

**KARNATAKA POWER TRANSMISSION CORPORATION LIMITED**

## **SECTION - DG SET**

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## **1. SCOPE OF SUPPLY**

The scope covers supply of Diesel Generator set of stationary type having a net electrical output of 250kVA capacity at specified site conditions of 50 °C ambient temperature and 100% relative humidity on FOR site basis. DG set shall be equipped with

- a) Diesel engine complete with all accessories.
- b) An alternator directly coupled to the engine through coupling, complete with all accessories.
- c) Automatic voltage regulator.
- d) Complete starting arrangement, including two nos. batteries & chargers.
- e) Base frame, foundation bolts etc.
- f) Day tank of capacity 990 Litre capacity.
- g) Engine Cooling and lubrication system.
- h) Engine air filtering system.
- i) Exhaust silencer package.
- j) Set of GI pipes, valves, strainers, unloading hose pipes as required for fuel transfer system from storage area to fuel tank including electrically driven fuel pump.
- k) All lubricants, consumable, touch up paints etc. for first filing, testing & commissioning at site. The fuel oil for first commissioning will also be provided by the contractor.
- l) AMF panel for control, metering and alarm.
- m) Enclosure for silent type D.G. Set

## **2. SCOPE OF SERVICE**

The Contractor shall provide following services:

- a) Design, manufacture, shop testing including assembly test.
- b) Despatch, transportation to site.

- c) Erection, testing & commissioning with all equipments/materials required for the purpose.
- d) Drawings, data, design calculations and printed erection, operation & maintenance manual.
- e) Certification and compliance for meeting noise level & emission parameters and other requirements in accordance with latest Notification of MOEF.
- f) D. G. Sets shall be compatible for SCADA/SAS system.

### **3. TECHNICAL REQUIREMENTS**

#### **3.1 The rating of DG sets are as follows:**

- a) DG set net output after considering deration for engine and alternator separately due to temperature rise in side the enclosure and on account of power reduction due to auxiliaries shall be 250kVA, 1500RPM, 0.8Pf, 415V, 3 phase, 50Hz. The above ratings are the minimum requirements.
- b) DG sets shall also be rated for 110% of full load for 1 hour in every twelve hrs of continuous running.

#### **3.2 The output voltage, frequency and limits of variation from open circuit to full load shall be as follows :**

- a) Voltage variation +5% of the set value provision shall exist to adjust the set value between 90% and 110% of nominal Generator voltage of 415V.
- b) Frequency 50Hz +2%

#### **3.3 The Diesel Generator and other auxiliary motor shall be of H class with temperature rise limited to Class-F for temperature rise consideration.**

#### **3.4 Noise Level & Emission Parameters : These shall be as per latest Notification of MOEF**

### **4. PLANT DESIGN**

#### **4.1 DIESEL ENGINE**

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

4.1.2 Diesel engine shall be turbo charged multi-cylinder V-type in line type with mechanical fuel injection system.

4.1.3 The engine with all accessories shall be enclosed in an enclosure to make it work silently (within permissible noise level) without any degradation in its performance.

4.1.4 The Diesel Engines shall be directly water cooled. Cooling of water through radiator and fan should be as envisaged.

4.1.5 The fuel used shall be High Speed Diesel oil (HSD) or Light Diesel Oil (LDO) as per IS:1460.

#### 4.2 AIR SUCTION & FILTRATION

4.2.1 Suction of air shall be from indoor for ventilation and exhaust flue gasses will be let out to outside atmosphere, Condensate traps shall be provided on the exhaust pipe.

4.2.2 Filter shall be dry type air filter with replaceable elements.

#### 4.3 FUEL AND LUBRICATING OIL SYSTEM

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.

#### 4.4 ENGINE STARTING SYSTEM

Automatic electric starting by DC starter motor shall be provided.

#### 4.5 FUEL INJECTION AND REGULATOR

4.5.1 The engine shall be fitted with electronic governor suitable for class A-1 as per IS 10000.

4.5.2 The engine shall be fitted with a heavy, dynamically balanced fly wheel suitable for constant speed governor duty.

#### 4.6 ALTERNATOR

- 4.6.1 The alternator shall comply with BS 2613/IS 4722/IEC 34; latest edition.
- 4.6.2 The alternator shall be of continuously rated duty, suitable for 415 V, 3 -phase, 50 Hz. Power development has brush-less, synchronous, self-excited, self-regulating system.
- 4.6.3 The alternator shall be drip-proof, screen protected as per IP-23 degree of Protection.
- 4.6.4 The rotor shall be dynamically balanced to minimize vibration.
- 4.6.5 The alternator shall be fitted with shaft mounted centrifugal fan.
- 4.6.6 It shall have the winding of class H but limited to Class-F for temperature rise consideration.
- 4.6.7 The Alternator regulator shall be directly coupled to the engine and shall be complete with the excitation system, automatic voltage regulation of +/- 1%, voltage adjusting potentiometer and under/over speed protection.

4.6.8 Terminal Box

- a) Six (6) output terminals shall be provided in alternator terminal box. Terminals shall be Suitable for 1 No. of single core, 630 mm<sup>2</sup> XLPE cables per phase for 250kVA DG set and 3-Core 300 mm<sup>2</sup> XLPE cable for 100kVA DG 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 material. It shall have necessary CTs on Phase & neutral for protection and measurement.
- b) The alternator with all accessories shall be enclosed in an enclosure to make it work silently (within permissible noise level).

4.7 COUPLING

- 4.7.1 The engine and alternator shall be directly coupled by means of self-aligning flexible flange coupling to avoid misalignment.
- 4.7.2 The coupling shall be provided with a protecting guard to avoid accidental contract.

#### 4.8 MOUNTING ARRANGEMENT

- 4.8.1 The engine and alternator shall be mounted on a common heavy duty, rigid fabricated steel base frame constructed from ISMC of suitable sections.
- 4.8.2 Adequate number of anti-vibration mounting pads 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 the common base frame or the foundation of the D.G. Set.

#### 4.9 PERIPHERALS

##### 4.9.1 Fuel Tank

- a) The Fuel tank of capacity 990 Litre shall be provided on a suitably fabricated steel platform. The tank shall be complete with level indicator marked in litres, filling inlet with removable screen, an outlet, a drain plug, an air vent, an air breather and necessary piping. The tank shall be painted with oil resistant paint and shall be erected in accordance with Indian explosive act of 1932. Fuel tank shall be kept outside of enclosure. The fuel piping shall be carried out to connect the D.G set kept inside.
- b) For transferring fuel to Fuel tank transfer pump is envisaged. The capacity of transfer pump shall be adequate to fill the day tank in about 30 minutes. Fuel pump shall be electrically driven.

##### 4.9.2 Battery and Battery Charger

- a) Two nos. 24V batteries complete with all leads, terminals and stand shall be provided. Each battery shall have sufficient capacity to give 10 nos. successive starting impulse to the diesel engine.
- b) The battery charger shall be complete with transformer, suitable rating (415 V, 3 Ph., 50 Hz. /230V, 1Ph., 50 Hz) 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.

- c) 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.
- d) Manual control for coarse and fine voltage variation shall be provided. Float charger shall have built-in load limiting features.
- e) Ripple shall not be more than 1% (r.m.s) to get smooth DC voltage shall be provided.
- f) Charger shall be provided with Out-put Voltmeter & Ammeter.
- g) Changeover scheme for selecting battery and battery charger by changeover switch should be provided.

## **5. CONTROL AND INSTRUMENTATION**

- 5.1 Each D.G. Set shall be provided with suitable instruments, interlock and protection arrangement, suitable annunciation and indications etc. for proper start up, control, monitoring and safe operation of the unit. One local AMF control panel along with each D.G. set shall be provided by the Supplier to accommodate these instruments, protective relays, indication lamps etc. The AMF Panel shall have IP-52 degree of Protection as per IS: 12063. All alarms and normal conditions of the Diesel engine shall be taken to SCADA system through potential free contacts and speed, frequency, voltage coolant temperature, Diesel levels etc shall be Analog 4-20mA signals where possible.
- 5.2 The D.G. sets shall be provided with automatic start facility to make it possible to take full load within 30 seconds of Power Supply failure.
- 5.3 Testing facility for automatic operation of D.G. Set shall be provided in AMF panel.
- 5.4 A three attempt starting facility using two impulse timers and summation timer for engine shall be provided and if the voltage fails to develop within 40 sec. from receiving the first impulse, the set shall block and alarm to this effect shall be provided in the AMF panel.
- 5.5 Following instruments shall be provided with Diesel Engine



- a) Lube oil pressure gauge
  - b) Water temperature thermometers
  - c) Engine tachometer/HR
  - d) Any other instruments necessary for DG Set operation shall be provided.
- 5.6 DG set shall be capable of being started/ stopped manually from remote as well as local. (Remote START/STOP push button shall be provided in 415V ACDB). However, interlock shall be provided to prevent shutting down operation as long as D.G. Circuit breaker is closed.
- 5.7 The diesel generator shall commence a shutdown sequence whenever any of the following conditions appear in the system :
- a) Over speed
  - b) Overload
  - c) High temperature of engine and cooling water
  - d) High temperature inside enclosure
  - e) Low lube oil pressure
  - f) Generator differential protection
  - g) Short circuit protection
  - h) Under voltage
  - i) Over voltage
  - j) Further interlocking of breaker shall be provided to prevent parallel operation of DG set with normal station supply.
- 5.8 Following indication lamps for purposes mentioned as under shall be provided in AMF panel.
- a) Pilot indicating lamp for the following :
    - i. Mains ON

- ii. Alternator ON
- iii. Charger ON/OFF

iv. Breaker ON/OFF

v. Main LT Supply ON/OFF

b) Audio-Visual annunciation shall be provided for set shut down due to :

i. engine overheating

ii. low oil pressure

iii. lack of fuel

iv. Set failed to start in 30 seconds after receiving the first start impulse

v. high cooling water temperature

vi. Low level in daily service fuel tank

vii. Over speed trip

viii. Audio & visual Annunciation for alternator fault

ix. DG set put into MANUAL mode

5.9 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.

5.10 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:

a) Frequency meter

b) 3 Nos. single phase CT's for metering

c) 3 Nos. (Provided by LT switchgear manufacturer) single phase CT's with KPV 300V & RCT 0.25 ohm for differential protection of DG Set on neutral side only for 250kVA.

- d) One (1) DC Ammeter (0-40A)
- e) One (1) DC Voltmeter (0-30V)
- f) One (1) Voltmeter Selector switch
- g) One (1) AC Ammeter
- h) One (1) AC Voltmeter
- i) Three (3) Timers (24V DC)
- j) Two (2) Auto/Manual Selector Switch
- k) Two (2) Auto/test/Manual Selector Switch
- l) Eleven (11) Aux. Contactors suitable for 24V DC
- m) One (1) Motorised potentiometer for voltage adjustment
- n) Two (2) Set Battery charger as specified in Technical Specification
- o) One (1) Set Phase & Neutral busbars
- p) Any other item required for completion of Control scheme shall be deemed to be included.
- q) Multifunction Meter(MFM):  
Microprocce 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.**

**6. D.G. SET ENCLOSURE**

**6.1 GENERAL REQUIREMENTS**

- 6.1.1 Diesel engine, alternator, Batteries and Chargers shall be installed outdoor in a suitable weather-proof enclosure which shall be provided for protection from rain, sun, dust etc. AMF panel shall be placed separately in the LT switchgear panel room at Control building.
- 6.1.2 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 50°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.
- 6.1.3 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 finalised during detailed engineering.
- 6.1.4 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.
- 6.1.5 Engine and Alternator used inside the Enclosure shall carry their manufacturer's Warranty for their respective Models and this shall not degrade their performance.
- 6.1.6 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, with thermal cladding at exposed surfaces within reach, to prevent injury to operating personnel due to "Hot-pipes".
- 6.2 All the Controls for Operation of the D.G. Set shall be easily accessible. There should be provision for emergency shutdown from outside the enclosure.

- 6.3 Arrangement shall be made for housing the Battery set in a tray inside the Enclosure.

6.4 CONSTRUCTION FEATURES

- 6.4.1 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-inside and outside 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.
- 6.4.2 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.
- 6.4.3 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.
- 6.4.4 High quality rock wool of required density and thickness shall be used with fire retardant thermo – setting resin to make the Enclosure sound proof.

6.5 PROVISION FOR DG SET NEUTRAL AND SEPARATE 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.

7. INSTALLATION ARRANGEMENT

DG set enclosed in enclosure shall be installed on Concrete Pedestal 300mm above FGL

8. DOCUMENTS

- 8.1 Following drawings and data sheet shall be submitted for approval:

- a) Data sheet for Engine, Alternator, Battery, AMF panel and Enclosure
- b) GA drawing of DG set
- c) Layout of DG set in the enclosure along with sections
- d) GA and schematic of AMF panel
- e) Arrangement of inclined roof and pedestal.

8.2 The D G Set shall be supplied with

- a) D G Set test certificate
- b) Engine Operation & maintenance Manual
- c) Engine Parts Catalogue
- d) Alternator Operation, maintenance & Spare parts Manual
- e) Alternator test certificate

## 9. **TESTS**

9.1 The Diesel generator sets shall be tested for routine and acceptance tests as per the relevant IS/IEC standards.

9.2 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. Type tests on indigenous equipment for which testing facility is available in India, should have been conducted in any independent laboratories approved by Government or accredited by National accreditation body of the country like Central Power Research Institute (CPRI), Electrical Research and Development Association (ERDA), etc.
- ii. 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 manufacturers shall also be acceptable provided the lab (manufacturer's) is accredited by National accreditation body of the country and the tests have been witnessed by a representative of NABL accredited Independent laboratory/Power utility.

**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 respective country.
- ii. Type tests conducted in-house by manufacturers shall also be acceptable provided the laboratory is accredited by National accreditation body of the country and the tests have been witnessed by a representative of accreditation body/Power utility.

**10. Commissioning Checks**

In addition to the checks and test recommended by the manufacturer, the Contractor shall carry out the following commissioning tests 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 Purchaser 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 and current output

ix. Oil tank level

The necessary load to carry out the test shall be provided by the purchaser.

b) Insulation Resistance Test for Alternator

Insulation resistance in mega-ohms between the coils and 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 500V Megger. The IR shall not be less than one mega ohm.

e) Functional Tests

i. Functional tests on control panel

ii. Functional test 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 and shall not exceed 250microns.

g) Noise Level check as per relevant standard

The tests shall be carried out with the DG set operating at rated speed and at maximum achievable load. Necessary correction for Test environment condition & background noise will be applied as per IS:12065.



