

Annexure – I

DETAILED TECHNICAL SPECIFICATIONS OF DG SET

1.0 INTENT OF SPECIFICATION:

1.1 This specification covers the design, manufacture, assembly, shop testing, packing, dispatch, transportation, supply, erection, testing, commissioning, performance and guarantee testing of Silent type Diesel Generating Sets, complete in all respects with all equipment, fitting and accessories for efficient and trouble-free operation as specified here under including statutory approvals.

1.2 SCOPE OF WORK :

General Scope of work shall include design, manufacture, shop testing, packing, dispatch, transportation to site, supply, erection, testing and commissioning of the following:

- a) Diesel engine complete with all accessories, an Alternator directly coupled to the engine through flexible/ rigid coupling complete with all CTs, PTs, etc as required or as per BOQ & specifications, accessories for starting, regulation and control, including base frame, foundation bolts etc, interconnecting piping and accessories, power and control cables, glands and lugs.
- b) AMF/Manual panel including various meters/Annunciation and other control components as per standard practice, BOQ & specifications. Control panel cabling between bidder's & local equipments and special cables if any.
- c) Equipments necessary for fuel storing and distribution, day fuel tank, piping, valves, level controller and indicators etc. Load sharing facility with Synchronization Panel.
- d) Flexible connections and Residential type silencer of exhaust system, including thermal lagging.
- e) Batteries with MS battery stand painted with one coat of Zinc Oxide and two coat of acid proof black paint and battery charging equipment, including their connections as necessary along with tools & accessories for battery maintenance.
- f) Anti Vibration Mountings etc.
- g) Preparing of all related shop drawings for approval from client/consultant and statutory bodies. Work shall be as per Final approved drawings
- h) Obtaining approval/licencing of the installation of Diesel Generators by the Electrical Inspectorate and Pollution Control bodies and any other statutory bodies. Any other registrations of Genset (eg. Industry department)
- i) Carrying out performance and guarantee test i.e. full load test for 6 hrs followed by 1 hour 110% over load and again 6 hrs full load. Vendor has to make arrangements for oil lubricants, HSD, other consumables and Electrical loads etc. as required
- j) The DG set shall be mounted on a suitable designed fabricated rigid common base frame with antivibration pads to provide not less than 99% vibration isolation. First filling of lube oil &

HSD shall be included in DG - sets cost. The DG Set shall include all standard accessories, fittings, instruments and 3 sets of operating & maintenance manuals, spare parts list etc. complete as per technical specifications. The DG set shall be inclusive of AMF controller, Fuel day tank, Residential Grade Silencer etc. complete as required.

- k) The DG Sets shall be subjected to load tests at factory before dispatch & IUCAA site after installation in the presence of IUCAA's representative with consultant. All consumables required during testing of DG Sets at factory & site testing shall be included in the scope of DG vendor. All consumables required during trial run of DG Sets on load for 13 hours out of which six hours for run up to full load, followed by six hours on full load and concluded by one hour 110% overload capacity to be arranged by DG Vendor. Also, Vendor has to arrange the 110% of rated capacity load availability for testing at factory and at IUCAA. The test shall be carried out as per Technical Specification & records to be submitted for approval. (The formats of all tests carried out at factory & at site with details of relevant standards as per latest standards & permissible limits should be submitted by DG vendor for reference along with tender).
- l) The design of DG Sets shall conform to the requirement of CPCB II norms for all parameters including flue gas emission and noise level. DG set should be provided with standard accessories like anti vibration pads, AVR, electronics governor, breaker, MFM, microprocessor-based controller (latest version), control cables, power cables complete as required up to AMF panel. BMS compatible ports & I/Os.
- m) RCC foundation as per manufacturer's drawings, minor civil works like chasing, grouting etc, for execution of jobs. All materials must possess high quality.

BMS Requirement:

DG Vendor to ensure the BMS system architecture (as indicated in Annexure - 1 for reference only) shall be able to satisfy the client's requirement. Following are some of requirement listed for guidance but not limited to:

- 1) RS 485 / Backnet Output from each DG set for our BMS.
- 2) Analog input along with monitor points for fuel level, generated voltage, current, engine temperature, Battery voltage, charging current, frequency & over speed, RPM, coolant temperature, oil temperature etc.
- 3) Potential free contacts from each DG set breaker for BMS for ON/OFF/Trip status
- 4) BMS Controller with 5 Universal Inputs and 5 Binary Outputs in MS Enclosure with required power supply, connectors, internal wiring etc.
- 5) Convertor with 2 inputs and 1 RS 232/485 output, cabling etc.

GENERATOR STANDARD FEATURES:

- 1) Vendor to provide one-source responsibility for the generating system and accessories.
- 2) The generator set and its components are prototype-tested, factory-built, and production-tested.
- 3) Two-year warranty covers all systems and components.
- 4) Industrial diesel engine with 24 Volt battery charging alternator.
- 5) Rated capacity Alternator with insulation class H & IP 23 protection.
- 6) Unit-mounted radiator.
- 7) Subbase fuel tank – Not less than 550 litres. capacity with float type level indicator, seven segment digital fuel level indicator.
- 8) Vibration isolators.

- 9) Dry type air filter with restriction indicator.
- 10) Fuel Water separator.
- 11) Main line breaker.
- 12) Starting battery and cables.
- 13) Sound enclosure with 75dB(A), (fully water proof)
- 14) Conveniently locate fuel level indication.
- 15) Operation and installation literature.

ADVANCED DIGITAL CONTROL:

Compact Controller comprising of :

LED display for measurement & display of –

- 1) Runtime hours
- 2) Current
- 3) Voltage
- 4) Frequency
- 5) Engine temperature
- 6) Engine Oil Pressure
- 7) Battery Voltage
- 8) LED display faults:
- 9) High engine temperature
- 10) Low oil pressure
- 11) Over crank
- 12) Overspeed
- 13) Over & under voltage
- 14) Over & under frequency
- 15) E-stop
- 16) Auxiliary fault
- 17) Display warning:
- 18) Low battery voltage
- 19) High battery voltage
- 20) Low fuel level

Note: Vendor has to provide latest version of controller for a particular DG

STANDARD FEATURES & ACCESSORIES :

- 1) Master switch: Run/Off-Reset/Auto
- 2) Current selector switch
- 3) Remote two-wire start/stop capability
- 4) Event log
- 5) Superior electronics
- 6) Factory-built and production-tested
- 7) Automatic start with programmed cranking cycle
- 8) Field software upgrade possibility
- 9) Environmental specifications:
 - i) Operating temperature : - 10°C to 55°C
 - ii) Humidity : 0--95% condensing
- 10) Power Requirements:
 - 24 VDC with fuse protection
 - 250 mA @ 12 VDC
 - 125 mA @ 24 VDC
- 11) Battery charger 24V

- 12) Mains sensing relay
- 13) Earth leakage protection

Important Notes:

- 1) DG Set should accept 55% load of rated capacity of DG Set in one step at the time of starting.
- 2) DG Sets panel shall be suitable for Auto operation controlled through AMF Relay as well as manual operation.
- 3) DG Set supplier shall provide microprocessor-based DG Local Control panel mounted on the engine having, all electrical parameters, and fault indication with provision for its remote control.
- 4) DG Supplier should provide for all required hardware (convertor to give bacnet compatibility, control wiring, potential free NO/NC, RS ports, A/D & D/A converters etc. as required to operate the BMS system software.) arrangement for remote start/stop and DG fault (LLOP, over speed) etc. along with remote adjustment of voltage & speed of the engine (Motorised/ solid state pot. may be required) & shall be included in the quoted rates as required.
- 5) The neutral CTs as per specification shall be provided on the neutral side of winding and connection brought out to a neutral CT box to be mounted on the alternators (All the six terminals are to be brought out and then shorted).
- 6) Supply, installation, testing & commissioning of residential type silencers as per CPCB norms with 75mm glass/ mineral wool insulation complete with wire chicken mesh and 24-gauge Aluminium cladding from engine up to silencers, including supporting arrangement suitable for the following DG Set complete as required.
- 7) Supply, fabrication, installation, testing & commissioning of M.S. day fuel tank fabricated out of min. 2.5 mm thick M.S. sheet installed on steel frame or masonry pedestal with all associated accessories, filters, valves & fittings including level controller, priming motor complete as required, float switch with contacts for remote interlock should be provided. The tank shall be suitably treated with diesel resistant paint/anticorrosive treatment. The contact of level controller shall be wired up terminal block. or as per manufacturer's design included in the enclosure. The tank level remote indicator to be provided at some suitable location as advised by client in the canopy.

1.3 CODES AND STANDARDS :

1.3.1 The equipment furnished under this specification shall conform to the following latest standards, except where modified or supplemented by this specification.

BS: 5514	: Specification for reciprocating internal combustion engine.
BS: 5000	: Rotating electrical machines of particular type or for particular applications.
IS: 1239 (Part-I & II)	: Mild steel tubes and fittings.
IS: 1651	: Stationary cells and batteries lead acid type (with tubular positive plates).
IS: 9224	: Specification of low voltage fuses, General purpose.
IS: 4540	: Mono-crystalline semi-conductor rectifier assemblies and equipment.
IS: 5	: Colours for ready mixed paints.
IS: 4722	: Rotating electrical machines.
IS: 1248	: Specification for electrical indicating instruments.
IS: 10000	: Methods of tests for internal combustion engines.
IS: 10002	: Specifications for performance requirements for constant speed compression ignition (Diesel) engine for general purposes (above 20 KW)

IS: 2147	: Degree of protection provided by enclosure for low voltage switchgear and control gear.
IS: 1600	: Code for type testing of constant speed IC engines for general purposes.
IS: 1601	: Performance of constant speed IC engines for general purposes.
ASME Power	: Internal combustion engines.
Test Code PTC-17	: Codes of Diesel Engine Manufacturer's Association U.S.A.

1.3.2 The installation work shall conform to Indian Electricity act and Indian Electricity Rules as amended upto the date of installation. The fuel oil installation shall meet all statutory requirements of Govt. of India as amended up to the date of installation. Any approval required from statutory authorities shall be obtained by the contractor. Nothing in this specification shall not be the limiting factor to relieve the contractor of their responsibilities.

1.3.3 The equipments furnished under this specification have to operate in a tropical climate and shall be given tropical and fungicidal treatment as per relevant specification.

1.4 ENGINE :

1.4.1 Type :

The diesel engine shall be of stationary type four stroke with In Line or (V) Type Cylinder arrangement, Turbo charged, cooled with radiators

1.4.2 Rating :

- a) BHP rating of the engine shall be such that the DG set can continuously deliver the specified net electrical output while supplying power/driving all electrical and mechanical auxiliaries connected to alternator terminals and engine shaft at specified site conditions and ambient temperature of 45 deg C.
- b) It shall also be capable of satisfactorily driving the alternator at 10% over load at the rated speed for one hour in any period of 12 hours of continuous running.

The successful bidder shall have to furnish supporting calculations to arrive at the diesel engine rating.

1.4.3 Speed and Vibration Level :

Speed shall be 1500 revolutions per minute. Speed governor/over speed protection shall be provided. At due running conditions, speed shall be stabilized at plus or minus 2% nominal speed, regardless of load. At transient condition, engine speed shall vary not more than 10% plus or minus. Governor class shall be G2 for normal application unless otherwise specified. The Governor of all DG set shall be of similar characteristics to enable synchronization. The engine vibration level shall be within the permissible limits.

1.4.4 Lubrication :

- a) The engine shall have a closed cycle forced & splash lubricating system with positive oil pressure and a crank chamber for collection/storage of the lubricating oil during circulation. No moving part shall require lubrication by hand or any other external source either prior to the starting of the engine or when it is in operation.
- b) A lubricating oil filter shall be provided for operation under normal conditions for a period of 500 hours without the necessity of its replacement or cleaning.

- c) In case lubricating oil coolers are required they shall be of the water cooled type and shall be supplied as an integral part of the Diesel Generator Set.
- d) Necessary temperature and pressure gauges and other instruments shall be supplied and fitted on the lubrication system.
- e) A lubricating oil level dipstick suitably graduated shall be provided and located in the accessible position.

1.4.5 Fuel System :

- a) The engine shall be capable of running on all types of diesel fuel oil normally available in India.
- b) The fuel consumption of the engine at full, three quarters and half of its rated power output shall be indicated by the Contractor in the bid.
- c) A fuel service tank of capacity as specified in BOQ 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 and necessary piping. The fuel tank shall be painted with oil resistant paint. Service tank level switches (2 Nos. per tank) for alarm & trip shall also be provided by the bidder. All pipe joints should be brazed/ welded. Digital Fuel level indicator recommended with clear 7 segment display.
- d) A hand pump for pumping the fuel into the fuel service tank together with necessary pipes or tubing shall be provided. The inlet of the pump shall be provided with 10 meters long armoured hose with suitable filter & nozzle.

1.4.6 Air Intake System :

The diesel engine shall be provided with special dry type air filters having low resistance to air passage, high dust retaining efficiency and provision for easy cleaning. Filters shall be suitable for achieving satisfactory engine operation and ensuring the engine life under tropical humid conditions, with sulphur dioxide and trioxide fumes, abrasive dust and coal particles of 5 to 100 microns present in the atmosphere. The minimum efficiency of filters shall be 90% down to 5 micron size.

1.4.7 Cooling :

The diesel engine should be liquid/fluid cooled.

1.4.8 Engine Governor :

The governor shall be G2 type as per ISO 8528 part V. It shall have necessary characteristics to maintain the speed substantially constant even with sudden variation in load. However, a tripping shall be provided if speed exceeds maximum permissible limit. The governor shall be suitable for operation without external power supply.

1.4.9 Turbo Charger :

It shall be of a robust construction, suitable of being driven by engine exhaust having a common shaft for the turbine and blower. It shall draw air from filter of adequate capacity to suit the requirements of the engine.

1.4.10 Quietness of Operation :

- a) The engine shall be designed to achieve maximum quietness of operation.
- b) Efficient residential type silencer shall be provided for the exhaust as well as the air intake.

c) Noise level of the set shall not exceed 75 dB at 1 meter distance of the DG Set.

1.4.11 Engine Starting :

a) Engine starting shall be by electric starting motor complete with manual/automatic starting arrangement. The starter motor shall conform to IS-4722 and shall be of adequate power for its duty and be of inertia or pre- engaged type. The pinion shall positively disengage when the engine starts up or when the motor is de-energised. The engine cranking shall be only from the panel and any engine starting devices etc, that are given as original fitment on the engine by engine manufacturers shall be either removed or padlocking arrangement given for this so that all normal start/stop operations could be done only from panel whether the set is AMF or manual.

b) Time for Run-up to Speed :

From the initial operation of the starting device, the engine shall start, run up to normal speed and be capable of accepting 80% of full load within a maximum time of 25 seconds, and full load within a further 5 seconds.

c) Duty Cycle / Period of Operation :

The set is intended to supply power only during an emergency for essential services and may be idle for long periods except for periodic routine run once in a day for a short time. When there is a total failure of mains power supply, the sets shall be required to operate continuously at full load for a period which at times may exceed even 18 hours at a stretch. It shall also be capable of satisfactorily running at 10% overload at the rated speed for 1 hour in any period of 12 hours of continuous running.

i) Starting Duty :

This DG Set shall withstand and shall be able to take care of starting load of largest machine and other running loads (55% of rated capacity).

ii) Running Duty :

This D G Set shall be capable of running continuously on primary duty of about 100% of its name plate rating.

1.4.12 Engine Instrumentation :

The following instruments mounted on instrument panel shall be essentially present as minimum, Engine speed tachometer with service hour counter.

- Lube oil pressure gauge
- Lube oil temperature gauge
- Coolant water temperature gauge

The instrument panel shall be mounted on engine using rubber dampers for vibration isolation. The gauge dials shall have clear red marking to identify the limiting dangerous levels, 'Zone markings' on the scale to indicate the normal healthy & abnormal operating zones for the parameters concerned. The metering could be either normal electromechanical analogue type or electronic digital type, latter being preferred as manufacturers fitment only.

1.5 ALTERNATOR :

1.5.1 The alternator shall be brushless type with rotating field and static excitation circuit controlled by field control unit suitably compounded for voltage and load current for a

self-excited self-regulated system.

1.5.2 The alternator shall be in Screen Protected Drip Proof (SPDP) IP 23 enclosure, foot mounted with ball and roller bearings on end shields.

1.5.3 The alternator shall conform to IS: 4722 / IS/IEC 60034-1/ BS: 2613 and shall be suitable for tropical conditions.

1.5.4 The alternator shall comply with the following specifications:

Rating	As specified in the B.O.Q
Voltage	415 V
Voltage Regulation	±1%
Speed	1500 RPM.
Frequency	50 Hz.
P. F.	0.8 lag
Waveform Distortion No Load	<1.8%, Non-Distorting Balanced Linear Load <5%
Enclosure	IP: 23.
Insulation	'H' grade
Unbalanced Load Capability	– 25 %

Excitation Self excited, self-regulated with brushless system and static voltage control unit suitably compounded for voltage and current to maintain terminal voltage constant at ± 5% at all load for p.f. not less than 0.8. Terminal Box shall be suitable Rating of cable for terminating DG Sets of rating specified in BOQ with Earthing studs.

1.5.5 Alternator meets IS/IEC 60034 and the relevant section of other international standards such as BS5000, VDE 0530, NEMA MG1-32, IEC60034-1, CSA C22.2-100, AS1359. Superior voltage waveform form a 2/3 pitch wound stator

1.6 DIESEL GENERATOR CONTROL PANEL :

1.6.1 General :

- a) The control panel shall be sheet steel enclosed and shall be dust, weather and vermin proof providing a degree of protection of IP-52. Sheet steel used shall be cold rolled and at least 2.00 mm thick and properly braced and stiffened.
- b) Control panel shall be provided with hidden hinged door(s) with pad locking arrangement and suitable brackets/channels shall be provided for floor mounting.
- c) All doors, removable covers and plates shall be gasketed all around with neoprene gaskets. All accessible live connections shall be shrouded and it shall be possible to change individual switches, fuses, ACBs, MCBs without danger of contact with live metal.
- d) All live parts shall be provided with at least phase to phase and phase to earth clearances in air of 30 mm and 25 mm respectively.
- e) Adequate interior cabling space and suitable removable cable gland plate shall be provided. Necessary number of cable glands shall be supplied and fitted on to this gland plate. Cable glands shall be screwed on type and made of brass.
- f) Two number of earthing terminals shall be provided.
- g) All sheet steel work shall be degreased, pickled, phosphate and then applied with two coats of finishing powder coating both inside and outside of shade Siemens Grey.

1.6.2 Control of Diesel Generating Sets : a) DG Set shall be capable of being controlled independently. Diesel Generator shall be capable of being stopped manually from remote as well as local. However, interlock shall be provided in the DG local control panel to prevent shutting down operations as long as DG Control circuit breaker is closed.

Auto Operation:

Necessary control equipments and system incorporating various function etc. shall be provided to ensure following:-

When mains power is available, the healthiness of this power shall be monitored through a mains voltage monitor. If voltage on the 3 phases are within limits, the monitor will send a closing signal to the mains breaker and mains power will be connected to the load.

If the voltage drops on any phase or on all phases, the monitor shall sense this drop, and if this drop persists for more than a pre-adjusted period of time (say 1 to 60 seconds) a signal is sent to start the DG sets. While at the same time opening the mains supply breaker and disconnecting load from mains as voltage is below acceptable limits.

The Command shall be sent for starting the engine through the starting solenoid. When the engine is healthy, it starts up in a few seconds and the generator develops voltage and when the voltage is developed, this give a signal to the generator breaker/contactors which closes and connects the diesel generator to the load (three DGs get synchronised first). Simultaneously, it sends a signal to de-energise the engine starting circuit and the starter motor is disengaged. The engine protection circuits for high water temperature and low lubricating oil pressure and engine over speed are also energised.

b) Resumption of Supply :

If voltage from mains is resumed, the main voltage monitor will sense this voltage for healthiness, i.e. for maintained correct voltage for a period of time (adjustable upto three minutes) and then send a signal to the panel to stop the engine and to change over the breakers from generator to mains and normal supply is resumed to the load. Provision shall also be made for effecting the change over to normal supply through a selector switch.

c) Failure to Start :

A three-attempt starting facility similar to using two impulse timers and a summation timer for engine shall be provided and if voltage fails to develop within 30 seconds from receiving the first start impulse, the set shall lockout automatically and a visual and audible alarm shall be given in the remote panel. The panel shall receive "DG Trouble Alarm" (potential free contacts to be provided).

1.7 ENGINE SAFEGUARDS:

Safeguards shall be provided and arranged when necessary to stop the engine automatically by the following:

- a) Energising a solenoid coupled to the stop lever on the fuel injection pump rack.
- b) Deenergising "fuel on" solenoid or
- c) Energising the "fuel - cut off" solenoid.

The operation of the safeguard shall at the same time give individual warning of the failure by illuminating an appropriate local visual indicator and remote alarm at generator panel.

The contactors, relays and other devices necessary for signal and control, for above purposes shall be provided at Generator panel.

At the set at a easily accessible place an "EMERGENCY STOP" mushroom head stay put type P.B shall be provided to stop the set in emergency mode.

The safe guards to "STOP THE SET" shall stop the set irrespective of mode selection of the set viz Auto, Manual or test for following cases, with simultaneous isolation of alternator circuit.

Emergency stop P.B's operation.

- b) Over speed.
- c) Low lube oil pressure.
- d) Earth fault or restricted earth fault or differential faults of Alternator.

1.8 BATTERY & BATTERY CHARGER :

1.8.1 Starter Battery :

- a) The battery shall conform to the requirement of IS-1651. Starting battery sets of 12 V, heavy duty high performance approved make/quality shall be provided to enable crank & start the engine even in cold/winter morning conditions. Type/ voltage/AH capacity of same on 20 hour rated discharge period shall be indicated in the offer. The battery shall be capable of performing at least eight (8) normal starts without recharging. Necessary battery calculations shall be furnished at the time of bid.
- b) The Battery shall be provided with good quality MS stand painted with one coat of Zinc Oxide & two coat of acid proof black paint with min **3 mm thick rubber mat** below the battery.
- c) Batteries shall be of lead container type only and not with PVC moulded sealed container so that each individual cells are available for individual monitoring during its life span. Each cell shall be provided with electrolyte filling cap with level floats for easy monitoring of electrolytic level.
- d) For each battery system following accessories shall be provided.
 - 1. PVC Funnel - 1 No.
 - 2. Small PVC mugs with handle - 2 Nos. (Red & white colour)
 - 3. Hydrometer syringe type with float calibrated (not with zero markings only) with one spare float.
 - 4. Centre zero voltmeter good quality with 3V-0-3V scale.
 - 5. PVC jerry-can white colour with tested quality distilled water, with can clearly marked with engraved PVC inscription plate "Distilled Water".
 - 6. One tin of petroleum jelly (500 gms).
 - 7. Painter brush 1" wide - 2 nos.
 - 8. Hand Fuel Pump - 01 No.
- e) The battery shall be provided with 2 nos. cables, min 1.5 m long heavy duty rubber/PVC insulated cabling with brazed tinned lug at one end and with brazed tinned brass terminal lug at battery end - for connecting batteries to cranking system - with 0.25 m long inter battery connecting cable.
- f) The lugs shall be clearly stamped + or - and positive cable also red sleeved for easy identification.

g) The batteries shall be supplied fully filled and charged ready to use.

1.8.2 Battery Charging System :

- a) Float rate charging and quick rate charging system shall be provided at the generator panel with appropriate bridge charger system, LC network, rate selector switch and generously rated charging transformer and silicon one rectifier bridge, so that the cranking battery system can be kept fully charged at all times from E.B. supply network with quick charging rate limited to 0.8 times rated discharge current with provision in control transformer and Silicon rectifier present to enable boost charging the battery at 2 times rated discharge current in case of emergencies. To this and in the mode selector switch boost charge position shall be present which however shall be kept disconnected at mode selector switch normally.
- b) Two DC ammeters to clearly indicate float charging current and quick/boost charging current shall be provided with 0-250 or 0-500 mA range and 15-0-15 or 30-0-30 A range respectively.
- c) The float charging ammeter circuit logic shall be so as to bring in circuit only on demand through a P.B. the R.S.S. (Rate selector switch) in it float charging mode to prevent damage to the ammeter.
- d) Dropper resistor network on the load side of battery charger system shall be provided so that higher charger voltages in quick or boost conditions does not get impressed on the I/L and contactor coils, which voltage shall remain well within +10% of rated voltage.
- e) Battery charging subsystem shall be designed for continuous operation at cubicle ambient of 50 deg C corresponding to 45 deg C ambient outside and should be designed to operate at 1.5 times rated maximum current corresponding to boost charge current which can reach in practice as high as 2.5 times or 3 times rated discharge current.
- f) Any charger dynamo and dynamo charging current network present on the set shall either have to be removed or made in operative so that both for AMF and manual application the cranking battery system is kept charged from the charger at the panels at all times during or shut down periods of the set.

1.9 ENGINE EXHAUST :

The exhaust of DG set shall be routed through the residential type silencer. It is desired to insulate the exhaust duct/chimney with insulation & appropriate support arrangement & adequate trap door with feasibility of cleaning.

1.10 SPARE PARTS :

1.10.1 Mandatory Spare Parts :

The list of mandatory spares which are considered essential by the Supplier shall be indicated in the bid for successful operation of DG Set for 3 years.

1.11 TESTS :

1.11.1 The alternator of each type and rating shall be type tested for the all tests as per IS:4722, IEEE 115 & BS:5000. Required type test certificates shall be furnished for information.

1.11.2 The alternators and the starting motors shall be tested for the routine tests as per IS:4722 and test certificates submitted for acceptance.

1.11.3 The control panels shall be tested/checked for following (but not limited to).

- a) Compliance to drawing, data sheet and this specification.
- b) Check for workmanship, wiring, conformity to functional requirements.
- c) Calibration of instruments, meters C.T., P.T. etc.
- d) H.V. Test
- e) I.R. Test before and after HV test.

1.11.4 The acceptance and routine tests of battery shall be done as per relevant standard.

1.11.5 Battery Charger (as per IS: 4540)

- a) All routine tests as per relevant IS.
- b) Test for ripple factor & regulation
- c) Heat run test (as type test)
- d) Operational and functional tests.

1.12 SPECIFIC EXCLUSIONS :

The civil works related to DG foundation is included in the scope of works under this specification. DG Vendor has to make sure OEM's approved or referred civil foundation & structure drawings for genset base.

1.13 NEUTRAL POINT : The winding of the alternator for 320 KVA shall be star-connected and neutral side leads shall be brought out to a separate terminal box.

1.14 ERECTION, TESTING, COMMISSIONING, PERFORMANCE & GUARANTEE TESTS / PROCEDURE AT SITE :

Client shall provide space for genset and its equipments. Contractor shall prepare and submit to Architect/Consultant the following drawings in six sets for approval before commencing the erection for construction work at Site –

- i. Equipment Layout drawing.
- ii. Foundation drawing of each equipment and supervise the foundation casting by another agency to ensure its corrections.
- iii. Bus ducting/Power cable, control cable and earth layout drawing.
- iv. Single line diagram.
- v. AMF Panel details.
- vi. Genset and controller wiring diagram
- vii. Canopy design with frame work details.

The entire work of erection, testing and commissioning of equipment supplied under this package shall be carried out by contractor and performance and guarantee tests to be conducted at site are also included under the scope of this specification. For this purpose the contractor shall depute suitable qualified technical supervisor to site on advance intimation to the Owner along with all special testing equipment required for testing and performance and guarantee tests. The supervisor(s) shall be responsible for the installation, testing, commissioning checks and performance & guarantee tests mentioned in relevant clauses of this volume and the checks recommended by the contractor.

The successful contractor shall submit sufficiently in advance the bio-data of the supervisor giving details of his experience for Owner's approval.

The vendor shall ensure that the equipments supplied by him are installed in a neat workman like manner such that they are levelled, properly aligned and well oriented. The tolerances shall be established in Contractors drawings and/or as stipulated by the Owner. The canopy of the Genset shall be strong and Waterproof (extra coating of any if required, has to specify while bidding)

All special tools and tackles and spares required for erection, testing and commissioning of equipment shall be supplied by the contractor. The bid shall include a list of these special tools, tackles and spares along with their item wise prices. The total cost for these tools, tackles and spares shall be included in the bid price.

Erection, testing and commissioning manuals and procedures shall be supplied, prior to dispatch of the equipment.

The contractor shall ensure that the drawings, instruction and recommendations are correctly followed while handling, setting, testing and commissioning the equipment.

1.14.1 Commissioning Check Tests/Performance and Guarantee Test :

In addition to the checks and test recommended by the manufacturer, the contractor shall supervise the following acceptance tests to be carried out on each set.

Load Test :

The engine shall be given test run for a period of at least 13 hours depending upon the actual power factor of the load and set shall be subjected to the maximum achievable load without exceeding the engine or alternator capacity.

This full load test is to be followed immediately by a 10% overload run for one hour. The performance of the engine, alternator and exciter shall be satisfactory at the end of this overload run. All the arrangements of factory visit of IUCAA engineers & consultant - three engineers including stay-if required, shall be in the scope of DG vendor. At the end of the full-load run, and again at the end of the over-load run, tests for temperature rise and insulation resistance of the alternator as specified shall be taken.

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

- a) Ambient temperature
- b) Exhaust temp. when exhaust thermometer is fitted.
- c) Lubricating oil temperature when an oil cooler is fitted.
- d) Lubricating oil pressure
- e) Speed
- f) Voltage, wattage and current output.
- g) Oil tank level
- h) Stored diesel oil temperature**

Regulation Test :

The automatic and manual regulation of the alternator load at half and full rated load shall be tested for a nominal volt of 240 volts, between phase to neutral and at 0.8 p.f. to verify the requirements of voltage and frequency variation as per IS:4722.

Speed and Governing:

The speed of the engine shall be verified to ensure that it conforms to the requirement of BS:5514.

Vibrations :

The vibrations shall be measured during full load test as well as during the overload test and the limit shall be limited to 250 microns.

Check of Fuel Consumption : A check of the fuel consumption shall be made throughout the test run of full load and overload.

Insulation Resistance of Wiring :

On completion of the engine tests, the insulation of each unit of local wiring in the control cubicles and other components of the engine set, shall be tested with a 500 V insulation tester. The insulation resistance shall not be less than one mega-ohm. between wires in a cable and engine set frame of cable sheath. Test will be done before and after the running of Genset

Functional Tests :

- a) Protective equipment on the engine against excessive cylinder temperature and low lubrication oil pressure.
- b) Type of starting provided for the engine.
- c) Pilot and fault indication lamps.

1.15 DATA SHEET FOR D.G. SETS (To be filled by the Vendor along with the bid)

Sr. No.	PARAMETERS	320 KVA
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1.0 Applicable Standards :

2.0 ENGINE:

- 2.1 Type :
- 2.2 Make :
- 2.3 Model Number :
- 2.4 Engine BHP :
- 2.5 RPM :
- 2.6 No. of Cylinder :
- 2.7 Specific Fuel Consumption at 100% Load Litre/Hr. :
- 2.8 Type of Cooling :
- 2.9 Type of Starting :

3.0 ALTERNATOR:

- 3.1 Make :
- 3.2 Model Number :
- 3.3 Type of Enclosure :
- 3.4 Mounting :
- 3.5 KW Rating :
- 3.6 KVA Rating :
- 3.7 Insulation :

- 3.8 Excitation :
- 3.9 Terminal Box Provided (Yes/No) :
- 3.10 Earthing Studs :
- 4.0 Dimensions (LxWxH) :**
- 5.0 Weight (in Kgs) :**
- 6.0 Anti-vibration pad provided (Yes/No) :**

7.0 BATTERY CHARGER:

- 7.1 Type:
- 7.2 Make:
- 7.3 Ampere Hour Rating:

8.0 CONTROL PANEL :

- 8.1 Type :
- 8.2 Facilities provided (bidder to furnish
Details & brief description) covered :
- a) Monitoring :
- b) Startup :
- c) Changeover :
- d) Operation :
- f) Protection & interlocks & safeguards :
- 8.3 Cable entry :
- 8.4 Weight :
- 8.5 Dimensions :

(NOTE : The tenderer should fill-in all the data in above format only. If above mentioned data is not filled properly or partially filled tender shall be liable to rejection).

9.0 ACOUSTIC ENCLOSURE :

The framework shall be made out of suitable sheet steel with anti-corrosive paint. Specially designed acoustic doors shall be provided with glass window for visibility of the DG sets from outside. These doors shall have a proper sealing arrangement to ensure that there is no sound leakage.

The enclosure shall be provided with suitable ventilating/exhaust fans for fresh air & hot air exhaust with all accessories required. The ventilation system shall be designed so that the temperature rise in acoustic enclosure shall be less than 15 Deg C above ambient.

The enclosure shall be supplied with necessary anti vibration pads between DG & Enclosure and also between enclosure & foundation.

Noise level – 75dB right around measured at a distance of 1 meter from the enclosure.

10.0 EXECUTION :

Vendor shall give necessary inputs for designing the foundations & shall be responsible for design, erection shall happen after completion of foundation works (done by other agencies). Vendor shall co-ordinate with other agencies like electrical contractors, civil contractors etc.

Further to erection, testing and commissioning of the DGs, the termination of cables at DGs, Between DGs and Main LT panel end shall be done by the main electrical contractor. Calibration of CTs, approval from statutory authorities like electrical inspectorate, PCB etc shall be the responsibility of the DG supplier. DG supplier shall coordinate with main electrical contractor for necessary control & power cable termination.

11.0 Auto Synchronizing & Auto Load Sharing Panel for 4 x 320 KVA DG Sets :

The panel includes Motorized MCCB FP 630A 36 KA with O/C, S/C & E/F as Incomer 1 to 4 from the DG set # 1 to 4. The ACB should be equipped with U/V, O/C, S/C and E/F protection. R-Y-B indication, ON, OFF, Trip indication, and Load Manager for measurement of ampere, voltage, Kw, kwh and frequency, and Max Demand with PC Compatible port. Microprocessor- based Relay with AMF, Auto Synchronizing & Auto Load Sharing and Auto shut off facility. It should have capability to manually synchronize the DG's. The 2 panels already handling 2 x 320 KVA DG set load, this tender is to add one more Genset for already available panel and get synchronise with them to share the load. Load Manager for measurement of ampere, voltage, Kw, KWh and frequency, and Max Demand with RS 232 / RS 485 port. The panel should have the following feeders: 4 Nos. 630 Amp FP MCCB 36 kA for with ON/OFF/TRIP indication & 01 No. 2000 A, 65 kA FP ACB, Busbar 2500 Amp, 65 kA

The panel shall be vermin proof and dustproof, having chemical surface treatment and finishing shall be of 2-coats of synthetic enamel, RAL – 7032

All internal wiring shall be of FRLS 1.1 KV grade, PVC wires. CT shorting links are to be provided for Ammeter and protection circuit.

A) **GENERAL :** The switchboard shall be metal clad, totally enclosed, rigid, compartmentalized design, floor mounting, air insulated, extensible cubicle type for use on low voltage power, 415V, 3 phase 4 wire, 50 Hz system. The equipment shall be designed for operation in high ambient temperature and high humidity tropical atmospheric conditions. Means shall be provided to facilitate ease of inspection, cleaning and repairs for use in installations where continuity of operation is of prime importance.

STANDARDS :

Following equipments shall conform to the requirements as per the latest revisions of the following standards: -

1. Air Circuit Breaker (ACB) : IS 13937- 1.2 / IEC 947 - 1.2
2. Moulded Case Circuit Breaker (ACB) : IS 13947 - 1.2/ IEC 947 - 1,2
3. Contactors : IS 13947-1,4
4. Miniature Circuit Breaker (MCB) : IS 8828- /IEC898
5. Residual Current Circuit Breaker (RCCB) : IS 12640 - / IEC 1008
6. HRC fuse link : IS 9224 and BS 8:8
7. Current Transformer : IS 2705 and IEC 185

- | | | |
|-----|----------------------------|-----------------------|
| 8. | Potential Transformer- | : IS 3156 |
| 9. | Relay -(For Static Relays) | : IS 3231 and IS 8686 |
| 10. | Indicating Instrument- | : IS 1248 |

B) TYPE AND CONSTRUCTION

The switchboard shall be metal clad, totally enclosed, rigid, compartmentalized design, floor mounting, air insulated, extensible cubicle type, CNC fabricated for use on medium voltage power, 3 phase 4 wire 50Hz system. The overall construction shall meet Form-4 constructional requirements.

C) GENERAL CONSTRUCTIONAL FEATURES:

The switchboard shall be:

- a) CRCA-Sheet steel enclosed, indoor floor mounted free-standing cubicle type & CNC fabricated.
- b) Made up of the requisite vertical sections which when coupled together shall form continuous switchboards.
- c) Dust, vermin and damp proof and enclosure protection not less than IP 42 for indoor & IP55 for outdoor applications and IP:32 for Battery Chargers or as specified elsewhere.
- d) Each feeder/instrument compartment shall be provided with a hinged door interlocked with ACB/LBS inside the compartment such that door can only be opened when ACB/ in off position.
- e) Readily extendable on either side by the addition of vertical sections after removal of the end covers.
- f) Switchboards shall have access to the feeders, bus bars, cable termination, cable alley, etc. as required.
- g) All CTs for metering/protection shall be mounted in respective feeder compartments either in front or on the rear side of the same compartment for easy maintenance without disturbing other feeders.
- h) Mounting of any metering OR instrumentation equipments in Bus chamber is not envisaged.
- i) All CT wiring shall be done with CT terminal block with shorting facility mounted in the metering compartment.
- j) Wherever control wiring is done between the shipping sections, terminal blocks shall be provided on both sides of shipping sections with TB diagram pasted near to the TBs.
- k) The total height of the panel shall not be more than 2200mm unless otherwise specified and maximum height of switch operating handle shall not be more than 1800mm from FFL. The

maximum shipping section shall be of 2000mm width. The total depth of the panel shall be adequate to cater for proper cabling space.

- l) Sheet thickness shall be as below
- Main frame : 2.5/3mm
 - Doors : 2mm
 - Covers/partitions : 1.6mm
 - Gland plate : 3mm

Wherever single core cables are used, 3mm thick aluminium gland plate shall be provided. All sheet steel work forming the exterior of switchboards shall be smoothly finished, levelled and free from flaws. The corners should be rounded.

- m) The Components in the switchboards shall be so arranged as to facilitate ease of operation and maintenance and at the same time to ensure necessary degree of safety.
- n) Components forming part of the switchboards shall have the following minimum clearances:
- | | |
|----------------------------|--------|
| Between phases | - 30mm |
| Between phases and neutral | - 25mm |
| Between phases and earth | - 20mm |
| Between neutral and earth | - 20mm |

Creepage distances shall comply to those specified in relevant standards.

- o) All insulating material used in the construction of the equipment shall be of non-hygroscopic material treated to withstand the effects of high humidity, high temperature and tropical ambient service conditions.
- p) Functional units such as circuit breakers, fuse switches, ACBs, etc. shall be arranged in multi-tier formation except that not more than two air circuit breakers shall be housed in a single vertical section.
- q) Metallic/insulated shrouding shall be provided within vertical sections and between adjacent sections to ensure prevention of accidental contact with Main bus-bars and vertical risers during operation, inspection or maintenance of functional units and front mounted accessories.
- r) Cable terminations of one functional unit, when working on those of adjacent unit/units.
- s) All covers providing access to live power equipment/circuits shall be provided with tool operated fasteners to prevent unauthorized access.
- t) Provision shall be made for permanently earthing the frames and other metal parts of the switchgear by two independent distinct connections.
- u) Thickness tolerance for sheets shall be as applicable in relevant IS.
- v) All capacitor control panels shall be of compartmentalized design. All capacitors & reactors shall have individual compartments. Exhaust fans shall be provided for ventilation purpose.
- w) The complete panel shall be designed such that it's rating is as per SLD without derating considering ambient temperature & temperature rise as per IS/IEC. De-rating of ACBs/ACBs

or the whole panel shall not be accepted. Panel shall be provided with necessary ventilation arrangements to meet the above requirement.

(D) EACH VERTICAL SECTION SHALL COMPRISE:

- a) A front framed structure of rolled/folded CRCA sheet steel angle section rigidly bolted together. This structure shall house the components contributing to the major weigh of the equipment such as circuit breaker cassettes, fuse switch units, main horizontal bus bars, vertical risers and other front mounted accessories.
- b) The structure shall be mounted on a rigid base frame of folded CRCA sheet steel of minimum 6 mm thickness and 100 mm height or ISMC100. The design shall ensure that the weight of the components is adequately supported without deformation or loss of alignment during transit or during operation.
- c) A cable chamber housing the cable end connections and power/control cable terminations. The design shall ensure generous availability of space for ease of installation and maintenance of cabling and adequate safety for working in one vertical / horizontal section without coming into accidental contact with live parts of the adjacent section.
- d) A cover plate at the top of the vertical section, provided with a ventilating hood wherever necessary. Any aperture for ventilation shall be covered with a perforated sheet having less than 1mm diameter perforations to prevent entry of vermin.
- e) Front and rear doors fitted with dust excluding neoprene gaskets with fasteners designed to ensure proper compression of the gaskets. When covers are provided in place of doors generous overlap shall be ensured between sheet steel surfaces with closely spaced fasteners to preclude the entry of dust.

(E) METAL TREATMENT AND FINISH :

- a) After fabrication the panel shall under go 7 tank treatment/sand blasting for removing grease, Rust etc. The panel shall be coated with zinc chromate primer(Applicable for outdoor panels).
- b) After coating of primer, the panel shall be coated with Epoxy based paint (powder coating/spray paint). Paint shade shall be as specified by the client/consultant during drawing approval.

(F) BUS BARS :

- a) The bus bars shall be made of high conductivity, Electrical grade Aluminum or copper (As specified in SLD), suitable for 415 volts, 3 phase 4 wires 50 Hz,
- b) The bus bars shall be suitably supported with non-hygroscopic supports to provide a fault withstand capacity as specified.
- c) High tensile (8.8 grade) bolts and spring washers shall be provided at all bus bar joints.
- d) Fish plates of equal type and size shall be used at all joints.

- e) The bus bars shall have uniform cross section throughout and shall be capable of carrying the rated current at 415V continuously. The bus bars shall be designed to withstand a temperature rise of 40 Deg. C above the ambient temp. of 50 deg. C. A current density (Amp/Sq.mm) shall not exceed 1 A/sq.mm for copper & 0.8 A/Sq.mm for Aluminium.
- f) The neutral bus bars shall have a continuous rating of at least 50% of the phase bus bars unless otherwise mentioned.
- g) Bus bars shall be fully sleeved using heat shrunk PVC sleeves appropriately color coded to identify different phases and neutral bar.
- h) All lighting & raw power panels/SMSBs shall be provided with neutral bus rated same as the size of Phase Busbars unless otherwise specified in SLD.
- i) MCCB/ACBs of rating 200A & above rating shall have copper spreaders on terminals & then connected to main busbars.
- j) All panels shall be provided with aluminium earth bus, which shall run throughout the length of switch board at top or bottom as required. Following size of earth bus shall be provided as per the switchboard rating:

PANEL RATING	Al. EARTH BUS SIZE
Up to 100A	25x3mm
250A	25x6mm
315A	25x10mm
400 to 630A	30x10mm
800 to 1000A	50x6mm
1250 to 2000A	50x10mm
2500 to 3200A	60x10mm
4000A	100x10mm

(G) POWER/CONTROL WIRING:

All control wiring shall be carried out with 1100/660 V grade single core PVC-FRLS cable having stranded copper conductors with minimum cross section of 1.5 Sq.mm for potential & control circuits and 2.5 Sq.mm for current transformer circuits. Control wiring for analog, digital inputs/outputs shall be done with 1.5/1 Sq.mm screened copper cables. All power cables shall be minimum cross section of 4 Sq.mm.

The colour coding of cables shall be as below:

- a) Power up to 25Sq.mm : Red/Yellow/Blue/black
- b) CT & PT : Red/Yellow/Blue/black
- c) Control AC : Black

- d) Control DC : Grey
- e) Analog/digital circuits : Red/black-screened

Wiring shall be neatly bunched, adequately supported and properly routed to allow for easy access and maintenance. Wires shall be identified by numbered ferrules at each end. The ferrules shall be of ring type and of non-deteriorating material. They shall be firmly located on each termination so as to prevent free movement. All control circuit fuses/MCBs shall be mounted in front of the panel and shall be easily accessible. All CT wiring shall be done with CT terminal block with Shorting facility mounted in the metering compartment.

Wherever control wiring is done between the shipping sections, terminal blocks shall be provided on both sides of shipping sections with TB diagram pasted near the TBs. Control wiring for analog, digital inputs/outputs shall be done with Screened cables & routed separately to avoid EMI.

(H) TERMINAL BLOCKS :

Terminal blocks shall be of 500 Volts grade and of stud/screw type. Terminal blocks shall have a minimum current rating of 10 Amps and shall be shrouded. Provisions shall be made for label inscriptions. At least 20% spare terminals shall be provided on each panel and these spare terminals shall be uniformly distributed on all terminal blocks. Terminal blocks for current transformer and voltage transformer secondary leads shall be provided with test links and isolating facilities with disconnecting type TBs. Also current transformer secondary leads shall be provided with Terminal block with short circuiting and earthing facilities.

Terminal blocks for power feeders shall be of stud type with bolts & nuts.

There shall be a minimum clearance of 250mm between the first row of terminal blocks and the associated cable gland plate. Also, the clearance between two rows of terminal blocks shall be a minimum of 150mm.

(I) CABLE TERMINATIONS :

a) Cable entries and terminals shall be provided in the switch board to suit the number, type and size of aluminium conductor power cables and copper conductor control cable specified in the detailed specifications.

b) Provision shall be made for top or bottom entry of cables as required. Generous size of cabling chambers shall be provided with the position of cable gland and terminals such that cables can be easily and safely terminated.

c) Barriers or shrouds shall be provided to permit safe working at the terminals of one circuit without accidentally touching that of another live circuit.

e) Cable risers shall be adequately supported to withstand the effects of rated short circuit currents without damage and without causing secondary faults.

f) Sufficient height shall be provided between busbar & gland plate in case higher size cable & more number of runs. Min. cable termination heights from gland plate shall be as below:

Up to 35 Sq.mm	: 200mm
50 to 95 Sq.mm	: 250mm
120 to 185 Sq.mm	: 350mm
240 to 400 Sq.mm	: 550-600mm

12.0 INSTRUMENT TRANSFORMERS :

A) CURRENT TRANSFORMERS :

a) Current transformer shall comply with the requirements of IS 2705. They shall have ratios, outputs and accuracy as specified/required. All CT's shall be of resin cast type unless otherwise specifically called for.

b) All CT's shall be of bar type primary or suitable for the cable given type and size.

c) For all the CT's suitable type and size clamps are to be supplied for mounting in the switchboards.

d) Polarities and terminal markings of primary and secondary shall be clearly marked on all CT's.

e) Specifications for CT's :

1. Current Ratios :

i. Primary : As per SLD

ii. Secondary : 5A

2.Type : Resin Cast

3.Class : PS-REF Protection
5P10-O/C & E/F Protection
Class 1 for metering

4. System Voltage : 440 Volts

B) POTENTIAL TRANSFORMER :

a) All the Potential Transformers shall comply with the requirements of IS 3156 latest edition. All PT's shall be resin cast type and shall have Voltage ratios, output and accuracy class as specified in SLD/Data Sheet.

b) All PT's shall be single phase, dry type suitable for mounting inside the panel/cubicles. Clamps / brackets / supports required for the mounting shall be supplied along with PT.

c) Polarities and Terminal markings shall be clearly marked in all PT's.

d) Name plate indicating, voltage ratio, burden, accuracy class, type, Sr. No. Make and Model etc., shall be provided.

e) A common earth terminal for earthing of core, bolts, clamps (noncurrent carrying metal parts) etc., shall be provided.

13.0 BREAKERS :

13.1 AIR CIRCUIT BREAKERS :

A) GENERAL:

The ACBs shall conform to IS 13947-1 / IEC 60947-1 for general rules and IS 13947- 2/IEC 60947-2 for Circuit Breakers. The ACBs shall be suitable for 3 phase 415 Volts. All the breakers shall have topicalization as a standard feature. ACBs shall meet the following minimum parameters

Rated operational Voltage	: 690V
Rated insulation Voltage	: 1000V
Rated impulse withstands Voltage	: 9kV
No. of mechanical operations	: 25,000(up to 2000A) 15,000(above 2000A, up to 4000A)
No. of electrical operations	: 10,000(up to 2000A) 5,000(above 2000A, up to 4000A)

B) CONSTRUCTION:

The Breaker shall be suitable for rear and vertical mounting and line load reversibility. All ACBs shall be draw out type & shall be with service-test-isolated positions.

C) CONTROL UNITS:

The Control Units shall be housed in a separate enclosure and there shall be total insulation of the control unit with respect to the power unit.

The Control Unit shall be of Microprocessor type & suitable to provide short circuit, overload and earth fault protection.

The setting range of the short circuit protection shall be from 3 to 9 x In and 5 to 15 x In. The overload settings shall be adjustable from 0.4 to 1.0 times the rated current.

The breaker shall provide Earth fault protection from 0.2 to 0.7 times rated current.

D) ACCESSORIES:

The connection for the auxiliary shall be accessible from the front.

ACB shall be provided with following accessories, in addition to the item specified in Bill of Quantities. Further these devices shall be fittable at site from the front and common for all ratings.

- a) Under Voltage trip coil.
- b) Shunt trip coil.
- c) Closing coil,
- d) 4NO + 4NC auxiliary switches.
- e) Fault indicator/Reset unit.
- f) Pad lock

E) INTERLOCKING:

ACBs shall be provided with the following interlocking: -

- a) Pad lock to prevent unnecessary manipulations of the breaker.
- b) Electrical interlock shall be done by using breaker aux. contacts only

F) BREAKING CAPACITY:

The ACB shall have minimum service breaking capacity of 65 kA. Preferably Ics shall be equal to ultimate breaking capacity Icu or it shall be rated as specified in SLD. Original test certificate of the ACB as per the IS shall be provided on request.

13.2 ACB / MOULDED CASE CIRCUIT BREAKER

The Moulded Case Circuit Breaker shall be incorporated in the switchboard wherever specified and shall be of the current limiting type. ACB shall conform to IS 2516, IS 13947-1/ IEC 947-1 (part I & II / section 1) 1977 for general rules. It should be suitable for Horizontal and Vertical mounting and line load reversibility. ACB shall be suitable either for Single Phase AC 230V Or Three Phase 415V. The MCCB/ACB shall be available in four pole versions for neutral isolation. It shall have tropicalisation as standard feature. The ACB/MCCB cover and case shall be made of high strength heat-resistant and flame retardant thermosetting insulating material. The operating handle shall be quick make, quick break, trip - free type. The operating handle shall have suitable 'ON' 'OFF' 'TRIPPED' indicators and in order to ensure suitability for isolation complying with IS 13947-2/IEC947-2, the operating mechanism shall be designed such that the toggle or the handle can only be in 'OFF' position, if the main contacts are actually separated.

A) ACCESSORIES:

ACB shall be designed to have following accessories and it shall be fittable at site.

- 1) Under voltage trip
- 2) Shunt trip
- 3) Alarm switch
- 4) Auxiliary switch

B) INTERLOCKING:

ACB shall be provided with following interlocking devices for interlocking the door of a switch board.

- a) Handle (Pad lock) interlock to prevent unnecessary manipulations of the breaker.
- b) Door interlock to prevent door being opened when breaker is in ON position.
- c) The interlocking defeating device to open the door even if the breaker is in ON position, In addition to the above, all other features indicated in the Bill of Quantities/SLD shall also be provided.

C) BREAKING CAPACITY:

Short time with-standing capacities & breaking capacities for different ratings of ACBs shall be as specified in the SLD.

Preferably Ics shall be equal to Icu or all breaking capacities shall be considered for Ics.

D) RELEASES:

Unless otherwise specified all ACBs up to 250A (including 250A) shall be provided with thermal magnetic releases & all ACBs of rating 315A & above rating shall be provided with Microprocessor releases.

All ACBs with Thermal magnetic releases shall be provided with adjustable overload of 70/80-100% & fixed short circuit releases.

All ACBs with Microprocessor releases shall be provided with adjustable overload of 50- 100% & adjustable short circuit releases.

Wherever earth fault module is required it shall be inbuilt with other releases, i.e. separate module for E/F is not recommended.

14.0 AMF Relay :

AMF Relay having numeric digital controller technology, Alpha numeric LCD displays with keypad having supervision of 3 phase mains voltages & DG voltages, remote starting & stopping facilities, 3 operating modes i.e automatic, remote, manual, password protection & able to start the stand by generators in case of main failures. The relay should at least following features:

- 1) Display of voltage, frequency of mains parameters
- 2) Display of generator parameters like V, Hz, Speed, Run hours
- 3) Measurement of load current
- 4) Site name & no. is programmable
- 5) Digital inputs, 6 relay outputs, 11 LEDs
- 6) Last 3 faults & events record
- 7) Internal interlock for EB & DG breaker for fail safe operation
- 8) Wide array of time circuit for start delay, stop delay, mains restoration, recooling etc.
- 9) Full engine safety function like :
 - 9.1) Over / Under frequency, speed indication, shutdown
 - 9.2) DG fault like fail to start, fail to stop & low battery
 - 9.3) Overload protection & selectable overload setting
 - 9.4) Protection against undesired conditions monitored via digital inputs
 - 9.5) Protection against engine faults like LLOP, SCT, Low fuel & over speed, phase reversal etc

15.0 Synchronization Controller Relay for Generators:

The Synchronization Controller relay should have programmable atleast 10 digital inputs, 18 analogue input, 8 output relays, 2 analogue output & communication port like RS 232, RS 485, USB & Bus communication & suitable converter for bacnet bus. It may also be indicated whether Stand Alone SNMP protocol-based communication interface is available for the generator control panel. The controller shall be able to control/monitor

following alarms of engine & alternator:

- 1) Engine temperature warning (analog sensor)
- 2) High engine temperature alarm (analog sensor)
- 3) Temperature analog sensor fault
- 4) High engine temperature alarm (digital sensor)
- 5) Oil pressure warning (analog sensor)
- 6) Low oil pressure alarm (analog sensor)
- 7) Oil pressure analog sensor fault
- 8) Low oil pressure alarm (digital sensor)
- 9) Temperature digital sensor fault
- 10) Fuel level warning (analog sensor)
- 11) Low fuel level alarm (analog sensor)
- 12) Fuel level analog sensor fault
- 13) Low fuel level alarm (digital sensor)
- 14) High battery voltage
- 15) Low battery voltage
- 16) Faulty battery
- 17) Battery charger alternator fault
- 18) Low engine speed
- 19) High engine speed
- 20) Starting failure
- 21) Emergency button
- 22) Mechanical failure
- 23) Stop failure
- 24) Low generator frequency
- 25) High generator frequency

- 26) Low generator voltage
- 27) High generator voltage
- 28) Generator overload
- 29) External generator protection
- 30) Generator wrong phases sequence
- 31) Mains wrong phases sequence
- 32) Wrong frequency setting
- 33) Generator contactor fault
- 34) Mains contactor fault
- 35) Internal system error
- 36) Expired rental hours
- 37) Low water level in the radiator
- 38) Ambient temperature too high
- 39) Ambient temperature too low

15.1 Controller shall be able to manage at least following functions:

- 1) Mains/Generator synchronization
- 2) Generators synchronization without limits
- 3) Bus communication
- 4) TCP/IP static address, for Ethernet/LAN control
- 5) Insulated analog output for voltage regulator +/-5V
- 6) Insulated analog output for RPM regulator 0-10V or 10-0V
- 7) Insulated voltage inputs 500Vac or 100Vac
- 8) Insulated inputs
- 9) Current measurements on Dead Bus
- 10) Active and reactive power sharing
- 11) Synchronization between sources with different powers

- 12) Quick control by display of voltage and current parameters
- 13) Sharing on mains when the mains voltage returns
- 14) Synchronoscope and "zero voltmeter" for manual operation
- 15) Self-learning function for quick and auto managed synchronizing
- 16) Management of mixed systems with several mains and several generators
- 17) Complete remote-control system,

16. Cables

1) *Codes And Standards*

The design, material, construction, manufacture, inspection, testing and performance of LV power cables supplied shall comply with all currently applicable statutes, regulations and safety codes in the locality where the material will be installed. Nothing in this specification shall be construed to relieve the BIDDER of his responsibility. Where no standards are available, the supply items shall be of good quality and workmanship and backed by test results. Any supply items which are bought out by the BIDDER shall be procured from MANUFACTURERS approved by the PURCHASER.

The cables covered by this specification, unless otherwise stated, shall be designed in accordance with the latest editions of the following standards.

IS 7098 -1988 (Part I)	Specification for XLPE insulated electrical cables
IS 8130-1984	Specification for conductors for insulated electric cables and flexible cords
IS 5831-1984	Specification for PVC insulation and sheath of electric cables
IS 3975-1988	Specification for mild steel wires, strips and tapes for armouring cables
IS 694	PVC insulated cables for wiring (1100V)
The cable manufacturing company should have been qualified for ISO-9001/2.	

2) *Design And Manufacturing Requirements*

Following are the technical particulars for the cables:

Power supply	: 415V, 3 phase, 4 wire,
Grounded system	: Solidly grounded.
System fault level	: 35 MVA (50 KA) symmetrical.
Type of cable	: Aluminium conductor, Cu conductors, XLPE insulated, armoured power cables
Voltage grade	: 1100 Volts
No. of cores	: 3 ½ core; 1 core

The cables supplied under this specification shall be aluminium/copper conductor, XLPE insulated, FRLS PVC sheathed and steel wire armoured cables. Adequate insulation shall be provided for the cables to operate continuously at the specified voltage with a high degree of safety and reliability throughout the life of the cables.

The insulating and sheathing materials shall be high quality XLPE and PVC based compound respectively.

The armoured cables shall conform to the following construction: XLPE insulated stranded & shaped aluminium conductor cable (as the case may be) with cores suitably laid up, extruded with inner sheath of unvulcanised rubber or thermo-plastic material compatible with insulating material, round steel wire armoured and overall extruded with general purpose FRLS PVC outer sheath, black conforming to IS: 7098 (Part-I):1988, 1.1KV grade.

The insulating material for power cables shall be cross linked polyethylene (XLPE) compound as per IS-7098 (Part-I/II)-1988. Gas curing process is desirable for XLPE insulation. The average thickness of insulation shall not be less than the values specified in Table-3 of IS-7098 (Part-I)-1988. The cores shall be identified by the following colour schedule:

3&1/2 core: Red, yellow, blue, black, reduced neutral core being black.

3) Inspection And Testing

The BIDDER shall carry out all the shop tests and inspections specified in the following clauses in addition to those normally carried out by him. For Material not covered by any code or specifically mentioned in this specification, the tests are to be agreed with the PURCHASER. All type tests, acceptance tests, routine tests and physical tests for LV power Cables, shall be carried out as per relevant Indian and International standards like IEEE, IEC, ASTM etc, If the MANUFACTURER has already conducted the type tests, then the type test certificates shall be submitted along with his offer.

All the tests specified below shall be carried out in accordance with relevant Indian Standards by the manufacturer in the presence of purchaser's representative. **If the cable fails to pass the test specified, the purchaser shall have the option to reject it.**

3.1 Routine Tests

The following routine tests shall be carried out on each and every length of the cable in the presence of purchaser's representative at manufacturer's works.

- i) Resistance test for Aluminium/copper
- ii) High voltage test.

3.2 Type tests

The following type tests shall be carried out on samples taken out from the production lot.

- i. Tensile test for conductor
- ii. Wrapping test for conductor
- iii. Resistance test for conductor.
- iv. Test for thickness of insulation and sheath.
- v. Physical test for insulation and sheath.
- vi. Fire resistance test.
- vii. Insulation resistance test.
- viii. High voltage test (water immersion test).
- ix. Tests on armour wires.

3.3 Acceptance tests

- i. Tensile test (for aluminium).
- ii. Wrapping test (for aluminium).
- iii. Conductor resistance test.
- iv. Test for thickness of insulation and sheath.
- v. High voltage test.
- vi. Insulation resistance test.

3.4 FRLS tests:

- i. Critical Oxygen index as per ASDM-D 2863
- ii. Temperature index as per ASTM-D 2863 & BICC Handbook Chp. No.6
- iii. Smoke Density (Light Transmission) as per ASTM –D 2843
- iv. Acid gas generation as per IEC 754-1
- v. Flammability tests as per IEC 332-1 and IS 694:1990

• Optional Tests

- i) Cold bend test for outer sheath.
- ii) Cold impact test for outer sheath.

The purchaser at his option may waive all or any of the type tests, provided type test certificate carried out on essentially identical cable are furnished by the manufacturer.

4) Guarantee :

The cable shall be guaranteed against any type of defects and for trouble free operation conforming to this specification for a period of at least 12 months from the date of commissioning or 18 months from the date of despatch from the supplier's works, whichever is earlier. The following performance characteristics of cables shall be guaranteed at the maximum continuous rating, when operating under the specified operating conditions:

- i) Voltage drops.
- ii) Maximum current rating.
- iii) Operating conductor temperature.
- iv) Resistance at 20 deg C.

5) Identification Marks

The manufacturer shall be identified throughout the length of the cable by the manufacturer's name or trade mark indented or embossed on the outer sheath of the cable. The cable shall be identified as per clause 17 of IS:1554 (Part- I)-1988.

17. Earthing System

Maintenance free earthing shall be carried out in accordance with Indian Electricity Rules and Regulations amended till date and also the Earth electrodes shall be provided in conformity with BIS 3043/ BS 7430 of the latest version expecting the specified values detailed herein. The earth electrodes shall be of high tensile low carbon steel circular rods, molecularly bonded copper or clad copper on the outer surface 25 mm dia having at least 250-micron copper plating and not less than 3.0 m length and shall be driven to a depth in the ground below the ground level and 3 meters away from any other earth electrodes or as per latest BIS 3043. The premixed power set carbon based backfill compound shall be poured in the bore with water and re- close the bore (Preapproval needed from client). Earthing shall be covered with RCC enclosure of size 400mm (Length) x 400mm (Breadth) x 100 mm (Thick).

Note: Contractor must visit/ inspect the work site, before quoting

Below are the approved make list. Vendor has to follow the list's approved makes

S. No.	Name of Item	Make Approved
1	Genset (Diesel Generator)	Kirloskar, Cummins, Mahindra, Caterpillar
2	LT Breakers	Legrand/ABB/ Schneider
3	LT Cables	Finolex/RR Kabel/Gloster
4	MV Boards, MCCs	Arrow/Zenith
5	MCB Distribution Boards	Legrand/ ABB/Indo Asian
6	Moulded Case Circuit Breaker, MCB	Legrand/ABB
7	Fuel Level Indicator	Honeywell / Jonson/ Siemens
8	Current Transformer	Kappa/ Legrand/Starlite
9	LED Indicating Lamps	Legrand/ ABB/DSS
10	Fuses & Fuse bases	Legrand/Indo Asian// ABB/Siemens
11	Digital KWH Meters with RS 485 Ports	Legrand /ABB/Schneider/L&T
12	Indicating / Measuring Instruments	Legrand/ L & T /Schneider
13	Terminals	Elmex/ Connectwell
14	Cable Glands Single/Double Compression	Braco/Dowells
15	Relays	Areva/ ABB/Schneider
16	Bi-metalic Crimping Type Lugs	Dowells
17	Wire mesh Cable Trays	Legrand/Supernova
18	Multi-Function Meter	L & T / HPL/Schneider
19	Anchor fasteners	Hilti/ Shakti
20	Anti-Vibration mountings	Dunlop (Cushy Foot).
21	Battery	Exide
22	Battery charger	NHP/Chhabi Electric / Max Power
23	M.S./G.I. Pipes	TATA / Jindal / Zenith
24	Valves	Audco / Leader
25	Earth rods	OBO Bettermann, True power
26	Steel for RCC	SAIL, JSW, TATA
27	Cement	UltraTech, Birla Super

SEAL & SIGNATURE OF THE VENDOR