ENQUIRY SPECIFICATIONS

2 X 1750 KVA, 415 V, 1500 RPM, EMERGENCY DG SETS

1 x 660MW PANKI THERMAL POWER STATION

CONSULTANT: DCPL/ NTPC LTD

INDUSTRIAL SYSTEMS GROUP
BANGALORE-560 012.

MOHIT RANJAN	VENKATESHWARA RAO V	SANGEETHA M.A.
PREPARED BY	CHECKED BY	APPROVED BY

CONTENTS

Bidders should note that the annexure are the integral part of this specification and the signed/stamped copy of the same shall be submitted with the offer.

NOTES FOR THE BIDDER:

1. All equipment shall be new and unused (not reconditioned) and of recent manufacture which shall in no case be of a date of manufacture older than one year of the date of delivery.
2. The list of items mentioned in the Scope of supply is not exhaustive. Anything over and above the items mentioned in the scope of supply required for making the system reliable and functional shall be in Bidder's scope.
3. Design for all equipment supplied by vendor shall be in accordance with the statutory norms and accordingly all drawings to be prepared and submitted by vendor for approval considering latest statutory norms of Explosive, pollution control board, Electrical, Civil design etc applicable for DG Set and its accessories in respective states.
4. Preservation of DG Set up to the commissioning date shall be in Bidder's Scope.
5. If commissioning gets delayed beyond the scheduled date (May 2021), preservation activities to be carried out shall be clarified in detail to BHEL.
6. Bidder to provide all necessary technical documents in obtaining approval on drawings documents and datasheets during engineering from customer/consultant and shall also visit customer/ consultant offices for the same if required.
7. It shall be responsibility of the supplier to convince the customer about the completeness of the parts and quantity offered under mandatory spares. Bidder shall supply all part numbers as required by customer.
8. No item shall be manufactured / dispatched without prior written clearance from BHEL.
9. **Battery**, **Tools and Tackles** and **Mandatory Spares, B-Check Kit and Lube oil and coolant** as per the BOM given in this specification shall be supplied during commissioning on intimation by BHEL.
10. Make of all components to be submitted along with the offer failing which it will be presumed that any makes as required by customer shall be supplied by supplier. Reputed vendors shall be considered for all items. Minor changes shall be accommodated by the supplier in the make of accessories in case same is not getting approved by customer.
11. For any technical queries please write to mas@bhel.in with CC to mohitranjan@bhel.in, & asr@bhel.in
12. BHEL logos/engraved name plate shall be fixed on the equipment in prominent places. Soft copy of the logo shall be furnished to the successful bidder.
13. Bidder to upload all the documents as mentioned in the below checklist along with the offer.

S NO.	DOCUMENTS	CHECK
1	BHEL Enquiry specifications along with annexure, duly stamped.	
2	Data Sheet of Engine.	
3	Data Sheet of Alternator	
4	Deration calculations for Engine and Alternator	
5	Data Sheet of DG set controller.	
6	GA drawing of Acoustic Enclosure	
7	OEM certificates from Engine and Alternator manufacturers.	
8	List of makes of all items as per enquiry.	

SECTION- I
SALIENT POINTS OF CONTRACT:

1. It shall be bidder's responsibility to ensure that the offered equipment is suitable for motor starting as mentioned in **SECTION- IV** of this enquiry.
2. Bidder to arrange for to and fro flight tickets, conveyance and boarding and lodging for 2 nos. officials from customer's end (UPRVUNL) who shall witness testing and inspection of DG Set and DG Control Panels at Bidder's works. Preferably, inspection of DG Set & Panels shall be conducted together.

SECTION - II
GENERAL INFORMATION:

1.1	**Project Title**	:	1 x 660MW Panki Thermal Power Station
1.2	**Owner**	:	Uttar Pradesh Rajya Vidyut Utpadan Nigam Limited , Lucknow (UPRVUNL)
1.3	**Plant site location**	:	Panki, Kanpur,Uttar Pradesh
1.4	**Location co-ordinates**	:	N 26°28'20" E 80°14'32"
1.5	**Meteorological Condition**		
1.6	**Climate**	:	Tropical, very dry and hot summer, dry and cold winter and good rain-fall in monsoon accompanied with strong wind
1.7	**Maximum Temperature**	;	47.3 ºC
1.8	**Minimum Temperature**	;	3.8 ºC
1.9	**Relative Humidity**		Maximum 84%; Minimum 28%
1.10	**Rainfall**		Annual Average : 832.6mm
1.11	**Basic wind speed**	:	47.00 m/s As per IS: 875 (Part III)
1.12	**Seismicity**		Zone: III as per IS-1893
1.13	**Design ambient temperature**	:	**50 °C**

Tropicalisation	All electrical equipment, accessories and wiring shall have fungus protection involving special treatment of insulation and metal against fungus, insects and corrosion.

POWER SUPPLY:

S N	LT Supply	VALUE
1	**Plant LT emergency supply.**	415V, ± 10% 3 phase 3 wire Resistance earthed.
2	**Plant LT auxiliary supply**	415V, ± 10% 3 phase 4 Wire solidly earthed.
3	**Frequency**	50 Hz, -5% to 3%
4	**System fault level**	50 kA R.M.S.for 1 SEC

5	**EDG output**	1750 KVA, 1500 RPM, 415 V at site conditions.
6	**DG Neutral Earthing**	Earthing through NGR.
7	**Panel space heater and light**	240 V AC ± 10% 1 PH with one point earthed.
8	**AC Control Supply**	110 V AC ± 10% PT Voltage.
9	**Control Supply for panel**	220 V DC+10% to (–)15%, 2wire, Unearthed
10	**Control supply for breakers**	220 V DC +10% to (–)15%, 2wire, Unearthed
11	**Control Supply for Engine**	24V DC Battery Supply.
12	**Short circuit rating for 220 V DC System**	25 KA for 1 sec.

SECTION – III
APPLICABLE CODES AND STANDARDS

1. The equipment & accessories covered by this Specification shall be designed, manufactured and tested in accordance with the latest relevant standards and codes of practice as applicable including the below mentioned list but not limited to it.
2. The DG Set & Electrical accessories shall be also confirm to the latest Electricity Rules & other related Statutory agencies as regards explosive, electrical, safety, earthing and other essential provisions specified(RESPECTIVE STATE)
3. The installation work shall confirm to Indian electricity Act and Indian electricity rules as amended up to the date this specification is issued. Nothing in this specification shall be construed to relieve the contractor of this responsibility.
4. In the event of any conflict between the codes and standards referred, and the requirements of this specification, the requirements, which are more stringent, shall govern.

APPLICABLE STANDARDS	COMPONENTS/ITEMS
BS : 5514, ISO : 3046 ,SAE J1349, IS – 10000, DIN 6270,BS 649/195B	ENGINE
IS- 1271, 2253, 4722, 4728, 4889, 6362, 7132, 7306, 7816, 12065, 12075, 12802, 13364, 13118, IEC-60034	ALTERNATOR
VDI 2063	Measurements and evaluation of mechanical vibrations of reciprocating piston engines and piston compressors.
IS-5, 2007	Color for ready mixed paints & enamels
IS-694, 2010-2012, IS-1554 Part 1, IS 7098 for XLPE	PVC Insulated cables for working voltage up to and including 1100 Volts.
IS-1248, Part - 1 to 9, 1991-2003	Direct acting indicating analogue electrical measuring instrument & their accessories.
IS-2026, Part-1, 1991-2011	Power Transformers (General)

IS-2551, 1990	Danger Notice Plates.
IS-2705,Part-1, 2,3,4, 1992-2002	Current Transformers
IS-3156,Part-1, 2,3,4, 1992-2002	Voltage Transformers
IS-3231,Part-0, 1,2,3, 1987-2001	Electrical Relays for Power System Protection.
IS-5082, 1998-2003	Wrought Aluminum & Aluminum alloy bars, Rods, Tools & Sections for Electrical purpose.
IS-5578, 1984-2001	Guide for marking of Insulated Conductors.
IS-7372, 1995	Lead Acid storage batteries for Motor vehicles.
IS-60947, Part-1-5, 2007-2012	Low voltage Switchgear & Control Gear assemblies.
IS-60947, Part-1-5, 2007-2012	Low Voltage Fuses: Supplementary requirement for fuses for Industrial applications.
IS-8183	Bonded mineral wool
IS-1460 -1995	HSD
IS-60034, 750	Classification of degree of protection provided by enclosures of electrical equipments
IS 2629	Recommended practice for HOT-DIP galvanization of Iron and Steel
IS 2623	Methods for testing uniformity of coating of Zinc coated articles.
OSID-GDN-180	OSID standard on lightening protection.
IS 4722	DG starting motor

SECTION – IV
OPERATING PHILOSOPHY:

1. Two Nos. **Emergency DG set of** 1750 KVA, prime power, 415 V, 1500 RPM,0.8 PF at 50 degree Celsius ambient has been envisaged for this Project. One DG set is envisaged as Main DG for 660MW unit and second is Stand By DG for single unit.
2. The worst case full load running duration of the DG can be considered to be 12 hours.
3. Emergency DG Set shall have AMF start facility and shall be capable of starting automatically on mains failure and take up the full load within 30 seconds. The DG I/C circuit breaker should close automatically to energize the essential loads. Loads connected through SFU/MCCB will get applied directly on closing the DG I/C breaker and balance loads will be switched on as per process requirement.
4. **The DG set shall be capable of starting the largest emergency motor (101.2KW, Motor running pf – 0.90, Motor efficiency – 0.945) DOL while the DG is operating at its base load (1504.89KVA)**. Starting power factor of 0.2 and starting current of 9.24 times of full load current is considered for calculating voltage drop at motor terminals during start of motor which should be **within 20% . Xd'=14.9% and design ambient temperature of 50 degrees Celsius to be considered for above calculations. From DG Set to DG PCC is 50m of 6x1Cx400sq.mm per phase, Cu,**

elastomer rubber, armoured fire survival cable. DG PCC to EMCC (Emergency MCC) is 240m 7x1Cx400sq.mm per phase, Cu, elastomer rubber, armoured fire survival cable. EMCC to 101.2 KW motor-170 m- 2x1Cx400sq.mm per phase, Cu, elastomer rubber, armoured fire survival cable. Supplier to confirm the suitability of the DG for this motor starting.

5. Manual control of engine speed and generator voltage shall be provided through raise/lower control switches located on AMF panel and ECP/DCS in control room.
6. On resumption of the Mains supply the DG shall be momentarily synchronized with any of the two Mains supply and the load shall be transferred to the Mains supply so that there is no break in power to the load.
7. Provision for auto as well as manual synchronization shall be provided.
8. Provision shall be provided to synchronize the DG to the EMCC Bus to take the load of the Mains supply without break in power to the load.
9. Two sets of Potential free contacts shall be provided for all major alarms and indications to be taken to Central control Room.
10. The fuel oil system and lubricating oil system shall also start simultaneously as soon the engine receives starting impulse.
11. There shall be a provision for Remote Start/ Stop of the DG set. The DG set shall have facility to stop manually from Remote/Local.
12. The DG set shall have suitable control arrangement so as to meet functional and control requirement mentioned elsewhere in the specifications.

SECTION V
BILL OF MATERIALS

S.N	DESCRIPTION	QTY
1	1750 KVA (e) 1500 RPM, 415V 0.80pf (lag) DG with Radiator and accessories on common Base Frame.	2 Set
2	Fuel Day tank of 990 Liters capacity with accessories.	4 Set
3	24V DC, 320 AH Lead Acid Type automotive Battery with accessories and stand, to be supplied at the time of commissioning.	4 Set
4	Float cum Boost Battery Charger Panel with stand.	4 Set
5	Heavy duty Changeover switch for selecting one out of two set of batteries	2 set
6	Necessary Fuel Piping, supports, accessories for one DG.	2 Set
7	Exhaust Piping, inside room supports and accessories like bellows, flanges, bends, hardware for one DG.	2 Set
8	Galvanized Exhaust pipe support structure with foundation bolts, erection hard wares (common for 2 DG).	1 set
9	Acoustic enclosure for one DG.	2 Set
10	LT Power, Control, Instrument and screened cable including all accessories like lugs, glands, ties etc for one DG.	2 Set
11	Commissioning Spares/B-Check kit for one DG, to be supplied at the time of commissioning.	2 Set

12	First fill of lube oil, coolant and coolant conditioner at site for one DG, to be supplied at the time of commissioning.	2 Set
13	Tools &Tackles specific to offered DG Set.	1 Set
14	Phase side and Neutral side terminal box for one Alternator	2 Set
15	Mandatory spares for DG Set and Panels.	1 Set
16	Container for DG Set for transportation and storage at site for one DG.	2 Set
17	AMF Panel for one DG including auxiliary distribution	2 Set
18	NGR PANEL with isolator	2 Set
19	Commissioning Spares for control panels.	1 Set
20	Supervision of Erection of one DG Set with exhaust piping and structure, fuel piping, control panels and cabling.	2 Set
21	Supervision of testing, pre commissioning checks, and commissioning and load trial of one DG SET with Control Panels as per operating philosophy.	2 Set
22	Supervision of Performance Guarantee Test for one DG.	2 Set

SECTION VI

DETAILED SCOPE OF SUPPLY AND TECHNICAL SPECIFICATIONS FOR ITEMS MENTIONED IN BOM.

1 .DG SET:

1. The Generating Set shall be **Prime continuous Power** of **1750 KVA (e) 1500 RPM 415V 0.80pf (lag) at 50^0** C ambient temperature at Alternator terminals excluding auxiliaries , capable of 10% over load at rated speed once in every 12 hours of operation, complete with all accessories, suitable for battery start.
2. The DG set shall be complete with Electronic Governor, with pre lube pump/motor (if required) with coupling, with QDCT, with AMF feature, with engine mounted radiator on common base frame, with elastic fastening equipment ,battery charging alternator, fly wheel cover, AVMS, turbochargers, residential Silencer, flexible bellows and reducers & water/fuel/lube oil/exhaust/air piping on skid including all erection hard ware, lube oil filters , fuel filters, heavy duty air filters**,** lube oil, coolant and conditioner, jacket cooling water and fuel oil etc required for factory testing.
3. The entire DG Set shall be mounted on a common base frame and the same shall be mounted on anti vibration mounting system.
4. Two nos. ground pads shall be provided on base frame for earthing.
5. The DG Set shall be housed inside acoustic enclosure (suitable for outdoor installation, if required) for noise reduction. However the entire equipment shall be inside a DG Building.
6. The governor shall have capability to maintain speed constant in case of sudden variation of load as given in this specification.
7. The engine shall be radiator cooled while the Alternator shall be air cooled.
8. Automatic pressure lubrication shall be provided by a shaft driven gear type pump. In addition to same hand driven/ AC motor driven lube oil priming pump **(If applicable)** shall be provided.

9. The Alternator shall be brushless type, self regulated, self excited, drip proof and screen protected. The terminal box should have **IP 54 protection**.
10. The AC generator shall be supplied with its excitation system, AVR and include all necessary auxiliaries.
11. The generator shall be star connected 3- phase 50 Hz synchronous generator and shall have continuous rating.
12. Alternator shall be of **class H insulation** with temperature rise limited **to class B** temperature type limits in line with IEC 60034.
13. The critical speed of the machine shall not be less than **120%** and all coupling shall be capable of withstanding the maximum generator sudden short circuit torque.
14. The serial communication port of the DG controller shall communicate with Plant control system with Modbus /OPC protocol. All software and hardware required for the same shall be in supplier's scope.
15. The DG shall be suitable for **HSD** as fuel.

2. FUEL TANK

1. Two no.s Fuel Day Tank of **990 Litres** capacity along with pre-fabricated stand shall be supplied for each DG. The thickness of the tank shall be **3mm**.
2. The tanks shall be kept inside the DG Room.
3. The tank shall be mounted on **pre fabricated steel platform**, with one common level indicator (heavy duty tubular level gauge marked in litres) with channel protection for two tanks.
4. Level switches with NO contacts for indicating Low, very low and high level shall be provided common for two tanks. Air vent, drain plug and required hardwares shall be provided for each tank.
5. The height of the steel platform/stand shall be finalized during detailed engineering and shall be as per manufacturer's standards.
6. The fuel tank shall be painted with oil resistant paint and all pipe joints shall be brazed / welded.
7. **Hand operated pumps (one for each DG Set)** with Hose pipes of length 10 meters for transferring fuel from barrels/drums to 990 Litres Day tank shall be supplied by the bidder. Inlet of the pump shall have 5m long armoured hose with suitable filter.
8. The paint shade of the tank shall be finalized during detailed engineering.

3.BATTERY

1. The DG set shall be suitable for battery starting.
2. **The minimum rating of battery shall be 24 V DC 320 AH,** heavy duty Lead Acid type automotive maintenance free battery suitable for Engine starting shall be supplied by the bidder at **the time of commissioning.**
3. Two sets of battery has been envisaged for this project which shall be in parallel operation. Each battery set shall be 100% Stand By to the other.
4. The battery shall be suitable for **6 consecutive start** of the Engine without recharging and shall also be used for control supply of DG AMF Panel for at least 8 hours and should be inclusive of 10% design margin.
5. The bidder shall also supply **prefabricated battery stand**, battery leads, nuts and bolts, hand gloves etc for maintenance purpose.

4. BATTERY CHARGER

1. Suitable **Float cum Boost battery Charger** for recharging Engine starting battery shall be supplied. Two chargers meant for one DG may be housed in one panel.
2. Input supply to Battery Charger shall be single phase 230 V AC.
3. The charger shall be protected by current limiting device. The charger shall be capable of recharging the discharged battery within **08 hours**.
4. The battery charger shall operate in **Float / Boost** mode depending on the state of the battery and shall have **Auto/Manual SS** and Voltage and current adjusting potentiometer.
5. Necessary filters and chokes and suitable input transformer to automatically reduce charging current, as battery gradually charges up and to prevent overcharging of battery
6. The charger shall be housed inside a small cabinet with the front facia having flush mounted 96 sq mm, Class 1 digital type DC Voltmeter, DC Ammeter, AC Voltmeter and Selector switches and indicating LEDs.
7. The charger shall be mounted on a stand to meet the minimum operating height criteria (750mm). **Prefabricated stand** if required to be supplied with the charger.
8. The degree of protection of battery charger panel shall be **IP 42.**
9. The charger shall have protection for over voltage, over current and short circuit.
10. The paint shade of the Battery Charger panel shall be finalized during detailed engineering.

5. HEAVY DUTY CHANGEOVER SWITCH FOR SELECTING ONE OUT OF TWO BATTERIES

1. One no. change over switch suitable for selection between the two sets of batteries of each DG shall be provided. Engine starting supply and Control supply for panels shall be taken after this switch. The switch and connecting cables shall be adequately rated to ensure that the protection relays/ auxiliary relays/ contactors/ other components do not drop/reboot during the engine starting time.

6 . FUEL PIPING

1. **Necessary Fuel Piping** with hardwares, U clamps,valves, pipe fittings, pipe support, flanges, gaskets, drain and vents from day tank to engine(Supply and Return line) as required for the DG Set.
2. MS channels, angles and plates, anchor fasteners to support fuel pipes inside the trenches shall also be in bidder's scope.
3. Hose pipe with accessories for connecting Fuel Lines to Engine Fuel inlet and outlet with necessary adapters/connectors to be provided by the bidder.

7. EXHAUST PIPINGAND ACCESSORIES

1. **Exhaust piping** with flanges, bellows, gaskets, necessary nuts and bolts, supports, starting from engine to outside of DG Room.
2. The **entire length** of exhaust pipe and stack along with silencers to be provided with **50mm thermal insulation** and **aluminum cladding** to maintain the temperature within required limits.

3. The exhaust stack height should meet the requirement given by gazette notification of Ministry of Environment and forest, CPCB guidelines, and state pollution board guidelines for the offered rating of the DG.
4. Erection materials like ISMC Channels, angles, base plates, anchor fasteners to support exhaust pipes and its support inside as well as outside the DG room shall be in scope of the bidder.

8. EXHAUST SUPPORT STRUCTURE:

1. **Galvanized exhaust support structure (610g/sq.m) with foundation bolts** (height as per applicable norms) shall be in Bidder's scope.
2. Exhaust support structure shall be bolted type.
3. Ladders up to the top and platforms to be considered for the structure.
4. Bidder to submit the CPCB guidelines for the height of the Stack.
5. Bidder may refer to tentative DG layout drawing **Annexure-1** to get an idea of the exhaust piping layout.
6. Bidder shall also consider channels and angles for erecting control panels over cable trenches as shown in layout drawing (Annexure-1).
7. Exhaust Structure shall be despatched in assembled/semi- assembled condition to prevent loss of pieces at site.
8. Lightning arrestor on exhaust structure is in bidder's scope. GI flat with insulators for connecting the arrestor to the earth pit shall be provided till the foot of the structure. Further connection by BHEL.
9. Aviation Obstruction Lamp shall be provided for the structure with wiring till bottom.
10. Supports for placing the DG Control Panels of the bidder on the trench shall be in bidder's scope.

9 .ACOUSTIC ENCLOSURE:

1. For details please refer attached customer specification.
2. The enclosure shall be fabricated out of 2mm CRCA steel.
3. Enclosure shall be provided with adequate number of doors with heavy duty hinges and handles and shall have adequate **lighting arrangements.**
4. Suitable louvers on fresh air intake side and radiator side with acoustic treatment shall be provided. The hot air from radiator shall be discharged through modular duct.
5. Any type of ducting required inside or outside of the enclosure for discharge or intake of air shall be in bidder's scope.
6. The acoustic enclosure shall be suitable enough to prevent leakage of sound and bidder shall ensure that noise measurement shall **not exceed 85 db(A)** at a distance of 1 meter around the machine or as per CPCB norms whichever is more stringent. Noise level measurement shall be carried out using applicable and internationally acceptable standards. The measurement shall be carried out with a calibrated integrating sound level meter meeting the requirement of IEC 651 or BS 5969 or IS 9779.
7. All lighting fixtures inside the acoustic enclosure shall be in bidder's scope.
8. Paint shade of acoustic enclosure shall be finalized during detailed engineering.

10. CABLES AND ACCESSORIES:

1. LT Power & Control Cables including all accessories like lugs, Double Compression nickel plated brass glands, ties etc, Special Cables, instrument Cables, inside DG Room between equipments supplied by DG supplier (Cables between DG Supplier supplied equipment and other equipment is not in DG Supplier scope) **. However all glands, lugs and ties required on generator panels and any other equipment supplied by the bidder shall be in Bidder's scope. List of glands/lugs required for terminating external cables (not in scope of bidder) shall be provided during detailed engineering.**
2. **LT Power cables** shall be 1100V grade single/multi core, stranded H4 grade aluminum conductor, XLPE insulated, armored, with PVC inner sheath, armoured & outer sheath made of FRLS PVC compound. Minimum conductor cross section for power cables shall be 10sq mm for aluminum cables.
3. **Control cables** shall be 1100V grade, multicore, min. 2.5sq mm cross section, stranded plain annealed copper conductor having minimum 7 strands, HR PVC insulated, HR PVC, FRLSH, ST2 inner sheathed/galvanized steel wire armored, overall FRLSH, HR PVC, ST2 outer sheathed generally confirming to IS 1554 part 1. From charger to battery minimum 6sq.mm copper cable shall be considered and from battery to engine minimum 120sq.mm copper cable shall be considered. CT circuits shall have minimum 4sq.mm Cu wire,
4. **Instrumentation cables** shall be annealed, tinned, stranded, copper conductor, 0.5 sq mm, twisted into pairs, HRPVC insulated, armoured, HRPVC, FRLSH, ST2 inner and outer sheathed.
5. **Screened cable** to be provided to connect RTD and BTD in alternator to temperature Scanner and for AVR and GOVERNOR connections for voltage and speed raise/lower.

11. COMMISSIONING SPARES/ B-CHECK KIT:

1. **Commissioning Spares/B-Check kit** shall be supplied by the bidder at the time of commissioning.
2. Lube oil filters /Bypass lube oil filter /Fuel oil filter kit & its seal rings, air filters and accessories, coolant filters, coolant testing kit, alignment check of the engine and alternator and any other commissioning spares recommended by the manufacturer shall be in bidder's scope and to be supplied at the time of commissioning.
3. The B-check of the Engine shall be carried out in the presence of Bidder's experts/ engine experts and the service charges towards the same to be borne by the bidder.

12. LUBE OIL AND COOLANT:

1. First fill of lub oil, coolant and coolant conditioner at site at the time of commissioning shall be in the scope of the bidder.
2. Lub oil and coolants for first fill to be supplied at the time of **commissioning only** and shall not be sent along with the DG Sets.
3. Lub oil & coolant shall be as per engine manufacturer's recommended makes only.

13. TOOLS AND TACKLES:

1. Bidder to supply **new set of tools and tackles of reputed make** specific to the supplied DG set for the maintenance of the equipment exclusively by customer.

2. These tools should be separately packed and shipped. Tentative List of tools is enclosed. **Vendor to confirm suitability** of the following tools for their equipment. If any addition / deletion / new list are required for the DG, it may please be furnished and will be decided during detailed engineering.

SN	DESCRIPTION	SN	DESCRIPTION
1	Torque Wrench (2-8 ft-lb),3/8" square drive	15	Double ended box spanners in 16 sizes with sliding bar and wallet: 6 x **7mm, 8** x 9mm, **10 x 11mm**, **12 x 13mm**, **14 x 15mm**, **16 x 17mm**, **18 x 19mm** and **20 x 22mm**.
2	3/8" to ½" square drive	16	Combination pliers – 8" long
3	Screw driver socket ½" square drive	17	Nose pliers –6" long
4	Ring and open end combination wrench (½",3/4,"9/16", 7/8", 15/16", 7/16"	18	Plastic hammer 0.1/2" diameter and iron hammer.
5	Ring Spanner Set (The ring sizes include 6X7 8X9 10X11 12X13 14X15 16X17 18X19 20X22 21X23 24X26 25X28 30X32 and are 12 in number.)	19	Half moon spanner – ¾" x 5/8"
6	Double ended Spanner set- (12 nos in 1 set)	20	Measuring Scale and tape(3m)
7	Tool box for the above	21	5 piece file set.
8	Socket 7/8" – ½" square drive	22	Socket 9/16" – ½" square drive
9	Socket 7/8" – ½" square drive	23	Extension – ½" square drive, 3" long
10	Dial gauge – 1" Travel, Least count 0.001" with magnetic base	24	Socket 5/8" – ½" square drive
11	Extension – ½" square drive, 5" long	25	Cable splicing knife.
12	Socket 1/2" – ½" square drive	26	Screw driver Set
13	Adjustable wrench – 10" long	27	Electrical Tester
14	Allen Key Set	28	Insulation tapes (R,Y,B,N) - 2 each.

14.ALTERNATOR TERMINAL BOXES

1. Neutral Side and Phase side terminal Box shall be supplied by the bidder.
2. The terminal box shall have **IP 54** protection class.
3. The terminal box shall be suitable to connect **6x1Cx400sq.mm per phase, Cu, elastomer rubber, armoured fire survival cable**.
4. The terminal Box shall be suitable to house protection CTs with necessary supports.
5. The paint shade of the terminal box shall be same as that of the DG Set.

15. MANDATORY SPARES

- Bidder to supply one set of mandatory spares for DG set package. These mandatory spares should be separately packed and shipped (refer to packing instructions).

S NO.	ITEMS	QUANTITY	UNIT
	DIESEL GENERATOR		
	ALTERNATOR		
1	Current transformers of each rating (1no. of each rating)	1	set
2	Space heaters with thermostat and isolating switch	1	set
	DIESEL ENGINE		
3	Fuel injection nozzles	2	set
4	Crank shaft with standard size journals	1	No.
5	Main Bearings	1	Set
6	Big end bearings	1	Set
7	Diesel filter packs (filter elements)	24	No.s
8	Mobile oil filter packs (lube oil filter elements)	24	No.s
9	V-belt for radiator fan	6	No.s
10	Fuel injector	2	No.s
11	Fuel injection piping	1	Set
12	Ring gear for flywheel	1	Set
13	Starter(spare Starter Motor)	1	Set
14	Nozzle testing machine, Barring Bar, slings, eyebolts & other special equipment necessary for servicing the engine	1	Set
	AMF PANEL		
15	Protective relay of each type	1	No.
16	Auxiliary relay of each type	1	No.
17	Timer of each type	1	No.
18	Indicating instruments of each type	1	No.
19	Fuses of each rating	1	No.
20	Indicating lamps of each type	1	No.
21	Cubicle illuminating light	1	No.
22	Terminal Blocks of each type	1	No.
23	Temperature Scanner	1	No

Note : 1 set means as required for 1 engine (including all cylinders).

16. CONTAINER FOR DG SET

1. Bidder shall supply the DG Sets, acoustic enclosure and loose engine accessories in container, suitable for outdoor storage at site.
2. The DG Set along with accessories shall be transported in containers and shall be stored in same at site until erection works begin.
3. The container shall be cargo worthy, without cracks or opening to ensure no dust, water or rodents may get inside.
4. Bidder to accommodate all important accessories of the DG Set in the container, so a suitable size container may be chosen.

5. The container shall be properly sealed at site after inspection of the supplied materials by BHEL, Customer and Bidder's officials.

17. AMF PANEL

The following are the necessary list of components in **each** DG AMF Control panel. However any other components required making the system operate as per the approved operating philosophy shall be in Bidder's scope.

SN	DEVICE NO.	DESCRIPTION	MAKE	TYPE	RATING	QTY
A. CURRENT/POTENTIAL TRANSFORMER						
1	CT	CT FOR METERING	As per customer approved list	Cast resin	3200/1A, Cl-0.5, ISF<5, VA as required.	3
2	CT	CT FOR DG SET CONTROLLER, if required	--do--	Cast resin	As required.	3
3	CT	CT for protection relay/ differential protection	--do--	Cast resin	3200/1A, Class PS/ 5P20-15VA.	3
3	PT	Potential Transformer Draw out	--do--	Protection & Metering. Insulation E or better.	$\frac{415 / \sqrt{3}\ V}{110 / \sqrt{3}\ V}$ 100VA, CL 0.5/ 3P, Cast resin	3
4	PT	OPEN DELTA Potential Transformer for earth fault sensing.	--do--	Protection. Voltage factor-1.2 Continuous and 1.9 for 8 hours	$\frac{415 / \sqrt{3}\ V}{110 / 3\ V}$ CL 3P, Cast resin, VA as required	3
B. TRANSDUCERS						
1	CTD 1,2,3	Current Transducer	---do---	Accuracy Class-1	Dual Output: 4 – 20mA Input: 0- 3200 A	3
2	PFTD	Power Factor Transducer	---do---	(For 3 Ph, 3 Wire System). Accuracy Class-1	Range: 0.8 Lag – 0.8 Lead Dual output: 4 – 20 mA	1
3	KWTD	Watt Transducer	---do---	3 Ph,3Wire un-balanced load. Accuracy Class-1	Dual Output: 4 – 20mA Input: 0 – 1600KW	1
4.	KVAR TD	Reactive power Transducer	---do---	3 Ph,3Wire un-balanced load. Accuracy Class-1	Dual Output: 4 – 20mA Input: 0 – 1200kVAr	1

SN	DEVICE NO.	DESCRIPTION	MAKE	TYPE	RATING	QTY
5.	VTD1,2,3	Voltage Transducer 1,2,3	---do---	Accuracy Class-1	Dual Output: 4 – 20mA Input: 0 – 500 V AC	3
6.	FTD	Frequency Transducer	---do---	Accuracy Class-1	Range: 45 – 50 – 55 Hz Dual Output: 4 – 20mA Input: 0 – 55 Hz	1
C. TEMPERATURE SCANNER						
1	TC	Temperature Scanner	---do---	PT 100 (RTD)	0 – 150 deg C 8- CHANNELS	1
D. MEASURING INSTRUMENT DETAILS.						
1.	M	Composite Multifunction meter **(sealable type).*** 3 Ph current 3 Ph line and phase voltage Frequency Power Factor Power(KW and KVA) Energy KWH It shall be possible to read all the above simultaneously. Otherwise separate meters shall be provided for each.	---do---	**FLUSH MOUNTED. DIGITAL. Meter shall be communication capable. Protocol details shall be decided during detailed engineering.**	Range: 0 – 3200 A 3200/1A, 110 V AC CL 1.0, with push buttons. ***(If sealable type multifunction meter is not offered then a separate sealed type KWH meter shall be considered by the bidder)**	1
E. AUXILIARY CONTACTORS						
1	K	Auxiliary / Power Contactors	---do---		220V or 24V DC with 4NO+4NC	As required.
2	R	Auxiliary Relay	---do---		220V or 24V DC with 4NO+4NC	As required.
F. SELECTOR SWITCHES						
1	S/S	Selector switches	---do---		Local/Remote TNC Switch for breaker	As required.

SN	DEVICE NO.	DESCRIPTION	MAKE	TYPE	RATING	QTY
					(16A DC,1/2 pole. 4 positions, lockable, Changeover etc as per the requirement.)	
G.	**PUSH BUTTONS**					
1	S	PUSH BUTTONS	---do---	RED /GREEN / BLACK	2NO+2NC	As required
H.	**INDICATING LAMPS (LED TYPE)**					
1	L	INDICATION LAMPS	---do---	CLUSTER LED TYPE	AC/DC	As required
I.	**HOOTERS**					
1	H	Hooters	---do---	Industrial type	AC/DC	1
J.	**CONTROL AND POWER FUSES, NEUTRAL LINKS WITH BASE**					
1	F	Fuses with base and N- links with base	--- do ---	HRC cartridge fuse link type	220 V DC/230 V AC	As required
K.	**MCB**					
1	Q	MCB with Base Plate	---do---		3/4 pole,2 Pole,10A,6A, AC/DC AS REQUIRED	As required
L.	**OTHERS**					
1	ANNUN	Annunciator (no. of channels as required)	--- do ---	static annunciator ,with acknowledge, reset and lamp test push buttons.	The sequence of operation shall be similar to ISA-2A	1 No.
2	T	Toggle Switch	--- do ---	1/2POLE	10A	As required
3	L	Limit Switch with Base	--- do ---	2NO+2NC	220 V DC /230V AC	As required
4		Plug & Sockets, space heater(with thermostat)	--- do ---	2 Pin with Earth	10 A , 230V AC	As required
5	T	Any Matching Transformer if required	--- do ---		415V/110V 415V/24V 230V/24V	As required
6	L	Panel Lamp	--- do ---	CFL lamp	230 V AC	1 No.

SN	DEVICE NO.	DESCRIPTION	MAKE	TYPE	RATING	QTY
M.	**MOTORISED POTENTIOMETERS**					
1		**Motorized Potentiometer/ or suitable provision for Voltage Control from AMF Panel/Remote**			Aux supply: As required	1 No.
2		**Motorized Potentiometer/ or suitable provision for Speed Control from AMF Panel/Remote**			Aux Supply:As required	1 No.
N		**Provision shall be provided for starting / stopping , voltage raise / lower and speed raise / lower commands from remote along with the local operation**				
O		**Master trip relay**				
P		**PT Fuse failure protection with contact for annunciation**				
Q		**Three attempt starter/cool down timer shall be included**				
R		**220 V DC supervision relay**				
S		**24 V DC Supervision relay**				
T		**Generator Numerical Protection Relay (MICOM P343 or comparable equivalent) with connecting cables and software confirming to IEC 61850 protocol.**				
U		***Bidders to note that the above components are tentative, any other item or protection required for safe and reliable operation of the DG as per the operating philosophy shall be considered by the bidder in his offer and shall be supplied without any commercial implications to BHEL.***				

Redundant 220V DC supply at one point in one panel shall be made available by BHEL. Further distribution is in vendor scope.

1. All CT/PT's shall be cast resin type. All standard accessories like test terminal blocks, disconnecting TB's etc is in the scope of the supplier.
2. The Panel shall have a rigid welded structural frame smooth finished and free from all flaws,enclosed completely by CRCA sheets of minimum 1.6mm for no load bearing members and **2 mm thickness** for load bearing members and 3mm thickness for gland plates/4mm for Al gland plates.. All doors panels, removable covers shall be gasketed properly with neoprene rubber gasket. The panel shall have openable front and back door with concealed hinges. Suitable shrouding arrangement shall be provided inside the panel for safety of maintenance personnel. Doors shall be provided with lockable knob.
3. Enclosure Protection shall be **IP 52.**
4. **4 sqmm cables** to be used for **CT and PT connection.** 2.5/1.5 sq mm cables to be used for voltage connections & control wiring. Wiring shall be1100 grade, single core stranded copper conductor wires with PVC insulation
5. Maximum operating height shall be less than **1800 mm** and minimum operating height more than **750 mm**. adequate clearances shall be provided between all live parts and structure etc., as per relevant Indian standards.
6. **Earthing bus of 50 x 6 mm** Al shall be provided at the bottom of the cubicle. All non-current carrying metal work of the panel shall be effectively connected to the earth bus. Earth bus shall be extended out of the panel.
7. Panel wiring and termination: Panel shall be supplied completely wired internally to equipment and terminal blocks and ready for purchaser's external cable connection, at the terminal blocks. The wiring shall be securely supported, neatly arranged, readily accessible and connected to equipment terminals and terminal blocks. Wiring should run through PVC slotted channel with covers. Wiring terminations shall be made by

solder less crimping fork type lugs on equipment side and pin type lugs on terminal side. Engraved tightly fitting plastic ferrules shall be provided for wire identification. These shall be suitably located for ease in external wiring.

8. **20% spare terminals shall be provided**. Window facia annunciation system shall be provided for centralized registration and indication of fault conditions. Potential free contacts are to be wired for indication. Audible alarm shall be provided. Push buttons for acknowledge, reset and test shall be provided. The facia windows shall have multiple LEDs and not incandescent lamps for illuminations in case of faults. List of faults will be finalized during drawing approval.
9. Two sets of potential free contacts to be given for all major alarms, annunciations and indications to be taken to plant control Room. Same shall be decided during detailed engineering.
10. The DG Set supplier shall provide engine governor and Automatic Voltage Regulator, which will have some signal, interlocks to the DG Control panel. The schemes of governor and AVR shall be furnished to the supplier during detailed engineering.
11. AMF Panel shall be provided with thermostatically controlled space heaters to keep the air inside the AMF panel enclosure sufficiently above the dew point to prevent condensation. The heaters shall be located such that wiring, buses and control devices do not get over heated.
12. Paint shade shall be finalized during detailed engineering**.**
13. Proper shrouding shall be provided wherever applicable.
14 Auxiliary Distribution for supplying aux. power to various auxiliary equipment for operation of DG SET shall be part of the AMF Panel. 415V AC, 125A, 3Ph, 3 wires, 50 HZ, power input will be provided by BHEL from EMCC.
15 The main and neutral bus bars shall be of Aluminum alloy of E91 WP grade conforming to applicable standards. The bus bars shall be fully insulated and sleeved for the full operating voltage and current. The short circuit withstand capacity of all bus bar shall be **50kA for 1 Sec**.
16 Earthing bus of 50 x 6 mm Al shall be provided at the bottom of the cubicle. All non-current carrying work of the panel shall be effectively connected to the earth bus. Adequate arrangement shall be provided for connection of external grid to the panel earth bus (earth bus shall be extended out of the panel). **Two earthing terminal** studs shall be provided as per Indian Electricity Rules in the earth bus.
17 Panel shall be provided with thermostatically controlled space heaters to keep the air inside the MCC enclosure sufficiently above the dew point to prevent condensation. The heaters shall be located such that wiring, buses and control devices do not get over heated.
18 Digital Ammeter and Voltmeter shall be provided for incoming feeder. Necessary LEDs and Pushbuttons for outgoing feeders shall also be provided.
19 The Auxiliary board shall have one.**415V/230V 7.5 KVA power transformer** for single phase load(Supplier to check and confirm suitability of rating). **415 V/110 V control transformer** shall be provided for control supply.
20 Following outgoing feeders. Any other feeder, if required for making the DG Set functional shall be in vendor scope.
    1. Outgoing feeders for Acoustic Enclosure lighting(MCB)- as required.
    2. Outgoing feeder for Alternator space heater(MCB+contactor)- as required.
    3. Outgoing feeder for Battery Charger Input Supply(MCB)- as required.

4. Outgoing feeders for AMF Panel space heaters, lamp, plug(MCB). – as required.
5. One spare feeder of each type shall be provided.

18 NGR PANEL:

1. Diesel Generator's neutral shall be earthed through resistance such that the 415V system earth fault current is limited to 1A when supplied from DG. NGR shall be suitable for continuous duty. Resistor shall be punched stainless steel grid type with suitable enclosure and isolator.
2. Isolator shall be provided with interlock from DG AMF panel so that the isolator opens when DG and Mains are running in parallel.
3. Paint shade of NGR panel shall be finalized during detailed engineering.

19. COMMISSIONING SPARES (PANELS)

1. **Control Fuses only** – 1 set (2 Nos. of each type as used in the complete set of panels above)
2. **Indicating Lamps** – 1 set (2 Nos. of each type as used in the complete set of panels above).
3. **Timer** – 1 no. of each type.
4. **Auxiliary Contactor**- 1 set (1 no. of each type used in DG AMF panel above).
5. **Auxiliary relay**- (1 no. of each type used in DG AMF panel above).
6. **MCBs** - 1 set (1 no. of each type used in complete set of panels above).
7. **Door Lock:** - 4 nos. of each type as used in AMF and Aux DB.

20. SUPERVISION OF ERECTION

1. Supervision of Erection of DG Set Package shall be in Bidder's scope.
2. Bidder shall send his supervisor for supervision of erection of the DG Set, acoustic enclosure, fuel lines, exhaust piping, exhaust structure, Control panels, Terminal boxes, CTs, cabling etc. as and when informed by BHEL.
3. At least one week prior notice shall be provided to bidder for deputation of his engineer/supervisor.
4. Bidder's supervisor shall support BHEL officials in getting the necessary erection protocols accepted by the customer/consultant.
5. Boarding and Lodging and conveyance of bidder's supervisor/engineer is not in BHEL's scope.

21. SUPERVISION OF TESTING & COMMISSIONING:

1. Supervision of pre commissioning checks, testing of DG and accessories and control panels and supervision of Commissioning of the same as per the approved operating philosophy shall be in Bidder's scope.
2. The test equipments and manpower for testing shall be provided by BHEL at site. However the Bidder's supervisor is expected to carry his basic testing kits and tools.
3. Load trials of one entire DG Set Package on maximum available plant load. **This shall also include proper training for customer's O&M team at site.**
4. Bidder's supervisor shall support BHEL officials in getting the necessary commissioning protocols accepted by the customer/consultant.

5. Supervision of testing and settings of **generator protection relay** through primary/secondary injection at site either by manufacturer/bidder's engineer shall be in scope of bidder. Secondary injection kit shall be provided by BHEL.

22. SUPERVISION OF PG TEST

1. Supplier to depute its representative to carryout supervision of PG Test as and when required by BHEL. Load/ Fuel not in supplier's scope.
2. The procedure for carrying out the PG Test shall be mutually decided by the supplier, BHEL and end customer/consultant.
3. The bidder shall provide support in the form of required copies of as-built drawings, documents, datasheets, protocols or any other information required by BHEL for obtaining statutory clearances from CPCB, CEA,CCOE and other applicable bodies for the supplied DG Sets (If applicable). Necessary approvals shall be taken by BHEL.

SECTION – VII

PAINTING

1. Painting shall be of high quality, long lasting and shall involve mechanical cleaning , chemical cleaning, derusting, primer application and application of final paint. All painting shall be in accordance with approved QAP and shade as per customer's approval.
2. Painting procedure followed by supplier for all items shall be furnished as and when required by BHEL, failing which it will be presumed that any painting procedure as required by customer will be acceptable to supplier.
3. The paint shade and thickness for DG set, Acoustic Enclosure, Fuel tanks, Battery Charger, Control Panels etc shall be decided during detailed Engineering.

SECTION – VIII

INSPECTION AND TESTING

1. All equipments to be supplied should be of **type tested design**. During detailed engineering the contractor shall submit for approval the reports of **all the type tests** as per relevant standards and carried out on machine and equipment of same capacity within last **5 years** from the date of bid opening. Failing to do so the supplier shall conduct the entire test under this contract at his own cost either at third party lab or in presence of owner's representative and submit the reports for approval.
2. **Type test certificates and reports of the Engine, Alternator, Control Panels and all individual components as applicable of similar rating** as per standards shall be submitted during detailed engineering for review and acceptance.
3. **Witness of routine test of alternator and engine (Stage inspection) has been envisaged.** Engine and Alternator MQP shall be furnished by the vendor and same shall include all tests as per relevant stadards. All documentation as per customer QAP shall be submitted.
4. All **routine/acceptance tests on DG** Set and accessories and control panels shall be carried out as per relevant standards. Inspection of DG Set, accessories and control panels shall be conducted as per approved QAP.
5. For **Factory Test**, each DG set or engine shall be tested for **four hours**. Fuel for testing shall be in bidder's scope and included in the price of the DG Set.

6. Control panels shall be tested with secondary injection kit.
7. TC for other items mentioned in BOM to be submitted by the supplier as and when required by BHEL.
8. One set of manufacturer's Test certificate and Internal Test reports to be made available at the time of inspection.

SECTION IX

PACKING AND TRANSPORTATION

1. Supplier shall be entirely responsible for ensuring that the packing suits the mode of shipment. Customer/BHEL may require inspecting and approving the packing before the materials are dispatched.
2. The bidder/supplier shall be responsible for any damage/loss of material during transit on account of improper packing.
3. Any material found short on opening the intact packing case shall have to be supplied by the bidder at no extra cost to the purchaser.
4. DG Set shall be fully packed in air tight polythene and shall be placed inside the container. All the openings on DG Set like exhaust opening, Air opening, Fuel openings to be capped tightly with metallic materials to prevent entry of water, moisture or dust.
5. All loose accessory of the engine shall be properly packed in a wooden box and shall be placed inside the container.
6. Loose erection materials shall be properly packed in sacks and supplied in wooden **boxes only.**
7. Control panels shall be fully packed in polythene and cushion and shall be supplied inside **Plywood cases**, suitable for outdoor storage.
8. Acoustic Enclosure shall also be packed in **wooden crate** with cushion to ensure no scratches during transportation and handling and shall be suitable for outdoor storage.
9. Mandatory Spares shall be packed in proper wooden/Tin box, suitable for long and safe storage.
10. Cables shall be supplied in cable drums. While accessories like glands and lugs shall be properly packed in **wooden boxes** only suitable for outdoor storage**.**
11. All boxes shall bear the relevant stamp, name of project, package, BHEL unit, and name of supplier.
12. **Proper packing list mentioning the name and quantity of each and every item** shall accompany all boxes. It shall be Bidder's responsibility to get the packing list verified and vetted by BHEL Stores in charge at Site.
13. In absence of signed packing list, it shall be Bidder's responsibility to supply any missing/damaged item at later stage.
14. All packing material shall become the property of the customer.
15. Bidder to take extreme care while packaging and transportation of materials to Site. Any damage to items due to lack of suitable packing shall be attributable to the bidder.
16. Bidder shall send its representatives for unloading and verifications of major items and shall collect required documents from BHEL-Stores for submission to BHEL-ISG, Bangalore office along with the invoices.

SECTION – X

DOCUMENTATION

The following documentation shall be supplied to BHEL at different stages of the Project. In preparing and submitting the documentation, the requirements given in subsequent clauses shall be strictly adhered to.

List of Drawing / Documents

TYPE OF DOCUMENTS	NO. OF COPIES	STATUS	TIME SCHEDULE
Sizing Calculations for battery & battery charger and catalogue of Engine, Governor, Alternator, and AVR.	Soft copy	For Technical scrutiny and Approval	Within 2 weeks on intimation by BHEL.
DG Building Layout and Cross Section considering acoustic enclosure, exhaust piping, cable trenches, cable trays, fuel trenches etc.	Soft copy	For Approval	Within 2 weeks on intimation by BHEL.
GA / OGA Drawing of Diesel Engine, Controller, Associated accessories, Alternator. Terminal Box /Adopter Box; DG Set, Base Frame.	Soft copy	For Approval	Within 2 weeks on intimation by BHEL.
GA of 990 liters fuel tank and P&ID of fuel line/system	Soft copy	For Approval	Within 2 weeks on intimation by BHEL.
QAP For all major items.	Soft copy	For Approval	Within 2 weeks on intimation by BHEL.
Field Quality Plan	Soft Copy	For Approval	Within 2 weeks on intimation by BHEL.
Data Sheets of Engine, Alternator, DG Set and Battery and Exhaust Structures..	Soft copy	For Approval	Within 2 weeks on intimation by BHEL.
Foundation Plan & Loading Details of DG Set.	Soft copy	For Approval	Within 2 weeks on intimation by BHEL.
GA drawing of exhaust stack with support structures, STAAD input files and calculations.	Soft copy	For Approval	Within 2 weeks on intimation by BHEL.
GA /Schematic/ BOM for AMF panel, Auxiliary Distribution Board, Battery charger panel, DG Local Isolator. Along with CT and Vt sizing calculations.	Soft copy	For Approval	Within 2 weeks on intimation by BHEL.
Proper Calculations for protections settings in Generator protection Relay.	Soft copy	For Approval	Within 2 weeks on intimation by BHEL.
GA, BOM & wiring diagram of Engine Control Panel	Soft copy	For Approval	Within 2 weeks on intimation by BHEL.
Total Integrated Cable Schedule for total integrated system which includes Electrical Panels.	Soft copy	For Approval	Within 2 weeks on intimation by BHEL.

TYPE OF DOCUMENTS	NO. OF COPIES	STATUS	TIME SCHEDULE
TEST CERTIFICATES of all major items	Soft copy	For Information	Within 2 weeks on intimation by BHEL.
CATALOGUE/Manual of all electrical items.	10 Sets	For Information	Within 4 weeks on intimation by BHEL.
O&M, Storage & Erection instruction manual.	10 Sets + CD	Documentation	Within 4 weeks on intimation by BHEL.
As built & Commissioned Drawings / final document	10 Sets + 2 CD	Final Documentation	Within 4 weeks on intimation by BHEL.

1. The GA / OGA drawing shall contain elevation, section, foundation / mounting for Civil Assignment and Layout.
2. Details of Exhaust Silencer; OGA/GA of, Lube oil priming pumps; Locations of total DG Auxiliaries; Location of Heaters; height; Mounting faces for vibration monitoring sensors; Heat loss data i.e., heat dissipation from engine surface/Ventilation Requirement.; Applicable codes and Standards.
3. **Master Drawing list and Title Block for all the drawings and documents shall be provided to bidder immediately after award of contract**.

SECTION XI

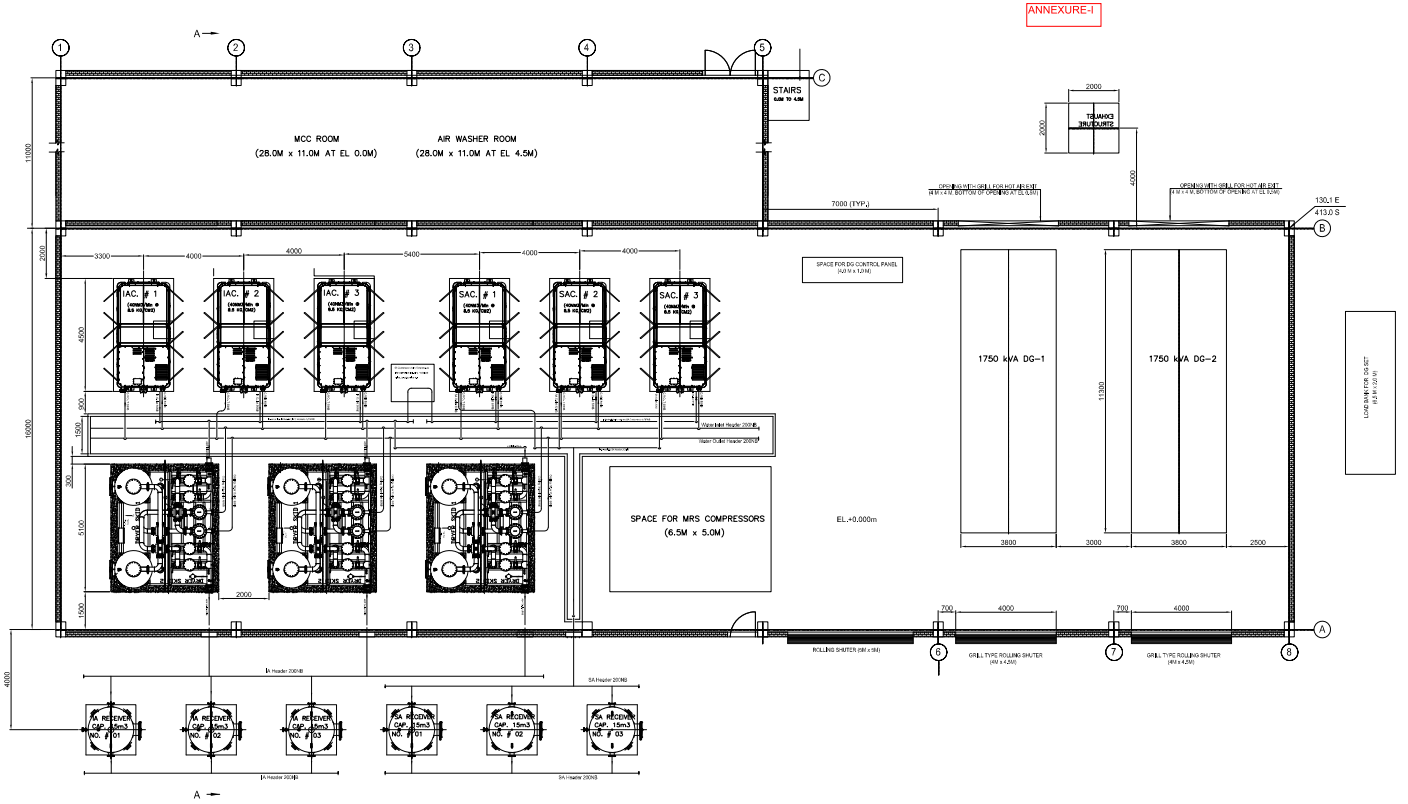
EXCLUSIONS

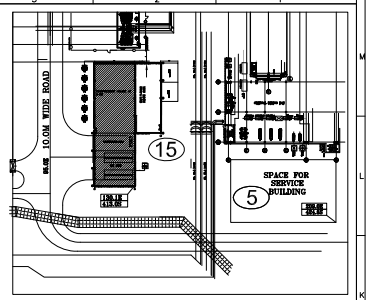
1. Load/ Fuel for commissioning, load trials and PG test of the DG at Site are not in Bidder's Scope.
2. Cable trays, supports and accessories are not in Bidder's scope.
3. Cable trench covers are not in Bidder's scope.
4. Earthing materials and plates are not in Bidder's scope.
5. Any Kind of Civil works at site is not in Bidder's scope.
6. Cables between Bidders' supplied equipments/panels and remote switchgear/DCS/Control Room is not in Bidder's Scope. **However All lugs and glands on Bidder's supplied equipment shall be in bidder's cope.**
7. Storage of materials, loading and unloading is not in Bidder's scope.
8. Transportation of materials from Stores to DG area is not in Bidder's scope.
9. Any kind of painting at site is not in bidder's scope.
10. Testing equipments like Primary injection kit, secondary injection kit, Megger etc at site are not in Bidder's scope.
11. Obtaining statutory clearance for DG Set is not in bidder's scope. However bidder to provide all necessary drawings and documents to get the clearance.
12. DG building lighting and fire protection is not in Bidder's scope.

DRAWING NO. PE-V0-426-555-A017

FIRST ANGLE PROJECTION | ALL DIMENSIONS ARE IN MM

ANNEXURE-I





KEY PLAN

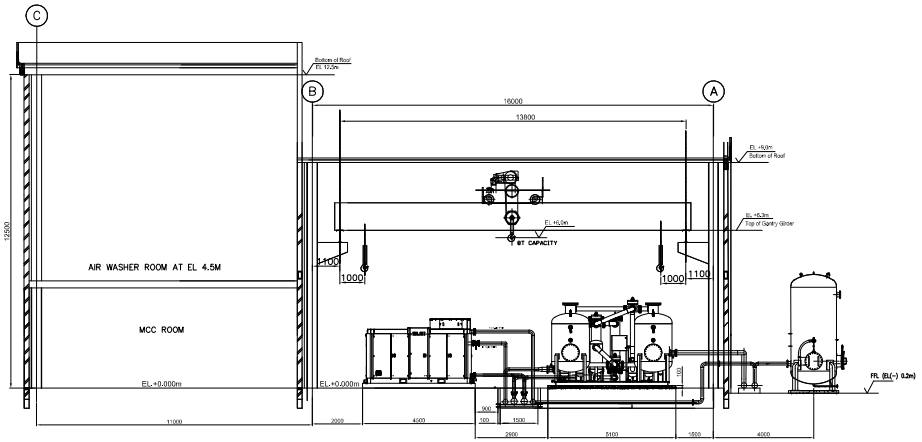
COMPRESSOR HOUSE EQP. LOAD DATA:-

S.No.	DISCRIPTION	QTY.	WEIGHT.(APPROX.)
01.	IA / SA COMPRESSOR	06	6500 Kg.(WITH MOTOR)
02.	AIR DRYER (ADP)	03	10000 Kg.
03.	15m3 AIR RECEIVER	06	3300 Kg.(EMPTY WT.)

MOTOR WEIGHT: 3500 Kg. (APPROX)

AIR WASHER ROOM EQP. LOAD DATA:-

S.No.	DISCRIPTION	QTY.	WT. PER UNIT (APPROX.)
01.	AIR WASHERS	02	13000 Kg.(ONLY STATIC LOAD)
02.	FAN WITH MOTOR	04	4000 Kg.(DYNAMIC LOAD)
03.	PUMP	04	1000 Kg.(DYNAMIC LOAD)



VIEW - AA

NOTES :-

1) ALL ELEVATIONS ARE MARKED WRT TG HALL FFL WHICH CORRESPONDS TO RL (+)126.5M.
2) ALL DIMENSIONS ARE IN MM.
3) CAPACITY OF DOUBLE GIRDER EOT CRANE IS 8.0 T.
4) DIMENSION FOR EQP. LOCATED IN COMPRESSOR HOUSE HAVE BEEN CONSIDERED MAXIMUM W.R.T. ALL PROSPECTIVE SUPPLIERS AND SHALL NOT CHANGE BUILDING DIMENSION (49.0Mx16.0M) AT LATER DATE.
5) EQUIPMENT DETAILS, VALVES & INSTRUMENTS SHALL BE INCORPORATED AFTER FINALISATION OF CAS SUPPLIER.
6) FOR E-DG SET, HEAVIEST PART TO BE LIFTED SHALL BE ENGINE WEIGHING 6000 KG (APPROX.)

NTPC DRG. No.9962-001-PE-102- PVM-F-205	REV. 00
PROJECT:	1 X 660MW PANKI THERMAL POWER EXTENSION PROJECT.
OWNER:	UTTAR PRADESH RAJYA VIDYUT UTPADAN NIGAM LTD.
REVIEW CONSULTANT:	NTPC LTD. (A GOVERNMENT OF INDIA ENTERPRISE)
CONSULTANT:	DEVELOPMENT CONSULTANTS PVT. LTD. KOLKATA
EPC CONTRACTOR:	BHARAT HEAVY ELECTRICALS LTD.

JOB NO: 426
STATUS: CONTRACT
DISTRIBUTION

REV.	DATE	ALTD	CHD	APPD

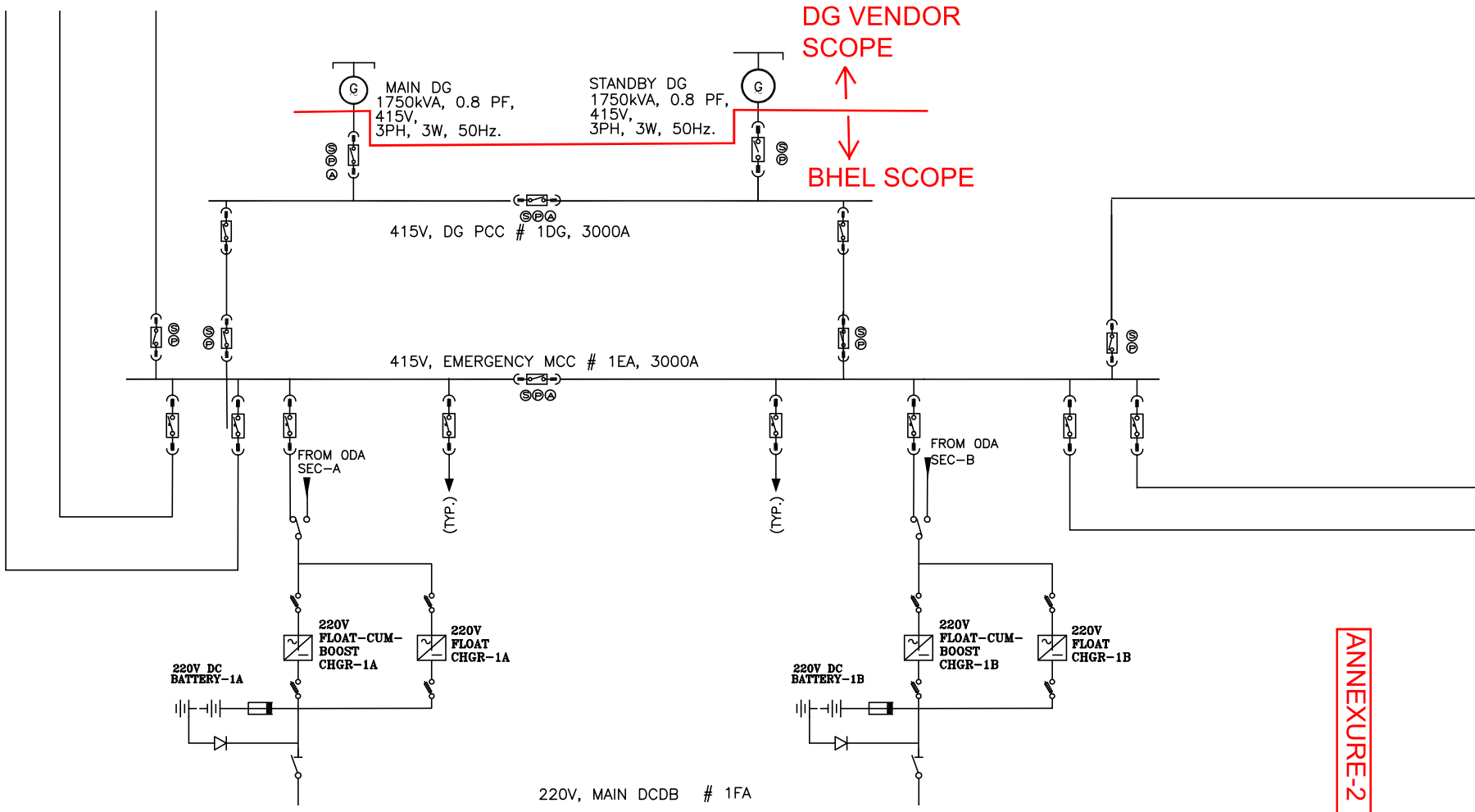
BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA

DEPT. CODE		NAME	SIGN	DATE
M	DRN	KARAN	- SD -	22.09.15
	CON	KARAN	- SD -	22.09.15
	CHD	HARISH	- SD -	22.09.15
	APPD	SNB	- SD -	22.09.15

TITLE: COMPRESSOR HOUSE LAYOUT

DEPT. | SCALE | SIGN | DRAWING NO. PE-V0-426-555-A017 | SHEET 1 OF 1 | REV. 00 | SIZE- A1

ELECTRONIC FILE NAME:



ANNEXURE-2

CHAPTER 28 : EMERGENCY DIESEL GENERATOR SETS

ANNEXURE-3

1.00.00 SCOPE OF SUPLY

1.01.00 The specification covers complete design, manufacture, packing, testing at manufacturer's work, erection, testing and commissioning of Two nos of adequately rated SKID mounted Diesel Generator Set with all accessories and related equipments including DG Emergency Board.

1.02.00 The offered Emergency DG System shall be strictly comply with the below mentioned type and rating.

i. The rating shall be as per the load requirement, however the DG set rating shall not be less than 1750 kVA, 415 V, 0.8 p.f, 3 phase, 3 wire, Emergency Diesel generator set in acoustic enclosure: Two nos.
ii. 415 V Emergency PCC-BHEL SCOPE
iii. AMF control Panel
iv. Remote control desk (UCD)-BHEL SCOPE
v. The connection arrangement of DG system shall be as per SLD.

2.00.00 CODES AND STANDARDS

2.01.00 The Design, manufacture, erection, testing and performance of items and services provided under this specification shall comply with the latest edition including all applicable official amendments and revisions as on date of award of the following standards. In case of conflict between this specification and code (IS Code, standards, etc.) referred herein, the former shall prevail. All work shall be carried out as per the following codes and standards.

2.02.00 Indian Electricity Act and Indian Electricity Rules can be obtained from bureau of Indian Standards.

2.03.00 Equipment complying with other internationally accepted standards such as IEC, BS, USA, VDE etc. will also be considered if they ensure performance and constructional features equivalent or superior to standards listed above. In such a case, the Bidder shall clearly indicate the standard(s) adopted, furnish a copy in English of the latest revision amendments and revision in force on date of opening of bid and shall clearly bring out the salient features for comparison.

Diesel Engine	IS-10000, BS : 5514
Internal Combustion Engines (12 Parts)	IS-10000
Speed of Diesel generator	BS649/195B
Alternator	IS-4722/IEC-60034, IS12065, IS12075
Permissible Limits of Noise Level of Rotating Machines	IS 12065
Measure, Evaluation and Limit of Vibration Severity of Rotating Electrical Machines Shaft 65 mm Dia or Higher	IS 12075
Diesel fuels – Specifications	IS 1460
Recommended Practice for Hot-Dip galvanizing of Iron and Steel	IS 2629
Methods for Testing Uniformity of Coating of Zinc Coated Articles	IS 2633

Code of Practice for Fire –Safety		IS 3034
	OISD Standard on Lightning Protection	OISD-GDN-180

3.00.00 EQUIPMENTS AND SERVICES REQUIRED

3.01.00 Two (2) Nos. of adequately rated (min. 1750kVA), 415V, 50 Hz, 1500-RPM diesel engine generator set in acoustic enclosure comprising the following:

3.02.00 Exhaust gas driven Turbo Charger flexible connection and exhaust piping suitably designed for operation at high temperature associated with exhaust gases.

3.03.00 Charge-Air Cooler, paper filter, corrosion inhibitor, dry paper elements, air cleaner, residential type silencers.

3.04.00 Over speed trip-mechanical should cut off fuel.

3.05.00 Crank case breather

3.06.00 DC motor starting device alongwith battery (Battery should be maintenance free Lead Acid)/ automatic battery charger (Charger should have trickle charge & boost charge facilities)and timing pointer.

3.07.00 Torsional vibration dampers

3.08.00 Fly-wheel and guard

3.09.00 Solenoid operated decompression valve, expansion joint

3.10.00 Piping, fittings and valves to connect the engine to the auxiliary systems

3.11.00 Indicator cocks and adaptors, oil/water heater, thermostats, Temperature Gauges.

3.12.00 Filters, strainers, lubricators and silencers, crank-case oil dip-stick.

3.13.00 Set of base frames, anti vibration mountings, flexible couplings between engine and generator.

3.14.00 DG Control panel (AMF Panel) for auto/manual start-up and stop operation with all related instruments ,controls and protection relays with associated alarms and annunciation system.

3.15.00 Circuit breaker panel (DG Board).-BHEL SCOPE

3.16.00 Local instrument gauge-board for oil pressure/temperature, water temperature, crank case oil level etc.

3.17.00 Expansion joints for connection of exhaust piping.

3.18.00 All cables & cabling system including supply, laying, termination of cables.

3.19.00 Remote control Boards /panels, Local Push Button Station

4.00.00 DESIGN CRITERIA

4.01.00 The Emergency DG set shall be connected to 415V Emergency MCC through DG PCC for safe shutdown of the power plant as well as to feed power to Emergency AC lighting system, DC system, UPS system etc.

4.02.00 The DG set shall have enough capacity to cover the maximum demand of the Emergency power. The sizing of DG shall be substantiated & approval obtained during engineering.

4.03.00 In normal condition the Emergency MCC shall be fed from 415V Turbine PMCC. Incase of complete power failure the start command will be issued to the main DG to start automatically. Upon attaining normal voltage and frequency the main DG incomer shall be closed automatically to restore Emergency power supply to the 415V Emergency switchgear and connected Emergency loads. Incase the main DG set fails to start then the standby DG set will receive start command and will feed power to the Emergency MCC.

On restoration of normal supply, changeover to normal supply from DG supply at Emergency switchgear will be done manually either from unit control desk (UCD) or emergency switchgear and switching off the DG set will be done manually after running the set few minutes on idle condition

4.04.00 DG with auto mains failure features, shall be capable of self-starting, delivering power in absence of any external utilities supply. It shall have all the facilities to start immediately, and deliver power as soon as there is a failure of plant power supply.

4.05.00 The DG shall be capable of starting and taking the full load within 30 secs.

4.06.00 The DG shall be capable of fulfill or operating under the following conditions:

i) Voltage variation shall be within ± 5% from no load to full load.

ii) Frequency regulation shall be within + 3% to -5% of rated voltage from no load to full load.

iii) The instantaneous voltage dip shall be less than 20% of rated voltage when three-phase full load at rated power factor is applied to the generator. Recovery to stable operation shall occur within 4.0 seconds.

iv) For steady state operation, frequency variation shall not exceed ± 0.25% and voltage variation ±1% of their mean value for constant load from no load to full load.

4.07.00 The DG set will be installed indoor and housed inside Air compressors & DG Building. All equipments and accessories shall be provided with tropical finish to prevent fungus growth.

4.08.00 Noise level and Vibration Level shall be within permissible limits as per applicable norms for HSD as fuel. Suitable noise suppressing / acoustic enclosure shall be provided

4.09.00 The contractor shall recommend in layout the space requirement. The Contractor shall have to take necessary approval of the installation from statutory authorities. The exhaust shall be discharged through a silencer and

stack outside the building at a sufficient height complying the pollution control board requirements. The stack height H shall be based on the following formula

Stack height shall be maximum of the following, in metre:

i. H = 14 * Q^0.3 ,

q=total SO2 emission from the plant in kg/hr.

ii. Minimum 6 m above the building where generator set is installed.

iii. 30 m

5.00.00 SPECIFIC REQUIREMENTS

5.01.00 Diesel Engine

5.01.01 Diesel Engine Stationary type, four stroke, single acting, multicylinder, with Vertical in line or 'V' type cylinder arrangement, mechanical injection system shall be furnished with all its associated standard accessories according to BS 5514/ ISO Standard practice. Contractor in his offer shall furnish a detail calculation justifying that the engine offered by him will meet the requirement of developing the rated conyinuous net power output at alternator terminals.

5.01.02 The power rating, required auxiliaries, guarantees of fuel consumption, parallel operation (if required), governor performance, torsional vibration, material and workmanship shall be in accordance with BS-5514 / ISO Standard Practice.

5.01.03 Engine shall be provided with an exhaust gas turbocharger with after cooler having an integral intake air filter and silencer , and also be quipped with fly-wheel.

5.01.04 Diesel engine shall be mounted on visco damper type vibration dampening system and shall be complete with integral air intake through dry type air filters and exhaust systems, metering facility, speed regulation system, fuel injection system, lube oil system, primary cooling water system alongwith necessary filters, silencers, ducts, piping and fittings, valves, instruments, etc. as required.

5.02.00 Fuel Oil System

5.02.01 The diesel oil system as provided shall be complete with duplex type filters, hoses, piping, fittings, relief valves, supports, control and instrumentation and all other accessories to make it complete.

5.02.02 The fuel consumption of the engine at full and three quarters of its rated power output shall be indicated by the contractor.

5.02.03 A day oil tank of 990 litres fuel capacity shall be provided by the contractor, mounted on fabricated steel plat form.

5.02.04 The tank shall be complete with level indicator marked in Litres, two nos. of level switches, 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. All pipe joints shall be brazed/ welded.

5.02.05 Tank shall be of minimum rated for 8 hours (at rated capacity) , provided with sight glass engine driven fuel oil booster pump and fuel oil injection pumps. The tank shall be complete with inlet, outlet and drains. Fuel oil tank shall be complete with instrumentation such as level gauges with low level sensing for annunciation. Tank design shall be subject to the statutory approval of Explosive Department, Nagpur. Any license required to be obtained from Explosive Department for installation of fuel tanks will be arranged by Vendor.

5.02.06 One (1) hand pump for fuel filling purpose with 3 metres long flexible hose pipe for oil transfer to day tank. - SEE BHEL SPEC

5.02.07 An engine driven booster pump shall be provided to deliver fuel ipl from the supply line, fuel oil filtered through simplex filters, to the fuel oil injectors. Power plant EPC contractor may also offer any alternative method of fuel supply to the engine.

5.02.08 The fuel injection system shall be designed to permit manual adjustment of indivisual cylinder loading so that the variation of exhaust temperatures and firing pressure shall be within the acceptable limits recommended by engine Manufacturer.

5.02.09 Fuel passages of proper size and types shall be provided.

5.02.10 Injection shall be provided to receive low pressure fuel from the fuel pump and deliver it into the indivisual combustion chamber at right time in exact quantity and proper condition to burn.

5.03.00 Lubricating Oil System

5.03.01 Automatic pressure lubrication shall be provided by a shaft driven gear type pump through an oil cooler and fin mesh filters to the end bearing, camshaft bearings, camshaft chain and gear drives, governor, air starting, distribution, auxiliary drive gears etc.

5.03.02 If prelubrication is required before starting of the DG set, than one (1) no. electrically operated and one (1) no. standby DC/ Diesel engine operated lube oil pump shall also be provided for the purpose.

5.03.03 All necessary accessories like pressure gauges, temperature and oil level indicators, pressure relief valves, bypass valves, pressure switches for alarm and control shall be provided by the Contractor together with all inter connecting piping, fittings, supports, valves, etc.

5.03.04 Lube oil service tank / sump shall be located near the engine.

5.03.05 A lubricating oil filter shall be provided for operation under normal conditions for period of a more than 250 hours without the necessity of its replacement or cleaning.

5.04.00 Jacket Water Cooling System

5.04.01 The jacket cooling water shall be circulated by an engine driven pump for cooling of cylinder head, cylinder liners,cylinder blocks,injectors,intake and

exhaust valve,charger air cooler and turbo charger. The quantity of water required for cooling in a closed circuit shall be provided through water by power plant EPC contractor.

5.04.02 Jacket water shall be cooled by the heat exchanger. If required, the temperature of the jacket water shall be thermostatically controlled. Heat exchanger shall be provided with bypass valve shall be used at the time of starting the engine to have jacket water temperature up to operating value.

5.04.03 The cooling water flow to charge air cooler shall be controlled thermostatically.

5.04.04 For heating of Jacket water during start-up of engine, needed number of heaters with ON/OFF switches and fuses shall be provided on the control panel.

5.04.05 Cooling tower, associated 2X100% pumps, piping or radiator along with fan shall be provided by the power plant EPC package contractor.

5.04.06 Jacket water cooling system is offered, same be in closed cycle and shall have radiator located in front of the engine with a fan driven mechanically from the engine shaft. Forced water circulation by means of pump driven by the engine shaft shall be employed. The radiator tubes shall be of copper with sufficient heat transfer area.

5.05.00 Heat Exchangers

5.05.01 Cooling of jacket Water and lube oil by heat exchangers shall be air cooled radiator type.

5.05.02 This type of heat exchanger shall be " composite" radiator type for cooling both Jacket Water and lubricating oil. The radiator shall be cooled by engine driven fans and shall be complete with screens, dampers, ducting accessories etc.

5.06.00 DC Equipment

5.06.01 For starting of Engine and to meet other D.C loads for protection relays, contactors etc,, One bank of 24V D.C. Lead acid Battery for each D.G set Equipment shall be supplied.

5.06.02 One additional back up batteries bank of 24 Volts 100% rated Lead acid battery for each D.G set with changeover facility of suitable rating on 10-hour basis to cater number of starting of engine and other as D.C. requirements of Engine/ generator control panel shall be supplied.

5.06.03 Input to battery charger is 1 phase, 1 wire, 240 V AC. A battery charger comprising of one Float charger unit and one Float cum Boost charger unit shall be supplied. Normally, the float charger shall supply continous D.C. requirmnets and trickle charge the Battery as and when required. Battery charger shall be rectifier type with all accessories mounted in an enclosed sheet steel cubicle. Battery charger which shall normally be used as trickle charger, shall have built in automatic voltage control to maintain output DC voltage within one (1) percent of the voltage setting when input AC supply has voltage and frequency variation as specified. When the battery has been substantially discharged, boost charger shall have built in automatic constant

current characteristic & load limiting feature. Battery charger shall be supplied complete with all devices including but not limited to following:

(a) ON / OFF switch

(b) HRC fuses with fittings for above switch with trip indication.

(c) Suitably rated transformer with required range of tapings on primary winding to compensate for AC supply voltage variations.

(d) Suitably rated rectifier for full wave and full controlled rectification with suitable semi conductor fuses on input and output.

(e) Ripple filtering device to give smooth DC output. The ripple current shall be less than ±2.5%

(f) Double pole ON / OFF rotary switch for DC heavy duty with one auxiliary contact for annunciation.

(g) HRC fuses with fittings for above with trip indication

(h) Red indicating light across DC output voltage to indicate DC supply 'ON'.

(i) Automatic voltage regulator consisting firing circuits, phase transformers, load limiter etc.

(j) Selector switch for selecting mode of charging i.e. float charging / quick charging current

(k) Suitable scaled square faced moving coil ammeter.

(l) Potentiometer with knob for setting the quick charging current or current limit for load limiting feature.

(m) Potentiometer with knob for setting the DC output voltage

(n) Voltmeter for indicating DC output voltage

(o) Ammeter for dc output current.

5.06.04 The engine starting system shall be suitable to start automatically. The contrctor shall provide all necessary devices including relays so that with an impulse for the starting of the engine received from DG AMF panel or manual push buttons, the whole process of the Diesel set, bring upto rated speed & build up of voltage takes place automatically.

5.06.05 The system shall be complete with all needed wiring, fittings, supports, relays, instruments, controls and accessories.

5.07.00 Air Intake And Exhaust System

5.07.01 The air intake and exhaust system shall be provided with :

i) Air intake silencer and filter
ii) Exhaust gas driven turbo charger
iii) Charge air cooler

iv) Exhaust gas residential type silencer
v) Necessary air inlet and exhaust pipe, supports, thermal insulation for the entire exhaust pipe length for personnel safety, flexible piping/expansion joints to avoid transmission of vibrations from the engine to the structures.

5.07.02 The exhaust system shall consist of exhaust gas driven by turbo-charger with lagged piping inter connecting cylinder head outlets with turbo charger inlet. Exhaust manifold shall be of fabricated steel construction and suitably insulated.

5.07.03 The exhaust gases of turbo charger should be taken out twelve metres above the roof of engine room through suitable piping, adopters etc.

5.08.00 Engine Governing System

5.08.01 The governor shall be A1 type as per BS-5514 provided with Electronic Type of "reputed" make conforming to "Class A.2 Precision Grade Governing" of BS:649 of approved equal and the governor shall have the following features:

5.08.02 It shall be capable of operating with "Zero Droop" and the droop shall be adjustable at the engine from 0 to 5% of the rated full load speed upon gradual changes from no load to full load.

5.08.03 The governor shall have necessary characteristics to maintain the speed substantially constant even with sudden variation in load. However a tripping shall be provided even if speed exceeds the maximum permissible limit.

5.08.04 A mechanical over speed trip device shall be provided to automatically shut-off fuel in case the speed exceeds 110% of the rated value. The valves at which the mechanism trips the engine shall be adjustable

5.08.05 An engine mounted Emergency stop push button shall be provided.

5.08.06 Vibrations - Max. 250 microns peak to peak with anti-vibration pads

5.09.00 Instruments for Diesel Engine

5.09.01 The following equipment shall be supplied for the Diesel Engine Gauge Board:

a. Flywheel
b. Fuel piping
c. Tachometer/RPM indicator
d. Lubricating oil cooler (if applicable)
e. Exhaust silencer and piping
f. Fuel and lubricating oil filters, air filters.
g. Temperature gauges for water and lubricating oil and pressure gauges for lubricating oil.
h. Hand barring gear.
i. Necessary foundation bolts and base channels for the engine, alternator, fuel service tank and for all other equipment included in this package.
j. Base frames
k. Platforms and hand railing and access ladder (if applicable)
l. Starting equipment
m. Protective equipment preferably in the form of fuel cut-off solenoid and suitable relays to protect the engine against low lubrication pressure.

n. lifting attachment for lifting the complete set or the engine alternator separately.
o. Radiator / Heat Exchanger.
p. Any other ancilliary equipment not specifically mentioned in the specification but are necessary for proper operation and maintenance of the set and safety of operating personnel.
q. Pressure gauges for lube oil, fuel oil system, jacket water.

r. Differential pressure gauges across strainers and filters for lube oil and fuel oil systems.
s. Exhaust gas thermometers shall be installed in two exhaust pipes coming out of rows of cylinder.
t. Dip-stick for crank-case oil level
u. Pressure switch for lube oil system to annunciate on the panel and trip the unit if the pressure falls below safe limit or temperature rises above desired limits.
v. Temperature switch for annunciation of high jacket water temperature shall also be provided.
w. Low/high level switches for fuel oil tank shall be provided for alarm and interlocking purposes.
x. Low/high level switches for makeup water shall be provided for alarm purpose
y. Cooling water temperature indication shall be provided for alarm purpose.

5.10.00 GENERATOR

5.10.01 The generator shall be of totally enclosed or screen protected drip proof and self air cooled type. The generator shall be driven by the Diesel engine specified above and shall match the same in all respects. The generator shall conform to IS 4722 or IEC-60034.

5.10.02 AC Generator complete with

- Directly coupled SPDP with IP-23 type AC Generator, with terminals arrangement suitable for mains cables of type and size as specified by the Contractor. Contractor shall finalize the same after taking approval from the owner.
- AC generator shall be supplied alongwith it's excitation system, AVR and include all necessary auxiliaries.

5.10.03 Rating

The Generator shall be star connected-3-phase, 50 Hz synchronous generator and shall have a continuous rating. The operating condition for each electric generator shall be as follows:

a)	Voltage	415V
b)	Frequency	50Hz (+3 to -5%)
c)	Power factor	0.80
d)	Design Ambient Temp.	50^0 C
e)	Number of Phases	Three (3)

f)	Winding Connection	Star (Y)
g)	Class of insulation	Class H
h)	Temperature rise limit	Class B
i)	Permissible voltage variation for satisfactory operation at rated KVA	± 5%
j)	Permissible frequency variation	+3% to -5%
k)	Permissible Combined voltage (absolute) and frequency variation	10%
l)	Method of Neutral grounding.	Non-effectively earthed through Neutral grounding Transformer
m)	Engine rating	To be decided & given by Contractor

5.10.04 The transient reactance shall be as low as possible consistent with the need to limit the voltage drop on sudden application of the load. When machine is running with other connected loads , it shall be possible to start the largest capacity motor fed from DG source without exceeding 10% dip in voltage and +3 to -5 % variation in frequency. In any event, the bus voltage and frequency recovery times are not to exceed maximum values of one (1) second and five (5) seconds respectively after the said application or rejection of loads.

5.10.05 The limits of temperature rise shall be in accordance with Class B insulation.

5.10.06 The design of all parts of the generator and accessories shall be able to withstand all electrical, mechanical and other stresses which may be experienced during operation, including short over-speed conditions. The generator and accessories shall be capable of withstanding three phase short circuit at the generator terminals when operating at rated KVA & power factor, 5 per cent over voltage and with fixed excitation for three (3) sec.

5.10.07 Generator winding shall be star connected and all the six winding leads shall be brought out on six suitably located terminals for insertion of CTs for protection, metering etc. along with the formation of star point. The short circuit ratio shall not be less than 0.5 (minimum) for such machines and shall be stated by BOP Contractor. The star point shall be solidly connected to the station ground mat through a single phase voltage transformer.

5.10.08 The stator shall be of rigid construction and be built up of steel stampings of high permeability and low hysterises loss. The design shall be such that the temperature of all parts of the windings and core is kept as uniform as possible throughout and to avoid excessive local heating. The generator shall incorporate 6 Nos. embedded temperature detectors which shall be wired to temperature scanner mounted on AMF panel with adjustable alarm. Six elements of PT100 distributed at locations where highest temperatures may be

expected in stator winding and cases. Alternator bearings shall also be provided with RTDs wired to temperature scanner with alarm-contacts.

5.10.09 The generator shall be capable of withstanding negative phase sequence fault current, I2 expressed in per unit of rated current of duration, t2 expressed in seconds related by the following equation :-

$I2^2 t = 20$

5.10.10 Short Time Overload

The generator shall be capable of withstanding on test without injury for not less than 15 secs. a current of 50% in excess of its rated current after having attained the thermal equilibrium corresponding to rated load, the terminal voltage being maintained as near as the rated value possible.

5.10.11 Suitably rated 240 V, single phase, 50 Hz, space heater located in lower part of alternator shall eb provided to maintain the internal temperature above the dew point to prevent moisture condensation on the insulation when the set is not running. These heaters shall be switchged on automatically, when DG set is not working.

5.10.12 A separate terminal box, shall be provided to house the space heater connections. The space heaters shall be cut off automatically, when the generator is running.

5.10.13 Earthing terminals with clamps shall be provided on the generator suitable for 75 x 10 mm GI flat conductors.

5.10.14 All current carrying parts shall be protected against accidental contacts.

5.10.15 The speed of the generator shall be the same as that of the diesel engine to which it is directly coupled.

5.10.16 The generator shall be of air cooled type with air circulation through the machine by blower fans mounted on to both the rotor ends. Open circuit cooling system when the cooled air is taken from atmosphere and is discharged from the machine, either into the machine room or back to the atmosphere shall be resorted to. Adequate surface area shall be provided to keep the air velocity sufficiently low to prevent carry-over. The ventilation shall be provided with renewable air filter to reduce the deposit of dust particles on the ventilation passages for avoiding excessive temperature rise of various parts.

5.10.17 The alternator rotor and bearings shall be so designed as to safely withstand an over speed of 20% over normal speed for a period of two(2) minutes . The type of the bearing provided shall be stated in the tender. The windings shall be so designed and arranged that displacement between portions of the coil and between the coils and the cover due to centrifugal force is minimized.

5.10.18 Terminal Box

Terminal Box: For each DG set, separate terminal boxes shall be provided for phase and neutral side of leads. The terminal boxes shall be dust tight, weather proof having degree of protection of IP-54 as per IS:13947. The terminal box shall be suitable for terminating Power Cables of adequate size, .

Suitable tinned copper pads shall be provided for power cable termination. For single phase cables gland plate shall be of nonmagnetic material and shall be removable type. As far as possible connection between exciter and alternator shall be contained within the machine fram and connections carrying AC and DC current shall be segregated from each other. The necessary CT's for differential protection shall be provided on neutral side. The neutral point shall be brought to DG control panel and shall be connected to 300/100 V VT, to be supplied and mounted inside the DG control panel by thebidder for earth fault detection.

5.11.00 Excitation System

5.11.01 The generator shall be provided with complete brushless excitation system capable of supplying the excitation current of the generator under all conditions of output from no load to full load and capable of maintaining voltage of the generator constant at any value with +/- 1 % of the rated voltage. The seeting range available on voltage regulator shall be at any value within +/-5% of the rated voltage. It shall be possible to set the same from remote also. The type of insulation of the armature field winding of the exciter shall be Class-B and the temperature shall not exceed the values specified in IEC-60034 Part-I for different parts. The excitation system shall be supplied with "voltage regulator with two channels of auto voltage regulation and one channel for manual voltage regulation" remote control of terminal voltage.

5.11.02 The components used in the system shall be adequately designed for satisfactory operation under full load condition, overload condition as specified and also under short circuit condition.

5.11.03 The allowable variation for the aforesaid system shall be within the range of ±2 %. It shall have a rapid transient voltage response to suddenly applied loads together with the reliability of the system.

5.12.00 Automatic Voltage Regulator

5.12.01 The regulation system shall be provided with equipment for automatic and manual control, solid state type, high speed voltage regulator. Necessary equipment shall be furnished for the following:

- To prevent automatic rise of field voltage in case of failure of potential supply.
- To initiate transfer from automatic to manual control of excitation on fuse failure in the generator potential signal.

5.12.02 Generator shall be capable of operation over a range of +/- 5% of rated voltage.

5.12.03 The regulator shall regulate from generator current and potential signals.

5.12.04 Voltage regulator shall be supplied complete with cross current compensation (preferably of the static type), voltage adjusting rheostat, all accessories and alarm contacts for successful operation including mounting and wiring current transformers for compensation

5.12.05 The above equipment shall be housed in self standing sheet metal cubicle, and shall be completely tested and wired.

5.12.06 The regulation equipment shall function correctly between the frequencies 47.5 and 51.5 C/s and shall ensure a voltage variation not more than +/- 1% of the set point in steady operating condition between no load to full load. The drop of voltage from no load to full load shall not exceed 2%.

5.12.07 The voltage regulator shall be provided with compensation circuit to assure correct division of reactive power in case of parallel operation. The excitation and voltage regulation should be designed so as to cause necessary de-excitation in case of any short circuit.

5.13.00 Control of Generating Set

5.13.01 When the normal AC supply is available from 415V Switchgear, Generator set will be normally at rest. In case of Emergency, the generator set shall be started to feed the Emergency loads of the power plant. In the event of failure of normal power supply, the DG shall auto start simultaneously and on attaining normal voltage and frequency in the DG incomer breaker of DG board shall close automatically to restore power supply.

5.13.02 Contractor shall provide all necessary accessories required for this purpose of automatic / manual starting and manual stopping involved in various stages of operation in the engine auxiliary systems. DG Local panel shall be furnished for diesel generator set which shall have the provision for automatic and manual starting of the generating sets through a suitable auto-manual selector switch. In the 'Automatic' position of selector switch the set shall start only when the starting impulse is received from U/V relay connected at 415V DG Board. In the manual positions of the selector switch the set is to be started manually. Test and shut-down sequence control should also be available.

5.13.03 Following provisions shall be provided for DG start / Stop operation:

(a) Readiness to Start

A master relay shall be provided to monitor the following requirements to be met before the set can be started and an indicating lamp shall be provided to indicate when all the requirements are met.

(i) The 415V circuit breaker of the Diesel generator is open and there is no fault on the bus.

(ii) Pre-requisite conditions for DC supply for safety are satisfied.

(iii) Pre-requisite conditions for Cooling water pump / System / Lubricating oil pump / System exhauster fans, fuel oil system, pre-lube system, Ventilation system for safety are satisfied as applicable.

(iv) No volt field, flashing circuit , if provided is available

(v) Non of the tripping signal enumerated in this specification is present.

(b) Automatic Starting

When the starting impulse is received from the AMF panel, the diesel generator set speed up provided the auto-manual selector switch is in the

'Automatic' position and all the pre-requisite conditions under ' Readiness to Start' are fulfilled.

Three attempt starting facility should be provided. In case the diesel engine fails to start and fails to reach the rated speed within 30 seconds, it shall be disconnected and locked out automatically.

When the automatically controlled frequency and voltage reach the pre-determined values, an impulse shall be received by the circuit breaker of the generator to close on dead bus.

The time interval between the instant of receiving the automatic starting impulse form any of the Emergency load system and the instant when the generator circuit breaker is just closed (fully) shall not exceed 10 seconds.

If due to any reason the above automatic starting of the set is not achieved within a pre-determined period then the same shall be annunciated at the control panel and provision for one normally open and one normally closed contact for annunciation shall be made by the power plant EPC Contractor and suitably terminated at his control panel terminal blocks.

(c) START-STOP OPERATION

(i) "Auto-Manual" selector switch at "Manual" position

In this condition, the Diesel Generator can be started / stopped from the DG AMF panel by pressing start/stop push button

(ii) "Auto-manual" selector switch at "Auto" position-

- The Diesel Generator shall be automatically started when normal power supply fails. A time delay contact, adjustable from 1 to 20 seconds, shall initiate the starting of the Diesel Generator. PT supply from DG bus PT and normal incomer PT to AMF panel and common synchronizing panel shall be provided. Contractor to use the PT supply for automatic start / stop and synchronization purpose of the D.G.

(iii) Irrespective of Auto / Manual selector switch position, DG set shall be stopped manually. On restoration of normal supply, changeover to normal supply from the DG supply at Emergency switchgear will be done manually from Emergency switchgear and switching off the DG set shall be done manually after running the set for around one minute on idle condition.

5.13.04 Manual Control of Speed & Voltage

The manual control of the engine speed and generator voltage shall be provided through suitable 'Raise / Lower' control switch on the AMF panel furnished by power plant EPC Contractor.

5.13.05 Diesel Generator Control Scheme

CTs shall be supplied for metering as well as protection of the generator. These CTs shall be located at the generator phase as well as neutral side as per requirement. Power Plant EPC Contractor shall develop the DG

requirement / successful operation on the plant Emergency system and submitted the same for owner approval.

5.14.00 AMF Control Panel

The AMF panel shall be floor – mounted type with degree of protection IP-54. The contractor shall provide a DG AMF Panel for each DG set which shall house the protection, control, instrumentation, alarms and the controls and distribution of the engine auxiliary system of the DG.

The AMF panel shall be complete with all accessories including, but not limited to the following items.

5.14.01 Engine, generator & exciter control panel with switches, meters, indication lamps, audiovisual alarm, etc, for manual as well as automatic operation.

5.14.02 Automatic voltage regulating equipment and accessories.

5.14.03 In addition, coupling relays (with diodes) having 24V DC or suitable energising coil in the control panel shall be provided for remote application for the followings
(a.) DG Start
(b.) DG Stop
(c.) DG Voltage raise
(d.) DG voltage lower
(e.) DG speed raise
(f.) DG speed lower
(g.) DG auto start

5.14.04 Annunciation

Annunciation for the following shall be provided with indication, alarm & trip contact, accept, reset and test facility. Any one or more of the following defects shall cause the alarm or running diesel generator to be tripped. In case of tripping, re-start shall be prevented until the faults are removed and removed and manual resetting is done. Separate indicators shall be provided for each of the following in control panel:

a) Engine fails to start(Alarm)
b) Low lube – oil pressure(Trip)
c) High cooling water temperature(Trip)
d) DG overload(Alarm)
e) DC failure (Alarm)
f) DG over speed(Trip)
g) Fuel level low in day tank(Alarm)
h) Fuel level very low in day tank(Trip)
i) Generator stator and bearing temperature high(Alarm)
j) Electrical protection operated (Trip)
k) Incomer to Emergency switchgear from DG closed.
l) Earth fault (alarm).
m) Lube Oil Priming Pump 'Fault' indication.
n) PT fuse fail (Alarm)
o) Voltage regulator trouble (Alarm)
p) Emergency stop (trip)

5.14.05 The spare contacts of all above alarms to hook up for Plant DCS system.

5.14.06 In addition to the above contact provision, the following remote alarm provision shall be made:

- Generator group fault
- Engine not ready to start
- Engine failed to start
- Engine tripped on fault

5.14.07 All alarm contacts for remote indication shall be open to alarm, potential free. All remote indication contacts shall close to indicate. Contractor shall provide provision at the AMF panel for the repeat annunciation at DCS.

(a) The following analog parameters shall also be provided with required transducers to hook up for Plant DCS system

(i) Voltage
(ii) Current
(iii) Frequency
(iv) Power

(b) The annunciation system shall be window type having static circuitry. On initiation by protective relay contact, the relay actuates and flashing signal is turned to the corresponding channel. Simultaneously, the alarm circuit is also made operative. On operation of the acknowledge push button, the audible signal is switched off and the flashing window changes its state to steady illumination, Operating sequence shall be as follows:

Condition	Audible Alarm	Visual Condition
Normal	OFF	OFF
Initiating contact makes	ON	ON (Flashing)
Acknowledge	OFF	ON (Flashing)
Initiating contact test	OFF	ON (Steady)
Reset push button operated	OFF	OFF

(c) AMF Panel shall also be provided with the following:

(i) All relays shall be of multifunctional numerical communicable type.
(ii) CTs for metering and protection (CL. 0.5/0.2 accuracy & protection of class 5P20, PS class for Differential Protection)
(iii) Ammeter
(iv) Voltmeter with selector switch
(v) Under voltage relay with timer
(vi) Over voltage relay with timer
(vii) Reverse Power relay
(viii) Voltage controlled inverse time over current relay
(ix) Inverse time earth fault relay
(x) Differential Protection
(xi) Restricted earth Fault protection
(xii) Voltage sensing relay to sense voltage developed is correct so that breakers are permitted to close. Having reset ratio better than 0.95
(xiii) Under / over frequency relay, with built-in-timers

(xiv) Frequency sensing relay to check that the frequency of the DG Sets is O.K. enabling the breakers to close.
(xv) Master lockout relay.
(xvi) Start and Stop push buttons
(xvii) Single phase PT of 415/√3/110/√3 of adequate burden to be selected by vendor to fulfill the requirement of protection & metering with 20% margin and 0.2 Accuracy class for metering and protection.
(xviii) PT fuse failure relay
(xix) Wattmeter to read 3 phase power
(xx) Frequency meter
(xxi) Non reset type Hour Meter
(xxii) Single phase potential Transformer 415/110V of adequate burden to be selected by vendor to full fill the requirement with 20% margin, 0.2 Accuracy class to cater the load of voltage & frequency sensing relay for voltage regulator.
(xxiii) Single phase transformer of ratio 415/240V, to cater the loads of various heaters, illumination etc.
(xxiv) Temperature scanner for the temperature of the stator windings and bearings of the alternator.
(xxv) Auxiliary supply for temperature scanner shall be 220V DC

(e) The control panel shall also be provided with generator voltage regulator along with the associated equipments including panel heaters and auxiliary services.
(f) 'Diesel Generator Trouble 'annunciation (single annunciation for whole group of troubles)
(g) Auxiliary supply to Multifunction numerical relay is 220V DC.

5.15.00 Constructional Features

(a) Diesel Engine

(i) Bed Plate

Cast iron / fabricated steel bed plate shall have integral well ribbed diaphragms for supporting the main bearing housings. Cast iron bed plates shall be of alloy iron. Incase of the fabricated steel bed plates, the welding shall be radio graphed and the entire fabrication shall be stress-relieved after welding. The bed plate shall have integral lube-oil sump and shall be mounted with the generator and exciter on a common steel sub-base.

(ii) Crank Case

Crank case shall be of alloy iron casting with integral transverse diaphragms or alternatively of fabricated steel construction provided with heavy steel inner side plates to form water compartments around the cylinder. Adequate detachable doors shall be provided on both sides of the crank case to facilitate access to the big-end and main bearings, camshaft and governor drive. Additional detachable doors shall also be provided to facilitate access for the cleaning of water jackets.

(iii) Crank Shaft

Crank shaft shall be machined from forged alloy steel and shall have suitable coupling flange to which the fly wheel shall be bolted.

(iv) Main and Big-end Bearings

These shall be detachable and pre-finished shells with high grade bearings. The dimensions shall be such that the connecting rods can be withdrawn through the liners

(v) Connecting Rods

These shall be 'I' be3am sections of high grade drop forged steel.

(vi) Cylinder Liners

These shall be of separately inserted 'wet' type cast in alloy iron and specially machined in their bores to give an oil retaining surface.

(vii) Pistons

These shall be of forged aluminium alloy and machined on their outer surface. The pistons shall be fitted with compression springs and oil scraper rings of hardened cast iron alloy.

(viii) Camshafts

The camshafts, one for bank of cylinders, shall built up in replaceable sections of heat treated precision machined steel with chromium plating. All cams shall have hardened profiles. Fuel injection cams of the spilt removable type shall be doweled for angular location.

(ix) Fly wheels

The fly wheel shall be of mild steel, statically balanced after machining and shall have graduated markings around the periphery to facilitate checking of valve and fuel pump timings. Barring slots shall be provided around the fly wheel rim for hand barring.

(x) Exhaust Manifolds

Exhaust manifolds shall be of multi branch, insulated design utilizing Ni-resist casting.

(b) Diesel Generator and Accessories

(c) AMF Panel and their Accessories

AMF Panel shall be of metal enclosed, sheet steel cubicle indoor, floor mounting, free standing type. Cubicles shall be totally enclosed dust and vermin proof with IP-54 degrees of protection as per IS:2147. These shall be made out of at least cold rolled 2.0 mm thick sheet steel, suitably reinforced to provide rigid flat level surfaces, resistant to vibration during transportation and installation. Doors or removable covers shall be at least 2 mm thick. No welds, revets, hinges or belt threads shall be apparent from outside.

(i) Panel /DB shall be assembly of a series of floor mounting, identical

cubicle type panels placed side by side. They shall be capable of being easily extended at site. The panels shall be fully compartmentalized, with separate totally metal enclosed compartment for every feeder, in their formation. Hinged covers for easy inspection and maintenance of equipment in cubicle shall be provided. Separate chamber shall be provided in panel to house busbars.

(ii) AMF Panel supporting frame work shall be sturdy and suitable base channels shall be provided. Maximum operating height shall preferably be limited to 2.0 metres. All openings for incoming and outgoing cables shall be at the bottom only. Necessary blank plates with cable glands shall be provided. Nameplates shall be provided individually for feeder and for complete switchgear and control panel shall consist of black Perspex with white engraving to approval.

(iii) Approved quality and make for equipment / components like switches, fuses, control fuses, push buttons, indicating lamps, current transformers, ammeters, voltmeters, terminal blocks etc needed for complete circuit shall be provided.

5.16.00 Piping

(a) Piping for oil etc shall be designed, fabricated and tested in accordance with the ASME code and ASA code for pressure piping or approved equivalent.

(b) Before commencing any welding operation, Contractor shall furnish to Owner / consultants for approval complete details of the method and procedures, which the contractor proposes to use. The Contractor shall strictly adhere to such procedures and methods once approved.

5.17.00 Instruments Tools and Tackles for Erection and Maintenance

Following shall be separately indicated in corresponding schedule:

(a) instruments, tools and tackles for erection

(b) Instruments, tools and tackles for erection

(c) Special instruments, tools and tackles for erection

(d) Special instruments, tools and tackles for maintenance

5.18.00 LOAD BANKS- LOAD BANK IN BHEL SCOPE

5.18.01 Load Bank shall be resistive/reactive type and shall be suitable for testing the generator on full load. The load bank shall be suitable for outdoor application with degree of protection IP 55. Load bank shall be fully automatic with provision for manual operation.

5.18.02 Constructional features:

The load bank shall be fan cooled constructed from 2.5 mm zinc coated steel incorporating removable panels for easy access to resistors and fan. The whole assembly shall be mounted onto a fully hot dipped galvanized base. The

control and electrical cabinet shall be part of the load bank and shall have doors with lift off hinges and security type loads. All screws, nuts and bolts shall be zinc plated and secured with vibration proof washers and thread locking adhesive.

5.18.03 The load bank shall be constructed as a free standing unit and be self supporting, vermin proof; with front, side and end panels forming uniform planes without protrusions or sharp edges. Provision shall be made for lifting the unit by the use of crane slings, rollers and fork lift trucks.

5.18.04 The load bank control cabinet doors shall be fitted with neoprene wire reinforced gasket. An anti-condensation heater protected by HRC fuse shall be provided in the control panel.

5.18.05 Load resistors shall be stainless steel, fully moisture-sealed and weather proof IP 65 degree of protection. Resistors shall be calibrated within 5% of their rated value and tested to 2 kV.

5.18.06 Cooling fans shall be adequately sized for cooling bank to maintain cabinet temperature at no more than 20°C above ambient temperature. The fans shall have electrical interlocks against fan failure, reverse rotation, air restriction or load bank high temperature. A 5 minute timer shall be provided to run fans after load shutdown.

5.19.00 Following digital meters and indication lamps shall be provided on the control panel:

1. Voltmeter with selector switch
2. Ammeter
3. Frequency meter
4. Indicating lamps for all the three phases
5. Over voltage indication
6. Indication of load bank ALARM
   Major Features:

1. Fan cooled
2. PLC based auto load control
3. Remote SCADA and data logger
4. Temperature and overload protection
5. Control features shall include Fan Start, Fan Stop, Emergency Stop

5.20.00 Sound Proofing System

5.20.01 The sound proofing system shall be designed to achieve a minimum insertion loss of 25dB /maximum sound level at ½ meter distance for enclosure/acoustically treated room as per State Pollution Control Board norms.

5.20.02 The ventilation system shall be of adequate design to ensure no deterioration in performance of DG.

5.20.03 Contractor shall furnish design calculation for sound proofing/ventilation system. The detailed frequency response for noise absorbing characteristic of acoustic material shall be furnished.

5.20.04 The acoustic enclosure shall provided at 800mm distance from the DG set. It shall be fabricated from 2.0mm thick CRCA sheet with ISMC(hot dip

galvanised) frame of suitable size. The construction shall be modular type to facilitate dismantling as required for maintenance. The ISMC frame shall be of sufficient stiffness and rigidity.

5.20.05 The sound absorptive layer shall comprise of bonded type mineral wool/rock wool/glass wool of adequate thickness and density to comply the design requirements.

5.20.06 The exposed surface of lining shall be retained in place by a 1.6mm thick CRCA/ aluminium perforated sheet. Absorptive lining shall be provided between the perforated plate and absorbing material. Necessary acoustic sealing shall be done in the panels/ modular unit joints.

5.20.07 All hardware of mild steel shall be electro-galvanised.

5.20.08 The acoustic enclosure shall be of modular construction to facilitate engine removal from front side. Necessary provisions shall be made in enclosure and associated ventilation duct.

5.20.09 The exhaust air from radiator shall be discharge through modular duct duly insulated of adequate size. The duct cross section shall be 1.5 times the cross-section of the radiator (radiator X-section is approx. 2mx2m).

5.20.10 The intake air shall be taken from outside of the room through intake air duct. Necessary opening shall be made in the wall for fixing of the intake air duct.

5.20.11 The door design shall be generally compatible to the enclosure design. The bonded mineral wool slab of adequate thickness shall be used.The door shall be provided with heavy duty hinges and handles. The sealing shall be done with neoprene/ silicon rubber gasket to avoid leakage of noise. The size of the door shall be as per the room design/ functional requirements.

5.20.12 The construction of ventilation duct shall be similar to that of the enclosure/room acoustic treatment.

5.20.13 Ventilation system of adequate capacity shall be provided. The system shall comprise of tubular axial flow fans for air intake and air exhaust. The ventilation shall be design to ensure required air flow rate as per manufacturer recommendations, after providing necessary acoustic treatment/ silencers in air flow path. The ventilation system shall be design to prevent leakage of sound and temperature shall not increase more than 5^0C when DG is running continuously at specified rating. Necessary opening in the room brick wall shall be carried out by the contractor for installation of the ventilation system.

5.20.14 In case of acoustic treatment of DG room, the following requirements shall be complied:

i. The acoustic treatment of wall, ceiling and other opening shall be done using galvanised steel sections. The framework shall be fixed on wall/ ceiling using expansion fasteners.
ii. Bonded mineral wool slab of required density and thickness shall be used for sound absorptive layer. This shall be concealed with minimum 0.8mm thick perforated aluminium sheet.
iii. Alternatively 1.6mm thick CRCA precoated perforated sheet can also be used. Suitable line shall be provided between the bonded wool and perforated sheet.
iv. Necessary acoustic sealing shall be done in the panel joints.

v. All hardware of MS shall be electrogalvanised.
vi. However in rolling shutter area removable type of acoustic paneling shall be done to facilitate maintenance.
vii. Enclosure shall be provided with adequate lighting. Enclosure shall be provided with adequate number of door and viewing glass.

6.00.00 TESTS

6.01.00 Type Test

6.01.01 All equipment to be supplied shall be of type tested design. During detail engineering, the contractor shall submit for Owner's approval the reports of all the type tests as listed in this specification and carried out within last ten years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client

6.01.02 However if the contractor is not able to submit report of the type test(s) conducted within last five (5) years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the owner either at third party lab or in presence of UPRVUNL representative and submit the reports for approval.

6.01.03 All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.

6.01.04 The type test reports once approved for any projects shall be treated as reference. For subsequent projects of UPRVUNL, an endorsement sheet will be furnished by the manufacturer confirming similarity and "No design change". Minor changes if any shall be highlighted on the endorsement sheet.

6.01.05 Type test reports for the following type tests shall be submitted:

6.01.06 Type test reports on Engine

6.01.07 This shall be as per BS-5514 Part-1 : List A, B & C (Table 5,6 & 7).

6.01.08 Type test reports on Alternator

(a.) Measurement of resistance
(b.) Phase sequence test
(c.) Regulation test
(d.) Measurement of open circuit and short circuit characteristics
(e.) Efficiency test
(f.) Temperature Rise Test
(g.) Momentary overload test
(h.) Over speed test
(i.) High Voltage test
(j.) Insulation resistance test (both before and after High Voltage Test)
(k.) Noise level as per IS:12065
(l.) Vibration as per IS: 12075.
(m.) Determination of Deviation of voltage waveform from sinusoidal.
(n.) Degree of protection test on control panel for IP-52

(o.) Battery and battery charger as per relevant standards
(p) Sudden short circuit test for determination of machine reactances and time constants. (q.) Measurement of bearing current
(r.) Measurement of leakage reactance and potier reactance

6..02.00 Routine test on Alternator

(a.) Measurement of resistance
(b.) Phase sequence test
(c.) Regulation test
(d.) Measurement of open circuit and short circuit characteristics
(e.) High Voltage test
(f.) Insulation resistance test .
(g.) Measurement of bearing current

6.02.01 Routine test of AMF panel at supplier's works

a) H.V test
b) Insulation resistance test
c) Interlock and automatic start up
d) Trip test through protection

6.03.00 SITE TESTS

The Contractor shall indicate tests recommended to be carried out at site during installation and commissioning to ensure satisfactory performance of all the equipment supplied. These tests shall be carried out by the Contractor in case order is placed on 6 Hours at maximum load, continuous running at low load to be performed in addition to the following test at site.

i) Fuel Consumption.
ii) Lube oil Consumption
iii) Generator Efficiency
iv) Full Load test

6.04.00 TEST ON COMPLETION

The Diesel Generator Plant to be supplied as per this specification shall be guaranteed for the performance specified in data sheet and the indicated below when operating at the rated / specified conditions. The acceptance of the plant shall be subject to satisfying these parameters during commissioning of the plant and satisfactorily conducting the tests as under :-

Functional test of complete D.G. Set along with AMF Panel etc. and Emergency Board.

Automatic start up of D.G. Set in case of AC failure for three consecutive start attempts to ascertain battery capacity.

Combined Load test of D.G. set alongwith AMF panel upto full load at 0.8 p.f. and for a combined load of D.G. Set at low load for 8 hrs. continuous run.

All instruments tools and tackles etc. required for testing will be provided by Contractor.

7.00.00 DRAWINGS/DOCUMENT & DATA TO BE FURNISHED ALONG WITH THE TECHNICAL OFFER

The following documents/information shall be furnished by the Bidder along with his technical offer.

7.01.00 Drawings

1. Schematic Drawings
   a) P & I diagram for
      i) Fuel Oil System
      ii) Engine Cooling System
      iii) Lubrication Oil System

   b) Power and other utility distribution scheme.
   c) Controls, instrumentation, alarms and protection.
   d) Single line diagram of generator metering & protection.

2. Schematic and wiring diagram of Battery charger.
3. Dimensional General Arrangement Drawing of Diesel Generator Set along with cross - section and bill of material.
4. Layout and mounting arrangement of battery.
5. Any other drawings/document deemed necessary by the Purchaser.

7.02.00 Data and Curves

1. All civil data for design and preparation of equipment foundation .
2. Generator curves and characteristics.
   a) 0.C & S.C Characteristics.
   b) 'V' curves.
   c) Capability curves.
   d) Generator transient and sub-transient reactance.
   e) Generator losses, fixed and variables.
   f) Communication non-interference test curves.
   g) All other necessary curves for the generator, exciter, AVR and auxiliaries.

3. Selection of D.C. battery and charger rating.

7.03.00 Write-ups and Leaflets

1. A comprehensive write-up or brochure on details of manufacturing and testing facilities in the shop of the manufacturer.
2. Write-up on governing system of DG set.
3. Write-up on starting system of DG set.
4. Write-up on specific features of equipment, if any.
5. Leaflets and Catalogues etc. covering equipment features.
6. The Bidder shall duly fill up the Data Sheets & Schedules enclosed with this Tender Document.

8.00.00 DRAWING/DOCUMENT, DATA & MANUAL TO BE FURNISHED AFTER AWARD OF CONTRACT

Following document/information shall be furnished by Successful Bidder during execution of the contract for Purchaser's approval/ information/record.

In addition to these document/ in-formations /drawings/ data, the Contractor shall also furnish all data/drawings submitted earlier with the bid under clause no. 10.00.00 above for Purchaser's approval.

8.01.00 Drawings

i) Dimensional layout and sectional drawings for the complete scope of work (including pipe and cable layout).
ii) Arrangement of generator phase & neutral terminals.
iii) Generator excitation system.
iv) Wiring diagram of AMF panels, D.C. battery charger etc.
v) Relay setting calculations for relays.
vi) Any other drawings/document deemed necessary by the Purchaser.

8.02.00 Data and Curves
i) Characteristics curves for Diesel Engines.
ii) Performance test curves and test certificates for all equipment as per the requirement of technical specification.
iii) Bill of material for pipes, valves and instruments.
iv) Generator relay setting calculations.
v) Any other data/curve deemed necessary by the Purchaser.

8.03.00 Write-ups, Manual & Leaflets

8.03.01 Write-up on operation, control and monitoring of the D.G. Plant.

8.03.02 Write-up on specific features of equipment, if any.

8.03.03 Replacement parts list with ordering information.
8.03.04 Leaflets and catalogues etc. covering equipment features etc.

8.03.05 Information, tools & plants, instruction, drawings and all other relevant data regarding erection and commissioning of the supplied plant.

8.03.06 PERT network and Quality Surveillance documents.
8.04.00 Detailed instruction manuals for equipment supplied presenting the following basic categories of information in a comprehensive manner, shall be submitted for approval of Purchaser/Engineer in the same fashion as that for other drawings.

i) Instruction for Erection.
ii) Instruction for precommissioning check-up, operation.
iii) Write-up on controls and interlocks provided.
iv) Recommended inspection points and periods of inspection.
v) Schedule of preventive maintenance.
vi) Ordering information for all necessary parts.
vii) Recommendation for type of lubricants along with the specifications and brand names for various suppliers, lubrication points, frequency of lubrication & lubricantchanging schedule.

8.04.01 The information shall be organised in a logical and orderly sequence. A general description of the equipment including significant technical characteristic shall be included to familiarize operating and maintenance personnel with the equipment.

8.04.02 Necessary drawings and/or other illustrations shall be included or copies of appropriate certified drawings shall be bound in the manual test, adjustment and calibration information, as appropriate, shall be included and shall be identified to the specific equipment. Safety and other warning notices and installation, maintenance and operating cautions shall be emphasized.

8.04.03 A parts list shall be included showing part nomenclature manufacturer's parts number and or/other in-formations necessary for accurate identification and ordering of replacement parts.

8.04.04 Instruction and part list shall be clearly legible and prepared on good quality paper.

8.04.05 The instruction manual shall be securely bound in durable folder.

8.04.06 If a standard manual is furnished covering more than the specific equipment purchased, the applicable model (or other identification) parts and other information for the specific equipment purchased shall be clearly identified.

8.04.07 The instruction manual shall include the list of spare parts that have been procured along with the equipment.

8.04.08 The instruction manual shall include list of all special tools and tackles furnished with complete drawings and instructions for use of such tools and tackles.

8.05.00 In addition to the above drawings/documents, any other information deemed necessary during detailed engineering shall also be furnished by the Contractor to the Purchaser/Consultant.

9.00.00 MEASUREMENT OF VIBRATION

The vibration shall be measured at no load and at load as close to maximum achievable load and shall not exceed 250 microns. Any modification/rectification required to bring down the vibration level with in allowable limits specified by the manufacturer shall be done by the bidder. Vibration test is to be carried out at site.

10.00.00 NOISE LEVEL (SOUND PRESSURE LEVEL) CHECK

Noise level measurement shall be done generally following the guidelines given in IS:12065. The measurement shall be carried out with a calibrated integrating sound level meter as per IS:9779. This test is to be carried out at site.

11.00.00 COMMISSIONING CHECKS

11.01.00 In addition to the checks and test recommended by the manufacturers, the contractor shall supervise the following commissioning test to be carried out on each set at site. The contractor shall arrange the testing equipment, instruments, fuel and any other facility required to carry out these test.

11.02.00 **Load Test**

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

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

(a.) Ambient temperature.
(b.) Exhaust temp. if exhaust thermometer is fitted.

(c.) Cooling water temp. at a convenient point adjacent to the water output from the engine jacket.
(d.) Lubricating oil pressure.
(e.) Speed.
(f.) Voltage, wattage and current output.
(g.) Oil tank level.

11.03.00 Insulation Resistance Test for Alternator

Insulation resistance in mega-ohms between the coils and the frame of the alternator when tested with a 500 V megger shall not be less than IR= 2x (rated voltage in KV) + 1.

11.04.00 **Check of fuel consumption**

A check of the fuel consumption shall be made throughout the load run test. The fuel consumption should not exceed the design values.

11.05.00 **Insulation Resistance of Wiring**

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

RATINGS AND REQUIREMENTS DATA SHEET – A

SR. NO	ITEM		
1.0	**DIESEL ENGINE**	:	
1.1	Type	:	Four (4) stroke, turbo charged, water cooled with mounted radiators.
1.2	Installation	:	Indoor (inside D.G. room)
1.3	Nominal output	:	To match with Generator rating (after excluding all DG auxiliaries)
1.4	Revolution	:	1500 rpm
1.5	Starting system	:	Electric starting by battery operated electric motor
1.6	Fuel	:	High speed diesel oil (IS-1460)
2.0	**GENERATOR**	:	
2.1	Type	:	Salient pole, synchronous, 4 pole
2.2	Rating	:	To be decided by bidder
2.3	Voltage	:	415 V
2.4	Phase	:	3 phase, 3 wire
2.5	Frequency	:	50 Hz
2.6	Power factor	:	0.80 (lagging)
2.7	Excitation type	:	Brushless exciter
2.8	Insulation class	:	F, temperature rise shall be limited to class –B
2.9	Cooling	:	Forced Water cooled for Engine & Air Cooled for Alternator.
2.10	Connection	:	Star with neutral terminal wired upto external bushing, in terminal box.
2.11	Degree of protection	:	IP 23
2.12	Design ambient	:	50°C
3.0	**VOLTAGE REGULATOR**	:	Fast acting solid state type
4.0	**GOVERNOR**	:	Electronic Type-Al. type as per BS: 5514
5.0	**LUBRICATION SYSTEM**	:	Antifriction type
6.0	**CONTROL PANEL**	:	
6.1	AMF panel	:	Yes
6.2	Degree of protection	:	IP- 54
6.3	Thickness of enclosure	:	2 mm(min)
7.0	**STARTING SYSTEM**	:	Electric starting system – battery operated electric motor starting. Starting system shall be capable of SIX (6) successive starts
8.0	**SYSTEM FAULT LEVEL**	:	50 kA for 1 sec
9.0	**SPACE HEATER**	:	240 V ±10%, 1 ph, 50 Hz

ANALYSIS OF HIGH SPEED DIESEL OIL
DATASHEET – B

SR. NO.	ITEM		
1.0	Specification	:	HSD, IS- 1460-1974
2.0	Acidity, inorganic	:	Nil
3.0	Acidity, total mg. of KOH/g max.	:	0.50
4.0	Ash, percentage by mass max	:	0.01
:5.0	:Carbon residue (Rams bottom)	:	0.20
:6.0	Cetane no. min.	:	42
7.0	Pour point maximum	:	6 Deg.C
8.0	Flash point, Abel O deg.C min.	:	38 Deg.C
9.0	Kinematic viscosity, CS at 38 Deg C	:	2.0 to 7.5
10.0	Sediment, percentage by mass max	:	0.05
11.0	Total sulphur, percentage by mass max.	:	1.0
12.0	Water content, percentage by volume max	:	0.5
13.0	Total sediments, mg. per 100 ml. max	:	1.0

E21: DIESEL GENERATORS

DIESEL ENGINE											
ATTRIBUTES, CHARACTERISTICS → **↓ ITEM, COMPONENTS, SUB SYSTEM ASSEMBLY**	Material Test	DP/MPI	UT(On forging and piston Bonding)	Balancing	Hydraulic/water fill test	Assy./fit up	Dimension	Functional/Operation test	Performance test as per BS-5514/or equivalent IS/ISO- Standard including Governing Test for 3 hors at full load and one hr at 10% overload	Fuel consumption, rated power measurement,rated speed	All other tests(if applicable) as per Spec./ relevant Std
Crank shaft	Y	Y	Y	Y							
Cylinder blocks/heads	Y				Y						
Liner/ Radiator	Y				Y						
Rotating/moving parts other than crank shaft	Y	Y									
Piston	Y	Y	Y								
Diesel Engine						Y	Y	Y	Y	Y	Y

Note:
This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.

ALTERNATOR																		
ATTRIBUTES, CHARACTERISTICS → / **ITEM, COMPONENTS, SUB SYSTEM ASSEMBLY** ↓	Visual	Dimensional	Make/Type/Rating/TC/General Physical Inspection	Mech/Chem. Properties	NDT /DP/MPI/UT	Metallography	Electrical Characteristics	Welding/Brazing(WPS/PQR)	Heat Treatment	Magnetic Characteristics	Hydrualic/Leak/Pressure Test	Thermal Characteristics	Run out	Dynamic Balancing	All tests as per IS-4722	Vibration	Over speed	Tan delta, shaft voltage & polarisation index test
Plates for stator frame,end shield, spider etc.	Y	Y	Y	Y					Y									
Shaft	Y	Y	Y	Y	Y	Y			Y									
Magnetic Material	Y	Y	Y	Y	Y		Y			Y		Y						
Rotor Copper/Aluminium	Y	Y	Y	Y		Y	Y		Y									
Stator copper	Y	Y	Y	Y			Y		Y			Y						
SC Ring	Y	Y	Y	Y	Y	Y	Y	Y	Y									
Insulating Material	Y		Y	Y			Y					Y						
Tubes for Cooler	Y	Y	Y	Y	Y				Y		Y							
Sleeve Bearing	Y	Y	Y	Y	Y				Y		Y							
Stator/Rotor, Exciter Coils	Y	Y	Y				Y	Y										
Castings, stator frame,terminal box and bearing housing etc.	Y	Y	Y	Y	Y			Y										

Fabrication & machining of stator, rotor, terminal box	Y	Y			Y				Y									

ALTERNATOR

TESTS/CHECKS / ITEMS/ COMPONENTS	Visual	Dimensional	Make/Type/Rating/TC /General Physical Inspection	Mech/Chem. Properties	NDT /DP/MPI/UT	Metallography	Electrical Characteristics	Welding/Brazing(WPS /PQR)	Heat Treatment	Magnetic Characteristics	Hydrualic/Leak/Pressure Test	Thermal Characteristics	Run out	Dynamic Balancing	All tests as per IS-4722	Vibration	Over speed	Tan delta, shaft voltage & polarisation index test
Wound stator	Y	Y					Y	Y										
Wound Exciter	Y	Y					Y	Y										
Rotor complete	Y	Y					Y						Y	Y				
Exciter, Stator, Rotor, Terminal Box assembly	Y	Y					Y											
Accessories, RTD, BTD,CT,AVR. Brushes, Diodes,Space heater, antifriction bearing, cable glands, lugs, gaskets etc.	Y	Y	Y															
Alternator (IS 4722)	Y	Y	Y												Y	Y	Y	Y1

Note:
1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents during QP finalisation.
2. Make of all major bought out items will be subject to Owner / Owner approval.
   Y1= for HT Machines only.

FINAL ASSEMBLY										
ATTRIBUTES, CHARACTERISTICS → **↓ ITEM, COMPONENTS, SUB SYSTEM ASSEMBLY**	Material Test	Dimension	WPS/PQR/Welding	NDT/DP/MPI/UT	Check completeness	Hydraulic/Leak/Pressure test	Functional Tests	All routine test as per Spec/ IS	No load test for one hour of the DG set assembly	Clearances & Alignment
Base frame	Y	Y	Y	Y	Y					
Fuel Tank	Y	Y	Y	Y	Y	Y				
Battery (IS – 1691)								Y		
Battery Charger								Y		
Control Panel								Y		

Assembled DG Set		Y			Y		Y		Y	Y

NOTES:

1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2. Make of all major Bought Out Items will be subject to Owner / Owner Engineer approval.

	a. At 30 °C		
	b. At 35 °C		
	c. At 45 °C		
	d. At 50 °C		
17.00.00	Cable drums		
17.01.00	Dimensions		
	a. Flange diameter		mm
	b. Barrel diameter	mm	
	c. Traverse	mm	
17.02.00	Shipping weight of drum for standard drum length		kg
17.03.00	Standard cable length for drum for each size of cable (single length)		
17.04.00	Tolerance on packing length		

15.00.00 EARTHING & LIGHTING PROTECTION SYSTEM

S. NO.	DESCRIPTION
1	**NDING SYSTEM**
	a) Main ground grid conductor material & size
	b) Ground electrode material & size
	c) Riser material & size
	d) Grounding installation work carried out as per specification
2	**LIGHTNING PROTECTION SYSTEM**
	a) Vertical air termination conductor material & size
	b) Horizontal air termination conductor material & size
	c) Down Conductor material & size
	d) Electrode material & size
	e) Riser conductor material & size
	f) Lightning Protection work carried out as per specification.

16.00.00 EMERGENCY DIESEL GENERATING SET

1.00.00 Diesel Engine

1.01.00	General	
1.01.01	Manufacture and model no.	
1.01.02	No. of Engines offered	
1.01.03	Continuous duty reacting (BHP)	
	i. At design condition	
	ii. At site condition	
1.01.04	Operating speed	RPM
1.01.05	Trip speed	RPM
1.01.06	Engine overhaul required after	___ Hours
1.01.07	Continuous hours of operation in full load of the engine at site elevation and design ambient temperature	
1.01.08	Total dimension of the set	__mm Lx __mm W x __mm H
1.02.00	Fuel Consumption	
1.02.01	Fuel oil grade	
1.02.02	Consumption at continuous duty rating	g/kwh
1.02.03	Consumption at generator rating output	g/kwh
1.02.04	Consumption at 25%, 50%, 75% generator output	g/kwh
1.02.05	Consumption at most economic load (mention also the load in BHP)	g/kwh
1.02.06	Engine fuel oil day tank	
	i.	Nos. offered
	ii.	Capacity
	a.	M^3
	b.	Hours of engine operation
	iii.	Overall dimension
	a.	Diameter mm
	b.	Height mm
1.03.00	Engine Lubrication	
1.03.01	Oil grade & Indian brand names	
1.03.02	Oil consumption at rated output	kg/hr
1.04.00	Main Lube Oil Pump details	
1.04.01	Type	
1.04.02	Number/Engine	
1.04.03	Location	
1.04.04	Drive rating	kW
1.04.05	Capacity	L/Min
1.04.06	Discharge pressure	kg/sq.cm(g)
1.05.00	Engine cooling system	
1.05.01	Method of cooling provided	Radiator/Secondary water cooling/air cooling
1.06.00	Engine starting system	
1.06.01	No. of electrical starter motors provided and total kW rating	
1.06.02	Max. No. of consecutive starting possible	
1.06.03	Is the system complete with auto starter, indicating lamps, cables,etc	Yes/No
1.06.04	Is hand cranking provided	Yes/No
1.06.05	Batteries, voltage and AH capacity	
1.07.00	Exhaust line	

1.07.01	Nominal size and material	
1.07.02	Is insulation over exhaust line provided	
1.07.03	Is vibration isolator provided	
1.07.04	Aluminium wrapping over the insulation provided	
1.07.05	Silencer	
	a.	Manufacturer
	b.	Dimension
	c.	Material of construction
1.07.06	Sound level (dB) at exhaust outlet	
1.07.07	Type and no. of ventilation fans provided	
1.07.08	Manufacturer	
1.07.09	Material of construction	
1.07.10	Recommended size of the DG skid mount plinth	
	a.	Length m
	b.	Width m
	c.	Height m
1.07.11	Weight schedule	
1.07.12	Shipping weight of DG set	
1.07.13	Shipping weight of engine	
1.07.14	Shipping weight of generator	
1.07.15	Weight of battery set	
1.07.16	Heaviest part to be handled at a time	
1.07.17	Load on foundation during running of DG set	
	i.	Vertical Load
	ii.	Horizontal Load
1.08.00	Piping, Valves, Fittings	
1.08.01	Pipes	
	a. and schedule/Thickness/Grade of	Manufacturer, standard
	i.	Fuel oil lines
	ii.	Lub oil lines
	iii.	Water line
	iv.	Exhaust gas line
1.08.02	Valves	
	a. standard and pressure rating (ANSI/Equipment) of valves	Manufacturer type
	i.	Fuel oil lines
	ii.	Lub oil lines
	iii.	Water line
1.09.00	Please furnish below list of all annunciation control and interlock features provided	
1.10.00	List of all instruments used in diesel engine	
1.11.00	Whether all pipe terminals are supplied with counter flange bolts, nuts, etc	
1.12.00	Whether insulation on exhaust pipe provided	
1.13.00	Safety system	
1.13.01	Digital display of lub oil pressure	
1.13.02	Digital display of lub oil temperature	
1.14.00	Governing System	
1.14.01	Type of governor and details	
1.15.00	Other accessories	
1.15.01	Flywheel	

1.15.02	Flywhel housing		
1.16.00	Acoustic Enclosure		
1.16.01	Details of enclosure		
1.16.02	Material		
1.16.03	Performance of enclosure		
1.16.04	Constructional feature		
1.16.05	Details of mounting		
2.00.00	**Generator Set**		
2.01.00	General		
2.01.01	Make		
2.01.02	Type		
2.01.03	Cooling medium for winding and core		
2.01.04	Method of cooling		
2.01.05	Maximum continuous rating under site Condition and at 0.8 p.f	kW	
2.01.06	Electrical power consumption of the running auxiliaries of DG set	kW	
2.01.07	Net maximum continuous output under site conditions at 0.8 p.f (excluding auxiliaries)		
2.01.08	Full load current	A	
2.01.09	Excitation at MCR		
	a.	Voltage	Volts
	b.	Current	Amps
2.01.10	Rise of voltage and frequency when rated load is thrown off		
	a.	With AVR	Volts,Hz
	b.	Without AVR	Volts, Hz
2.01.11	Terminal voltage at rated load	kV	
2.01.12	Frequency	Hz	
2.01.13	Variation of terminal voltage	%	
2.01.14	Variation of frequency	%	
2.01.15	Speed	RPM	
2.01.16	Direction of rotation		
2.01.17	Class of insulation		
2.01.18	Bearings		
2.02.00	Temperature rise over ambient at rated operating condition		
2.02.01	Temperature rise of armature windings above cooling medium temperature (Measured by embedded detectors)	°C	
2.02.02	Temperature rise of field winding above cooling medium temperature	°C	
2.02.03	Temperature of exit cooling air from windings (detected by thermocouple)	°C	
2.02.04	Generator bearing temperature rise	°C	
2.03.00	Losses		
2.03.01	Copper loss		
2.03.02	Iron loss		
2.03.03	Windage and friction loss		
2.03.04	Stray loss		
2.04.00	Efficiencies		
2.04.01	At MCR and rated p.f	%	
2.04.02	At 75% MCR and rated p.f	%	

2.04.03	At 50% MCR and rated p.f	%
2.04.04	At 40% MCR and rated p.f	%
2.04.05	At 20% MCR and rated p.f	%
2.04.06	Regulation under condition of rated speed, voltage and output	
	a.	At 0.80 p.f lag
	b.	At 1.0 p.f
	c.	At 0.80 p.f lead
2.05.00	Type and degree of enclosure	
2.06.00	Type of mounting	
2.07.00	Type of bearing and its lubrication	
2.08.00	Space heater provide: if yes,	
2.08.01	Quantity	
2.08.02	Voltage	
2.08.03	Wattage	
2.09.00	Exciter	
2.09.01	Make	
2.09.02	Type of excitation	
2.10.00	Automatic voltage regulator (AVR)	
2.10.01	Make	
2.10.02	Type	
2.10.03	Dead band	
2.10.04	Range of droop setting	
2.10.05	Response time	
2.10.06	Voltage of operation	Volts
2.10.07	Range of voltage adjustments	
2.10.08	Catalogues and characteristic curves attached	Yes/no
2.10.09	CT/PT burden	
2.11.00	Make, quantity and location of the following	
2.11.01	Current transformers	
2.11.02	Temperature detectors	
2.11.03	Space heaters	
2.12.00	Annunciation system	
2.12.01	Make	
2.12.02	Model no.	
2.12.03	Catalogue No.	
2.12.04	Type	
2.12.05	Architecture	
2.13.00	Auto mains failure panel (AMF) panel	
2.13.01	Make	
2.13.02	Type	
2.13.03	Construction	
2.13.04	Material	
2.13.05	Sheet metal thickness	
2.13.06	Degree of protection	
2.13.07	Floor channel sills and kick plate furnished?	
2.13.08	Nameplate	
2.13.09	Material	
2.13.10	Thickness	
2.13.11	Size for	
	a.	Equipment
	b.	Panel
2.13.12	Internal illumination	
2.13.13	Volt	
2.13.14	Watt	

2.13.15	Space heater
2.13.16	Volt
2.13.17	Watt
2.13.18	Thermostat controlled
2.13.19	Plug socket
2.13.20	Rating
2.13.21	panel illumination, space heater and plug socket circuit provided with individual switch fuse unit?
2.13.22	AC/DC supply Type and rating of isolating switch fuse units for: a. Incoming AC supply b. Incoming DC supply
2.13.23	Internal wiring
2.13.24	Wire type
2.13.25	Voltage grade
2.13.26	Conductor material
2.13.27	Conductor size for a. Current/control circuit
2.13.28	Wires identified at both ends with ferrules?
2.13.29	Terminal block
2.13.30	Make
2.13.31	Type/catalogue no.
2.13.32	20 % spare terminals furnished
2.13.33	Ground bus
2.13.34	Material
2.13.35	Day tank capacity & material

17.00.00 BATTERY

S. NO.	**DESCRIPTION**	
1.00.00	***BATTERY***	
1.01.00	***General***	
	a. Make	
	b. Type	
1.02.00	***Rating***	
	a. Rated Voltage	Volt
	b. 10-hour rating at 27 Deg.C to end cell voltage	AH
	c. 2-hour discharge rate to end cell voltage	Amp
	d. 1 –hour discharge rate to end cell voltage	Amp
	e. 1 -minute discharge rate to end cell voltage	Amp

1.03.00	***Performance***	
	a. Battery duty cycle curve furnished	Yes/No
	b. Cell voltage characteristics during duty cycle furnished	Yes/No
	c. Minimum cell voltage during duty cycle	Volt
	d. AH efficiency at 10-hour discharge rate	%
	e. Expected life of Battery	Yr
1.04.00	***Battery Characteristics***	
	a. Recommended charging rate for	
	i) Float charging	Amp
	ii) Equalising Charge	Amp
	iii) Boost charging in 10 hrs.	Amp
	Start	Amp
	Finish	Amp
	b. Recommend specific gravity at 27	
	i) For first filling	
	ii) At full charge	
	iii) At end of 10-hour discharge	
	c. Short-circuit current for a dead-short across battery terminals, when	
	i) Float charge at 2.15 V/Cell	kA
	ii) Boost charge at 2.75 V/Cell	kA
	d. Battery internal resistance	Ohm
	e. Cell voltage characteristics during charging furnished	Yes/No

18.00.00 BATTERY CHARGER

S. NO.	DESCRIPTION	UNIT
1.00.00	General	

	a. Make	
	b. Catalogue No.	
	c. Type	
	d. Reference Standard	
2.00.00	A.C. Input	
	a. Voltage ± % variation	Volt, %
	b. Phase	No.
	c. Frequency ± % variation	Hz., %
	d. Input current	Amp
3.00.00	D.C. Output	
	a. Voltage	Volt/Cell
	b. Current	Amp.
	Type of Cooling	
4.00.00	Max. Temp rise within cubicle above site ambient	
	a. Rectifier transformer	Deg.C
	b. SCR	Deg.C
5.00.00	Performance	
	a. Regulation for 0-100% rated load with ±10% Input voltage and ±5% input frequency variation	%
	b. Ripple content in O.C. output	
	i) With battery	%
	ii) Without battery	%
	c. Guaranteed efficiency at rated load	%
	d. Power factor at rated load	%
6.00.00	Miscellaneous	
	a. Charger provided with following features	
	i) Automatic voltage regulation	Yes/No
	ii) Current limiting circuitry	Yes/No
	iii) Smoothing filter circuit	Yes/No
	iv) Soft-start feature	Yes/No
	v) Automatic load shahng during parallel operation	Yes/No
	b. SCR elements provided with	
	i) Surge protection	Yes/No
	ii) Fast acting HRC fuse	Yes/No

7.00.00	A. C. Switch / MCCB	
	a. Make	
	b. Type/Cat. No.	
	c. Reference Standard	
	d. Current rating	
	i) Continuous	Amp
	ii) Interrupting	kA
8.00.00	A. C. Fuse / MCB	
	a. Make	
	b. Type/Cat. No.	
	c. Reference Standard	
	d. Current rating	
	i) Continuous	Amp
	ii) Interrupting	kA
9.00.00	A.C. Contactor	
	a. Make	
	b. Type/Cat. No.	
	c. Reference Standard	
	d. Rated Current	Amp
	e. Utilization category	
	f. Thermal overload with In-built single-phase preventer provided	Yes/No
10.00.00	Rectifier Transformer	
	a. Make	
	b. Type/Cat. No.	
	c. Reference Standard	
	d. Rating	
	i) KVA	KVA
	ii) Voltage	V
	iii) % reactance	%
	e. Class of insulation	
	f. Method of cooling	
11.00.00	Controlled Rectifier (SCR)	
	a. Make	
	b. Type/Cat. No.	
	c. Reference Standard	

	d. RMS Current rating	Amp
	e. Surge Current	
	i) One-cycle	Amp
	ii) Repetitive Cycle	Amp
	f. Peak inverse voltage	
	i) Continuous	Volt
	ii) Surge	Volt
12.00.00	D.C. Fuse/MCB	
	a. Make	
	b. Type/Cat. No.	
	c. Reference Standard	
	d. Current Rating	
	i) Continuous	Amp
	ii) Interrupting	KA
13.00.00	D.C. Contactor	
	a. Make	
	b. Type/Cat. No.	
	c. Reference Standard	
	d. Current Rating	Amp
	e. Utilization category	
14.00.00	Blocking Diodes	
	a. Make	
	b. Type/Cat. No.	
	c. Reference Standard	
	d. Current Rating	
	i) One – minute	Amp
	ii) One-hour	Amp
	e. Peak inverse voltage	Volt

19.00.00 MOTORS
1.00.00 H.V. & L.V. MOTORS

Sr. No.	**Description**
1.01.00	Manufacturer
1.02.00.	Type and frame size &
1.03.00	design code no.
1.04.00.	Nos. required
1.05.00.	Application
1.06.00	Specification & Codes
1.07.00	Capacity for
	i) for specified climatic conditions (50^0C)
	ii) At 40^0C ambient