

**TECHNICAL SPECIFICATION
Section-D.G. SET**

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SECTION: D.G SET

CLAUSE	PARTICULARS
1.00	SCOPE OF SUPPLY.
2.00	SCOPE OF SERVICE.
3.00	SPARE PARTS.
4.00	TECHNICAL PARAMETERS AND GENERAL REQUIREMENTS.
5.00	TESTS.
6.00	COMMISSIONING CHECKS.

SECTION - D.G.SET

D.G.SET (Only for 220KV Station)

1.0 Scope of Supply

The scope covers supply of Diesel Generator Set of stationary type having a net electrical output of 58.5KVA capacity at specified site conditions of 50°C ambient temperature & 100% relative humidity on FOR site basis. DG set shall be equipped with:

- i) Diesel engine complete with all accessories.
- ii) An alternator directly coupled to the engine through coupling, complete with all accessories.
- iii) Complete starting arrangement, 'including battery & charger.
- iv) Base frame, foundation bolts etc.,
- v) Interconnection piping, cables, cabling & accessories.
- vi) Double compression type brass cable glands & timed copper lugs for all cables.
- vii) All lubricants consumable, touch up paints etc., for first filling testing & commissioning at site. The fuel oil for first commissioning will also be provided by the contractor.
- viii) Earthing with Interconnection.
- ix) Day tank
- x) Automatic voltage Regulator
- xi) Exhaust silencer package
- xii) AMF panel for control, metering and alarm
- xiii) Enclosure of silent type DG Set

- xiv) Set of GI pipes, valves, stainer, unloading host pipe as required for fuel transfer system from storage tank to fuel tank including motor driven fuel pump

2.0 Scope of Service: The contractor shall provide following, services:

- a. Design, manufacture, shop testing including assembly test.
- b. Dispatch transportation to Site.
- c. Erection, testing & commissioning with all equipments / materials required for the purpose.
- d. Drawings, data, design calculations & printed erection, operation & maintenance manual.
- e. Certificate and compliance for meeting noise level and commission parameters and other requirements in accordance with latest notification of MOEF

3.0 Spare parts

3.1 Mandatory spare parts

The list of Mandatory spares, which are considered essential by the owner, is indicated at Annexure-I of Section-I (GENERAL). Whenever spares have been defined as 'of each type' the type (rating) of the spares shall also be defined.

3.2 Optional Spares

In addition to the mandatory spares, Bidder shall indicate the recommended optional spares with unit & total prices for three- (3) years of normal operation of the equipment. The owner reserves the right to buy any or all-recommended spares.

4.0 Technical Parameters & General Requirements

4.1 The ratings of DG sets are as follows.

- 1) D.G.Set net output after considering for engine and alternator separately due to temperature rise inside the enclosure and on account of power reduction due to auxiliaries shall be 58.5 KVA, 1500 RPM, 0.8 p.f., 415 V, 3 phase, 50 Hz. The above ratings are the minimum requirements.

However standard capacity D.G.sets meeting the above mentioned requirement shall be provided.

- 4.2 DG sets shall also be rated for 110% of full load for 1 hour/day of continuous running,
- 4.3 The output voltage, frequency & limits of variation from open circuit to full load shall be as follows

Voltage variation $\pm 5\%$ of the set value provision shall exist to adjust the set value between 90% to 110% of nominal Generator voltage of 415V.

Frequency 50 Hz \pm 5%

Efficiency > 90%

- 4.4 The equipment shall be suitable for continuous full load operation for 140 hours.
- 4.5 The equipment shall be suitable for site conditions.
- 4.6 The Diesel generator and other auxiliary motor shall be of H class with temperature rise limited to class F for temperature rise consideration.
- 4.7 Noise level and commission parameters shall be as per latest notification of MOEF
- 4.8 Based on above, the systems envisaged each D.G.Set shall generally comprise of the following equipments.
 - a) DG set of min. 58.5 KVA rating complete with all accessories control & protections.
 - b) A control & metering panel automatic voltage regulator (AVR) & a generator Circuit Breaker (CB).
 - c) Starter batteries & battery charger.
 - d) Fuel system including day .
 - e) Engine Cooling & lubrication system.
 - f) Engine air-filtering system.
 - g) Exhaust silencer package.
 - h) Set of piping, valves, stainers, unloading hose pipes as required.

4.9 Diesel Engine

A : Design Parameters

The engine shall comply with the IS 10002/BS 5514/ ISO 3046 latest edition.

- a) The fuel tank of minimum capacity 120Ltrs shall be provided. The tank shall be fabricated from MS sheet painted with oil resistant paint & provided with inlet, outlet connections, air vent tap, drain plug & level indicator (gauge). The location of tank shall depend on standard manufacturer design. Further storage tank for storing diesel to an extent of 200Ltrs shall be provided also two numbers of container/cans of around 50Ltrs capacity each shall be supplied. Suitable hand pump for pumping Diesel from storage tank to DG set shall be provided.
- b) Facility for manual start of diesel engine & connection to 415V AC Bus bar shall be provided. This shall be done locally.
- c) A three (3) attempt starting facility using two Hinpulse timers & summation timer for engine shall be provided & if the voltage fails to develop within specified time from receiving the first impulse, the set shall block.
- d) The generator Term Mal box shall be suitable to house necessary cables & current Transformers for protection purposes.

B: System Design

- a) The Diesel Generator units shall be installed indoors. Suction of air shall be from indoor for ventilation and exhaust fume will be let out to outside atmosphere- Condensate traps shall be provided on the exhaust pipe. The exhaust pipe & silencer shall be thermally insulated.
- b) The fuel used shall be high Speed Diesel oil (HSD) or Light Diesel Oil(LDO) as per IS: 1466.
- c) The diesel engine shall be directly water cooled. Cooling of water through radiator & fan is envisaged.

- d) The engine shall have closed loop-lubricating system. No moving parts shall require lubrication by hand prior to the start of engine or while it is in operation.

C PLANT DESIGN

- a) The engine with all accessories shall be enclosed in a enclosure to make it work silently (within permissible noise level) without any degradation in its performance.
- b) The equipment shall be safe & proper & without undue vibration or stored for continuous operation at all loads up to rated output at operating & test conditions.
- c) The equipment shall have provision for easy maintenance, overall cleaning & inspection & replacement of parts. All tools for operation & maintenance of equipment shall be supplied.
- d) Diesel engine shall be turbo charged multi-cylinder V- type in line type with mechanical fuel injection system.
- e) Manual electric starting by DC starter motor shall be provided. Necessary battery with battery charger shall be provided.
- f) Air suction and Filtration
- g) The filter shall be dry type air filter with replaceable element.
- h) Fuel injection and regulator:
 - (i) The engine shall be with electronic governor suitable for class A-1 as per IS 10000.
 - (ii) The engine shall be fitted with a heavy, dynamically balanced fly wheel suitable for constant speed governor duty.

4.10 Alternator:

- (a) The Alternator shall comply with BS 2613/ IS 4722/ IEC 60034 latest edition.
- (b) The Alternator shall be continuously rated duty suitable for 415V, 3 Phase, 50 Hz power development having brush-less, synchronous, self excited, self regulating system.
- (c) The Alternator shall be drip proof, screen protected as per IP-23 degree of protection.
- (d) The rotor shall be dynamically balanced to minimize vibration
- (e) The Alternator shall be fitted with shaft mounted centrifugal fan.
- (f) It shall the winding of class H but limited to class F for temperature rise consideration.

- (g) The Alternator regulator shall be directly coupled to the engine and shall be complete with the excitation system, automatic voltage regulation and of + - % Voltage adjusting potentiometer and under/over speed protection.

4.11 Terminal Box:

- (a) Output terminals shall be provided in Alternator terminal box. Terminals shall be suitable for 1 no. of single core 240 sq.mm. XLPE/PVC cable per phase for 58.5 KVA D.G.Set. The neutral shall be formed in AMF panel. The generator terminal box shall be suitable to house necessary cables and should be made of non-magnetic materials.
- (b) The Alternator with all accessories shall be enclosed in a enclosure to made it work silently (within permissible noise level)

4.12 Coupling:

- (h) The engine and alternator shall be directly coupled by means of self aligning flexible flange coupling to avoid misalignment.
- (i) The coupling shall be provided with a protecting guard to avoid accidental contact.

4.13 Mounting arrangement:

- (a) The engine and alternator shall be mounted on a common heavy duty, rigid fabricated steel base frame constructed from ISMC of suitable section.
- (b) Adequate no. of antivibration mounting pad shall be fixed on the common base frame on which the engine and the alternator shall be mounted to isolate the vibration from passing on to common base frame or foundation of DG Set.

4.14 Control & Instrumentation

- a) Each D.G.Set shall be provided with suitable instruments, interlock & protection arrangement suitable annunciation's & indications etc., for proper start up, control, monitoring & safe operation of the one local AMF control panel along with each D.G.Set (D.G.Control Panel) shall be provided by the supplier to accommodate these instruments i.e., protective circuits, relays, lamps etc., The AMF Panel shall have IP-52 degree protection as per IS: 2147.
- b) Following instruments shall be provided with Diesel Engine:
 - i) Lub oil pressure gauge.
 - ii) Lub oil temperature thermometers (both on engine & at

Local panel)

- iii) Water temperature thermometers (both on engine & at Local panel)
- iv) Exhaust gas pyrometer (both on engine & at local panel)
- v) Engine tachometer /HR (engine panel)

Any other instruments necessary for DG Set operation shall be provided.

- vi) Meters: Ammeter, Voltmeter with selector switch phase, KWHr meter with 5 Amp CT, frequency.
- c) The Diesel Generator & other auxiliary motor shall have epoxy thermosetting type insulation but limited to class B for temperature rise consideration.
- d) **BATTERY AND BATTERY CHARGER**
- (i) 24/12V batteries complete with all leads, terminals and stand shall be provided. Each battery shall have sufficient capacity to give 10nos. successive starting impulse to the diesel engine.
 - (ii) The battery charger shall be complete with transformer, suitable rating (415 V, 3ph., 50Hz./230V, 1Ph., 50Hz) rectifier circuit, charge rate selector switch for “trickle”/’boost’ charge, D.C. ammeter & voltmeter, annunciation panel for battery charge indication/ loading/ failures. The charger shall have adequate output potential free contacts for SCADA system interface, giving alarm for charger fail, DC overvoltage/ under voltage, charger problem, Charger AC fail etc.
 - (iii) The charger shall float and Boost Charge the battery as per recommendation of manufacturer of battery. The charger shall be able to charge a fully discharged battery to a state of full charge in 8 Hrs. with 25% spare capacity.
 - (iv) Manual control for coarse and fine voltage variation shall be provided. Float charger shall have built-in load limiting features.

- (v) Ripple shall not be more than 1% (r.m.s) to get smooth DC voltage shall be provided.
 - (vi) Charger shall be provided with Out-put Voltmeter & Ammeter.
 - (vii) Change over scheme for selecting battery charger by changeover switch should be provided.
- e) Diesel Generator Shut-down: Interlocking to prevent the shutdown of DG while the DG circuit breaker is closed shall be provided.
- f) The diesel generator shall commence a shutdown sequence whenever any of the following conditions appear in the system
- Over speed
 - Overload
 - High temperature of engine and cooling system
 - High temperature inside enclosure
 - Low lub oil pressure
 - Short circuit protection
 - Reverse power
 - Under voltage
 - Under frequency
 - Under Voltage
 - Over voltage
 - Generator differential protection
- Further interlocking of breaker shall be provided to prevent parallel operation of DG set with normal station supply.
- g) Following indication lamps for purposes mentioned as under shall be provided in AMF panel:
- (i) Pilot indicating lamps for the following:
 - Mains ON
 - Alternator ON
 - Charger ON/OFF
 - Breaker ON/OFF
 - Main LT supply ON/OFF
 - (ii) Visual annunciation shall be provided for set shut down due to :
 - Engine overheating
 - Low oil pressure
 - Lack of fuel
 - Set failed to start in 30 secs after receiving the first start impulse
 - High cooling water temperature
 - Low level in daily service fuel tank

Overspeed trip
Audio & visual annunciation for alternator fault.

- h) Thermostatically controlled space heaters and cubicle illumination operated by Door Switch shall be provided in AMF panel. Necessary isolating switches and fuses shall also be provided.
- i) AMF panel shall have facility for adjustment of speed and voltage including fine adjustments in remote as well as in local mode.

Following shall also be provided in AMF panel:

- (i) Frequency meter
- (ii) 3 Nos. single phase CT's for metering
- (iii) 3 Nos. (Provided by LT swgr manufacturer) single phase CT's with KPV 300V & RCT 0.25 ohm for differential protection of DG set on neutral side only for 250KVA.
- (iv) One (1) DC Ammeter (0-40A)
- (v) One (1) DC Voltmeter (0-30V)
- (vi) One (1) DC Voltmeter Selector switch
- (vii) One (1) AC Ammeter
- (viii) One (1) AC Voltmeter
- (ix) Three (3) Timers (24/12V DC)
- (x) Two (2) Auto/Manual Selector Switch
- (xi) Two (2) Auto/test/Manual Selector Switch
- (xii) Eleven (11) Aux. Contractors suitable for 24/12V DC
- (xiii) One (1) Motorised Potentiometer for voltage adjustment
- (xiv) Two (2) Set Battery charger as specified in Technical Specification
- (xv) One (1) Set phase & Neutral busbars
- (xvi) Any other item required for completion of Control scheme shall be deemed to be included.
- (xvii) Multifunction Meter:
Microprocessor based, 3 phase 3element 4 wire with accuracy class 0.2S, with RS 485 Modbus protocol & IEC 61850 Protocol for interfacing with SAS. It shall display current, Voltage, frequency, power factor, active power, reactive power etc.,

Note:

- 1. Potential free contacts shall be provided, duly wired upto the control cabinet for the alarms and indication status for SAS. To cater to this requirement, sufficient number of potential free contacts shall be provided.**
- 2. Current and Voltage Transducers(4-20mA signals) shall be provided for SAS.**

5.0 D.G. Set Enclosures

5.1 General requirements

- a) Diesel engine, alternator, AMF panel, Batteries and chargers shall be installed outdoor in a suitable weather-proof enclosure which shall be provided for protection from rain, sun, dust etc. Further, in addition to the weather proofing, acoustic enclosures shall also be provided such that the noise level of acoustic enclosure DG set shall meet the requirement of MOEF The diesel generator sets should also conform to Environment (Protection) Rules, 1986 as amended. An exhaust fan with louvers shall be installed in the enclosure for temperature control inside the enclosure. The enclosure shall allow sufficient ventilation to the enclosed D.G. Set so that the body temperature is limit to 50Degree C. The air flow of the exhaust fan shall be from inside to the outside the shelter. The exhaust fan shall be powered from the DG Set supply output so that it starts with the starting of the DG Set and stops with the stopping of the DG Set. The enclosure shall have suitable viewing glass to view the local parameters on the engine.
- b) Fresh air intake for the Engine shall be available abundantly; without making the Engine to gasp for air intake. A Chicken mess shall be provided for air inlet at suitable location in enclosure which shall be finalized during detailed engineering.
- c) The Enclosure shall be designed and the layout of the equipment inside it shall be such that there is easy access to all the serviceable parts.
- d) Engine and Alternator used inside the Enclosure shall carry their manufacturer's Warranty for their respective Models and this shall not degrade their performance.
- e) Exhaust from the Engine shall be let off through silencer arrangement to keep the noise level within desired limits. Interconnection between silencer and engine should be through stainless steel flexible hose/pipe.

5.2 All the Controls for Operation of the DG Set shall be easily assessable there should be provision for emergency shut down from outside the enclosure.

5.3 Arrangement shall be made for housing the battery set in a tray inside the enclosure.

5.4 CONSTRUCTION FEATURES:

- a) The enclosure shall be fabricated from at least 14 Gauge CRCA sheet steel and of Modular construction for easy assembling and dismantling. The sheet metal components shall be pre-treated by seven Tank process and Powder coated (PURO Polyester based) both in side and out side-for long life. The hard-ware and accessories shall be high tensile grade. Enclosure shall be given a lasting anti-rust treatment and finished with pleasant environment friendly paint. All the hardware and fixtures shall be rust proof and able to withstand the weather conditions.
- b) Doors shall be large sized for easy access and provided with long lasting gasket to make the enclosure sound proof. All the door handles shall be lockable type.
- c) The enclosure shall be provided with anti-vibration pads (Suitable for the loads and vibration they are required to carry) with minimum vibration transmitted to the surface the set is resting on.
- d) High quality rock wool of required density and thickness shall be used with fire retardant thermo-setting resin to make the enclosure sound proof.

5.5 Provision for Neutral/Body Earthing

Points shall be available at two side of the enclosure with the help of flexible copper wires from alternator neutral, and electrical panel body respectively. The earthing point shall be isolated through insulator mounted on enclosure.

6.0 Installation Arrangement.

DG Set enclosed in enclosure shall be installed on Concrete Pedestal 300mm above FGL. DG Set shall be installed vibration free with suitable foundation.

7.0 TESTS:

The diesel generator sets shall be tested as per the relevant IEC standards. Type tested Diesel Generator sets shall be offered. The type test reports shall not be older than Ten (10) years as on the last date of submission of bid.

a) For Diesel Generator sets manufactured in India:

- i. The type tests on indigenous equipment for which testing facility is available in India, should have been conducted in any independent laboratories approved by the Government or the laboratories accredited by the National accreditation body of the country like Central Power Research Institute (CPRI), Electrical Research and Development Association (ERDA), etc.

- ii. The type tests on indigenous equipment, for which testing facility is not available in India, should have been conducted in a laboratory of foreign country accredited by National accreditation body of that country.
- iii. The type tests conducted in-house by a manufacturer shall also be acceptable provided the laboratory is accredited by National accreditation body of the country and the tests has been conducted in the presence of a representative of NABL accredited laboratory or any of the purchasing utilities or CEA in that order. Such type test reports shall record the details of such witness including the signature/authentication in the type test report.

b) For Diesel Generator sets manufactured Abroad:

- i. Type tests on imported equipment should have been conducted in an Indian Laboratory or foreign laboratory accredited by National accreditation body of the country where the Type test has been conducted.
- ii. The type tests conducted in-house by a manufacturer shall also be acceptable provided the laboratory is accredited by National accreditation body of the country and the tests has been conducted in the presence of a representative of accredited laboratory or any of the purchasing utilities or CEA in that order. Such type test reports shall record the details of such witness including the signature/authentication in the type test report.

In case of in-house type tested imported equipment of foreign OEM, the term “Purchasing Utility” covers the foreign Utility who has purchased that equipment. The supplier shall submit test reports as per the following but not limited to

-Quality test of materials

-Crack detection & ultrasonic tests of foreign & castings.

-Hydrostatic tests on pressure parts.

-Static balancing on rotating parts, shafts shall be statically & dynamically balanced.

-Bench tests on safety control devices

-Performance tests on fuel pump & injectors.

a) Routine tests

-Measurements of the open circuit & short circuit characteristics

-High voltage test

- Regulation test
- Phase sequence test
- Noise & vibration test

b) Type tests:

The alternator & start motor shall be type tested as per the relevant specifications. Type test shall include following tests:

- Resistance measurement & air gap measurement.
- Measurement of leakage reactance & pottier reactance.
- Short circuit characteristics(Alternator)
- Efficiency test
- Momentary overload test
- Over speed test
- Installation test (Before & after HV test)
- Determine deviation of voltage wave form
- Measurement of polarisation index.
- Load characteristics test.

8.0 Commissioning Checks

In addition to the checks & test recommended by the manufacturer, the contractor shall supervise the following commissioning checks to be carried out at site.

a) **Load Test :**

The engine shall be given test run for a period of at least 6 hours. The set shall be subjected to the maximum achievable load as decided by the owner without exceeding the specified DG Set rating:

During the load test, half-hourly records of the following shall be taken:

- i) Ambient temperature.

- ii) Exhaust temperature if exhaust thermometer is fitted
- iii) Cooling water temperature at a convenient point adjacent to the water output from the engine jacket.
- iv) Lubricating oil temperature where oil cooler fitted.
- v) Lubricating oil pressure
- vi) Colour of exhaust gas.
- vii) Speed
- viii) Voltage, Wattage & current output.
- ix) Oil Lank level

The necessary load to carryout the test shall be provided by the owner.

b) Insulation Resistance Test for Alternator

Insulation resistance in mega-ohms between the coils & the frame of the alternator when tested with a 500V megger shall not be less than

$$IR = 2 \times (\text{rated voltage in KV}) + 1.$$

c) Check of fuel Consumption

A check of the fuel consumption shall be made during the load run test. This test shall be conducted for the purpose of proper tuning of the engine.

d) Insulation Resistance of Wiring

Insulation resistance of control panel wiring shall be checked by 500 V megger. The IR shall not be less than one mega ohm

e) Functional Tests

- i) Functional tests on control panel.
- ii) Functional tests on starting provision on the engine.
- iii) Functional tests on all field devices.
- iv) Functional tests on AVR and speed governor.

f) Measurement of vibration:

The vibration shall be measured at load as close to maximum achievable load & shall not exceed 250 microns.

g) Noise Level (Sound pressure level) check

Noise level measurement shall be done generally following the include lines given in IS: 12065. The measurement shall be carried out with a calibrated integrating sound level meter as per IS: 9779.

Sound level shall be measured all round the diesel Generator set at a distance of 1 meter from the nearest surface of the machine & at a height of 1.5 meter from the floor level as illustrated in IS: 12065 for electrical machines.

A minimum of 8 points (5 around diesel engine & 3 around alternator) shall be covered for measurement. Additional measurement points shall be considered in case the criteria indicated in Clause of IS: 12065 is not met.

The measurement shall be done with slow response meter on the A-weighting scale. The average of the A-weighted sound level measurement expressed in decibels to a reference of 0.0002 microbar shall not generally exceed 93 dbA.

The tests shall be carried out with the D.G.Set operating at rated speed & at maximum achievable load. DG set shall be located in a room having an approximate dimension of 10m x 8m. Necessary correction for Test environment condition & background noise will be applied as per IS: 12065.