Per WSA 201, System POW, PUR-A or PUR-B, as applicable	
SPARE PARTS			
Years (Recommendation List)	Years	5	
Availability	-	Supplier to Advise	
Warehouse Location	-	Supplier to Advise	
Pricing	-	Supplier to Advise	
DOCUMENTATION and CERTIFICATION			
Drawings	-	As Per Specification	
Test Documentation	-	As Per Specification	
Operation and Maintenance Manuals	-	As Per SWC Specification Commissioning – transitioning assets into operation	
INSPECTION and TEST REQUIREMENTS			
Inspection and Test Plan	-	Required	
Factory Acceptance Test	-	Required (Witnessed)	
Pre-Site Acceptance Test	-	NA	
Site Acceptance Test	-	NA	
PERFORMANCE TESTING			
Factory Acceptance Test: 1) General construction checks against the Specification 2) Electrical wiring checks against the Specifications 3) Operation of unit under load conditions The generator unit must not be shipped to site until all defects noted at the FAT have been rectified and accepted by Sydney Water.			
SPECIFIC REQUIREMENTS			
Tenderers MUST include the following information with their offers:			

- Technical brochures
- Control system details
- Dimensional drawings showing the overall dimensions of the packaged unit including load bank
- Gas engine details
- Generator details
- A statement regarding the availability of spare parts

NOISE DATA SHEET

Measured Sound Pressure Levels	Octave Band Frequency Hz								8 Position Average
	65	125	250	500	1000	2000	4000	8000	
With Acoustic Enclosure Fitted									
Air Intake Into Enclosure									
Air Exhaust From Enclosure									

- Tests performed on full load with radiator fitted.
- Tests conducted as per AS/NZS 1269 or approved equivalent.
- Reference sound pressure is 20uPa.
- Sound measurement locations is to be 1m from the centre of the generator unit.

Measured Sound Power Levels	Octave Band Frequency Hz								Sound Power Level
	65	125	250	500	1000	2000	4000	8000	
With Acoustic Enclosure Fitted									
Air Intake Into Enclosure									
Air Exhaust From Enclosure									

- Tests performed on full load with radiator fitted.
- Tests conducted as per AS/NZS 1269 or approved equivalent.
- Reference sound power 1pW = 1x10E-1

Date:					
Revision:					
Prepared by:					
Mechanical verified by:					
Electrical verified by:					
Process verified by:					
Approved by:					