

TECHNICAL SPECIFICATIONS

DIESEL GENERATOR SETS

1. GENERAL

Work covered by this contract shall include design, manufacture, supply, transportation, delivery, installation, testing and commissioning of automatic start direct coupled Diesel Generator Sets and shall include but not limited to the following.

- Diesel engine with alternator mounted on a rigid fabricated steel base frame with resilient ant vibration mountings
- Water cooling system including cooling towers, pumps, piping and controls.
- Exhaust piping with Residential type Silencer.
- Electric starting equipment including batteries and battery chargers.
- Fuel supply system including bulk oil storage and automatically operated fuel transmission system.
- Statutory approvals including permission from Electric Supply Authority for operation of DG sets, approval from RSEB, clearance from Electrical Inspector, approval from Pollution Control Board and necessary approvals from Department of Explosive for bulk oil storage.

2. STANDARDS

The equipment offered shall conform to the latest revision of relevant Indian or British Standard (BSS.) and Codes together with the requirements of the Local Supply Authority and Department of Explosive etc.

Tenderers shall clearly state the standards to which the equipment they are offering conform.

3. ENGINE AND ACCESSORIES

3.1 Engine

The engine shall have the following characteristics:

Type	- Suitable for generating set application, turbo charged, multi-cylinder, solid injection, cold starting.
Cycle	- Four stroke.
Speed	- 1,500 r.p.m.
Speed Variation	- Within 2% for operation between 10% and 100%
Method of Starting	- Battery
Net site output	- This shall be the continuous rating under the ambient conditions given in Clause 3.3 of SCC and as per schedule of quantities.

The engine rating shall be stated in the tender in accordance with the latest revision of relevant I.S. or B.S. Adequate precautions shall be taken to safeguard the sets against low lubricating oil pressure, high water temperature, overspeed and overcurrent.

3.2 Fuel Consumption

The engine shall be suitable for satisfactory operation on H.S.D. as locally available. The tenderers shall declare the guaranteed fuel consumption in liters per BHP/hr, in accordance with relevant I.S. or B.S. at 1/2, 3/4 and full load under the maximum output after de-rating to ambient conditions.

Such guaranteed fuel consumption is also to be expressed in liters per gross / nett kWh output from the alternator (after supplying the requirements of auxiliaries) at 1/2, 3/4 and full load and at 0.8 and unity power factors.

If guaranteed fuel consumption is exceeded, the Contractor shall make such amendments or alterations as are necessary to bring the consumption to within the guaranteed figures.

Tolerance of + 5% as defined in BSS-649-1958 shall be allowed.

3.3 Lubricating Oil Consumption

The tenderers shall state the guaranteed lubricating oil consumption in liters per hour.

3.4 Governing

The governor shall be of electronic type with governing class A direct.

3.5 Mounting And Foundations

The engine and direct coupled alternator shall be rigidly secured to a common rigid base frame fabricated from MS sections.

The DG set shall be placed on the RCC Floor with GERB make antivibration mountings. A lifting hook of required capacity shall be provided above the finalized location of the DG set to facilitate installation and subsequent maintenance of the DG sets.

The design of mounting arrangements with antivibration mountings shall be as recommended by the DG manufacturers and shall be such that a maximum of 2% vibrations are transmitted to the structure.

The tenderer shall confirm the type and design of mountings provided and the vibration isolation efficiency in the tender.

3.6 Exhaust Piping

The engine shall be provided with an exhaust pipe and fitted with a residential type silencer to reduce the noise level as per CPCB norms

Exhaust piping shall be fabricated from class 'C' MS pipes upto 150 mm dia as per IS and above as per IS 3589 of 5.20 mm thickness of size suitable to limit back pressure to within permissible limit. All exhaust piping inside the DG canopy shall be insulated with 50 mm mineral wool lagging covered with 26 SWG aluminium sheet cladding. Flanged joints in the exhaust piping shall be covered with removable insulation at suitable intervals for permitting access to the joint if and when required.

Exhaust piping shall be connected to the engine by means of flexible section or an expansion joint and shall also be graded to a drain pocket inside the building. The pocket shall be fitted with a drain cock.

The exhaust piping should be such that back pressure should not be more than 2.5 inches of mercury (Hg)

3.7 Air Filters

The engine air intake shall be fitted with a substantial air cleaner of oil bath/ paper element type. The filter shall be suitable for operation under dusty conditions.

3.8 Crank Case Breather

The crankcase breather outlet of the engine shall be fitted with a filter cap capable of preventing entry of dust.

3.9 Fuel And Lubricating Oil Filters

Filter for fuel and lubricating oil systems shall be of simplex type. Lubricating oil filters shall be of an efficient full flow type of ample capacity and suitable for use with detergent oils. They shall be capable of removing all foreign matter above a particle size of 5 microns.

3.10 Tools

Two sets of standard tools kit for maintenance shall be provided by Contractor. Tenderer shall submit a list of the tools alongwith the tender.

3.11 Lubricating Oil System

The engine shall be of the totally enclosed type and fitted with a positive pressure system of lubrication to all working parts. Lubricating oil shall be circulated in the engine by an engine driven pump. There shall be no moving part requiring lubrication by hand prior to the starting of the engine or while in operation.

3.12 Safety Controls

Low Lubricating Oil Pressure

Pressure sensors shall be fitted such that in the event of a fall in the lub oil pressure, an alarm and indication shall be actuated. In addition, the engine shall be automatically shut down in the event of lub oil pressure dropping to a predetermined low value.

High Water Temperature

An alarm shall be given if the close loop engine jacket cooling water temperature exceeds safe limits stipulated by the engine manufacturer due to any reason (including low level of water in secondary cooling system cooling tower). The engine shall be shut down when a pre-determined set water temperature is reached.

Over Speed

Speed control shall be so arranged that a 12-1/2% increase over normal rated speed shall cut off fuel supply, thus stopping the engine.

Overload Protection

The engine shall be adequately protected against operating under overload conditions. The requirements shall be met by the provision of a fixed overload limit stop on the fuel pump rack control rod to prevent the set being subject o to a load exceeding the site rating plus 10%.

Excess Starting Time

The starting circuit for the automatic mains failure diesel generator sets shall be arranged to attempt upto three starting cycles, each not exceeding 10 seconds duration with a similar OFF period between each cycle. If the set fails to start upon completion of the third attempt the starting circuit shall be locked out until it is restored manually. An alarm shall be given and "Set failed to start" indication given on the panel.

Provision shall also be made to avoid re-engagement of the starter pinion until after the engine has come to rest. Failure of the starter motor to disengage shall close down or lock out the engine.

Fuel Level Protection

A level sensor shall be provided in the day fuel tanks to give visual and audible alarms if the level in the tank falls to below 1/4 full.

3.13 General

The DG sets shall be complete with all equipments, visual and audible alarms, indications and controls required for fully reliable and safe operation of the DG sets whether specifically stated in these specifications or not. It is essential that the operation of all protection equipments be completely reliable in all respects.

Whenever the engine is shut down due to overspeed, low lubricating oil pressure, high water temperature or excess starting time, the circuit breaker shall also be tripped and the starting systems of the engine shall be locked out until the respective protective relay is reset.

3.14 Accessories, Instruments and Safety Controls for Engine

Accessories, instruments and safety controls to be provided with the engine shall be (but not limited to) as below. All accessories shall be of design compatible with the design and /or operation of the engine.

- a. Accessories:
 - Flywheel to suit flexible coupling.
 - Flexible coupling with guard.
 - Air cleaner oil bath/paper element type.
 - Corrosion resistor.
 - Heat exchanger.
 - Governor - electronic.
 - Fuel filter
 - Lub. oil filter.
 - Heavy duty batteries with leads and battery charger with battery stands.
 - Stainless Steel Bellows
 - Flexible coupling
 - Exhaust silencer residential type
 - Interconnection wiring, cabling and piping as required
 - Set of standard tools
 - Anti-vibration mounting pads.
- b. Instruments and Gauges:
 - Lub. oil pressure gauge.
 - Water temperature gauge.
 - Battery charging ammeter.
 - Hour meter (mechanical) to show total engine hours run 10,000 hr capacity
 - R.P.M. indicator of the tachometer type.
 - Starting switch with key
 - Lamp indicator for charging alternator
 - Push button for starting
 - Safety control indication lamp
- c. Safety controls for
 - Low lub oil pressure
 - High water temperature
 - Over speed
 - Low fuel level in buffer tank
 - Low water level sensor in cooling towers

3.15 Alternator

The Alternator shall have the following characteristics

- | | | |
|-------|---|--|
| Type | - | Drip Proof Screen protected for power generation |
| Speed | - | 1500 R.P.M. |

Net Site Output	-	Rated continuous at ambient conditions and as per schedule of quantities.
Voltage Regulation	-	Within 0.5% of the rated voltage
Overload	-	More than 10% of the nominal for 1 hour every 12 hours without exceeding permissible temperature rise.
Harmonics	-	Maximum 1% between phase and neutral and total maximum 3%

Construction

A screen protected drip proof type, alternator directly coupled to the Diesel Engine by a flexible coupling shall be provided. The combined engine alternator unit shall be mounted on a common rigid fabricated base frame. The alternator shall have its windings star connected with the neutral connection brought out to a separate terminal. The alternator shall fully comply with the latest Standard BS 2613 and BS 269 in respect of winding insulation and fast response to maintain steady voltage.

Temperature Rise

The maximum temperature rises of the various components of the alternator shall not exceed those permitted under I.S. with full output and under the ambient temperature conditions specified in Clause 3 above.

Rating And Regulation

The alternator shall be continuously rated to deliver the rated output at 0.8 P.F. lagging, on a 3 phase 4 wire 415 volts 50 cycle system. The alternator shall be of the self regulated and self excited type brushless. The alternator shall be provided with a static excitation system and the voltage regulation from no load to rated load shall be within 0.5% of rated voltage.

Alternator Insulation

The alternator should have class H insulation suitable to withstand tropical conditions.

4. DG CONTROL AND OPERATION

Operation of DG sets shall be monitored and controlled by a Programmable Logic Controller (PLC) based Logic Panel provided by Owners on the Main LT Panel of the system. DG contractor shall coordinate this aspects with the electrical contractor appointed by the Owners.

5. PIPING

Piping Materials

Unless otherwise specified, pipes shall be medium class MS (black steel) as per IS 1239 (Class C) suitable for welded joints.. Wherever so specified, class C GI pipes with screwed joints could be used for pipes upto 50 mm dia.. MS/GI pipes shall be of makes as per approved list. Pipes shall be given one primary coat of rust inhibiting paint before being installed.

Fittings shall be new and from approved manufacturers, Fittings shall be of pressure ratings suitable for the piping system. Flanges shall confirm to ISS. Supply of flanges shall include bolts, nuts, washers, gaskets etc., as required. All equipment and valve connections shall be through welded flanges.

Gate valves and check valves shall conform to IS:780/1969. Gate valves shall have non-rising spindles unless otherwise specified. Valves upto 40 mm dia.. shall have gun metal body and valves of more than 40 mm dia.. cast iron body unless otherwise specified. Valves shall be suitable for test pressures as per piping system requirements and as per ISS.

Butterfly valves shall conform to BS:5155, MSS SP 67 & API 609. The valves shall be suitable for flow in either direction and seal in both directions. The valve shall be of integral moulded design.

Strainers shall be Y type or Pot type as per schedule of quantities and /or as required with CI or fabricated steel bodies. Strainers shall have removable bronze screen with 3mm perforations. All strainers shall be provided with equal size isolating valves so that the strainer may be cleaned without draining the system.

Pressure gauge shall be not less than 100 mm dia dial and of appropriate range and be complete with shut off gauge cocks etc.. and shall be duly calibrated before installation.

Pressure gauges shall be provided at the following locations:

- a) Suction and discharge of pumps.
- b) Inlet and outlet of heat exchangers.

Care shall be taken to protect pressure gauges during pressure testing.

Thermometers shall be either 100 mm dia dial or direct reading industrial type of appropriate range duly calibrated before installation.

Thermometers shall be installed in separable wells.

Thermometers shall be provided at the following locations:

Dial type thermometers on supply and return of heat exchangers.

Piping Installation

The Contractor, on award of work, shall prepare detailed working drawings showing the piping route, typical sections, location and detail of fittings, valves, strainers and instruments. The planing of piping system shall take existing wall and ceiling openings, if any, into consideration. Piping layout shall take due care for expansion and contraction in pipes.

Piping shall be installed only after thorough cleaning. Pipes shall be cut square. Proper edge preparation with 'V' grooves shall be done and edges grinded before welding. Sufficient gap shall be maintained. Electrodes of approved makes only shall be used for welding and tacking.

Pipes shall be supported from floor /wall mounted or ceiling suspended supports at an interval of maximum 2 mtrs unless otherwise states/approved. Supports shall be designed to withstand the weight of pipes, fittings and fluid in motion. Pipe supports shall be of steel, adjustable for height and primer coated with rust preventive paint and finish coated with 2coats of enamel paint of approved colour. Where pipes and clamps are of dissimilar material, a gasket shall be provided in between. Pipe hangers shall be fixed on walls and ceilings by means of dash fastners. Vertical risers shall be parallel to walls and column lines and shall be straight and plumb. Risers passing from floor to floor shall be supported at each floor by clamps or collars attached to pipe and with a 12mm thick ribbed rubber pad or any other approved resilient material. Where pipes pass through the terrace floor, suitable curbing shall be provided to prevent water leakage. Risers shall also have a suitable concrete pipe support at the lowest point.

Pipe sleeves of 50mm or larger diameter shall be provided wherever pipes pass through wall and the annular space filled with felt and finished with retaining rings.

Insulated piping shall be supported in such a manner as not to put undue pressure on the insulation.

Piping shall be pitched towards drain points. Drain outlets shall be provided at all low points in the piping system with 25 mm dia pipe (for upto 300 mm dia water pipe) with gate valves of equal size with rising spindels . Drain outlets shall be connected through equal size GI pipe to the nearest drain or floor waste.

All piping buried directly in ground shall be provided with a coat of primer paint after surface preparation over which rust preventing tape (Pipekote 4 mm) shall be wrapped.

Testing

Entire piping system after installation shall be flushed with clean water to ensure thorough inside cleaning of the system. All piping shall be tested to hydrostatic test pressure of at least one and a half times the maximum operating pressure, but not less than 7 Kg/Sq cm for a period of not less than 24 hours. All leaks and defects in joints revealed during the testing shall be rectified to the satisfaction of the Project Manager.

Piping required subsequent to the above pressure test shall be retested in the same manner.

Systems may be tested in sections and such sections shall be securely capped.

The Project Manager shall be notified well in advance by the contractor of his intention to test a section of piping and all testing shall be witnessed by the Project Manager or his authorised representative.

The Contractor shall make sure that proper noiseless circulation of fluid is achieved through all coils and other heat exchange equipment in the system concerned. If proper circulation is not achieved due to air bound connections, the Contractor shall rectify the defective connections. He shall bear all the expenses for carrying out the above rectifications including the tarring-up and re-finishing of floors, walls etc. as required.

No insulation shall be applied to piping until the completion of the pressure testing to the satisfaction of the Project Manager .

The Contractor shall provide all materials, tools, equipment, instruments, services and labour required to perform the test, and shall ensure that the plant room and other areas are cleaned up and spill over water is removed. And also ensure that there is no flooding of water.

After the piping has been installed, tested and run for at least ten days of eight hours each, the piping shall be given two finish coats, 3 mils each of approved color and shade.

6. ENGINE AUXILIARIES AND WIRING

All engine auxiliaries shall be checked and tested for proper operation. Wiring between the engine auxiliaries and the DG control logic panel shall be provided with copper conductor PVC insulated 1100 V grade armoured cables. Loop earthing as required shall be provided.

7. STARTING BATTERY AND BATTERY CHARGER

7.1 24 Volt DC Batteries

24 volt batteries for each set shall comprise of standard lead acid stationary batteries consisting of required cell of each 2 volts to have 180 AH/360 AH capacity a one hour rate of discharge to attain voltage of 1.85 volt per cell to 2 volts supplied complete with inter cell connectors and acid level indicating floats. Battery cells shall conform to IS 1651 with up to date amendments. The battery bank shall be provided with the following accessories.

- a) Battery stand
- b) Set of connectors with ends take off suitable for connections.
- c) Cell insulator and stand insulators
- d) Spring type hydrometer
- e) Thermometer with specific gravity correction scale
- f) Cell testing voltmeter

- g) Set of tools consisting of spanners, rubber syringe, acid resisting funnel and acid resisting tube of 2 litres capacity – one set

The batteries shall be supplied duly filled, charged and acidic filled.

7.2 Battery Charging Equipment (Trickle and Boost Charging)

Battery trickle and boost charge of suitable capacity intended to operate on single phase 230 volts, so cycles supply system and suitable for charging current. The battery boost charger shall be provided with the following accessories.

- a) AC and DC “ON” and “OFF” switches with HRC fuses
- b) Indicating lamps for indicating mains “ON” and battery charging
- c) Ballast to give charging
- d) Single phase double wound (copper conductor) impregnated natural air cooled mains transformer for rectifier stack.
- e) Rotary switch to give step control.
- f) Single phase full wave bridge connected silicon rectifier stack
- g) Moving coil ammeter to indicated charging current
- h) Moving coil voltmeter with a selector switch to measure the battery/charger voltage.
- i) Silicon blocking diodes connected to a suitable tap to maintain continuity of DC supply.
- j) AC and DC contactors of suitable rating as required.

All the components for battery charger shall be adequately rated and housed in a well ventilated sheet steel cubicle with input and output terminals. Proper cable glands shall be provided for incoming and outgoing cables. Battery charger shall form part of DG Protection and PLC panel.

8. RADIO INTERFERENCE

All equipment provided under this specification shall be so designed that it will not cause interference with radio equipment. In the event of the inherent characteristics of the equipment being such that radio interference is possible, efficient devices to nullify the same shall be provided. Suppressers shall be as per the relevant I.S./B.S. Standards.

9. PRE-COMMISSIONING CHECKS

All standards checks including the ones elaborated in the specifications to ensure that the installation of the DG sets and associated systems has been carried out satisfactorily shall be done on completion of installation. These shall include.

- DG sets
 - Checking of piping interconnections
 - Checking electrical interconnections
 - Checking of insulation resistance
 - Checking of earthing
 - Checking of instruments and controls.
 - Checking of alignment
 - Checking of vibration transmission to building a structure.
 - Checking of expansion joints.
- Exhaust system
 - Checking of silencer operation
 - Checking of surface temperature of exhaust piping
- Fuel system
 - Checking of automatic operation of fuel transfer pumps.

10. PERFORMANCE TESTING AND TYPE TESTS

10.1 Performance Testing

DG sets shall be tested at varying loads at manufacturers works prior to dispatch of the sets to site. The performance tests at the works shall be carried out in presence of authorized representative from the Owners. Due notice for the programme of performance testing at works shall be given to the Owners to enable them to arrange for their representatives for this inspection to be at manufacturers works for this inspection and testing. The costs for the arrangement shall be borne by the Contractor.

The performance test on each DG sets shall be of minimum 8 hours duration.

All instruments, materials, consumables (fuel oil, lube oil etc.) load and labour required for carrying out of the test shall be provided by the Contractor .

Following test acceptance criteria shall be applicable.

1.	Fuel consumption at 50%, 75%, 100% and 110% load.	± 5% of guaranteed performance. Actual alternator efficiencies as determined in the manufacturers works tests shall be used as the basis of calculation of specific fuel consumption ratio.
2.	Voltage regulation from no load to full load	± 1%
3.	Frequency regulation from no load to full load	± 0.5%
4.	Maximum water temperature	± 5% of guaranteed performance
5.	Maximum lubeoil temperature	± 5% of guaranteed performance
6.	Minimum lubeoil pressure	± 5% of guaranteed performance
7.	Lub Oil consumption	± 5% of guaranteed performance

10.2 Type test

Copies of manufacturers type test for the engine and the alternator of all ratings shall be enclosed alongwith the dispatch of the DG sets.

11. GUARANTEED TECHNICAL PARTICULARS

Guaranteed technical particulars in format enclosed as Annexure-I, I.1 and I.2 of these specifications shall be filled in by the tenderer and enclosed **alongwith** the tender. Tenders not complying with this requirements are liable to be rejected. Guarantee

TECHNICAL PARTICULARS
(Technical particulars to be filled in by tenderers and enclosed alongwith the tender)

DG SETS TECHNICAL PARTICULARS

ITEM	Confirmations or Comments or data shall be furnished by tenderer against each item
Diesel Generating Set	
Packager of DG Set	
Prime rating of the DG set based on continuous operation for 365 days in a year at varying loads. The prime rating as above shall be suitable for continuous operation over an ambient of 50° C. Tenderer to categorically confirm this operation and to furnish design calculation in support of this confirmation.	
DG set to be suitable for 10% overload capacity for 1 hour on 12 hours – over and above the governor capacity being suitable.	
Diesel Engines	
Manufacturer of Diesel Engine	
Manufacturers Model No	
Type of Cooling	
Aspiration	
Air cleaner type.	
Fuel / Lub Oil Filter Type	
Governor type and class	
Flywheel to suit flexible coupling.	
Flexible coupling with guard.	
Fuel pump.	
Shaft motor water pump with thermostatic control to maintain the water temperature in the engine jacket at 40 deg C.	
Interconnection wiring, cabling and piping as required	
Cooling water quality	
Max. engine water temperature	
Lub oil pressure	
Max. Lub oil temperature	
Fuel Consumption	
Typical fuel consumption litres/BHP/hr	
50% load	
75% load	
100% load	

110% load	
Fuel consumption figures vis-a-vis Alternator electrical output - kWH/litre	
50% load	
75% load	
100% load	
110% load	
Fuel air compression ratio	
Suitability for locally available HSD	
Suitability of operation of DG set on cheaper fuel like LDO etc.	
Lub oil consumption	
Lub oil consumption at 100% load	
Heat Balance	
Typical heat balance	
Heat rejected to cooling water	
Heat rejected to after cooler	
Heat rejected to exhaust	
Heat rejected to Ambient	
Alternator	
Manufacturer	
Enclosure	
Insulation class	
Temperature Rise under continuous operation	
Excitation unit	
Voltage Regulation no load to full load	
Wave form distortion on full load	
Radio Interference	
Telephone Interference	
Stator winding thermistor with trip	
Space heater	
Single step load acceptance	
Peak Motor starting kva	
Sustained short circuit % of rated current for 10 seconds	
Overload rating for	
15 seconds	
60 seconds	
10 minutes	
30 minutes	
Instrument and Controls	
Instruments :	
Oil temperature gauge	

Oil pressure gauge	
Water temperature gauge	
Battery charging ammeter.	
Hour meter to show total engine hours run - 10,000 hr capacity	
R.P.M. indicator .	
<u>Indication lamps</u>	
Battery charging indication	
System ready	
<u>Safety controls</u>	
Safety control – low lub. oil pressure	
Safety control - high water temperature.	
Safety Control – Overspeed	
Antivibration mounting	
Make	
Vibration Isolation Efficiency	
Exhaust system	
Exhaust silencer type	
Number of Silencers provided	
Noise level dB at 1 m from silencer	
Noise level 1 m outside DG room	
Exhaust pipe diameter, material and thickness	
Guaranteed Temperature on external face of exhaust pipe insulation	
Details of insulation provided for exhaust pipe	
Temperature of flue gases at exhaust manifold	
Expansion joints in exhaust piping	
Exhaust stack height - alongwith back pressure calculation	
Approvals from following shall be obtained by Contractor prior to commencement of work and after completion as required	
Chief Electrical Inspector to the Local State Government	
State Electricity Authorities/HERC	
Pollution Control Board for air and noise pollution	
Department of Explosives	
Noise Limit (Pollution Norms)	
Confirmation of compliance to noise limits stipulated in Central Government Notification dated May 17, 2002 to comply with Environmental Protection Second Amendment	

Rule 2002 or latest amendment in Pollution norms laid by Statutory authority	
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Signature of tenderer.

DG SETS – COST OF GENERATION

ITEM	Unit	Data shall be furnished by tenderer against each item
Make of Engine		
Make of DG set		
Engine Model		
DG set rating	KVA	
DG set rating	Kw	
Average Load factor	%	75%
Units generated per hour	kwh / hour	
Number of hours per year	hours / annum	2400 hours
Number of units generated per year	kwh / annum	
Fuel Cost		
Fuel rate	Rs per litre	
Fuel consumption	Litres/ hour	
Number of units per litre of Diesel	Kwh / litre	
Fuel cost	Rs per kwh	
Lub Oil Consumption Cost		
Lub oil consumption	litres / hour	
Cost of Lub oil	Rs per litre	
Lub Oil consumption cost	Rs per hour	
Lub Oil consumption cost	Rs per kwh	
Lub Oil Replacement Cost	Rs per litre	
Lub Oil replacement period	hours	
Lub Oil replacement quantity	litres	
Lub oil replacement	litres / hour	
Lub oil replacement cost	Rs / hour	
Lub Oil replacement cost	Rs per kwh	
Maintenance Cost		
"B Check" maintenance period	hours	
"B check" maintenance kit cost	Rs	
"B Check" maintenance cost	Rs per kwh	
"C Check:" maintenance period	Hours	
"C Check:" maintenance kit cost	Rs.	
"C Check" maintenance cost	Rs per kwh	
"D Check:" maintenance period	Hours	
"D Check:" maintenance kit cost	Rs.	
"D Check" maintenance cost	Rs per kwh	

Air Cleaner element change period	hours	
Air Cleaner Element cost	Rs	
Air Cleaner Element replacement cost	Rs per kwh	
Total Cost per kwh generated		

Signature of Tenderer

DG SETS – EMISSION LEVELS – at 100% load

ITEM	Emission level as per Pollution Control Board Norms	Guaranteed emission level of the engine offered to be filled in by the tenderer
NO _x	9.2 g/kW-Hr	
SO _x		
CO	5 g/kW-Hr	
HC	1.3 g/kW-Hr	
Dust (particulate matter)	0.5 g/kW-Hr	

Signature of tenderer

BEE Schedule-18 for Fuel efficiency testing methods

Voluntary Energy Efficiency Labeling Program for Diesel Generator Sets

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Annexure I

1. Scope

This schedule specifies the star labeling requirements for various classifications for the application, rating and performance of single/three phase Diesel Generating sets consisting of a Reciprocating Internal Combustion (RIC) engine driven by diesel as fuel, Alternating Current (a.c.) generator, any associated control gear, switchgear and auxiliary equipment. It applies to A. C. generating sets driven by RIC engines for land and marine use being manufactured, imported or sold in India.

It excludes generating sets used on aircraft or to propel land vehicles and Locomotives.

Diesel Generating (DG) Sets up to 19 kW ratings are covered under pilot energy labeling scheme for single/threephase DG Sets.

Generating sets meeting the requirements of this schedule are used to generate electrical power for continuous, peak-load and standby applications.

This document applies to new DG sets. Existing & Retrofitted DG sets shall not be required to be modified to conform to this schedule.

2. Normative Reference

This schedule shall be read in conjunction with Indian Standard IS 10000, IS 10001, IS 13364 & IS 4889: 1968 (all parts with amendments till date) & “**Scheme for Energy Efficiency Labeling**” covered under Standard Labeling Program, with all applicable amendments.

2. Terms & Definitions

Star Rating

“Star rating or star level” means the grade of energy efficiency based on specific fuel consumption (SFC) in g/kWh (electrical unit), displayed on the label of the generating set. The available stars are between a minimum of one and

a maximum of five shown in one star interval. The star rating is calculated from the Star Rating Band (refer 5 of this Schedule).

Star Rating Band

The Star Rating Band is a range of SFC (g/kWh) which is arrived by clause 6 of this schedule, and is used for determining the number of stars displayed on the star label.

Equipment/Unit

A Generating set described under Section 1 (scope) of this schedule.

Authority

Government of India.

Star Label

Star label as described in Section 6 of this schedule.

Participant

Manufacturers, trader, importers or retailers of the equipment participating under this program

Scheme for Energy Efficiency Labeling

The Bureau of Energy Efficiency's Labeling Scheme for all the voluntary products covered under Standard & Labeling Scheme.

3. Eligibility Criteria:

Participant involved in manufacturing, trading, importing or retailing in Diesel Generator sets as a finished product, are only eligible to participate in the scheme.

3.1 Pre-requisite

- Diesel Generator set must comply with latest statutory requirements (such as CPCB and others as applicable) of Govt. of India.
- Engine shall be ISI marked. Participant shall submit BIS certificate as a proof of same.

3.2 Requirements

Participant shall submit following in order to register under the scheme:

3.2.1 Mandatory:

- Participant shall submit test report of engine and alternator as per Indian Standard IS 10000, IS 10001 & IS 4889: 1968. However if engine & alternator are tested more stringently (compared to IS 10000, IS 10001 1980, IS 13364 & IS 4889: 1968), then the parameters where the greater stringency has been applied should be declared by the manufacturer in the test report.
- Participant shall submit CPCB compliance report/certificate for complete DG set.
- Participant shall submit BIS certificate for diesel engine.

3.2.2 Wiring Diagrams (Mandatory):

Submit wiring diagrams for diesel engine driven generator units showing connections to electrical power panels, feeders, and ancillary equipment. Differentiate between portions of wiring that are manufacturer installed and portions that are field installed.

3.2.3 Certifications (Mandatory):

Provide diesel engine driven generator sets certified test record of the following final production testing:

- ✓ Safety shutdown device testing
- ✓ Voltage regulation

3.2.4 Battery Charger (Voluntary):

The battery charger shall be readily accessible and designed that it shall not be damaged and shall not trip its circuit protective device during engine cranking or it shall be automatically disconnected from battery during cranking period. The charger shall be mounted inside the emergency generator enclosure. The charger shall have a 7-day/24- hour timer control.

3.2.5 Fault Indicators (Mandatory):

Individual press to test fault indicator lights for low oil pressure, high water temperature, low water level, overspeed, over crank, and for aboveground storage tank and high and low fuel level shall be provided. Provide relay dry contacts for interface of fault alarms with SCADA system.

3.2.6 Circuit Breaker (Mandatory): A generator circuit breaker shall be installed as a manual load circuit interrupter and an automatic overload and short circuit protection device should be used to interrupt load circuit.

4. Testing Guidelines

4.1 Testing requirements:

The instruments as detailed below (as per Annexure VIII of IS: 10001 – 1981), need to be maintained by the testing agency (participants own lab or third party lab) for the testing of specific fuel consumption of DG sets. All the instruments shall have valid calibration certificates with traceability to NPL and facilities accredited by NABL: -

- Test bed with suitable electrical loading arrangement / Power analyzer.
- Energy Meter
- Pressure Gauges
- Barometer
- Hydrometer / Humidity indicator
- Tachometer / Stroboscope
- Fuel Measuring apparatus
- Stop watch
- Thermometer / Pyrometer / Temperature Gauges
- Exhaust Back Pressure Gauge / Manometer
- Arrangement for measuring calorific value of fuel

4.2 Standard Reference Conditions:

The standard reference conditions for the purpose of determining the fuel consumption for constant speed Engines is as under (as per Section 1 of IS 10000 (Part II) 1980) shall be as under:-

- Mean Barometric Pressure = 100 kPa
- Atmospheric Temperature = 300 K
- Relative Humidity = 60 % at 300 K
- Charge Air Coolant Temperature = 300 K
- Intake Air depression and exhaust back pressure = Equal to that obtained with intake and exhaust systems normally fitted with the engine. It shall not exceed 50mm of water unless the manufacturer has accepted higher back pressure prior to the test.

4.3 Correction Factors considered:

The following correction factors based on ambient conditions need to be considered: -

- Power adjustment factor “ α ” – The net output in power at the site conditions shall be corrected to the standard reference conditions specified in section I of IS :10000 (Part II) – 1980 using correction factor “ α ” as determined from the IS: 10000 (Part IV), in item 2.2.2 and Appendix A.

$$P_x/P_r = \alpha$$

Where P_x = Power under ambient conditions &

P_a = Power under standard reference conditions

$$\alpha = k - 0.07(1-k) (1/\eta - 1)$$

$$k = (T_r/T_x)^n \times (p_x - a \cdot \Phi_x \cdot p_{sx})^m / (p_x - a \cdot \Phi_x \cdot p_{sx})^m$$

Where,

P = Power in kW

α = power adjustment

factor K = ratio of indicated

powers P = barometric

pressure (kPa)

P_s = saturation vapour pressure

(kPa) Φ = Relative humidity

T = absolute air intake temperature

(K) η = mechanical efficiency

Values of a, m, n are taken from table 1 of IS 10000 (Part IV) - 1980

- Specific fuel consumption adjustment factor “ β ” – The specific fuel consumption at the site conditions shall be corrected to the standard reference conditions specified in section I of IS :10000 (Part II) – 1980 using specific fuel consumption correction factor “ β ” as determined from the IS: 10000 (Part IV) item 3.2.3 and Appendix F.
 β = SFC (ambient site condition) / SFC (standard reference conditions) Also $\beta = k / \alpha$

- Adjustment for calorific value of fuel – in case the fuel used is different from the fuel with calorific value of 42000kJ/Kg, a correction for the difference in calorific value to be applied as under

$$\beta_{cv} = CV / 42000$$

$$\text{And adjusted SFC} = \beta_{cv} \times \text{calculated SFC}$$

Where β_{cv} = SFC adjustment factor for calorific value of fuel
 fuel CV = net lower calorific value of fuel used in kJ/kg

4.4 Testing Procedure:

The testing procedure for specific fuel consumption norms under standard and labeling program for DG sets with Diesel engines conforming to IS 10001 (< 19 kW) and alternator conforming to IS 4889 is proposed as under: -

- The DG set will be set up as per the standard procedure of the manufacturer and connected to the standard electrical load. Earthing shall be provided as per IS 3043: 1987.
- DG set shall run on 100% loading for 15 minutes after reaching thermal stability (as defined clause 8.7 of IS/IEC 60034 part 1: 2004). Then DG set load shall be gradually reduced to 75% load. After reaching 75% loading, 0.8 Power Factor and normal ambient conditions, fuel consumption and other parameters shall be recorded for 4 hours at an interval of 30 minutes each. Average SFC of 4 hours will be considered for test result.
- The data will be recorded as per the parameters given in Annexure I. The kWh will be taken from power analyzer / Energy meter.

4.5 Test Parameters

SFC: Specific Fuel Consumption in g/kWh shall be recorded.

4.6 Test report: The results of tests shall be furnished to Bureau in form of test report. The same results shall also be reported as per **Annexure I** of this Schedule.

4.7 Tolerance:

There is no tolerance for Star Rating Bands (as mentioned in Table 1). The average of products tested must be at par with type generating set or better than the Label threshold.

A tolerance of +/- 5% in specific fuel consumption shall be allowed.

5. Sampling

The samples for check testing picked up randomly by the Bureau or its designated agency for testing as per the sampling plan from the retail outlet or manufacturing facility or warehouse and as mentioned in the check testing scheme.

6. Energy Labeling Plan

The Star Rating plan for a generating set shall be based on the Specific Fuel Consumption (SFC) in g/kWh declared by the participant. Declared value of SFC shall not be less than the test result. Energy labeling star rating plan is as indicated below:

Star Level	Specific Fuel Consumption (SFC) in g/kWh
1 star	$> 302 \text{ \& } \leq 336$
2 star	$> 272 \text{ \& } \leq 302$
3 star	$> 245 \text{ \& } \leq 272$
4 star	$> 220 \text{ \& } \leq 245$
5 star	≤ 220

6. Manner of Display

The label shall be affixed on the alternator where DG set is not sold with canopy or on canopy where DG sets is sold with canopy. The participant should ensure that the label appears on every registered Unit on display for identification purpose, at point of sale or hire. The label shall also be printed or pasted on the packaging.

6.1 Color scheme of Sample label

The color scheme of the label shall be as given in Figure 1

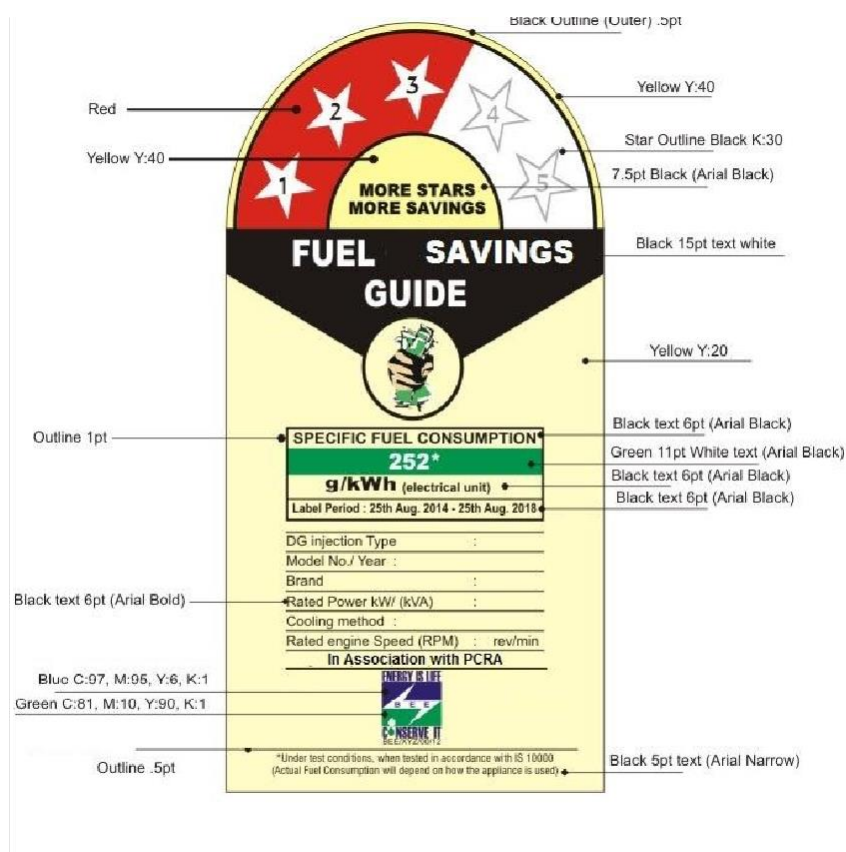


Figure 1

The following colour scheme for Bureau's logo, namely:-

BLUE –

Hue (H)-239o Saturation(S):64% Brightness (B):59%
Luminance or lightness (L):28, chromatic components -
a:24 b:54Red(R):54 Green (G):55 Blue (B):151
Cyan(C):97% Magenta (M):95% Yellow(Y):6% Black
(K):1%Web colour code - #363797

GREEN –

Hue (H)-150o Saturation(S):10% Brightness (B):67%
Luminance or lightness (L):61, chromatic components -a:-
53 b:32Red(R):0 Green (G):170 Blue (B):87
Cyan(C):81% Magenta (M):10% Yellow(Y):90% Black
(K):1%Web colour code - #00AA56;

6.2 Design of label

The design of the label shall be as given in Figure 2

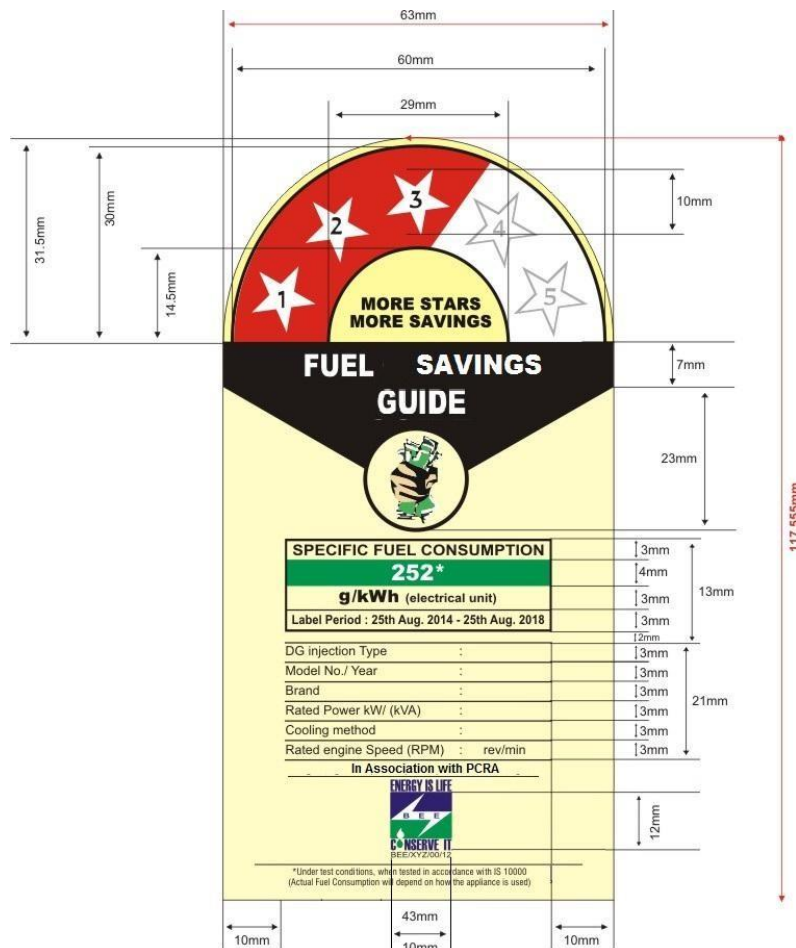


Figure 2

6.3 Material of Label

The label shall be durable and possess good wear and tear characteristics and self adhesive type. It should stick tightly on the equipment surface.

7. Fees

7.1 Security deposit for Company Registration:

An amount of INR 25,000 shall be deposited to Bureau by the small scale manufacturers holding SSI certificate. An amount of INR 1,00,000 shall be deposited by other manufacturers

7.2 Application processing fee:

To avail the grant of permission to affix the star label on the model, a registration fee of INR 1000 /- (One thousand only) per model shall be paid to Bureau.

7.3 Labeling fee:

Labeling fee for each star label of DG sets covered under this schedule is INR 10 (Ten) only.

7.4 Fee for renewal of label registration:

To avail the grant of permission for renewal of affixing the star label on the existing model, a renewal fee of INR 500 /- (five hundred only) per model shall be paid to the Bureau.

8. Review of the product schedule

BEE reserves the right to revise this schedule, should technological and/or market changes affect its usefulness to consumers or industry or its impact on the environment. In keeping with current BEE policy, whenever there is any changes in the schedule particularly with regard to changes in the test procedure or the and/or the energy efficiency norms/values, the manufactures/user of the label shall ensure that their product meets the requirements of the revised schedule for which they should submit fresh application for fresh registration. To qualify as Star labeled product, a model shall meet the revised schedule of BEE, in respect of the products and models dispatched or shipped from the manufacturer's premises immediately after the effective date of implementation of the revised schedule.

9. Abeyance of the product schedule

The product may be put on abeyance in special circumstances with approval of DG, BEE.

Annexure 1:**TEST REPORT FORMAT**

This annexure shall provide the template of the test report to be used by manufacturers to present the test results to the Bureau. This must include (minimum requirement)

Specification	Value
DG Set complete unit	
KVA Rating @ 0.8 Power Factor	
Control Panel (Manual/Automatic)	
Size - Length × Width × Height (mm)	
Fuel Tank Capacity (ltrs)	
Weight (Kg)	
Radiator capacity	
Specific Fuel Consumption (SFC) in g/kWh	
Ambient Temperature	
Engine	
Engine Model	
Gross Power 100% (100%) hp	
Type (Stroke)	
Rated Output (HP)	
Rated RPM	
Cooling (Water cooled/Air cooled)	
Cylinders- Bore × Stroke	
Governing System (Mechanical or any other type shall be mentioned by Manufacturer)	
Turbocharger (type)	
Altitude	
Air Temperature	
Exciting/Starting system (Applicable only if DG set includes a battery starter)	
Battery Capacity (AH)	
Battery Rated DC Voltage	
Alternator	
Make	
Type (Synchronous or any other type shall be mentioned by Manufacturer)	
No. of Phases (Electrical)	
Rated kVA	
Rated Frequency (HZ)	
Rated Voltage (V)	
Rated Current (Amp)	

ANNUAL MAINTENANCE CONTRACT

1.0 SCOPE OF WORK FOR AMC FOR DG SETS

The following inspections, maintenance and rectifications for the equipment as defined in the manufacturers manual but not limited to the same shall be undertaken by Contractor.

1.1 Fort nightly

- i. Checking the engine for its smooth running, unusual noise sound and colour of the smoke from the exhaust.
- ii. Checking the leakage of fuel lube oil and coolant
- iii. Checking and adjusting fan belts and water pump belts tension
- iv. Checking of air filter to increase their life as well as proper in flow of air.
- v. Checking of proper functioning of various instrument panel
- vi. Checking and changing wiring systems for its loose and dry connection
- vii. Checking battery, terminals for sulphation and checking its state.
- viii. Check for hunting and rectify if required.

1.2 Half Yearly

- i. Cleaning and greasing of alternator
- ii. Cleaning and tightening of all electrical connections
- iii. Insulation, testing of alternator
- iv. Perform lube oil and fuel consumption test, exhaust temp. test and below bye test.

1.3 Yearly

- i. Descaling of heat exchanger
- ii. Check alignment of engine and do alignment if required
- iii. Check generator brushed and commutators

1.4 Other Checks and Maintenance “As and when Required Basis”

- i. Periodic checks 1.1, 1.2, 1.3
- ii. Valve tappet setting
- iii. End play checking of crank shaft, accessory drive and turbo charge
- iv. Diagnosis of various faults and its rectifications
- v. Checking and fault finding in the whole system
- vi. Maintenance of instrument relays and connector fitted in generator control panel
- vii. Changing of brushes and rectifier
- viii. Diagnosis of all electrical faults and its rectifications
- ix. Inspection of build up voltage and RPM adjustment.

Task After doing all checks not limiting to the above set the system right whenever required confirming to the recommended parameters given in the manufacturer manual.

2.0 SPARES AND CONSUMABLES

Spares and consumable will be at extra cost at prices agreed with the Contract (The Contractor shall the furnish a current price list for spares). The Owners reserve the right to purchase the spares and consumable from any other agency. In case any spares and consumable are supplied by the Contractor an additional services charges will be applicable. Only genuine and approved spares will be used.

3.0 LABOUR

All maintenance and repair work shall normally be performed during the regular working hours 0900 to 1800 hrs, Mondays to Sundays. However, there may be occasions to perform work out side regular hours, for which no additional overtime cost shall be payable. The Contractors workers shall be covered with insurance and statutory requirements of ESI and PF and the Owner shall be indemnified against any claims/expenses etc in this regard.

4.0 CONTRACTORS RESPONSIBILITY

- 4.1 Minimum number of visits for preventive maintenance will be twenty four per year. Break down visits will be separate. Breakdown visits shall not be paid for and are deemed to be included in the AMC charges
- 4.2 Services reports on prescribed formats for each visit giving details of preventive maintenance, diagnosis or break down repairs, as the case may be will be rendered to the Owner.
- 4.3 An approximate budget for expenditure towards the maintenance servicing and envisaged repairs, replacements during the year.
- 4.4 Testers and measuring equipment will be provided by Contractor. These should have valid test and calibration certificate
- 4.5 Associate technicians of the Owner in the maintenance /repair work.