**Diesel Generator Package Technical Specification**



**SCOPE**

This document provides guidance for design, materials, fabrication, inspection, testing, documentation, preparation for shipment commissioning, and operating requirements for diesel generator package based on BS standards suitable for operation on alternating current supplies at 400VAC @ 50Hz.
Units must be manufactured in Europe or N America.

**CODES, REGULATIONS AND STANDARDS**

Vendor shall meet or exceed the requirements of the latest edition of the following codes, regulations and standards. In cases where more than one code, regulation or standard apply to the same condition, the most stringent shall be followed.

BS EN 60034-1:2004 - Rotating electrical machines. Rating and performance.

BS EN 60034-5 :2001 - Rotating electrical machines. Degrees of protection provided by the integral design of rotating electrical machines (IP code). Classification.

BS EN 60034-14:2004 - Rotating electrical machines. Mechanical vibration of certain machines with shaft heights of 56mm and higher. Measurements, evaluation and limits of vibration severity.

BS EN 60034-22:2009 - Rotating electrical machines. AC generators for reciprocating internal combustion (RIC) engine driven generating sets.

BS 4999-140: 1987 - General requirements for rotating electrical machines. Specification for voltage regulation and parallel operation of a.c. synchronous generators.

**Applicable Standards: Engines**

BS ISO 3046-1:2002 - Reciprocating internal combustion engines. Performance. Declarations of power, fuel and lubricating oil consumptions and test methods.

**Applicable Standards: Generating Sets**

ISO 8528-1:2005 - Reciprocating internal combustion engine driven alternating current generating sets. Application, ratings and performance.

ISO 8528-2:2005 - Reciprocating internal combustion engine driven alternating current generating sets. Engines.

ISO 8528-3:2005 - Reciprocating internal combustion engine driven alternating current generating sets. Alternating current generators for generating sets.

ISO 8528-4:2005 - Reciprocating internal combustion engine driven alternating current generating sets. Control gear and switchgear.

ISO 8528-5: 2005 - Reciprocating internal combustion engine driven alternating current generating sets. Generating sets.

ISO 8528-6:2005 - Reciprocating internal combustion engine driven alternating current generating sets. Test methods.

ISO 8528-9: 1995 (BS 7698-9: 1996) - Reciprocating internal combustion engine driven alternating current generating sets. Measurement and evaluation of mechanical vibrations.

ISO 8258-10: 1998 (BS 7698-10: 1999) - Reciprocating internal combustion engine driven alternating current generating sets. Measurement of airborne noise by the enveloping surface method.

**General Standards**

ISO 12100-1:2003 - Safety of machinery. Basic concepts, general principles for design.

Basic terminology, methodology.

IS012100-2 :2003 - Safety of machinery. Basic concepts, general principles for design.

Technical principles.

BS EN 60439-1:1999 - Low-voltage switchgear and control gear assemblies. Type­ tested and partially type-tested assemblies.

BS EN 953 :1997+Al :2009 - Safety of machinery. Guards. General requirements for the design and construction of fixed and movable guards.

BS EN 60529 :1992 - Specification for degrees of protection provided by enclosures (IP code).

BS EN 12601:2010 - Reciprocating internal combustion engine driven generating sets. Safety.

BS EN 60204-1:2006 +Al:2009 - Safety of machinery. Electrical equipment of machines. General requirements.

BS EN 55011:2009 +Al:2010 -Industrial, scientific and medical equipment. Radio­ frequency disturbance characteristics. Limits and methods of measurement.

BS EN 61000-6-2:2005 - Electromagnetic compatibility (EMC). Generic standards. Immunity standard for industrial environments.

Suppliers must comply and **provide evidence** of compliance to the following management Systems

BS ENISO 9001:2008 - Quality management systems. Requirements.

BS EN SO 14001:2004 - Environmental management systems. Requirements with guidance for use.

BS OHSAS 18001:2007 -Occupational health and safety management systems. Requirements.

**TECHNICAL REQUIREMENTS**

General Design Requirements

The diesel generator sets shall be sound attenuated type. The diesel engine and the alternator shall be mounted on a common steel skid with anti-vibration mounts. The generator sets should include the diesel engines, alternator, cooling system, lube oil system, fuel system, exhaust system, DC system, control and relay panels, and all necessary accessories for this package.

**Mechanical Design Requirement**

**Diesel Engine**

 The diesel engines shall be turbocharged, multi-cylinder, electronic controlled fuel injection, in-line or Vee type, of the manufacturer's current standard design for package service. The engine shall be either directly connected or by a flexible coupling to a generator of electrical characteristics required to meet conditions of motor loads.

The crankshaft, flywheel, piston connecting rod and other related reciprocating parts should be balanced and counterweights provided to ensure minimum practical unbalanced forces and moments.

Oil tight removable covers shall be provided and arranged to facilitate inspection and maintenance.

The engine assembly shall include all parts, accessories and auxiliary equipment required for installation and satisfactory operation, under specified operating conditions. All shall be designed and constructed of materials suitable for the service requirements and shall be arranged and supported to minimize fire hazards and vibration damage.

The engines shall be equipped with a turning gear for the maintenance operation. The turning gear shall be interlocked with the starting system.

All packing and gaskets supplied shall be of non-asbestos material.

The hot surface of equipment and pipe lines shall be properly insulated by asbestos free material to give a surface temperature lower than 60°C to safeguard the personnel from burn unless wire mesh guards are provided as per CE Machinery Directive

 **Cooling System**

Cooling water system shall include at least, but not be limited to:

Jacket water, make up expansion tanks with Level gauge, engine driven circulation pumps (centrifugal) or manufacture standard, interconnecting piping and accessories.

Expansion tanks including level indicators, covers, and draining pipe.

The vendor shall provide and size cooling radiators and main cooling piping for 50 degree C ambient temperature

Ethylene glycol water mix 50/50

**Lubricating Oil System**

The systems shall include filters, pressure gauges, oil coolers, thermostatic three way bypass valves, screened vents, engine driven oil circulation pumps, suction strainer dipsticks or level gauges, and pressure-actuated switches for alarm and safety shut­ down. Low-pressure protection devices, auto lubrication systems, and other essential components should also be included.

The diesel engines shall be designed with sufficient provisions to prevent leaking lube oil from.

**Fuel System**

For the diesel system, vendor shall provide a local fuel filter, regulator, instrumentation, flow control and relief valves as required for each unit.

The vendor shall provide a Racor water separation system for the diesel supply.

The engine fuel supply and injection system shall include, but not be limited to the following:

Engine driven fuel injection pump, electronic management system with customer interface tool for trouble shooting, fuel filter, hand priming pump, fuel supply piping, ventilation piping, and other accessories for each diesel generator unit.

In addition the Vendor shall provide all ancillary equipment and materials including interconnecting pipework between the diesel fuel storage tank and diesel engine enclosure.

Medium duty intake air filter

Vendor shall provide an industrial type intake air filter with replaceable dry elements.

A residential type silencer with flexible exhaust connection shall be furnished with the diesel engine and mounted inside the enclosure.

Silencer (mounted inside the enclosure) shall be properly sized for the engine and be complete with companion flanges and rain cap. Flexible exhaust expansion joints shall be furnished for the exhaust outlet.

All exhaust pipes and other hot surfaces shall be lagged or otherwise shielded for personnel protection.

**Engine management system**

Engine shall include an electronic control module (ECM). The ECM shall keep engine at selected speed. From no load to full load, ECM shall smoothly and control engine speed correctly. Stabilizer/compensator shall be included to prevent hunting or over speed. Remote control function & device shall be included in order to parallel operation with other diesel generator units. ECM shall keep record of all faults on engine.

**Electrical and Control Design Requirements**

The diesel generator must be rated at prime power with 10% overload capacity. The vendor shall coordinate the design, and ensure the satisfactory functioning of the complete package. The satisfactory functioning of the complete package shall form part of the vendors guarantee.

The scope of supply shall include the following:

A.C. generator complete with associated excitation and digital voltage regulation.

Digital synchronizing control panel capable of synching multiple generators in parallel

Lead Acid Battery and associated charging system

Circuit breaker.

**AVERAGE CLIMATIC CONDITIONS**

Maximum Ambient Temperature 50 deg.C

No derate is to apply at maximum ambient. Engine and alternator derate data to be provided at bid stage to prove correct sizing of generator.

**Control Panel**

The system shall be capable of manual operation.

During normal condition without running the diesel generator unit, the control system shall have the capabilities to supervise the operational preparedness of the diesel generator units, and initiate an alarm in the event of abnormal condition.

During operation of the diesel generator units, the control system shall supervise the diesel engines, the generators and auxiliaries, the starting systems, the lube oil systems, the cooling water systems, the fuel systems, and initiate alarms in the event of occurrence of faults. It shall also trip and shut down the diesel generator units in the event of serious faults.

Following features shall be monitored, displayed and also provide extra dry contact for remote monitoring as minimum requirements.

Low oil pressure (warning/shutdown/alarm/light)

Jacket coolant temperature high (warning/shutdown/alarm/light) Generator under voltage (alarm/light)

Engine over-speed (shutdown/alarm/light) Generator common fault (shutdown/alarm/light)

Jacket coolant level low in expansion tank (warning/alarm/light) Engine running (light)

Switch not in auto (alarm/light)

Circuit breaker trip (shutdown/alarm/light)

Each engine should include but not be limited to the following monitoring devices:

-Running hour meter

-Jacket cooling water temperature

-Lube oil temperature/pressure

**AC synchronous Alternator**

The alternators shall be capable to carry load independently.

The generators shall be drip proof, rated, 400V, 50 Hz. Insulation class F and temperature rise class F. The generator winding shall be three-phase, Wye connected, all six leads brought out for external connections. The Vendor shall make the neutral-end connections at the generator neutral cubicle. The alternator should be suitable for outdoor installation.

The alternator is to be air cooled. A fan mounted on the generator shaft takes cooling air from the engine hall, through washable filters, and passes it through the generator.

The following accessories shall be included with the generator:

Anti-condensation heater

Voltage transformer for excitation power and measurement

Current transformer for measurement

Current transforms for protection

**Exciter and voltage regulator**

The excitation system shall be brushless type, three-phase , full wave rectified with silicon diodes mounted on a common rotor shaft integrally mounted with generator, and shall have capacity to provide 130% of required excitation at rated load and voltage. Rotor shall be polyester vacuum integrated.

Automatic voltage regulator shall be an electronic unit. The voltage regulation from no load to full load will be within 1 minute.

The arrangement should be based upon a digital AVR configuration and shall include protection against over voltage.

The choice of digital AVR would introduce additional control and monitoring features.

The AVR shall be provided with means to adjust the set point of the main generator output voltage over a range of plus or minus 10% of nominal voltage rating at full load.

The AVR system shall allow 100% voltage to be generated at 80% speed under all conditions of operation.

**DC Power System**

The battery cells shall be of lead acid type. The end voltage of battery should not be under 85% rated voltage at 25°C. Cell plates shall be supported on corrosion resistant structure .

The container of battery shall be made of heat resistant, shock absorbing, clear plastic resin such that Electrolyte level can be inspected through external casing.

Electrolyte high-and low-level line shall be marked. Each cell of the battery shall be numbered. The terminal shall be permanently identified by "plus" and "minus" symbol.

All external wirings and terminals shall be insulated by plastics to prevent external short circuit and electric shock.

At least one (1) ungrounded battery set shall be provided by Vendor, When the AC power failure, the battery set can supply 100% DC loads of the two diesel generator sets for 8 hours.

The battery chargers shall be of 3 phase, constant voltage. Static type operating on 400VAC , 50Hz. In normal operation both chargers will be connected to battery and permit recharging the battery in no more than 8 hours.

**Wiring**

Internal wiring shall be identified with the Vendor's wire numbered at each end of each wire by a flame resistant plastic sleeve-or similar permanent marker. All internal wiring shall be routed from point to point without splices, and be placed in cable trays.

The Vendor's wiring shall not have more than two wires connected to any terminal point. The Purchaser's external wiring will be arranged for one wire to each terminal point. 5% spare terminals shall be provided in the terminal block.

**IP Rated Acoustic Enclosure**

The engine, generator , control panel and all ancillary equipment shall be provided with a suitably IP Rated acoustic enclosure (85db @ 1metre)

The enclosure shall be:

Of robust construction, corrosion resistant, and water proof

Fabricated with suitably certified lifting and jacking points.

Large hinged doors providing optimal access

Retaining bars to secure doors during service

Lube oil and coolant drains piped to external base frame

Control Panel viewing window and lockable access door.

External emergency stop button

Cooling Fan and Battery Charging Alternator fully guarded

Fuel Fill and Battery only reached via lockable doors.

Exhaust/Silencer System totally enclosed

**INSPECTION AND TESTING**

Inspection

The generating set shall be subject to inspection by the owner, or owner's appointed representative at any stage of manufacture, testing or preparation for shipment. Owner/Purchaser shall have unrestricted access to the Vendor's factory, factory procedures, schedules, testing and inspection procedures and schedules.

Approval by any of the above inspectors shall not relieve the manufacturer of his commitments under the terms of the purchase order and this specification.

Purchaser shall be given fifteen (15) days’ notice before shipment to arrange for formal inspection.

**Testing**

The generating set shall be subject to witness tests in accordance with the current Standards referenced herein and manufacturer's standards carried out at the manufacturer's works.

These tests shall be witnessed by the owner or its appointed representative either at the Vendor's works, during site installation or erection. The Vendor shall give the owner a minimum of 21 days notice before the start of any test. The tests shall include the following:

Full functional testing to ensure proper operation of all components.

Full load heat run for a period of 1 hour test to determine temperature rise, and to demonstrate engine and generator performance. Heating effects based on maximum design ambient shall be simulated to confirm the adequacy of the cooling system. Engine generator controls shall be used during testing. The heat run test shall be carried out in accordance with the following:

Test Program

Generator control tests to demonstrate all generator trips and alarms and changeovers from duty to standby equipment.

Rejection of full load current at the design power factor. Voltage, frequency and load current should be recorded on chart recorders.

Trip of main auxiliaries from generator fully loaded condition to demonstrate ability of emergency run down equipment.

One hour running at 110% load Cooldown

After acceptance the engine water-cooling system shall be drained prior to packing for shipment.

The test certificates shall be approved by the owner before the machines are dispatched from the manufacturer's works.

**GUARANTEE**

The equipment is to be guaranteed without qualifications and for satisfactory application in every other respect to the operating conditions specified. The Vendor will further guarantee the equipment furnished by him against defective design, materials and workmanship for a period. The guarantees shall be in effect for the following:

2 years for standby application, maximum 500 hours per year

Or

One year unlimited hours running for prime application

The Vendor will promptly repair or replace, without cost to the owner any defective part, or parts. The Vendor shall also guarantee all parts of packages and equipment supplied by sub-suppliers.

**VENDOR DATA AND REQUIREMENT**

The Vendor shall provide the owner with the following drawings and data in English at no cost to the owner:

Complete technical Vendor's product catalogues.

Single line and wiring diagrams of control and electrical panels (as applicable) with indication of characteristic of control alarms and shutdown devices.

Declaration of confirmation with the set standards and/or clear indication of deviations from the standards and this specification.

Vendor's design calculation, necessary documents and/or data for the calculation of the power output of the engine.

De-rating curves.

Performance curve showing torque, fuel consumption, engine speed and power output.

Recommended commissioning and 2 years running consumable and spare parts separately listed, numbered, referenced and duly priced.

Shipping dimensions (length, width and height) and weight with shipping schedules.