SITA Diesel Generator Set Specification

Version: 02
Date: 2022-06-14
Doc No: eSDHS-01299

Notice

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Approval

The signatories hereof, being duly authorised thereto, by their signatures, hereto authorise the execution of the work detailed herein, or confirm their acceptance of the contents hereof and authorise the implementation/adoption thereof, as the case may be, for and on behalf of the parties represented by them.

Contents

1 Design requirements

1.1 Industry Standards and Guidelines

1. All work shall meet all the requirements of national and local Statutory Authorities and shall be in accordance with the following:

Table 1: Industry standards and guidelines

Document number	Description
SANS 1091	National Colour Standards
SANS 1186-1	Symbolic safety signs - Part 1: Standard signs and general requirements
SANS 1507 (All Parts)	Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V)
SANS 2001 (All Parts)	Construction Works
SANS 3046	Reciprocating internal combustion engines - Performance, Declarations of power, fuel and lubricating oil consumptions, and test methods
SANS 8528	Reciprocating internal combustion engine driven alternating current generating sets Part 1: Application, ratings and performance Part 2: Engines Part 3: Alternating current generators for generating sets Part 4: Control gear and switchgear Part 5: Generating sets Part 6: Test methods Part 7: Technical declarations for specification and design Part 8: Requirements and tests for low-power generating sets

	Part 9: Measurement and evaluation of mechanical vibrations Part 10: Measurement of airborne noise by the enveloping surface method Part 12: Emergency power supplies to safety services Part 13: Safety
SANS 10089-2	The petroleum industry Part 2: Electrical installations in the distribution and marketing sector.
SANS 10108	The classification of hazardous locations and the selection of apparatus for use in such locations
SANS 10131	Above-ground storage tanks for petroleum products
SANS 10140 (All Parts)	Identification colour marking
SANS 10142-1	The wiring of premises Part 1: Low-voltage installation
SANS 10198 (All Parts)	The selection, handling and installation of electric power cables of rating not exceeding 33 kV
SANS 10228	The identification and classification of dangerous goods for transport
SANS 10400 (All Parts)	The application of the National Building Regulations
SANS 60034	Rotating electrical machines Part 1: Rating and performance Part 2-1: Standard methods for determining losses and efficiency from tests Part 5: Degrees of protection provided by the integral design of rotating electrical machines Part 8: Terminal markings and direction of rotation

	Part 9: Noise limits Part 11: Thermal protection Part 15: Impulse voltage withstand levels of form-wound stator coils for rotating a.c. machines Part 18-1: Functional evaluation of insulation systems - General guidelines Part 22: AC generators for reciprocating internal combustion (RIC) engine driven generating sets
SANS 60204 (All Parts)	Safety of machinery
SANS 60502-4	Power cables with extruded insulation and their accessories for rated voltages from 1 kV (U m = 1,2 kV) up to 30 kV (U m = 36 kV) – Part 4: Test requirements on accessories for cables with rated voltages from 6 kV (U m = 7,2 kV) up to 30 kV (U m = 37 kV)
SANS 60529	Enclosures for electrical equipment
SANS 61000-5-2	Electromagnetic compatibility (EMC) Part 5: Installation and mitigation guidelines Section 2
SANS 61000-6-2	Electromagnetic compatibility (EMC). Generic standards. Immunity standard for industrial environments
SANS 61000-6-4	Electromagnetic compatibility (EMC). Part 6-4: Generic standards. Emission standard for industrial environments
SANS 62305-1	Protection against Lightning – Part 1: General Principles
SANS 62305-3	Protection against Lightning – Part 3: Physical damage to structures and life hazard
SANS 62305-4	Protection against Lightning – Part 4: Electric and Electronic Systems within structures

SANS 62561 (All Parts)	Lightning protection system components (LPSC)
IEC 88528-11	Reciprocating internal combustion engine driven alternating current generating sets - Part 11: Rotary uninterruptible power supply systems
NRS 024-1	Diesel Alternator Sets - Part 1: Diesel alternator sets for fixed installations
NRS 042	Guide for protection of electronic equipment against damaging transients
BS EN ISO 7010	Graphical symbols -- Safety colours and safety signs -- Registered safety signs
IEC 62444	Cable glands for electrical installations
IEC 60051	Indicating instruments
IEC 60071-1	Insulation coordination
IEC 60255 (All Parts)	Electrical relays
BS EN 60068	Environmental testing
ANSI S1.13 -1971	Measurement of sound pressure levels in Air
IEEE446	Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
ISO 8528-1	Reciprocation Interval Combustion (RIC) engines, alternating current (AC) generators, and associated systems.
ISO 8528 – 5	Generating sets
IEC 8528 – 4	Control Systems for Generator Sets
IEC 61000	Electromagnetic compatibility

IEC 61439	Low Voltage Switchgear and Control Gear Assemblies
IEC 60034 – 1	Rotating Electrical Machines: Rating and performance
IEC 88528	Reciprocating internal combustion engine driven alternating current generating sets
IEC 60529	Degrees of protection provided by enclosures
ISO 3046	Reciprocating internal combustion engines; performance (specification by diesel supplier)

1.2 Design Requirements

Table 2: Site locations and design requirements

Generator Voltage	240/415V
Frequency	50Hz
Acoustic Performance Intake	65 dBA at 1m distance from intake louver
Discharge/ exhaust	65 dBA at 1m distance from exhaust louver

2 Equipment requirement

1. The intention is to allow the diesel generator specialist contractors to carry out their work as required.

2.1 Equipment rating

2.1.1 Generator

Table 3: Equipment Rating

Projects item	Principal Requirement
Engine rating	1. Data Centre Continuous Ratings. Supplier must provide certification that the engine satisfies Uptime Institute continuous rating requirements. 2. Unit shall be prime rated (PRP) in accordance with ISO8528 as a minimum
Alternator rating	The minimum output at ambient temperatures (after deducting all parasitic load).
Connected load	Data Centre load, non-UPS supported loads, as well as generator parasitic loads.
Load Characteristics	The generator shall provide full rated output for all loads ranging from 0.9 leading to 0.8 lagging power factor.
Start to load time	The supplier shall state the guaranteed time from start-up to load connection. The maximum allowable time shall not exceed 10 Seconds
Fault Level	The generators shall be connected to large Data Centre systems and shall be configured to provide the required inrush current during start-up and load acceptance without tripping.

2.2 Diesel Engine

1. Suitable for diesel fuel generally available in South Africa (SANS 342:2016).
2. The system shall conform to the following standards:

Table 4: Diesel Engine Standards

Project item	Principal Requirement
RPM	1500
Performance class	G3

2.3 Exhaust System

1. Required for design, including back pressure calculation, factory testing and final installation. System to be manufactured of suitably sized stainless-steel silencer and piping, fully lagged and weather proof extended to above roof level including all fixing, mounting brackets and weather proof top hat if required.
2. Weatherproof flashing, sleeves and acoustic seals shall be provided where the exhaust system penetrates the wall.
3. The exhaust line shall be graded away from the engine to drainage pockets or suitable drainage outlets.
4. Exhaust pipes and silencers shall be cladded with 304 stainless steel.

3 Specifications

3.1 Standards

1. As per section above

3.2 Internal combustion engine

3.2.1 General Requirements

Table 5: Diesel Engine General Requirements

Description	Requirement
Cycle	4-Stroke
Speed	1500rpm nominal
Cooling	Water
Fuel	Diesel
Starters	Automatic, dual starters
Step-Load Performance	Minimum 75% of the load as a single step load without exceeding any limits.

3.2.2 Governor

1. Electronic, self-lubricating (actuator) suitable for automatic operation with digital control system

2. Overspeed Control
    (a) Electronic
3. Filtered to prevent harmonics and switching spikes interfering with governor operation, under-speed and over-speed cut-out devices
4. Isochronous operation

3.2.3 Protection

1. DC operation including:
    (a) Overspeed
    (b) High jacket water temperature
    (c) Low engine water level
    (d) Low-Low water level shutdown
    (e) Low lubricating oil pressure
    (f) Crank case high oil pressure
    (g) Low fuel level in day tank
    (h) Critical low fuel in day tank shutdown
2. “Fail safe”, such that a fault results in a critical alarm and the solenoid prevents fuel entering engine.
3. Require system to be reset manually at the control panel after protection activation.

3.2.4 Starting

1. Automatic by dual 24VDC redundant starter motors and battery systems. The starting systems shall include a selector switch as flows:
    (a) A starter system
    (b) B starter system
    (c) Auto
2. Each starter system shall be provided with its own dedicated batteries and battery charger system.

3.2.5 Fuel System

The generator contractor shall supply, deliver, install and commission the following new components to be installed as part of the existing fuel system.

1. Remove existing generator day tanks and replace with new 1000l double skin day tanks, one per generator.

2. Each new day tank shall be equipped with isolation ball valves, breathers, pipe connections, electronic level sensors, spin-on diesel filter with clear plastic water trap and permanent resin coated stainless steel screen to remove free and suspended water.
3. Each installation shall be capable of the lift required from the day tank to the engine fuel inlet.
4. Provide detailed drawings and allow for all interface points for the fuel supply, auxiliaries, controls and monitoring.
5. Provide valves on Generators and connect to the fuel system.
6. Provide day tank monitoring and control of fuel level. Each day tank shall be equipped with a motorized valve on the inlet, controlled by the generator controller such that the value will be opened and closed to fill the day tank at levels to be programmed during commissioning. The valves shall be 24vDC and shall have an isolation ball valve installed before the motorized valve.
7. Provide and connect fuel pipework from Generators to fuel supply system. Fuel piping shall be stainless steel suitably sized and SANS compliant.

3.2.6 Filters

1. The filters Include:
   (a) Dry type air-cleaner
   (b) Lubricating oil
   (c) Diesel fuel filter – engine mounted,
   (d) Diesel fuel filter – day tank mounted, as specified above

3.2.7 Jacket Heater

1. Sufficient to keep engine at a high enough temperature so that it can accept load < 10 seconds.
2. The heater jacket system shall be equipped with the continuous operation circulating pump

3.2.8 Pre-lubrication

1. The engine shall be provided with a pre-lubrication pump with interval control to maintain an oil film on all running parts

3.2.9 Instruments

1. Controller, panel mounted shall as a minimum display:
   (a) Tachometer
   (b) Service hour recorder

(c) Oil temperature

(d) Coolant temperature

(e) Container temperature

(f) Oil pressure

(g) Manual override starter button

(h) Engine low level water alarm

(i) Engine shutdown emergency pushbutton

(j) Failure to start and alarm

(k) Current per phase

(l) Voltage L-L and L-N

(m) PF

(n) kW

(o) kVA

3.3 Alternator

3.3.1 General

1. Type: Synchronous
2. Winding Configuration: Star
3. Temperature Class: H
4. Stator Winding Pitch: 2/3
5. Short Circuit Capacity: (See 3.3.6 requirement)
6. Output voltage: 240/415V
7. Output frequency: 50Hz
8. Total Harmonic Distortion at rated load: 5% with resistive load.
9. Impedance (<12% X”d)

3.3.2 Automatic Voltage Regulator

1. Solid State
2. Remain within ±1% of set value over 46-54Hz Frequency range steady state
3. True RMS three phase voltage regulator
4. The regulated voltage shall be taken as the average of the phase to neutral of the 3 phases excluding cases where the current ratio is greater than 2:1 between any 2 phases.
5. Built-in overload protection

6. Adjustable to ±10%, adjusted to generate correct voltage at output switchboard.
7. Include Voltage transient protection

3.3.3 Excitation

1. Type: Brushless
2. Permanent magnet exciter
3. Torque matching characteristic
4. Voltage transient protection for rotating diodes
5. Failure of a single diode shall not prevent machine operation
6. Exciter diode failure monitoring

3.3.4 Overspeed withstand

1. 1.2 x unit rated speed for both engine and alternator

3.3.5 Underspeed withstand

1. Normal operation at net continuous rated output at a speed of 90% rated, without overheating.

3.3.6 Sustained Short-Circuit Withstand

1. Maintain at least 300% rated current for 10s to allow operation of protection relays

3.3.7 Winding Thermistors

1. General: Provide separate thermistors to alternator stator windings for alarms and engine shutdown functions. Provide spare thermistor set for alarms and shutdown functions.
2. Thermistor type: Positive temperature coefficient.
3. Thermistor temperatures:
   (a) Engine shutdown: 160oC
   (b) Winding temperature high pre-alarm: 140oC.

3.3.8 Thermal boxes

1. Construction: Provide metal terminal boxes. Size to allow the current transformers, power and control cables and cable lugs to be neatly installed and terminated with necessary clearances between live parts and the box, and without placing undue strain on termination points.
2. Supply cable terminal box: Provide removable lid, side covers and mounting plates.
3. Terminals: Provide star connected windings. Bring both ends of each winding out to separate terminals. Establish a neutral terminal.

4. Sealing: Provide neoprene or bonded cork gaskets between terminal boxes and their frames and covers.

3.3.9 Anti-Condensation Heaters

1. General: Provide anti-condensation heaters within the winding enclosure with at least 1 redundant heater.
2. Rating: Rate heaters to maintain the windings and insulation above the dew point when the alternator is at rest and one heater is in service.
3. Location: Locate at least 1 heater at each end of alternator windings in a position which allows heat transfer to the winding insulation by convection, without exceeding maximum allowable insulation temperature. Do not fix heaters to windings.
4. Terminations: Connect heaters to separate identified terminals within a separate accessories terminal box which is connected to a permanent supply.
5. Connection diagram: Provide a connection diagram for the heaters. Locate within the terminal box.

3.4 Operation

3.4.1 General

1. Provide automatic and manual modes to start and shut down generating sets.
2. It should be noted that although the generators will run as a synchronized set on day one, this arrangement will change in future and each generator will operate as a single stand-alone unit. To this end, each generator shall be equipped with its own generator controllers enabling the unit to operate as a synchronized system now and stand-alone system later without replacing or adding controllers at a later stage.
3. The generator controllers shall therefore have auto mains failure and change-over control capabilities.

3.4.2 Automatic start control

1. Provide for the following:

   (a) Upon detecting mains failure, start the generators automatically, come on-line and connect to the load

3.4.3 Automatic engine shutdown

1. Provide for generating sets to run to suit the load demand until the controller senses “mains return”. At this point the automatic engine shut-down signal must be activated.

3.4.4 Engine shutdown

1. Provide a shutdown control system which disconnects the alternators, and shuts down engines upon the occurrence of genset or controller fault conditions, such that:
   (a) Engines cannot be restarted before safety devices have been manually reset and system alarm sensors have returned to the normal state
   (b) The overspeed shutdown acts directly to disconnect the fuel supply independent of the governor
   (c) The shutdown control system may be reset by the operation of one reset switch, after safety devices have been manually reset

3.4.5 Emergency and fault shutdown

1. Provide for the following conditions to register as audible and visible alarms, as well as BMS alarms and to cause each generating set to immediately shutdown:
   (a) Emergency stop push-button: Pressed
   (b) Generating set protection: Activated:
      - Overspeed/Under speed
      - Under/Over Voltage
      - Reverse Power
      - Excitation Loss
      - Phase Sequence
      - Over current
      - Voltage Balance
      - Over Frequency / Under Frequency
   (c) Engine oil pressure: Low
   (d) Jacket water temperature: High
   (e) Day fuel tank: Critical low

3.4.6 Automatic synchronising

1. All three generators will start-up, synchronize and take the load. This shall happen in 10 seconds or less from the time that the mains supply fails. The controller shall shut down the 1 or 2 of the generators depending on the load at the time. The controller shall also call on additional generators as soon as the load increases above 80% of the capacity of the running units.

3.5 Control panels

3.5.1 Engine local control board

1. An OEM pre-assembled engine/alternator solution with “on-board’ control panel may be offered.
2. The generator controller should be capable for both synchronization to the mains and the other generators with remote auto change over capability.
3. For each generating set, provide the following:
   (a) Key operated local engine start/stop control
   (b) Controls for auto/off/manual
   (c) Emergency manual shutdown
   (d) LCD indication for:
   - Speed
   - kVA
   - Power (kW)
   - Reactive Power (kVAR)
   - Voltage, L-L & L-N (V)
   - Current (A)
   - Frequency (Hz)

     Power factor (average and per phase)
   - Hours run
   - Day tank fuel level
   - System faults
   - Battery voltage and health
   - Indicators showing generating set under local control or remote control
   - Oil pressure indicator
   - Coolant temperature indicator
   - Unit running on load, indicator
   - Unit running off load, indicator
   - Failed to start indicator and alarms

   (e) Adjustable protection for:
   - Undervoltage protection

- Overvoltage Protection
- Reverse Power protection
- Overcurrent Protection
- Under frequency protection with two stages
- First stage: Adjustable 47-50 Hz with time delay 0-10 s
- Second stage: Adjustable down to 40 Hz and with instantaneous trip
- Low-Low Coolant level
- Low-Low Day Tank fuel level

(f) Anti-condensation heater indicator

(g) BACnet or Modbus Ethernet ports for connection to the BMS. All registers shall be fully accessible by the BMS.

3.5.2 Control Panel Power Supply

1. The control panel shall be provided with a dedicated dual redundant DC power supply to ensure continuous operation.
2. Both supplies shall be connected via blocking diodes. Provide suitable labelling indicating both sources of supply.

3.6 Batteries and Chargers

3.6.1 General

1. Provide separate batteries and charger systems for

   (a) Engine start (A & B systems)

   (b) Control and alarm functions

3.6.2 Control and alarm batteries

3.6.2.1 Location:

1. Segregate battery and charger equipment within generator control cabinets.

3.6.2.2 Capacity:

1. Sufficient to supply full generating set control, monitoring and alarm functions for a period of 48 hours.

3.6.3 Chargers - Control and Alarm Batteries

1. Alarm outputs: Provide the following local audible and visual alarms together with BMS communication:

   (a) Mains off

(b) Over battery voltage

(c) Over charge current

(d) Low battery voltage

(e) Insufficient charge rate

(f) Charger failed

(g) Dead battery

(h) Battery boost 'ON' status indicator

(i) Mains 'ON' status indicator Starting

3.6.4 Electric starting

3.6.4.1 General

1. Provide dual starter motors, batteries and chargers, and associated control equipment to automatically start each engine. Each battery and starter system shall be capable of starting the engine without assistance from the other system.

3.6.4.2 Wiring

1. Wire starter motors so that starter motor solenoid contacts are on the active side and field windings are at earth potential when the motor is de-energised. Provide an interlock, connected directly to the engine, to prevent the starter motor operating when the engine is running.

3.6.4.3 Starting interlock

1. Provide a starting lock out system, which prevents further starting attempts after 3 (adjustable) successive unsuccessful attempts.

3.6.4.4 Selector switch

1. Provide selector switches as follows:

   (a) A starter

   (b) B Starter

   (c) Auto.

3.6.5 Starting batteries

1. Shall be maintenance free valve regulated lead acid batteries.

3.6.5.1 Location

1. Locate in proprietary battery holders attached to the generating set, constructed of timber or other corrosion resistant material. Isolate batteries from vibration.

3.6.5.2 Covers

1. Provide a high-impact resistant transparent cover for each battery.

3.6.5.3 Capacity

1. Sufficient to crank the engine for minimum 6 successive start attempts, repeated at 10 second intervals.

3.6.5.4 Isolator

1. Provide a lockable isolator on the DC cable loop to prevent accidental starting and to provide safe isolation of the engine without requiring disconnection of the battery cables. The isolator shall be provided with a relay output to indicate an alarm condition when the isolator is open, and the battery is disconnected from the system. Labelling to be provided to clearly note the sources of supply.

3.6.6 Starter Batteries Chargers

1. Mains power: Connect chargers to the generating set auxiliary supply so that mains power is maintained when the generator system is in operation.
2. Alarm outputs: Provide the following local audible and visual alarms together with BMS alarm output.
   (a) Mains off
   (b) Battery over voltage
   (c) Over charge current
   (d) Low battery voltage
   (e) Insufficient charge rate
   (f) Charger failed
   (g) Battery boost 'ON' status indicator
   (h) Mains 'ON' status indicator.

3.7 Installation

1. The following provides details of elements required by the generator installation contractor.

3.7.1 General

1. Engine and Alternator mounted in line with direct drive.
2. Engine and Alternator bolted to a common rigid steel base.
3. Coupling: Directly connected to engine flywheel housing

3.7.2 Plinths

1. Mount on existing generator footprint.

3.7.3 Resilient mounts

1. Appropriate vibration isolation mounts are to be provided to achieve 95% isolation efficiency.

3.7.4 Shaft Coupling

1. Directly couple the engine and generator shafts using a self-aligning type coupling, capable of transmitting the engine maximum output torque under operating conditions, including starting and overload conditions.

3.7.5 Signs

1. Warning: Provide the following signs on each side of each generating set:

   (a) "WARNING: This set may start at any time without notice"

2. Lettering: 50 mm high, red on white background.
3. “Generator A, B & C respectively, on two sides
4. Lettering: 300mm high, black on white background

3.7.6 Drip trays

1. General: Provide removable metal drip trays under those parts of the assembly where fuel or lubricant leakage may occur. Provide overflow outlet pipes taken to a point where a receptacle can be fitted under the pipe outlet.

3.7.7 Emergency stop push-buttons

1. Provide one push-button per generating set. Refer to paragraph “Site Conditions” regarding key interlock system and emergency push buttons.
2. Wire to disconnect the generator and immediately shut down the engine when the controls are in the automatic or manual mode.

3.7.8 Fuel connections

1. Stop valves: Provide stop valves on the inlet to, and outlets from, the day tank.

3.7.9 Safety Guards

1. Provide safety guards to prevent contact with any rotating or high temperature parts, at least complying with the local Occupational Health and Safety Act - General Machinery Regulations.

3.7.10 Acoustic insulation

1. Acoustic insulation is included elsewhere in this specification.

3.7.11 Engine Cooling

1. Water cooled by integrated cooling system. The maximum sound pressure level of the operational radiators shall comply with the stated acoustic requirements within the technical schedules.

3.7.12 Engine Air Intake

1. Provide dry type air intake filters with water droplet separators and insect wire mesh of sufficient capacity to permit continuous engine operation for 200 hours before filter servicing becomes necessary

3.7.13 Exhaust system

1. The complete silencer and exhaust piping are included as part of the contract.

3.8 Marking

3.8.1 Rating plates

Table 6: Rating Plate General Requirements

Description	Requirement
Temperature-rise limits	If temperature-rise limits are achieved by de rating an oversized generator, state the de-rated value
Alternator mass	State alternator mass

3.8.1.1 Thermistor detector identification and warning plates

1. Thermistors - Provide details of thermistor type classification and reference temperature.
2. Warning - Provide a warning engraved in 4 mm high lettering as follows:
    a. "WARNING - Do not apply more than 2.5 V across the protection thermistor devices".
3. Anti-condensation heater identification and warning: Shall be located next to heater terminals. State the number, voltage and power rating of the heaters, and the following separate warning engraved in red letters on a white background:
    a. "WARNING - Anti-condensation heater. Circuit is live when the set is off".

3.8.2 Auxiliary wiring

1. Provide ferrules to wiring ends identifying each conductor.

3.8.3 Engine direction of rotation

1. General

1.1. If driving shafts or associated rotating parts are accessible, clearly and permanently mark the direction of rotation on an adjacent fixed surface.

2. Rotation identification

2.1. Provide a label within the supply cable terminal box identifying the relationship between the direction of rotation and the marking of terminals.

4 Testing and Commissioning

1. Along with the commissioning requirements referred to in the standard MEP specification the following are equipment specific requirements.

4.1 Witnessed Factory Acceptance and Testing

1. The following specific tests shall be carried out during witnessed factory testing including all other tests that might be specified by the Commissioning Agent or Commissioning Manager and the following specific tests shall be carried out during witnessed site acceptance testing

Table 7: Visual Inspection Requirements

Visual Inspection	Requirements
	Perform a visual inspection of the unit. 1) Record the Serial Number of the unit and any ancillary cabinets under test. Confirm a match with the factory inspection documents. 2) confirm the following: a) Units are undamaged b) Cabinets and Connections are clearly labelled c) Doors and access panels open freely. d) Equipment positioning and clearances are in line with design drawings 3) Record ambient temperature and humidity during the testing.

Table 8: Functional Operation Test Requirements

Functional Operation Tests	Requirements
	Perform the following functional tests: **Single Units:** 1) Unit start up using manual or test option on panel control 2) Unit start up using remote switching contacts 3) Shutdown via same process 4) Shutdown via emergency stop button 5) Crank testing of the generator & battery proving 6) Test of fire trip while the unit is operating

Table 9: Performance Testing Requirements

Performance testing	Requirements
	Perform the following performance tests, including capture of waveform events at transition points: **Single Units:** 1) From Cold Start confirm time taken for engine to reach steady state output and for output breaker to close onto load. 2) Record transient load steps for the following steps and confirm the system output remains within nominated tolerances and recovers within specified timeframes: a) 0-25% of full unit rating b) 25-50% c) 50-75% d) 75-100% e) 100-75% f) 75-50% g) 50-25% h) 25-0% i) 0-50% j) 50-100% k) 0-100% l) 100-0% 3) Carry out a Continuous steady state load test as follows (% based on full unit rating) – 30 min at 25% rated power – 30 min at 50% rated power – 30min at 75% rated power – 4 hours at 100% rated power – 30 min at 75% rated power – 30 min at 50% rated power – 30 min at 25% rated power Monitor the following key parameters at intervals no greater than 15 minutes: – Voltage – All Phase-to-phase and all Phase-to-neutral – Current – Three phases – Power (kW, kVAR, kVA) – Frequency (Hz) – Inlet & Outlet temperatures (°C) – Exhaust temperature (°C) – Ambient Temperature (°C) – Oil Pressure (Pa)

	– Coolant Temperature (°C) – Remote fuel cooler inlet & outlet temperatures (°C) – Day tank fuel temperature (°C) – External noise levels (dBA) outside louvres and plant room doors (1m and 7m distances) 4) Verification of fuel consumption at the following loads: – 25% – 50% – 75% – 100% 5) Carry out a Continuous steady state load test as follows (% based on full unit rating) – 4 hours at 100% rated power Monitor the following key parameters of all units at intervals no greater than 15 minutes: – Voltage – All Phase-to-phase and all Phase-to-neutral – Current – Three phases – Power (kW, KVAR,KVA) – Frequency (Hz) – Inlet & Outlet temperatures (°C) – Exhaust temperature (°C) – Ambient Temperature (°C) – Oil Pressure (Pa) – Coolant Temperature (°C) – External noise levels (dBA) outside louvres and plant room doors (1m and 7m distances)

Table 10: Output and Interfaces Requirements

Outputs & Interfaces	Requirements
	Perform the following output and interface tests: – Test all nominated alarms by simulation of condition, verifying signal indication at FCMS (if available) or point of interface (only if FCMS is unavailable). – Test all nominated equipment status indications and outputs by simulation of condition, verifying signal indication at FCMS (if available) or point of interface (only if FCMS is unavailable).

Table 11: Test equipment provided by the Contractor during the testing

Equipment Item	Purpose

Digital Multimeters	1. Multi-meters shall only be utilised for point checks
Digital Power Analyser	1. Power analyser shall be three phase and neutral units, capable of detecting simultaneous events across all three phases and neutral concurrently. 2. Power Analyser shall be capable of recording waveforms for later use in the formal test record.
Digital Oscilloscopes	1. Digital Oscilloscope shall be provided with triggering functionality capable of recording waveform events from a separate trigger channel. 2. Oscilloscope shall be capable of recording waveforms for later use in the formal test record. (note: may be excluded provided the digital power analyser is able to provide similar functionality and accuracy)
Load banks and connection cables	1. Load banks shall be provided with remote digital controllers that allow control of the load banks within 1% increments. 2. Load banks shall allow simultaneous switch on of loads to simulate large load steps of up to 100% of rated load in one step.
Infrared Temperature Gun	1. Provide an infrared temperature gun for use throughout the testing.
Acoustic Meter	2. Calibrated acoustic meter capable of taking instantaneous readings in DBA.

5 Equipment Schedule

1. Schedules below shall be completed and returned with the tender for each product Option listed in the Specification document. Schedules to be resubmitted for reconfirmation for all subsequent purchase order confirmations.

DESCRIPTION	UNIT	OFFERED
Generator Rating (at specified Ambient)	kW / kVA	
Generator Rating	Data Centre Continuous	Yes / No
Heat output to room	100% load – Engine	
	100% load - Alternator	
All Controllers	Make	
	Model	
Guaranteed time from start to load acceptance	Seconds	
Noise Output		
	Diesel Operation Sound Power Level (31 Hz – 8 kHz)	
Engine	Name of Manufacturer:	
	Country of Manufacture:	
	Rating of Units (kW)	
	Hours per year at rating	
	Number of cylinders	
	Formation	
	Governor Type	
	Governor Manufacturer	
	Fuel Consumption	

	100% load (l/ hour)	
	Fuel Consumption 75% load (l/ hour)	
	Fuel Consumption 50% load (l/ hour)	
	Fuel Consumption 25% load (l/ hour)	
Alternator		
	Name of Manufacturer:	
	Rating (kVA)	
	Voltage	
	Total Harmonic Voltage Distortion at full load (%)	
	Degree of enclosure (IPxx)	
	Efficiency 100% load (%)	
	Efficiency 75% load (%)	
	Efficiency 50% load (%)	
	Efficiency 25% load (%)	
	Load on system at 0% output load	
	Direct axis sub transient reactance (%)	
	AVR	
	Make	
	Model	
Dimensions – Radiator	Width(mm):	
	Depth (mm):	
	Height (mm):	

	Mass (kg):	
Dimensions – control panel	Width(mm):	
	Depth (mm):	
	Height (mm):	
	Mass (kg):	
Dimensions – Sound Attenuation	Intake	
	Width(mm):	
	Depth (mm):	
	Height (mm):	
	Mass (kg):	
	Exhaust	
	Width(mm):	
	Depth (mm):	
	Height (mm):	
	Mass (kg):	
	Container	
	Thickness (mm):	
External - Container Dimensions	Length (mm)	
	Width (mm)	
	Height (mm)	
Complete Diesel Generator Weight	Shipping Weight (kg) (Dry)	
	Operational Weight (kg) (Wet)	