

Project Information & Auxiliary Facilities

1.	Purchaser	Institute for Plasma Research Village Bhat, Gandhinagar Dt. 382 428 Gujarat, INDIA Phone: (079)-23962000 Fax: (079)-23962277 Web: www.ipr.res.in
2.	Site elevation	55 meters above MSL
3.	Ambient temperature	Max. (annual): 46 °C Min. (annual): 9 °C Average (annual): 37 °C
4.	Relative humidity	Max.: 93 % ; Min.: 17 %
5.	Rainfall	932 mm average (annual) June-August
6.	Wind data	Max. wind speed: 130 kmph Prevailing direction: SW to W Design wind pressure: 100 kgm ⁻²
7.	Seismic data	0.04 g as per IS:1893-1973
8.	Accessibility	by road : Up to site (on Hansol-Gandhinagar H-way) by rail : Ahmedabad Rly. Stn. (12 km.) by sea : Bombay Harbor (525 km.) by air : Ahmedabad Airport (6 km.)
9.	Auxiliary power supply	AC 415 ± 10 % V, 3 phase, 50 ± 5 % Hz, 4 wire system
10.	Expected date of commissioning	2 months from LOI

Technical Specifications for Diesel Generator Set for Standby Power Supply

1. Scope:

The scope of this tender includes design, manufacture, inspection, testing at works, safe transportation to the site, erection, site testing & commissioning of one unit Diesel Generator set with a minimum capacity of 500 kVA along with all auxiliaries and accessories required for satisfactory operation of the set, including the following:

- 1.1 Control, protection, interlocking, metering, alarm systems for DG Set for auto-start with transfer and mains synchronizing,
- 1.2 Mains circuit breaker with associated protection and metering,
- 1.3 All control and power cabling for DG Set and auxiliaries/accessories,
- 1.4 Integrated fuel storage tank with fuel supply lines,
- 1.5 Exhaust system for effluent gases with turbo-charger and muffler,
- 1.6 Suitable extension of fuel oil piping from day tank room along with controls,
- 1.7 Appropriate fire fighting system,
- 1.8 Earth bus and grounding system for all the equipments,
- 1.9 All related civil works which includes RCC foundation for DG Set,
- 1.10 Auxiliary lighting for DG set periphery for operational convenience, and
- 1.11 Suitable all weather proof canopy enclosure with sound attenuation.

The scope also includes receipt, unloading, safe storage of all materials at site, transportation of materials up to the place of installation, erection, integration of accessories, auxiliaries and pre-testing, commissioning, acceptance load testing of all equipment in scope.

2. Application note:

- (a) The DG set is intended for standby power supply to all electrical loads in the Hostel/Guest House facilities and other essential auxiliary loads like facility lighting, water pumps, etc.
- (b) The DG set is required to automatically start & affect transfer of the load for all scheduled and unscheduled outages either from the utility supply and internal maintenance/breakdown of the mains distribution. The projected average number of start up can be 2 to 3 times a week and for 8-12 hours usually and occasionally up to 24 hours. For operation periods exceeding 12 hours, at least 90% of the rated DG output power shall be available.
- (c) On interruption of mains power supply, the DG set should auto start and transfer the power to the loads within a maximum period of 1 minute. The DG set should be able to instant load to the extent of minimum of 40% of the rated output power, i.e. 200 kVA at 0.8 pf lagging.

- (d) Foolproof starting & transfer of load to DG set is expected from the DG system.
- (e) On restoration of grid power, the DG set should transfer the load back to the grid power without interruption, i.e. it is envisaged that the DG set is to be momentarily synchronized with grid power & transfer the load softly from DG set to the grid power & the DG set shall stop after pre-set cool down time & should be ready for next operation.
- (f) The system shall have the facility for one hour test run of DG set on full load in parallel with the grid. The testing will be carried out manually on weekly basis.

3. Bill of materials:

(1) One no. Diesel Engine of suitable BHP to drive respective Alternator & provided with:

1.1 Engine driven pumps for lubricating oil, jacket water & fuel oil.

1.2 Fuel oil day tank suitable for 8 hrs. of continuous operation with strainers, filters, etc.

1.3 Governor with the following capabilities:

- 1.3.1 Droop operation.
- 1.3.2 Isochronous operation.
- 1.3.3 Constant power mode

In addition to above, it should have provision for remote adjustment of speed.

1.4 Flywheel & flexible coupling.

1.5 Base frame for DG set.

1.6 Radiator with fans for jacket water cooling.

1.7 Pressure & Temperature sensors, Transducers & switches for lubricating oil & jacket water circuits.

1.8 Filters & strainers required in the lubricating oil & fuel oil system.

1.9 Starting system for the engine consisting of :

- 1.9.1 DC Motor.
- 1.9.2 Battery(s) with isolating switch
- 1.9.3 SMPS type Battery charger of reputed make.

1.9.4 DC distribution & control system.

1.10 Turbo charger with charge air cooler.

1.11 Exhaust system with silencer & exhaust pipe routed as per stipulations of local Pollution Control Board and as per IS-8118.

1.12 Jacket water & lubricating oil heating circuits, if required.

1.13 Lubricating oil system & lubricating oil cooler with sump capacity suitable for 3 days of operation.

1.14 Auto- mains failure system.

1.15 Redundant over speed trip device for engine

1.16 AC motor driven pre-lubricating oil pump (intermittent operation).

(2) Alternator with preferably brushless excitation system & automatic voltage regulator (AVR) with provision for remote voltage adjustment suitable for manual operation of DG set.

(3) Diesel Generator set control & instrument panel(s) consisting of following:

NOTE: The following control & instrumentation features are to be provided as per standard practices applicable for Outdoor Canopy type Acoustics Enclosure design. The absence of some of the features may be acceptable provided the safe operation with full functionality and performance at rated capacities are guaranteed for specification operating conditions.

3.1 Controls:

- (a) Auto / Manual selector switch.
- (b) Remote / Local selector switch.
- (c) Start - Neutral - Stop hand switch for DG set.
- (d) Speed raise-lower hand switch.
- (e) Voltage raise-lower hand switch.
- (f) DG breaker Close-Neutral open hand switch.
- (g) Field circuit breaker ON / OFF switch (in case of static xciter).
- (h) Quadrature Droop circuit IN / OUT.
- (i) Isochronous / Speed Droop selector switch.

(j) Start-Neutral-Stop hand switch for fuel oil transfer pump.

3.2 Instruments :

(a) Lubricating oil pressure indicator.

(b) Lubricating oil temperature indicator.

(c) Jacket water pressure indicator.

(d) Jacket water inlet & outlet temperature indicator.

(e) Fuel oil pressure indicator.

(f) Differential pressure indicator across filters in fuel oil & lubricating oil system.

(g) Engine speed indicator.

(h) Turbocharger speed indicator.

(i) Bearing temperature indicator.

(j) Generator winding temperature indicator.

(k) Cylinder exhaust temperature indicator.

(l) Generator bearing temperature indicator.

(m) Voltmeter with selector switch.

(n) Ammeter with selector switch.

(o) Ammeter & voltmeter for excitation measurement.

(p) Frequency meter.

(q) 3-phase kW meter.

(r) 3-phase KVA meter.

(s) Temperature & pressure indicator for inlet air at charge air cooler outlet.

(t) Voltmeter & ammeter for field circuit.

(u) Power factor meter.

(v) Hour-run meter.

- (w) Fuel oil day tank level indicator.
- (x) Storage tank level indicator.
- (y) Temperature indicator for cylinder heads.

3.3 Lamp indicators :

- (a) Lamp indicators for DG breaker ON / OFF.
- (b) Lamp indicators for fuel oil transfer pump ON / OFF.
- (c) Lamp indicators for indicating extreme limit positions of raise / lower controls for engine speed generator voltage.
- (d) Lamp indication for "Load on DG set" i.e. DG running - red.
- (e) Lamp indication for battery charging.
- (f) Lamp indication for "Load on mains" i.e. DG off - green.
- (g) Lamp indication for prelubricating pump ON / OFF.
- (h) Lamp indication for "DG fails to start".
- (i) Status indication lamps for lubricating oil & jacket water heater.
- (j) Lamp indication for "DG ready to start".

3.4 Alarms:

Set of twenty six (26) windows for annunciating various alarms related to the DG set shall be provided along with hooter, flasher, alarm acknowledge push buttons & alarm reset facility.

The a annunciation system will be provided for :

- (a) Low lubricating oil pressure.
- (b) High lubricating oil temperature.
- (c) Lubricating oil sump level low.
- (d) Prelubricating oil pump not in operation.
- (e) Low fuel oil pressure.
- (f) Differential pressure across lubricating oil filter & fuel oil filter.

- (g) High water temperature.
- (h) Jacket water level low.
- (i) Engine overspeed
- (j) High exhaust gas temperature.
- (k) Overcurrent & earthfault conditions.
- (l) Engine fails to start.
- (m) Inlet air temperature high.
- (n) Generator bearing lubricating oil temperature high.
- (o) Differential signal..
- (p) Reverse power signal.
- (q) Negative phase sequence signal.
- (r) Undervoltage signal.
- (s) Voltage raise / lower limit reached.
- (t) Generator winding temperature high.
- (u) Rotor earthfault.
- (v) Excitation failure.
- (w) Overvoltage signal.
- (x) Overpower signal.
- (y) Underfrequency signal.
- (z) PLC failure signal.

For remote monitoring / control, some critical parameters should be available for purchaser's SCADA system, which will include :

- (a) Lubricating oil pressure.
- (b) Jacket water temperature.
- (c) Voltage & current at DG side.
- (d) Engine running signal.

- (e) Engine fails to start signal.
- (f) DG tripped signal.
- (g) Mains voltage & current signal.
- (h) Overcurrent & earthfault signal.
- (i) Control power supply failure signal.
- (j) PLC failure signal.
- (k) Lubricating oil temperature signal.
- (l) Fuel day tank level signal.
- (m) Cylinder head temperature signal.
- (n) DG kW & KVA signal.
- (o) Fuel oil pressure signal.
- (p) DG breaker ON/OFF signal.
- (q) Position of local / remote selector switch.

3.5 Protections:

The DG should be tripped if any of the following situations arise :

- (a) Control power supply failure.
- (b) Engine over-speed.
- (c) Low lubricating pressure after 90% speed.
- (d) Low fuel oil pressure after 90% speed.
- (e) High jacket water temperature.
- (f) Excitation failure.
- (g) DG differential protection operated.
- (h) Reverse power.
- (i) Negative phase sequence.
- (j) Overcurrent.

(k) Earthfault.

4. Description of major items:

(1) Diesel engine :

(a) Diesel engine shall be designed to operate satisfactorily within the steady state & transient response specified when subjected to operating conditions defined in “application note” & “project information” above.

(b) Applicable derating factors should be considered to ensure that the Diesel engine provide specified output under site conditions of maximum ambient temperature of 48 °C at an altitude of 55 meters above sea level with humidity of max. 90%. The contractor shall provide adequate ventilation for the enclosure to maintain appropriate conditions for reliable operation.

(c) Diesel engine shall be provided with thermostat controlled jacket water & lubricating oil heater circuits to keep the engine warm to facilitate quick starting. Further, diesel engine shall also be provided with intermittently operated pre-lubricating oil pump to periodically lubricate all wear parts of engine, when these are in stand-by condition.

(d) All high pressure fuel oil components close to high temperature surfaces shall be shielded properly or routed in double walled pipes with leakage detection facility. All potential points for leakage of fuel & lubricating oils shall be provided with trays & connected to waste oil tank.

(e) Filters provided in fuel oil & lubricating oil shall be of duplex type & shall have change over and regeneration provisions to facilitate operation with one element in circuit. Differential pressure indicators & switches shall be provided to monitor the condition of filters.

(f) The fuel oil proposed to be used is high speed diesel HSD as per IS - 1460. The engine provided shall be capable of generating rated output without exceeding guaranteed fuel consumption when supplied with HSD confirming to the standard.

(g) The rating of engine considered shall provide for consumption of all auxiliaries, losses in generator, exciter, radiator fans etc.

(h) Protection shall be provided to prevent accidental contact with moving parts. Further ladders, platforms etc. required to access components on engine shall be provided.

(i) Electronic governor system capable of both isochronous & droop mode of operation & suitable to obtain specified steady state & transient response shall be provided.

(j) All high temperature parts particularly of exhaust system within the DG room shall be properly insulated.

(k) Radiators provided shall be suitable for 100% engine rating.

(l) Diesel engine shall be provided with DC motor starting consisting of :

(a) SMPS battery charger.

(b) Tubular lead acid batteries suitable for engine starting.

(c) DC electric motor & control circuitry.

The batteries shall be adequately sized to cater to 6 successive start attempts. While designing the capacity of batteries, factors for temperature correction up to min/max ambient specified, design margin (1.1), ageing factor (1.25) shall also be considered. Charger shall provide finely controlled & filtered DC output & shall be provided with all necessary controls, indications, meters & alarm devices.

Diesel engine shall be provided with vibration damper, belt tensioner for suppressing vibrations & repeated belt tightening.

(2) Alternator, Exciter & AVR(Automatic Voltage Regulator) :

(a) The capacity of the alternators shall be selected considering the continuous load indicated, steady state & transient voltage drop limits specified.

(b) Alternators shall be provided with totally enclosed fan cooled enclosure.

(c) The exciters shall be brushless type with permanent magnet generator. The excitation system shall have the capability to provide adequate excitation during all switching operations such as motor starting & short circuit conditions.

(d) All wound components shall be provided with class-F insulation & vacuum impregnated. Temperature limit corresponding to class-B insulation shall be applied.

(e) Alternators shall be provided with phase segregated terminal box on the line side & neutral side. Neutral side leads should be brought out to a separate terminal box which shall have provision for mounting AVR-CT & CTs for differential & other protections.

(f) Alternators shall be provided with 2 no's. of PT-100 type RTDs embedded in each phase winding.

(g) Alternators shall be designed to operate satisfactorily with the diesel engine offered.

(h) Alternators shall be designed to have SCR value greater than or equal to 0.5.

(i) Alternators shall be designed to operate satisfactorily with permissible voltage variation of + / - 5% & frequency variation of + / - 3%.

(j) The excitation & AVR system shall have steady state accuracy of + / - 0.5 % of rated generator voltage & voltage setting range of + / - 10%.

(k) Suitable protective relays shall be provided to detect rotating diode failure.

(l) AVR shall have provisions for remote manual adjustment of voltage.

(m) Alternators shall have the capability to continuously supply 8% negative sequence current.

(n) Alternators shall be provided with auto / manual selector switch.

(o) In addition to the primary protection, control fuses for backup shall be provided with easy accessibility.

(p) DG set shall be provided with governor having following characteristics :

(a) Overspeed trip setting of 110%.

(b) During loading sequence, frequency should not go below 47Hz & voltage should not go below 80% of full load voltage.

(c) On rejection of largest single load, speed should not exceed 75% of difference between normal speed & over-speed trip setting.

(d) The voltage & frequency shall recover to within 2% & 10% of nominal value (respectively) in 60% of the time interval for successive starts in the loading sequence.

(e) On rejection of rated load, speed shall not reach over-speed trip setting.

(3) Control panels :

(a) Diesel generator control & instrument panel(s) shall be free standing, floor mounted sheet steel panels housing all controls, indications & alarms.

(b) All process sensors shall transmit 4 - 20 mA DC signals & meters provided shall be suitably calibrated.

(c) The control panel(s) will include automatic engine starting controls, automatic battery charger & automatic transfer control. In addition to this it shall have the option of operating the DG set in manual mode & test mode, which have been explained later. A microprocessor controller shall be provided to integrate most of the automation and control functions of the DG set.

(d) Control panel(s) shall have solid state AMF logic card which will be programmed in such a way to give starting impulses in the following conditions

- i. If mains voltage failing below a preset value.
- ii. Monitoring power supply quality for a preset time on resumption from main utility source & giving signal for appropriate action.
- iii. If the Diesel Engine fails to start after receipt of the first starting impulse, preset number of additional starting impulses (up to 6 starts) should be given to start DG set. In case the Set fails to start even after the additional impulse are given, audible alarm & suitable indication should be available.
- iv. In the manual mode, it shall be feasible to start-up the DG set by operator on activating start command by push button.
- v. In the Auto-mode, Mains breaker trip & DG breaker close operation shall be automatic with necessary interlocking to avoid damage due to wrong operation.
- vi. In test mode, it shall be feasible to start-up only the DG set by operator on activating start command by push button to check the healthiness of DG set. In this mode, it shall also be feasible to have manual starting for 1hour at an interval of 7 days.
- vii. It is also required to provide the synchronizing circuit for :
 - (a) Soft transfer of load back to mains power when mains power resumes back.
 - (b) Soft transfer of load to DG set in test mode to ensure proper loading of DG set.
- viii. Suitably rated ACB should be included in the scope for DG output. The ACB should be electrically operated, draw out type and have a minimum rating of 800 A at 415 V. The short circuit rating should be at least 50 kA. The installation should include instrumentation, control, protections for the ACB should be provided as per applicable standards. The output of the DG power after ACB should be terminated in outdoor type receptacle suitable for this rating.

(4) Acoustic Treatment:

The DG set is to be operated in sub-urban area and hence, the noise level shall be within the permissible limits as per applicable pollution norms. It is

envisaged that the DG set is to be housed in a all weather proof suitable for outdoor installation with acoustic treatment.

The bidders are requested to offer suitable acoustic treatment for the DG set so as to maintain the noise level within the permissible limit as applicable by governing standards and norms prescribed by the CPCB.

The acoustic treatment shall include the profiled side walls, top ceiling and doors and shall be fabricated CRCA sheets fixed along structural frame work and filled with suitable rock wool or equivalent material of relevant thickness and density to maintain the noise level as per the pollution norms. The steel structure and sheet walls shall be treated for corrosion protection and finished for outdoor duty.

The design of the enclosure should ensure trouble free operation in all weather conditions and provide appropriate access windows and doors for maintenance and observation.

The ventilation design should be suitable for proper inlet and outlet of natural air circulation.

The exhaust systems should be suitable for silent operation as applicable for residential areas.

The design of the enclosure and the installation should be at least IP 5X class and ensure for vermin proof. Suitable opening/glands should be provided for interfacing cables between the DG set and Power distribution panel.

5. Documents to be enclosed in the offer:

- (a) Single line diagram with bidder's scope clearly identified.
- (b) Layout of DG Set.
- (c) Sizing and rating selection of major components
- (d) Make and type numbers of major components
- (e) Completed technical data sheets
- (f) Routine test record format
- (g) Deviations list
- (h) Recommendation list of spares for 2 year/1000 hour

6. Specific requirements:

Sr. No.	Parameter	Value	Unit
1.0	Diesel engine :		
1.1	Quantity	One unit	
1.2	Minimum capacity or power output	Should be adequate to meet specified requirements	BHP
1.3	Method of cooling	Radiator cooling	
1.4	Fuel used	HSD as per IS-1460	
1.5	Time for speed build up	< 15	Sec.
1.6	Engine speed	1500	RPM
2.0	Alternator :		
2.1	Quantity	One unit	
2.2	Minimum KVA required	500	KVA
2.3	AVR accuracy	+ / -0.5 %	
2.4	Voltage adjustability	+ / - 10 %	
2.5	Overload capacity	10 % overload for 1 hr., every 12 hrs. Operation	
2.6	Class of insulation & Temperature rise	Class F with temperature rise within class-B limits	
2.7	No. of phases	3	
2.8	Rated generator voltage	415	Volts
2.9	Nominal voltage build up time	< 15	Sec.
2.10	Power factor	0.8	
2.11	Maximum time to connect first load to DG set from the moment when the mains supply fails	< 30	Sec.
2.12	Duty cycle of operation	2 - 3 starts & transfers per day	
2.13	Frequency	50 + / - 3 %	Hz.
2.14	Minimum Unbalanced loading	8% of rated current	
2.15	Negative sequence current rating for the alternator	8% Continuous and $(I_2 / I_N)^2 t = 20$ under fault conditions as per BS-4999	
2.16	Total Harmonic Distortion in output waveform	3% as per IS-4722	

2.17	Short circuit Withstand capability	At least 3 sec. for 3-phase fault.	
2.18	Terminations	Terminal box at the output	
2.19	Operation	Auto & Manual both	
3.0	Auto mains failure panel :		
3.1	Maximum time to connect first load to DG set from the moment when the mains supply fails	30	Sec.

7. Documents to be provided with DG set supply :

(1) Performance curves of Diesel engine according to fig.-1 as per clause 6.2.23 of IS - 10003.

(2) Accessories on engine as tested & for which a power allowance has been made in the manufacturer's calculation of site rating as per 6.2.24 of IS - 10003.

(3) Detailed list of equipment & tools that will be supplied.

(4) List of supplementary equipment.

(5) The test certificate of Diesel engine may be issued in the proforma given on page 16-17 of IS - 10003 both for type test as well as for performance test.

(6) For carrying out type test as well as performance test on the Diesel engine, test conditions will be strictly followed as per clause 2.1.2 of IS - 10003.

(7) Preparation of Diesel engine tests & wear measurements will be done as per clause 4.1 & 4.2 of IS - 10003.

(8) All the Diesel engine tests, type & performance will be carried out as per clauses 5.1, 5.2, 5.3, 5.4, 5.5 & 5.7 of IS - 10003.

(9) The test results shall be recorded as per Appendix - D of IS - 10003.

(10) Type tests & routine tests on alternator shall be carried out strictly as per clause 29.3.2.1 of IS - 4722.

(11) The dielectric test shall be carried out as per clause 30.1 of IS - 4722.

(12) The unbalanced current test of alternators shall be carried out to verify the provisions of clause 18 of IS - 4722 & the test values shall not exceed the value given in table - 4 of the same standard.

(13) The short circuit current test & the occasional excess current test shall be carried out to verify the provisions 19 & 20 of IS - 4722.

(14) The determination of temperature rise of AC generators delivering rated output under the rated conditions of voltage, frequency & pf shall be in accordance with IS - 12802. The limits of temperature rise applicable to alternators shall be in accordance with table-1 to table-3.

(15) Excitation of alternators shall be in accordance with clause 20.2 of IS - 4722.

(16) The limits of vibration severity shall be within the limits specified in IS - 12075.

(17) The insulation resistance test shall be carried out & recorded as per IS - 7816. The minimum value of insulation resistance shall be determined by the formula given in clause 30.2.2 of IS - 4722.

(18) Troubleshooting guidelines in details shall be supplied by the manufacturer for diesel engine, alternators & other associated auxiliaries & accessories.

(19) Literature related to each component / equipment description, make, drawings, catalogues & other relevant information.

(20) Maintenance manuals of diesel engine, alternator, AMF panel & other auxiliaries shall be supplied with the DG set by the manufacturer.

(21) Spare parts lists of all equipment & other auxiliaries for 2 years of safe operation shall be supplied with the DG set by the manufacturer.

(22) The circuit diagrams, cable schedule & wiring schedule shall be supplied with DG set by the manufacturer.

(23) The vendor shall provide three copies of operating manual which contains the following :

- (a) Electrical schematics.
- (b) Outline drawings.
- (c) Installation instructions.
- (d) Operating instructions.
- (e) Maintenance instructions.

(24) Design drawings :

The vendor shall provide two hard copies & one soft copy of following drawings :

(a) Block diagram of DG system, including flow charts of all interlock signals, description of how DG works etc.

(b) Drawings of the DG set units indicating their layout, dimensions, weight, mounting etc.

(c) Detailed & complete electrical design drawings including all drawings relevant to the automatic mains failure panel & related control system (including logic).

(d) Details of the cable terminations.

(e) Parts list.

(f) Outline of mechanical design drawings.

(g) Complete information of types & quantity of coolants required & oils used.

(h) Piping layout & sectional views.

(i) RCC foundation drawings.

(j) Structural steel supports.

(k) Pipe support details.

(l) Wall openings / floor openings.

(m) Exhaust gas ducting layout.

(n) Required documentation & drawings for statutory approvals (Electricity board / Pollution control board / Electrical inspector etc.)

8 Factory Inspection, Site commissioning & Acceptance Testing:

All material / equipments offered / to be supplied by the DG vendor shall be Type / Routine tested as per relevant IS / BS standard prior to assembly / dispatch. For carrying out l tests on various equipments purchaser may depute his representative or appoint third party, to inspect any / or all major equipments / assembly requiring inspection at manufacturer's works. The successful bidder will intimate the date of testing of equipments at the

manufacturer's works before conducting the tests. The successful bidder shall give sufficient advance notice regarding the dates proposed for such test. The engineer incharge / agency at his discretion may witness such testing. The suppliers shall have to submit all the original type / routine test certificates.

Each engine shall be tested at works in accordance with IS / BS - 5514/6491/ISO3046 or any other acceptable international standard.

During the engine test, the following shall be noted & recorded :

- (a) Load
- (b) Speed
- (c) Fuel consumption
- (d) Lub-oil consumption
- (e) Operating temperatures for fuel, lub. oil, coolant, Exhaust gas etc.
- (f) Checks for correct functioning of governors & over speed devices.
- (g) Checks for protection & warning devices.
- (h) Checks for automatic operation of temperature & pressure controls on engine.

Alternators shall be tested at manufacturer's works as per IS:4722 or any other acceptable international standard.

During testing of alternators following shall be tested & noted :

- (a) Residual voltage measurement.
- (b) Voltage symmetry.
- (c) Phase sequence test.
- (d) Load characteristics.
- (e) Set point potentiometer range / voltage adjustment range.
- (f) Voltage regulator :
 - (1) Voltage regulator adjustment.
 - (2) Underspeed protection adjustment.
 - (3) Parallel operation adjustment.
- (g) Shorttime overload .
- (h) Winding test.
- (i) Overspeed test at 120% of rated speed.
- (j) Insulation resistance measurement.

Following tests will be conducted on control panels :

- (a) Visual checks :
 - (1) Layout of the equipment & BOM check & dimensional checks.
 - (2) Clearance & creepage distance between bus bars, risers & also between bus bar, risers & earth.
 - (3) Effectiveness of interlocks, locks etc.

- (4) Adequate contact of connections.
- (5) Identification of various individual circuits & their protective circuits, with regard to wiring diagrams, technical data etc.

(b) Continuity test (For small wiring) :

A point to point check shall be made to ensure the compliance of complete wiring as per the approved electrical schematic diagram.

- (c) Operational test (IS:8623 clause 8.3.1.3)
- (d) Testing of relays, meters, lamps etc.
- (e) Control wiring : Between all wiring terminals connected together & earth.

For auxiliary equipment offered / used, such as valves / pumps etc. for manufacturing / erection of DG set by the DG supplier, the manufacturer's test certificate will be acceptable. However the same are also type / routine tested as applicable & specified below.

Commissioning & Site testing:

The DG set shall be tested for performance after the same is installed & trial run at site. The set shall be deemed commissioned only after successful completion of performance tests & acceptance of test results.

For the purpose of performance tests, customer shall provide the following:

- a. Load
- b. Lubricating Oil
- c. Diesel Fuel

The supplier shall depute his testing & commissioning engineer with a team of technicians to conduct the performance tests & demonstrate the adequacy of the plant as per specifications. The tests shall be conducted for a period not less than 8 hours.

In case, customer is unable to provide the full load for testing of the DG set, the load test could be conducted at available load.

The test shall include the following :

(1) Engine:

Measurement of following parameters at various loads:

- (a) Speed
- (b) Fuel consumption
- (c) Lub.-oil consumption

- (d) Operating temperatures for fuel, lub. Oil, coolant, exhaust gas etc.

Functional tests:

- (a) Functioning of governors.
- (b) Functioning of protection & warning devices.
- (c) Functioning of controls on engine.
- (d) Functional tests on engine control panel.

(2) Alternators:

- (a) Voltage regulation test from no load to full load.
- (b) Frequency regulation test.
- (c) Measurement of harmonics.
- (d) Synchronizing tests.
- (e) Functional tests on control & relay panel.
- (f) Testing of operation of engine-alternator interlocks.

(3) Panel(s):

Panel(s) shall be commissioned only after the successful completion of the following tests. The tests shall be carried out in the presence of engineer in charge.

- (a) All wiring terminations & cable joints shall be checked & tightened.
- (b) Wiring shall be checked to ensure that it is according to the drawings.
- (c) All wiring shall be tested for insulation resistance.
- (d) Phase sequence / rotation shall be estimated.
- (e) Tests for all the measuring instruments to establish the correctness & accuracy of calibration & working order.
- (f) Tests for all the relays & protective devices to establish the correctness & accuracy of calibration & working order.

(4) Earthing:

On the completion of the entire installation, the following tests shall be conducted:

- (a) Earth resistance of electrodes as per IS:3043.
- (b) Earth loop impedance as per IS:3043.

All meters, instruments & labour required for the tests shall be provided by the bidder. The results shall be submitted in triplicate to the engineer-in-charge.

9 Preferred makes of engine/alternator:

Engine: Caterpillar / Cummins / Kirloskar / Volvo Penta
Alternator: Stamford / Leroy-Somer

10 Deviations & reasons thereof:

The bidders are requested not to deviate from the technical specifications / scope of items / commercial terms & conditions etc.

Should the bidder wish to depart from the specifications, bidder should list such deviation in the separate sheet & should submit the full particulars & reasons for the deviations, separately for technical matter & commercial matter.

The bidder should also ascertain the performance compliance with the deviations with suitable technical details. Unless this is done, the equipment shall be considered to comply in every respect with these specifications.

11. Data to be furnished along with the offer:

Sr. No.	Parameter	Rating / Data
1.0	Diesel Engine:	
1.1	Application	
1.2	Applicable standards	
1.3	No. of diesel engine(s)	
1.4	Engine type	
1.5	No. of strokes / cycle	
1.6	No. of cylinders	
1.7	Cylinder bore & strokes	
1.8	Revolutions per minute	R.P.M.
1.9	Compression ratio	
1.10	Cubic capacity	cc
1.11	Engine block material	
1.12	Combustion chamber design	
1.13	Cyclic variations	
1.14	Fuel used	
1.15	Arrangement of cylinders	
1.16	Fuel day tank storage capacity	Litre
1.17	Fuel tank storage capacity for 3 days of operation	Litre
1.18	Time required for starting from cold	Sec.
1.19	Output at NTP	
1.20	Method of aspiration	
1.21	Method of cooling	
1.22	Clearance volume	cc
1.23	Ignition type	
1.24	Maximum fuel flow to pump	
1.25	Maximum exhaust back pressure	
1.26	Overload capacity	
1.27	Maximum oil pressure	
1.28	Minimum oil pressure	
1.29	Direction of rotation looking from the engine	
1.30	Specific fuel consumption at 100% rated load	
1.31	Specific fuel consumption at 110% rated load	
1.32	Specific oil consumption at 100% rated load	
1.33	Specific oil consumption at 110% rated load	
1.34	Total system lubricating oil capacity	
1.35	Exhaust gas temperature	deg. cen.
1.36	Exhaust gas flow	
1.37	Intake air flow	
1.38	Fuel pump type	
1.39	Fuel filter type	
1.40	No. of fuel filters	
1.41	Air to fuel ratio of the mixture	
1.42	Specific cooling water consumption at rated	

	load	
1.43	Injection pump pressure range	
1.44	Weight of engine	Kg
1.44(a)	Wet weight of engine	Kg
1.44(b)	Wet weight of radiator	Kg
1.44(c)	Wet weight of engine with heat exchanger	Kg
1.44(d)	Dry weight of engine	Kg
1.44(e)	Dry weight of radiator	Kg
1.44(f)	Dry weight of engine with heat exchanger	Kg
1.45	Floor area required	Sq. Meter
1.46	Lubricating oil pump rating	
1.47	Lubricating oil filter type	
1.48	Lubricating oil storage capacity	Litre
1.49	Whether bypass filter employed	Yes / no
1.50	Air cleaner type	
1.51	Coupling arrangement	
1.52	With or without flywheel	
1.53	Enclosure type	
1.54	Whether built with thermostat	Yes / no
1.55	If yes in 1.54 rating of thermostat	
1.56	Cooling water centrifugal rating	
1.57	Radiator / Heat exchanger rating	
1.58	Whether exhaust gas turbocharger employed	Yes / no
1.59	Top & bottom dead centre	mm
1.60	Whether overspeed trip employed	Yes / no
1.61	Whether low lubricating oil pressure trip employed	Yes / no
1.62	Whether high cooling water temperature trip employed	Yes / no
1.63	Heat transfer rate from the diesel engine to coolant	
1.64	Whether cooling fan employed with the engine	Yes / no
1.65	Surface / Volume ratio	
1.66	Injection pump type	
1.67	Injection pump make	
1.68	Injection pump no. Of units	
1.69	Type of governing with speed drop, if required	
1.70	If governor employed for variable speed duties, the working speed range & the idling speed	
1.71	Specific emission from the engine	
1.72	Emission rate	
1.73	Air temperature at the engine (Ambient temperature)	deg. cent.

1.74	Exhaust gas temperature at the cylinder outlet	deg. cent.
1.75	Exhaust bellows type	
1.76	Exhaust chimney type	
1.77	Exhaust chimney length	mm
1.78	Coolant temperature	deg. cent.
1.79	Flat-bed cooler	
1.80	Expansion tank	Yes / no
1.81	Expansion tank capacity	
1.82	No. of bearing(s)	
1.83	Bearing type	
1.84	Lubricating oil temperature	deg. cent.
1.85	Fuel temperature	deg. cent.
1.86	Rating at site conditions & engine speed both at idling & at maximum	
1.87	Recommended fuel & oil specification	
1.88	Overall dimensions of engine & an outline drawing	
1.89	Performance curves (at specified reference conditions) as per IS - 10003 enclosed	Yes / no
1.90	Safety precautions taken	Yes / no
1.91	Maximum possible back pressure in the exhaust system & maximum permissible intake depression	
1.92	List of equipment & tools that will normally supplied	
1.93	Whether fitted with tropical radiator	Yes / no
1.94	Fan guard provided	Yes / no
2.0	Alternator:	
2.1	Application	
2.2	Applicable standards	
2.3	No. of alternator(s)	
2.4	KVA rating	
2.5	Continuous rating	kW
2.6	Standby rating	kW
2.7	Voltage rating	Volts
2.8	Voltage regulation	
2.9	Voltage adjustability	
2.10	Voltage adjustability, Auto / Manual	
2.11	Cooling type	
2.12	Winding type	
2.13	Impregnation type	
2.14	Rotor magnetic material	
2.15	Rotor magnetic flux density	Wb. / sq. mm
2.16	No. of poles	
2.17	No. of slots in stator	

2.18	No. of conductors per slot	
2.19	Conductor current density	Amp. / sq. mm
2.20	Current	Amp.
2.21	Total distortion factor	
2.22	Short circuit current	Amp.
2.23	Over load capacity	
2.24	Winding temperature rise at rated load	deg. cent.
2.25	Winding temperature rise at short circuit	deg. cent.
2.26	Maximum ambient temperature	deg. cent.
2.27	Insulation level (peak / rms)	
2.28	Harmonic capability	
2.29	No. of winding RTDs employed	
2.30	Voltage build up rate	
2.31	Response time	msec.
2.32	kW rating	
2.33	Frequency	Hz.
2.34	Frequency tolerance	
2.35	No. of exciter(s)	
2.36	Rating of exciter(s)	
2.37	Exciter classification, AC / DC	
2.38	Type of motor	
2.39	No. of storage batteries	
2.40	Battery rating	Amp.- hr
2.41	Battery voltage	Volts
2.42	Battery type	
2.43	Power supply source for alternator field	
2.44	kW rating of source in 2.43	
2.45	Response time of source in 2.43	msec.
2.46	Voltage rating of source in 2.43	Volts
2.47	Charger for batteries	Yes / no
2.48	Charger rating	
2.49	Charging rate options	
2.50	Charging transformer pri. / sec. Turn ratio	
2.51	Charging rectifier	
2.52	Rectifier diode average current density	
2.53	Diode PIV rating	
2.54	Diode short time current rating	Amp.
2.55	Junction temperature at maximum charging rate	deg. cent.
2.56	Maximum turn off time	
2.57	Cooling type	
2.58	Heat sink & operating temperature	
2.59	Diode semiconductor fuse rating	
2.60	Filter used with charger	
2.61	Impedance (ref. base)	
2.62	Rotor stamping material	
2.63	Rotor stamping flux density	

2.64	Exciter permanent magnet details	
2.65	Shaft material	
2.66	Stator yoke material	
2.67	Stator yoke flux density	
2.68	Insulation between stampings	
2.69	Synchronous reactance of alternator (X_d'' , X_d')	
2.70	SCR value of the alternator	
2.71	Rectifier cable details	
2.72	Insulation between conductors in alternator	
2.73	AMF panel to starting motor cable details	
3.0	Controller scheme:	
3.1	Analog / Digital control	
3.2	Feedback parameter(s)	
3.3	Controller range	
3.4	Controller accuracy	
3.5	Controller design	
3.6	Controller response time	
3.7	Mains power supply monitoring time after its resumption	
3.8	DG set off time after mains supply resumption	
3.9	Time duration between consecutive control impulses	
3.10	Power required for controller	
3.11	Controller power supply details	
3.12	Controller power supply cable details	
3.13	Control range	
3.14	Response time	
3.15	Control options, Auto / Manual	
3.16	Provision for spare cable entry	Yes / no
3.17	Parallel connections from control push buttons wired to terminal blocks	Yes / no
3.18	All indications provided as per specification	Yes / no
3.19	All controls provided as per specification	Yes / no
3.20	All input signals provided as per specification	Yes / no
3.21	All output signals provided as per specification	Yes / no
3.32	Details of PT & CT employed:	
3.22(a)	Quantity	
3.22(b)	Ratio	
3.22(c)	Accuracy loss	
3.23	All accessories supplied:	
3.23(a)	Flywheel	Yes / no
3.23(b)	Tropical radiator	Yes / no
3.23(c)	Storage day tank	Yes / no

3.23(d)	Storage tank for 3 days of operation	Yes / no
3.23(e)	Starting unit including batteries & power supply	Yes / no
3.23(f)	Others if any	
4.0	Protection scheme:	
4.1	AC mains side unbalance / undervoltage	Yes / no
4.2	AC mains side thermal overload	Yes / no
4.3	DG side overcurrent with directional restrained	Yes / no
4.4	DG side unbalance / undervoltage / overvoltage	Yes / no
4.5	DG side thermal overload	Yes / no
4.6	Earthfault protection	Yes / no
4.7	Interturn fault protection	Yes / no
4.8	Control fuse(s)	Yes / no
4.9	Recommended special protection	Yes / no
4.10	If yes in 4.9 list provided	Yes / no
4.11	Quoted price is including special protection	Yes / no
4.12	If "no", charges for providing the special protection. Quote separately	
4.13	All protections provided as per specification	Yes / no
4.14	Protection against low lubricating oil pressure	Yes / no
4.15	Protection against high cooling water jacket Temperature	Yes / no
4.16	Overspeed protection	Yes / no
5.0	Metering & monitoring:	
5.1	AC measurement type	
5.2	AC measurement gauge	
5.3	AC meter type & range	
5.4	AC measurement accuracy	
5.5	AC measurement response & bandwidth	
5.6	AC meter rating	Amp.
5.7	AC voltage measurement type	
5.8	AC voltage measurement gauge	
5.9	AC voltage meter rating	Volts
5.10	AC mains indicator	Yes / no
5.11	DG set ON indicator	Yes / no
5.12	DG set OFF indicator	Yes / no
5.13	Load on mains indicator	Yes / no
5.14	Load on DG set indicator	Yes / no
5.15	DG set fails to start indicator & alarm	Yes / no
5.16	Low lubricating oil pressure indicator	Yes / no
5.17	High cooling water jacket temperature indicator	Yes / no

5.18	Overspeed indicator	Yes / no
5.19	AC frequency measurement type	
5.20	AC frequency measurement gauge	
5.21	AC frequency meter range	
5.22	AC frequency measurement accuracy	
5.23	AC frequency measurement response & bandwidth	
5.24	Power factor measurement type	
5.25	Power factor measurement gauge	
5.26	Power factor meter range	
5.27	Power factor measurement accuracy	
5.28	DC measurement type for batteries	
5.29	DC measurement gauge	
5.30	DC meter range	
5.31	DC measurement accuracy	
5.32	DC measurement response	
5.33	DC voltage measurement type for batteries	
5.34	DC voltage measurement gauge	
5.35	DC voltage meter range	
5.36	DC voltage measurement accuracy	
5.37	DC voltage measurement response	
5.38	AC kW measurement type for DG set	
5.39	AC kW measurement gauge	
5.40	AC kW meter range	
5.41	AC kW measurement accuracy	
5.42	AC kW measurement response & bandwidth	
5.43	AC kWhr. Measurement type for DG set	
5.44	AC kWhr. Measurement gauge	
5.45	AC kWhr. meter range	
5.46	AC kWhr. Measurement accuracy	
5.47	AC kWhr. Measurement response & bandwidth	
5.48	Counter for counting the impulses given to the DG set	Yes / no
5.49	Hr. - meter	Yes / no
5.50	Hr. - meter range	
5.51	Hr. - meter accuracy	
5.52	Tachometer measurement type	
5.53	Tachometer measurement gauge	
5.54	Tachometer range	
5.55	Tachometer measurement accuracy	
5.56	Tachometer measurement response	
5.57	Cooling water jacket temperature measurement type	
5.58	Cooling water jacket temperature measurement gauge	
5.59	Cooling water jacket temperature meter	

	range	
5.60	Cooling water jacket temperature accuracy	
5.61	Cooling water jacket temperature response	
5.62	Lubricating oil pressure measurement type	
5.63	Lubricating oil pressure measurement gauge	
5.64	Lubricating oil pressure meter range	
5.65	Lubricating oil pressure measurement accuracy	
5.66	Lubricating oil pressure measurement response	
6.0	AC output:	
6.1	AC harmonics present	
6.2	AC voltage harmonics present	
6.3	Maximum AC current continuous	
6.4	Whether DG short circuit proof / stable	Yes / no
6.5	Tests conducted on diesel engine:	
6.5(a)	Preliminary run test conducted & recorded as per IS - 10003	Yes / no
6.5(b)	Type tests conducted as per IS - 10003:	
6.5(b).1	Initial performance tests :	
6.5(b).1(a)	Idling test	Yes / no
6.5(b).1(b)	Speed limiter (governor) test	Yes / no
6.5(b).2	100 hrs. endurance test	Yes / no
6.5(b).3	Final performance test	Yes / no
6.5(b).4	Smoke emission test as per IS - 10000	Yes / no
6.6	Declaration of power & specific fuel consumption	Yes / no
6.7	Test certificate for type test & performance test conducted as per IS - 10003	Yes / no
7.0	Tests conducted on alternator:	
7.0(a)	Type tests conducted as per IS - 4722:	
7.0(a).1	Measurement of resistance	Yes / no
7.0(a).2	Phase sequence test	Yes / no
7.0(a).3	Regulation test	Yes / no
7.0(a).4	Measurement of leakage reactance & potier reactance	Yes / no
7.0(a).5	Measurement of open circuit characteristic	Yes / no
7.0(a).6	Measurement of short circuit characteristic	Yes / no
7.0(a).7	Efficiency test	Yes / no
7.0(a).8	Temperature rise test as per IS - 4722	Yes / no
7.0(a).9	Occasional excess current test	Yes / no

7.0(a).10	Overspeed test as per IS - 5422	Yes / no
7.0(a).11	Insulation resistance test (both before & after high voltage test)	Yes / no
7.0(a).12	High voltage test	Yes / no
7.0(a).13	Determination of deviation of voltage waveform sinusoidal	Yes / no
7.0(a).14	Measurement of bearing current	Yes / no
7.0(a).15	Short circuit withstand test & measurement of reactance & time constants	Yes / no
7.0(a).16	Pressure test on coolers for closed circuit cooling	Yes / no
7.0(b)	Routine tests conducted:	
7.0(b).1	Measurement of resistance	Yes / no
7.0(b).2	Insulation resistance test as per IS - 7846	Yes / no
7.0(b).3	Phase sequence test	Yes / no
7.0(b).4	Regulation test	Yes / no
7.0(b).5	Measurement of open circuit characteristic	Yes / no
7.0(b).6	Measurement of short circuit characteristic	Yes / no
7.0(b).7	High voltage test	Yes / no
7.0(b).8	Measurement of bearing current	Yes / no
7.0(b).9	Pressure test on coolers for closed circuit cooling	Yes / no
7.0(b).10	Dielectric test as per IS - 10003	Yes / no
7.0(b).11	Unbalanced currents of alternator	Yes / no
7.1	Tests conducted on controller when fixed with the DG set :	
7.1(a)	Test for calculation of time for transfer of load from mains to DG set	Yes / no
7.1(b)	Time calculation for monitoring the resumed mains supply & transferring the load to mains	Yes / no
7.1(c)	Power quality monitoring & transfer of load to DG set on poor power quality	Yes / no
9.0	List of other tests which will be carried out against extra price. Whether already quoted	
9.1	Charges for other tests quoted separately	
9.2	All items / parts not specified confirm to relevant standards	Yes / no
9.3	List of tests that can not be performed as specified (if any), give reasons	
9.4	Manufacturer's maintenance procedure &	Yes / no

	schedule for DG set provided	
9.5	Provision for lifting each unit	Yes / no
9.6	Total floor area required for each unit & fitted with all accessories like flywheel, tropical radiator etc.	
9.7	Sheet metal thickness	
9.8	Flywheel material	
9.9	Dimensions of each unit (LxBxH)	mm
9.9(a)	Unit - 1 (Diesel engine)	
9.9(b)	Unit - 2 (Alternator)	
9.9(c)	Unit - 3 (AMF panel)	
9.9(d)	Battery dimension (individual as well as all taken together)	
9.10	Noise level	db
10.0	Installation & commissioning :	
10.1	Erection scope	
10.2	Installation scope	
10.3	Precommissioning checks done	Yes / no
11.0	Other information enclosed :	
11.1	Power circuit schematic enclosed	Yes / no
11.2	Controller schematic enclosed	Yes / no
11.3	Calculation for generator winding temperature enclosed	Yes / no
11.4	Calculation for diesel engine cooling enclosed	Yes / no
11.5	DG panel layout & dimensional drawing enclosed	Yes / no
11.6	List of spares for 2 years of safe operation enclosed	Yes / no
11.7	List of similar systems supplied with reference Enclosed	Yes / no
11.8	Other information provided	
12.0	Time for supplying DG set after allotment of tender	
12.1	Time for erection of DG set after allotment of tender	
12.2	Warranty / Guaranty period	