TECHNICAL SPECIFICATIONS
FOR
2Nos., 2. 5 MW, CONTINUOUS, 6.6 KV, DG SET FOR 700 MW(2X350 MW) COMBINED CYCLE POWER PLANT , PIPAVAV
FOR
GSPC PIPAVAV POWER COMPANY LTD

BHARAT HEAVY ELECTRICALS LTD
INDUSTRIAL SYSTEMS GROUP
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BANGALORE-560 012.

CONTENTS

Any deviation from this specification shall be clearly spelt out in the offer, failing which it will be presumed that the offer is in line with our requirement.

Sangeetha.M.A		
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SECTION - I
GENERAL INFORMATION

SITE CONDITION :

1.1 Ambient temperature & relative humidity and location

1.1.1	Project		700(2X350)MW Combined Cycle Power Plant
1.1.2	Ambient Air temperature	:	10 ^{0} C Min 50 ^{0} C Max
1.1.3	Basic Wind speed	:	16.5 km/hr
1.1.4	Average Annual Rainfall	:	286.3 mm
1.1.5	Isoceraunic Level	:	76
1.1.6	Relative humidity	:	89 % Max
1.1.7	Seismic Zone		III
1.1.8	Horizontal Acceleration due to Earthquake		0.04g
1.1.9	Site location	:	Village Kova,near PIPAVAV,Taluka:Rajula .Amreli.Gujarat
1.1.10	Altitude above mean sea level	:	3.0 Mtrs above MSL (< 1000 mtrs)
1.1.11	Atmosphere	:	Hot Humid and Highly polluted with coal dust ,fly Ash
1.1.12	Nearest Rly station	:	Rajula

1.2 Power Supply Systems

HT Supply

System voltage	:	6.6KV, ± 10%
System Frequency	:	50 Hz, ± 5%
Phase	:	3ph, 3 wire.
System fault level	:	40 kA R.M.S.for 3 SEC
System Earthing	:	Resistance grounded System
EDG OUT PUT	:	6.6KV , 3 Ph , 3W, 50 Hz , Resistance grounded
Panel space heater ,light		AC 240 V ± 10% 1 PH
AC Control Supply	:	110 V ± 10%
DC Control Supply for panel	:	220 VDC +10%to –15%, 2wire, U/G
DC Control Supply for engine and Control Panel.	:	24V DC

SECTION - II
APPLICABLE STANDARDS

The equipment & accessories covered by this Specification shall be designed, manufactured and tested in accordance with the latest relevant Indian/ international as applicable.

1. The DG Set & Electrical accessories shall be also confirm to the latest Electricity Rules & other related Statutory agencies as regards safety, earthing and other essential provisions specified(of RESPECTIVE STATE).

2. **APPLICABLE STANDARDS: -**

For Engine:

BS: 5000, 1980	:	Generators to be driven by reciprocating internal combustion engine.
BS: 5514, 1987, IS-10000	:	Specification for Standard Reference conditions and declarations of Power, fuel consumption & lubrication oil consumption.

For Alternator:

IEC : 34		
IS-1271, 1990	:	Evaluation and classification of electrical insulation.
IS-2147, 1962	:	Degree of protection provided by enclosures for low voltage Switchgear & Control Gear.
IS-2828, 1997	:	Glossary of forms used in the Plastic industry.
IS-4722, 1992	:	Rotating Electrical machines.
IS-4728, 1990	:	Terminal marking & direction of rotation of rotating electrical machinery.
IS-4889, 1991	:	Method of determination of efficiency of rotating electrical machines.
IS-6362, 1995	:	Designation of methods of cooling of rotating electrical machines.
IS-7132, 1991	:	Guide for testing synchronizing machines.
IS-7306, 1991	:	Methods for determining synchronous machines, quantities from test.
IS-7372, 1995	:	Lead Acid storage batteries for Motor vehicles.
IS-7816, 1991	:	Guide for testing insulation resistance of rotating machines.
IS-12065, 1987	:	Classification of degree of protection provided by enclosures of electrical equipments.
IS-12075, 1991	:	Mechanical Vibration of rotating electrical machines with shaft height 56 mm and severity.
IS-12802, 1989	:	Temperature rise measurement of rotating electrical machines.
IS-13364, Part-I & II, 1992	:	AC Generators driven by reciprocating internal combustion engines.

The above list is not exhaustive. Standards not listed above but are applicable also to be followed to meet the requirement.

SECTION – III
SCOPE OF SUPPLY

Description:

The scope of work includes the design, detailed engineering, construction/ manufacture, shop testing, packing, transportation, handling, supervision of erection, pre-commissioning tests and commissioning of all equipment/system including preliminary acceptance test & performance guarantee .

The supplier shall be responsible for satisfactory working of system with guaranteed parameters. All the major equipment shall be installed, tested and commissioned under supervision of representative of manufacturer of respective equipment.

The scope of supplier shall include all electrical equipment required for 2 x 2.5MW CONTINUOUS DG set and its associated accessories and ensure operation

without any constraint during maintenance of any set. Excluding DG Set's own auxiliary power consumption net out put at Generator terminal required is 2,5MW (e)

APPLICATION

The DG Set (generators) shall operate individually and in parallel among themselves and in parallel with the grid.

The engine governor shall be designed to take care of loading requirement during normal running in isolated mode or parallel with another set or grid. The governor, AVR and the generator control systems shall be designed to take care of above situations.

SCOPE OF SUPPLY

COMMON ITEMS

SL. NO	DESCRIPTION	QTY
1	**Compressed Air Starting System common for both DG Sets above** Compressed Air starting System (500 litre air bottle-2NOS & 15 litre air bottle- 2NO.S) as per IS:2002 and ASME Sec VIII Div-1. The air pipe lines shall be A 106 Gr. B pipes. All the welds of high pressure(30 bar) shall be 100% radio graphed. The compressor shall be designed for continuous operation. Three no.s compressors are to be provided common for 2 Nos. DG sets . Two no.s compressor shall be electrical motor driven and one no. compressor shall be diesel engine driven.	1 Set
2	**Acoustic treatment of DG Room. Refer enclosed customer spec-** GSPC SPEC TCE-4916A-H-500-001, SECTION D1:14 DG SETS slno-14.13 and ,B-Technical Deviation(Tentative size 30 m X 20 m x 10m).	1set

TWO OPTIONS ARE REQUIRED IN DG SET –EITHER OPTION-I OR OPTION - II. One of the options will be decided during ordering stage.

OPTION –I (BOTH ENGINE & ALTERNATOR FROM VENDOR AS FOLLOWS)

SL. NO	DESCRIPTION	QTY
3.1	The Generating Set shall be 2.5MW, 6.6KV, 0.8 pf (lag) at 50^0 C ambient , capable of continuous running of which one hour at 10% over load at rated speed in every 12 hours, complete with all accessories, with Electronic Governor, with pre lube pump, with coupling, with QDCT-2nos , NCT/ VT-1no ,Differential CTs-6nos ,RTD –6nos ,BTD –2nos, **NGR Panel**, Set mounted control panel, suitable for Air Starting, with AMF feature, with **Cooling tower,** with common base frame, with elastic fastening equipment, fly wheel, cover , AVMS, silencer, bellow & water/fuel/lube oil/Exhaust/air system with piping on skid, including all erection hard ware and **with first fill of lub oil, fuel oil, coolant conditioner, jacket cooling water for factory testing**. DG Set Shall be suitable for parallel operation and have provision for remote operation for Start / Stop , Voltage & Frequency RAISE / LOWER ETC.	2 SET

OPTION-II (ALTERNATOR & AVR WILL BE BHEL SUPPLY)- AS FOLLOWS

3.2	The engine shall be 2.5MW, 6.6KV, 0.8 pf (lag) at 50^0 C ambient , capable of continuous running of which one hour at 10% over load at rated speed in every 12 hours, complete with all accessories& Electronic Governor with pre lube pump motor with **coupling for coupling with BHEL Alternator** with ,QDCT-2nos , NCT/ VT-1no ,Differential CTs- 6nos ,RTD –6nos ,BTD –2nos, **NGR Panel,** Set mounted control panel, suitable for Air Starting, with AMF feature, with **cooling tower,** with common base frame, with elastic fastening equipment ,fly wheel, cover , AVMS, Silencer, bellow & water/fuel/lube oil/Exhaust/air system with piping on skid including all erection hard ware and **with first fill of lub oil, fuel oil, coolant conditioner, jacket cooling water etc for factory testing.** DG Set Shall be suitable for parallel operation and have provision for remote operation for Start / Stop , Voltage & Frequency RAISE / LOWER ETC.	2 SET

ACCESSORIES

SL. NO	DESCRIPTION	QTY
4	**Fuel tank** of 990 Ltr. Capacity with fuel pipes , gauges ,level switches, heavy duty tubular level sensor/gauges with channel protection and required hardware. Hand operated pumps with Hose pipes of length 10 mtrs for transferring fuel from storage tankers to 990 ltrs day tank. Inlet of the pump shall have 5m long armored hose with suitable filter.	2 sets
5	**Necessary fuel, water, air piping** with hardware, pipe support from engine to equipment fuel tank, air intake etc inside DG room as required for one DG Set. .	2 sets
6	**Exhaust** piping, insulation & hangers & Support structure with foundation bolts & nuts with necessary hardware as required, starting from engine to out side DG Room as required for one DG Set (height as per applicable norms) and also meeting pollution control requirements as per latest Govt of India norms. Inside the DG room aluminum cladding for exhaust pipes shall be given to maintain the temperature within required limits.	2 sets
7	**FRLS HT, LT Power & Control Cables including all accessories like lugs, glands, ties etc**, Special Cables, instrument Cables, inside DG Room as required for one DG Set.	2 sets
8	**Galvanized Cable trays** & Slotted channel supports ,steel structural material for Cable trays/Electrical panels with all hardware ,nut –bolt and accessories in side DG room as required for one DG Set-List of cables to be furnished along with the offer	2 sets
9	Total **Earthing materials** such as copper cables, GI earthing strips, GI / CI ear thing electrodes for neutral and body earthing of all equipment pertaining to DG Set and its accessories including panels, cable trays etc and connection to the earth pit etc as required for one DG Set. This includes earthing strip along the cable tray and **safety items** such as rubber mat, danger boards, buckets, first aid chart etc as required.	2 sets
10	Commissioning Spares as required (list to be furnished with offer) The following items to be considered anyway. Anything else as required to be given free at the time of commissioning. Lube oil filters – 4no.s Bypass lub oil filter – 2no.s	2 sets

	Fuel oil filter kit & its seal ring – 2no.s Seal ring – 2no.s Strip test – 1no.	
11	Tools &Tackles as per Section VII (anything else required also to be quoted)	2 sets
12	**Supervision Of Erection of one entire DG Set Package including AMF panel/ Aux. Dist Board./LPB Station.**	2 sets
13	Testing and commissioning, load trail of one entire DG Set Package including AMF Panel/ Aux. Dist. Board/Local PB Station etc.	2 sets
14	PG test, all drgs/docs and support required for obtaining statutory clearances from CPCB, CEA and other applicable bodies for one DG Set.	2 sets
15	180AH minimum (or as required) lead acid maintenance free **battery for control supply.** Battery shall be provided with its accessories such as stand, gloves, specific gravity measuring instrument, distilled water etc	4 sets
16	Float cum Boost Charger for recharging the above battery in 10 hours. Charger shall be provided with voltmeter, ammeter, automatic voltage stabilizer, necessary filters and chokes and suitable input transformer impedance to automatically reduce charging current, as battery gradually charges up and to prevent overcharging of battery. Charger shall be protected by suitable current limiting device	4 sets
17	Maintenance platform for DG Set	2 sets
18	**Storage tank of 10 kilo litre capacity** with all required piping, valves, level transmitter, level/pressure gauges, level/pressure switches etc.	2 sets
19	**Motorised Fuel transfer pump with all required accessories**	4 sets
20	Alternator Main & Neutral Terminal Box for one alternator	2 sets
21	First fill of lub oil at site for one engine	2 sets
22	First fill of coolant conditioner/ jacket cooling water at site for one engine.	2 sets

Note: -

1. Design for all equipment supplied by vendor shall be in accordance with the applicable statutory norms and accordingly all drawing to be prepared and submitted by vendor for approval considering latest statutory norms as applicable for DG Set and its accessories at respective states.
2. The Scope of supply mentioned above is not exhaustive and the supplier shall supply all the relevant items for the satisfactory working and performance of the DG Set.
3. All prices as per above list are to be indicated separately. Combined prices are not acceptable.

SECTION – IV
DETAILED TECHNICAL SPECIFICATIONS

Also see attached GSPC specifications.

1 **DIESEL ENGINE:** The Diesel Engine shall be Stationary type, four stroke, water cooled, with exhaust Turbo chargers, charge air coolers manufactured as per BS: 5514/equivalent with an overload capacity of 10% for one hour in any 12 hrs continuous operation and generating 2.5MW(e) 50Hz, 6.6KV, at 50 ^{0}C. Diesel Engine shall be mounted on vibration damping pads and shall be complete with integral air intake through suitable dry type air filters and exhaust systems, metering facility, speed regulation system, fuel injection system, lube oil system, primary jacket cooling water system along with necessary filters, silencers, ducts, piping and fittings, indicator valves with cock on each cylinder head,

instruments etc., as required. Engine capacity shall be for 2.5MW continuous out put at alternator terminals excluding DG auxiliaries at 50 ^{0}C. The time required for starting from cold conditions till achieving full load shall be 30 seconds. Noise level of the set shall be as per applicable statutory norms. Two (2) sets of earplugs (muffler) shall be provided for operating staff in case noise level is higher than 85 dB. Critical speed of the machine shall not be lesser than 130% of the normal speed. Coupling shall be capable of withstanding the maximum generator sudden short circuit torque. Vibration level shall not exceed 250 microns peak to peak. with anti vibration pads.

2 FUEL SYSTEM: -

HSD shall be provided as fuel for the diesel engines. Fuel system shall include fuel day tank, control valves, PRVs etc. Fuel system consist of injectors with pump, fuel filters with service indicator, self contained flexible piping, fuel oil manifold with filter, fuel piping and fitting between engine & day tank. Fuel tank shall include (minimum) level indicator, level switches, removable screen for filling inlet, outlet, drain plug, air vent and necessary piping, hand pump for pumping fuel into tank with necessary pipes/tubing for each tank. Inlet of pump shall have five meter long armoured hose with suitable filter.

Brief Scope is as follows.

Sl. No.	Description	Qty for each DG
1	HSD Unloading station including unloading header, pumps etc	1 set
2	HSD Bulk Storage Tank(BST) 10kL with instrumentation	1 set
3	HSD Daily Service Fuel Tank(DSFT) 990 litres with instrumentation located inside DG Room	1 set
4	Fuel pipe lines with valves, flanges, gauges, fuel transfer pump etc from bulk storage tank to day tank	1 set
5	Fuel pipe lines from day tank to engine and back	1 set
6	HSD Duplex type coarse filter(60 micron)	1 set
7	Flow meter with strainer(volumetric type)	1 set
8	Fine filter for HSD(duplex)	1 set
9	Fuel feed pump engine driven(engine mounted)	1 set
10	Pressure regulating valve for HSD	1 set

3 LUBRICATING OIL SYSTEM: -

The engine shall have closed cycle lubricating system with positive valve pressure and crank chamber for collecting oil. Automatic pressure lubrication shall be provided by a shaft driven gear type pump through an oil cooler and fine mesh filters to the rockers, valve stems, end bearings, camshaft bearings, camshaft chain and gear drives, governor, air starting, distributor, auxiliary drive gears etc. 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 supplier together with all inter connecting piping, fittings, support valves etc. No moving part shall require manual lubrication or external source either prior to starting or during operation of engine. However one electrically operated pre lube oil pump & one pneumatic pre-lub pump shall be provided for intermittent priming of DG Set.

Brief Scope is as follows.

Sl. No.	Description	Qty for each DG
1	Main lub oil pump engine driven engine mounted	1 set
2	Electric motor driven lub oil priming pump	1 set
3	Pneumatic pre lubricating pump	1 set
4	Automatic self cleaning Moatti lub oil filter with clogging indicator engine mounted	1 set
5	Lub oil cooler (PHE)	1 set
6	Centrifugal filter engine mounted	1 set
7	Wet lub oil sump	1 set
8	Lub oil thermostat	1 set
9	All necessary piping with safety valves	1 set

4 COOLING SYSTEM (JACKET WATER-COOLING SYSTEM) : -

Evaporative Cooling tower and Heat Exchanger is acceptable for cooling for DG Set.

1. All fans/pumps/motors etc shall be provided in redundant configuration.
2. As the DG System provided is for Emergency safe shutdown and with the proposed cooling tower arrangement, the DG, for it to start and synchronise and provide load for cooling circuit, it may take around 10 minutes, for which time DG set should be capable of stability in its operation.
3. The cooling tower of both DG shall be interconnected and proper interlock and logic shall be built so that any DG can work with any cooling tower.

   Supplier to clearly indicate the water requirement, the time required from starting impulse till taking load etc.

Supplier to clearly indicate the scope of items in the cooling system.
The details of Cooling water available (sea water) for cooling are as follows.

1. Colour – Colourless
2. pH – 7.8
3. Temp. – 28 Deg. C.
4. Total Suspended solids – 1000 mg/l.
5. Sodium – 11360 mg/l.
6. Calcium – 441 mg/l.
7. Magnesium – 1384 mg/l.
8. Total hardness – 6800 CaCo3.
9. Turbidity – 100 NTU.
10. Chlorides – 20648 mg/l.
11. Sulphates – 2496 CaCo3.
12. Bi carbonates – 196 CaCo3.
13. Potassium – 241 mg/l.
14. TDS – 36712 mg/l.
15. Iron – 0 mg/l.
16. BOD – 5 mg/l.
17. COD – 10 mg/l.
18. TOC – 0 mg/l.

19. Colloidal Silica – 0 CaCo3.
20. Reactive Silica – 5 CaCo3.
21. Odour - Odourless

5 AIR INTAKE & EXHAUST GAS SYSTEM: Complete Air intake system shall have dry type air filter with low resistance, high dust retaining efficiency and provision of easy cleaning. Exhaust gas system comprising of exhaust Y-piece, metal manifold, expansion bellows, exhaust piping bends, fittings shall be in scope of vendor. Exhaust piping shall be routed from DG Room to outside the building and shall meet the minimum pollution control requirements in terms of discharge height. Exhaust piping shall be glass wool Insulated with Al cladding to maintain the temperature less than 70 degree inside DG room. Necessary pipes flanges, bends, bolts, nuts, supports and structures including foundation bolts inside and outside of DG Room for exhaust piping system shall be in supplier scope. Exhaust System shall consist of thermocouples for measuring exhaust temperature behind each cylinder and behind turbochargers including wiring on the engines to common terminal box, crank case ventilator or breather, dry type filter, air intake manifold with necessary connections, turbocharger with after cooler, flexible piping, residential silencer with spark arrester etc as required.

Brief Scope is as follows.

Sl. No.	Description	Qty for each DG
	Air intake System	
1	Dry type filter cum silencer(mounted on turbo charger)	1 set
	Exhaust System	
2	Turbo charger	1 set
3	Exhaust gas silencer residential type	1 set
4	Expansion bellows	1 set
5	Structural chimney with common structure and exhaust ducts as required	1 set
6	Ducting, insulation & cladding of exhaust system (100kg/cm3 density mineral wool, Al cladding)	1 set

6 STARTING SYSTEM- AIR START

Brief Scope is as follows.

Sl. No.	Description	Qty for 2 DG sets
1	Electric motor driven air compressor	2 set
2	Diesel engine driven air compressor	1 set
3	Air Bottle for compressors (500 litre-2 no.s + 15 litr-2 no.s)	1 set
4	Compressed air module with air filter, pressure regulator, gauges, solenoid valve etc for engine & auxiliary control air	1 set
5	All pipe lines for air starting system with related valves & gauges.	1 set

Each diesel engine shall be provided with an air bottle for a minimum of 6 starts. The air bottles shall be made as per material of IS 2002 and all the weld shall be 100% radiographed. The air bottles shall be designed as per ASME Sec. VIII Divi I and other relevant standards/codes. THREE air compressors, two driven by electric motor and other

by a small diesel engine shall be provided. The air bottles /receivers to be provided for each DG set shall remain charged at all times. The capacity of air bottles shall be adequate for min. 6 starts for one (1) Diesel engine. Solenoid operated valves shall be provided for starting, one for each engine. Pressure switches for automatic starting/stopping of air compressor shall be provided. The system shall allow the engine to be started from any crankshaft position by means of compressed air entering directly into the cylinders. Each compressor shall have adequate capacity to allow recharging one air bottle within 5 minutes after one engine cold starting sequence, with maximum 30 minutes filling time of air receiver from atmosphere. The compressor shall be provided with all necessary filtration, inter and after coolers. The compressors and associated equipment shall be designed for continuous operation within the DG room at an ambient temperature of 50 degree C. Oil and water separator shall be provided after the compressors. The air piping shall be as per ASTM A 106 Gr. B Sch. 40 or higher. No screw joints will be permitted in the air piping network. Pipe work and valves shall be provided from compressors to receiver to engine cylinders. Pipe work shall be provided with moisture traps, by pass valves, and the drain pipe work. All take off shall be from the top of the supply pipe. The air system shall be complete with all instruments and controls for auto functioning. Pipe welded joints shall be 100% radiographed.

7 **GOVERNOR: Electronic** Speed governor class A1 type as per BS-5514. / ISO 3046/IV Suitable for auto or manual and remote speed control and parallel operation.

a) The Governor shall be suitable for operation without external power supply and shall provide adequate speed control even if there is loss of external signal. The governor shall be provided with a motor operated potentiometer for remote adjustment of generator frequency. The governor and excitation / control systems shall permit the operation of the unit isolated or in parallel with the other DG Set or the grid without exceeding the active and reactive power limitations of the generator.
b) A mechanical over speed trip device shall also be provided to automatically shut off fuel in case the speed exceeds 30% of the rated value.

8 **INSTRUMENTS & CONTROLS:**

Engine Mounted Instruments &Controls: The flexibly mounted instrument panel on engine shall be complete with the following

- **Engine Controls & Monitoring:**
  - Automatic & Manual Start and manual Stop control
  - Engine Control Switch for Off/Reset
  - Multi attempt starter
  - Cool down Timer
  - Emergency Stop Push-button
- **Local gauge panel consisting of**
  - Cooling Water temp & pressure gauge.
  - Lube oil temperature & pressure gauge.
  - Hour meter with RPM indicator.
  - Exhaust temperature at out let.
  - Contact type thermometers for each cylinder head / compressor stages.
  - Pressure gauges for lube oil system, fuel oil system air starting system

- Differential pressure gauges across strainers and filters.
- Speed indicator
- Exhaust pyrometers with temperature switch

Provision for remote indication of remote operation of DG Set ie start / stop, speed raise /lower, alarm & annunciation facility shall be provided in the engine control panel.

- **Local Mounted Instruments:**
  - Level gauges/switches for fuel tank
  - Local thermometers for lube oil , cooling water , exhaust gas temperature
  - Level sensor switches for lube oil sump and jacket cooling water
  - 2nos independent over speed safety device
- **Transmitters & Switches for alarm and trip :**
  - Low Lub oil pressure - Alarm /Trip.
  - High Lub oil temperature - Alarm /Trip
  - High Engine Water temps. - Alarm /Trip
  - Low Coolant level – Alarm/Trip
  - Low Fuel oil Level – Alarm/Trip
  - Engine Over speed – Alarm /Trip
  - Engine fails to Start - Alarm (A), Followed by Shut down after three unsuccessful start
- **PROTECTION SYSTEM**
  - Manual Shutoff
  - Safety Shutoff Protection Electrical

The above list is not exhaustive. If any standard tripping / alarm / instrument is not listed above but are applicable also to be included by the Supplier.

9 **Base frame / Skid**: The Diesel generator shall be mounted on single structural skid complete with fuel piping, electrical and Instrumentation cabling. The Skid shall be designed to ensure convenient operation of all the equipment and accessories. Skid should be sturdy, fabricated, of welded construction, of channel iron base frame suitable to take the static & dynamic load of the diesel engine and alternator and its accessories mounted on it.

10 **Engine Emission Data**: Vendor shall furnish the engine emission data at full / part loads and shall be as per relevant standards/ statutory regulations.

11 **Safety: All** couplings, gears and exposed rotating parts shall be provided with adequate guards of non-sparking type. Drive belts, if use, shall be of antistatic type. Fuel Manifold & Silencer of engine shall be insulated to ensure that temperature does not exceed 70°C.

12 **STORAGE TANK , TRANSFER PUMPS PIPES (Unit rates for pipes, bends etc shall be given) and NECESSARY HARDWARE with fittings .**

a. The capacity of the HSD storage tank shall be 10cu.m. It shall be provided out side the Emergency DG Set building. All statutory requirements pertaining to the storage of HSD tank shall be taken care of. One no (1)HSD pump for Each DG Set shall be provided to transfer HSD from the storage tank to the day tank

b. Storage tank shall be of horizontal & cylindrical type and shall be located outside the DG plant building. The plant shall have capacity of 10000 liters of HSD. The tank shall be fabricated from MS plates of minimum of 14 SWG thickness conforming to IS: 2062-1992. The tank shall be complete with necessary piping, valves, level gauges, level transmitter(4-20mA output) vent, drain, inlet, outlet and overflow connection and supporting structure, earth connection base etc, as per relevant codes.

c. Each day tank shall have the storage capacity of 990 liters of HSD. The tank shall be of horizontal & rectangular type and shall be fabricated from MS plates of minimum of 14 SWG thickness conforming to IS: 2062-1992. The tank shall be complete with high/low level switches with contacts for control/signaling/alarm, level gauge , vent, drain, inlet and outlet connection and supporting structure etc.

13 Transfer Pumps.

a. The transfer pumps shall be horizontal, centrifugal type mounted on a common base plate with the motor through a flexible coupling. The pumps and motors shall be suitable to handle fuel oil of specified characteristics. The motor capacity shall have a margin of 15% over its BHP absorbed at the pump shaft at the duty point. The speed of pump shall not be more than 1500 rpm.

b. The design of the pumps shall conform to IS 5120 / Design standard of "Hydraulic Institute" of USA / approved equivalent.

c. The head Vs discharge characteristics of the pump shall be continuously rising from the duty point to the shut off point with out the zone instability. The power Vs discharge characteristics shall be non over loading type. The discharge pressure of the pump shall be such as to suit the requirement of the system.

d. The pump shall be of proven make and design having material of construction which is the best of kind for the particular application and shall be manufactured using best engineering practice under strict quality control stipulated elsewhere in this document.

e. Dial type pressure gauges shall be provided at the suction and delivery side of each pump.

f. The drive motors for oil pumps shall be of totally enclosed fan cooled with flame proof enclosure conforming to IS: 2148-1918.

DATA SHEET FOR ENGINE		
1	Manufacturer	
2	Engine Model / frame	
3	WT of Engine	
4	Dimension of Engine	
5	O/L Capacity of Engine in %	
6	No. of Cylinders & Arrangement	
7	Bore/Stroke	
8	Speed (rpm)	
9	Mean piston Speed(m)/sec	
10	Compression Ratio	
11	Type Combustion Chamber	
12	Rotation viewed from coupling end	
13	Engine cooling	
14	Method of starting	
15	Mode of starting	
16	Mode of stopping	
17	Cold starting	
18	Rated engine power at operating Site condition in BHP / KW (with engine driving all its ancillaries including CW pumps,fans & Motor Driven Pumps)	
19	Power required for following Auxiliaries driven by Engine	

CW Pump Motor	Fuel Pump	Other Auxiliary

20	Engine Governing				
21	Lube oil consumption				
22	Fuel consumption in lt./ KW/ hr at following load				
¼ Load	½ Load	¾ Load	Full Load	110% Load	

23	Mechanical Efficiency	
24	Vibration Level	
25	Noise Level	
26	Time required for starting from cold to full load	
27	Time Intervals between starting impulses	
28	No. of Starting impulsed	
28	Capacity of fuel tank	
30	Battery & Battery charger	
31	List of electrical & Mechanical Aux. And their Power consumption	
32	Complete technical literature and catalogue of Engine along with all its accessories including starting device, cooling system, governing system, fuel oil system etc	

14 GENERATOR: - 2.5MW, 6.6KV, 3ph, 3 wire 50Hz, 0.8pf lag, Star connected, continuous rated at 50 deg C, self regulated with excitation, voltage regulation within 1% of rated voltage, class F insulation and temperature rise limited to class B, air cooled, with RTD/BTD/anti condensation heater. The generator shall be of screen protected drip proof type, IP 23 and self air-cooled type. The neutral side leads shall be brought out to terminal box. Neutral side CT on each phase shall be provided for differential protection. Generator shall be complete with VTs for AVR/ synchronization.

Separate Terminal Box for Main, Neutral, RTD/BTD/Space heater, with class of protection IP –54 to be provided. Main & neutral terminal box should be suitable to terminate required number of cables as decided during detailed engg. The terminal boxes shall be dust tight, weather proof phase segregated double walled (metallic as well as insulated barriers) having degree of protection of IP-54 as per IS:2147. The alternator should conform to the latest standards as applicable. NGR of suitable rating with isolator completely assembled in panel shall be provided.

The Generator stator and rotor windings, core insulation and all connections including main and neutral leads shall have Class-F insulation with temperature rise limited to Class-B. The winding shall be given powerhouse treatment i.e., vacuum pressure impregnation (V.P.I.). The total insulation shall be non-hygroscopic. The temperature rise of the Stator core and mechanical parts in contact with or adjacent to winding shall not exceed the limits specified in IEC.

Space heater suitable rated 220 V, 1 Phase, 50 Hz shall be provided in the lower part of the Generator. The alternator vibration level shall not exceed 250 microns. The alternator driven by Diesel Engine shall be able to withstand vibration level of Engine.

NOTE: MAKE OF NGR PANEL SHALL BE NARKEDE/NATIONAL SWITCHGEAR/OHMARK CONTROLS.

14.1 EXCITATION SYSTEM: -

The Generator shall be provided with brush less 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 within ± 1 % of the rated voltage. It shall be possible to set the same from remote also. The setting range available shall be +/- 10% .The response ratio of the excitation system shall not be less than 0.50.

14.2 AVR

i. The regulation System shall be provided with equipment for automatic and manual control. Necessary equipment shall be furnished for the following:-
   a) To prevent automatic rise of field voltage in case of failure of potential supply.

ii) The Regulator shall regulate from Generator output and potential signals.

iii) The above equipment shall be housed in self-standing sheet metal cubicle and shall be completely tested and wired.

iv) The Regulation equipment shall function correctly between the frequencies 47.5 and 51.5 Cycles.

14.3 The voltage regulator shall be provided with compensation circuit to ensure correct division of reactive power in case of parallel operation with grid and/or with other DG set. The excitation and voltage regulation should be designed so as to cause necessary de-excitation in case of any short circuit and signal to be provided from PCC/AVR Panel for Loss of Excitation.

14.4 AVR catalogue indicating clearly all features to be provided.

14.5 TEMPERATURE DETECTORS: RTD &BTD

Resistance element temperature detector shall be installed at the following locations:

- Six elements of Platinum each having a DC resistance of 100 Ohms at 0^0 C suitably distributed at locations where highest temperatures may be expected in stator windings and cases.
- One (1) element in each bearing.

The RTDs shall comply with the latest edition of IS:2828. Separate terminal boxes shall be provided.

14.6 ATTACHMENTS TO THE BASIC GenSet :

Charging Alternator - 24 V, 60 Amps
Voltage Indicator
Flexible Fitting, Exhaust (Shipped Loose)
Flange and Exhaust Expander (Shipped Loose)
Muffler (Shipped Loose)
Fuel Priming Pump
Primary Fuel Filter (Shipped Loose)
QDCT –1 Nos
Differential CT –(3+3) Nos
Diode Fault Detector
Provision for Manual Voltage & Speed Control from remote in addition to auto
Electric operated Pre Lube Pump (A.C. Operated)
Pneumatic Pre Lube Pump
Electrical Shutoff for LLOP/HWT/OS/ EFS
Explosion Relief Valve
Hand operated Transfer pump –2nos
Jacket Water heater with thermostat/ Temp. controller

Data Sheet for Alternator

Make		
Design ambient		
Alt above MSL		
Humidity		
Area classification		
Frame designation		
Rated output		
Applicable Code		
Duty		
No. units		
Type of driver		
Terminal Voltage		
Enclosure		
Rated P.F		
Phase/connection/ no. of terminals		
Full load current		
Speed		
Rated frequency		
Cooling system		
Max. permissible inductive loading		
Excitation system		
Steady state 3 - phase S.C currents		
Type of voltage regulator		
3- phase S.C withstand time		
Painting		
Colour shade		
Insulation class		
Type of excitation system		
Type of cooling		
Terminal Box Enclosure		
Continuous parallel operation		
Black start facility		
Generator line side termination		
Line side cable - type / size		
Neutral side cable -type / size		
Voltage drop permissible when largest motor of 75 kVA is started direct on line with 1350 kVA base load.		
Max. permissible impact load		
Method of Drive		
Reactances :		
Direct axis transient reactance Xd'		
Direct axis subtransient reactance Xd		
Synchronous reactance Xd		
Zero sequence reactance Xo		

Negative sequence reactance X2		
Resistance's and time constants :		
Armature resistance (25 deg.C)		
Armature resistance (100 deg.C)		
Transient time constant Td'		
Sub - transient time constant Td'		

Efficiency	P.F	25% load	50% load	75% load	100% load
%	Rated P.F				
%	Unity P.F				

SECTION V
PAINTING

Final painting shade of DG Set and painting procedures shall be as per customer approved procedures/QAP.

SECTION – VI
INSPECTION AND TESTING

Also see attached GSPC QAP.

The Engine , Alternator and DG SET & ECP is to be tested at manufacturers work in presence of BHEL/ CONSULTANT/CUSTOMER Representative as per approved QAP. QAP for the following shall be submitted by vendor for approval & all inspections & testing will be as per approved QAP by BHEL/ CONSULTANT/CUSTOMER. Reports of all relevant type tests as per applicable Indian/international standards not older than five years shall be submitted for approval for all items. In case any type test is not carried out supplier's to do so at their own cost. All routine tests as per applicable standards shall be carried out on all items during inspection by BHEL/CONSULTANT/CUSTOMER.

- **ENGINE**
- **ALTERNATOR**
- **DG SET**
- **STORAGE TANK/FUEL TANK**
- **AIR STARTING COMPRESSORS**

TESTS:

- **ENGINE** : Engine & Governor testing on a Brake Dynamometer to certify the Engine output and fuel consumption & efficiency , over speed , Vibration, noise level and safety trip test by simulation in accordance with the standard operating conditions as laid down in BS : 5514/equivalent standard or for following minimum duration.
  - No Load - 20 min
  - Part Load - 25% - 20 min
  - 50% &75% load - 1hr each
  - Full Load - 4hrs
  - 10% Over Load - 1hr
  - engine & Governor regulation
  - SFC Test
  - ECP signal &protective device test
  - BOM

- **Alternator :** Routine tests for alternator as per IS 4722/equivalent standard at manufacturers works
  1. Phase sequence test
  2. Over load test
  3. H.V Test
  4. IR Value before and after HV Test
  5. Measurement of resistance/reactance
  6. OC Char
  7. SC Char
  8. Regulation Test
  9. Measurement of polarization index
  10. AVR functional & performance test
  11. Vibration & noise level test
  12. Transient response tests for sudden application & rejection of loads of 25%, 50%, 75%, 100% of rated capacity.
  13. BOM
- **DG SET** : DG Set testing on load to certify the DG output and fuel consumption , Vibration , efficiency ,noise level, Over speed test in accordance with the standard operating conditions as laid down in BS : 5514 for following duration.
  - No Load - 20 min
  - Part Load - 25% - 20 min
  - 50% &75% load - 1hr each
  - Full Load - 4hrs
  - 10% Over Load - 1hr
- **Fuel TANK** :
  - D.P.& Pressure test for fuel tank
  - Leakage test
  - Painting
  - BOM
- **GENERAL** : All equipments will be checked for following
  Dimensional check , Painting thickness , finish quality & workman ship.
  a. One Set of Manufacturer's Test certificates for major bought out equipments shall be made available during inspection.
  b. The DG Set complete unit along with job accessories & auxiliaries shall be tested at site for 8 hrs at full load & at 10% overload for 1 hr.
  c. Combined test on DG Set: After installation at site following test shall be conducted.
     i. Check for function of the auxiliaries

SECTION VII
SPECIAL TOOLS & TACKLES

SPECIAL TOOLS & TACKLES – 1 SET for each DG : Vendor to supply one set of new tools for the maintenance of their equipment exclusively by customer .This tools should be separately packed and shipped .The tool set supplied shall not be used by VENDOR for erection purpose. Tool set for erection purpose shall be arranged by vendor. Tentative list of tools is enclosed . Vendor to confirm suitability of tools for their equipment , If any addition /

deletion / new list is required by vendor , it may please be furnished and will be decided after discussion .Tools supplied should be specific to equipment supplied by Vendor.

LIST OF TOOLS &TACKLES :

Sl.No.	Description	Sl.No.	Description
1	Torque Wrench (2-8 ft lb),3/8" square drive	16	Screw driver 12 " long
2	3/8" to ½" square drive	17	Combination plier – 8" long
3	Screw driver socket ½" square drive	18	Nose plier –6" long
4	½" Ring and open end combination wrench	19	Plastic hammer 0.1/2" diameter
5	9/16" Ring and open end combination wrench	20	Half moon spanner – ¾" x 5/8"
6	3/4" Ring and open end combination wrench	21	3377181 – Vacuum gauge 0-30"hg
7	7/8" Ring and open end combination wrench	22	3375932 – Pressure gauge 0-300psi
8	15/16" Ring and open end combination wrench	23	Hand Tachometer – 0-1500 rpm
9	7/16" Ring and open end combination wrench	24	Socket 9/16" – ½" square drive
10	Dial gauge – 1" Travel, Least count 0.001"	25	Extension – ½" square drive, 3" long
11	Extension – ½" square drive, 5" long	26	Socket 5/8" – ½" square drive
12	Socket 1/2" – ½" square drive	27	Tool box for the above
13	Adjustable wrench – 10" long	28	Socket 7/8" – ½" square drive
14	Allen wrench set – 1/16", 5/64," 3/32," 1/8" , 5/32" , 3/16", 7/32", 1/4", 5/16" , 3/8"		
15	Feeler gauge set – 4" long (0.0015" , 0.002" , 0.003" , 0.004" , 0.006" , 0.008" , 0.010" , 0.012" , 0.015" , 0.023"		

SECTION – VIII
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. Following drawings/documents shall also be submitted in pdf format for e-mail transmitting

List of Drawing / Document

SL. NO.	TYPE OF DOCUMENTS	NO. OF COPIES	STATUS	TIME SCHEDULE
1	Equipment sizing calculations such as air receiver tank, battery & battery charger and catalogue of Engine, Governor , Alternator , AVR etc	2 Sets	For Technical scrutiny and Approval	Along with Offer and after P.O
2	DG Building Layout and Cross Section considering room acoustic	8 Sets	For Approval	Within one week of PO/LOI.
3	GA / OGA Drawing and BOM of	8 Sets	For Approval	Within one week

SL. NO.	TYPE OF DOCUMENTS	NO. OF COPIES	STATUS	TIME SCHEDULE
	Diesel Engine, ECP, Fuel Tank ,Compressor skid , associated accessories, P&I DIAGRAMS			of PO/LOI
4	GA / OGA and BOM of Alternator . Terminal Box /Adapter Box	8 Sets	For Approval	Within one week of PO/LOI
5	GA / OGA and BOM of DG Set , Base Frame	8 Sets	For Approval	Within one week of PO/LOI
6	QAP For Engine, Alternator, DG Set, Fuel Tank, Compressor Skid, Air receiver tank	8 Sets	For Approval	Within one week of PO/LOI
7	Data Sheets of Engine ,Governor , Cooling tower & Silencer, transfer pump, Alternator , , RTD/BTD, Air Compressor, Battery , Battery charger, Fuel Tank.	8 Sets	For Approval	Within one week of PO/LOI
8	Foundation Plan & Loading Details of DG Set ,air compressor,air receiver tank	8 Sets	For Approval	Within one week of PO/LOI
9	P&ID for Compressor Air System	8 Sets	For Approval	Within one week of PO/LOI
10	P&ID for Cooling System	8 Sets	For Approval	Within one week of PO/LOI
11	P&ID for Diesel Oil System	8 Sets	For Approval	Within one week of PO/LOI
12	P&ID for Lubrication Oil System	8 Sets	For Approval	Within one week of PO/LOI
13	P&ID for Exhaust & Air intake system	8 Sets	For Approval	Within one week of PO/LOI
14	GA Drawing & BOM for Charger Panel	8 Sets	For Approval	Within one week of PO/LOI
15	Battery & Charger Sizing calculation	8 Sets	For Approval	Within one week of PO/LOI
16	GA, BOM & wiring diagram of Engine Control Panel	8 Sets	For Approval	Within one week of PO/LOI
17	Wiring diagram of Engine Local Control Panel , AVR , Compressor, Battery charger Panel etc.	8 Sets	For Approval	Within one week of PO/LOI
18	Total Integrated Cable Schedule and termination chart.	8 Sets	For Approval	Within one week of Drawing approvals of Electrical Panels
19	TEST CERTIFICATES	8 Sets	For Information	Along with dispatch documents.
20	O&M, Storage & Erection instruction	8 Sets +	Documentation	Draft O&M manual

SL. NO.	TYPE OF DOCUMENTS	NO. OF COPIES	STATUS	TIME SCHEDULE
	manual	CD		copy should be available at site one month prior to start of erection activity
21	As built & Commissioned / final document	8 Sets +CD	Final Documentation	After commissioning
22	QAPs for all the above mentioned items where ever required	8 sets		

The GA / OGA drawing shall contain Elevation, Section, Foundation / Mounting for Civil Assignment and Layout. This should cover the following information: -

a) Static loading and dynamic loading
b) Details of Exhaust Silencer with spark arrestor details
c) Locations of total DG Auxiliaries
d) Location of Heaters
e) Direction of Rotation
f) Rating Plate
g) Earthing Terminals
h) Lifting hooks with height
i) Mounting faces for vibration monitoring sensors
j) Earthing bolt
k) Protection class for Engine/ alternator
l) Heat loss data i.e., heat dissipation from engine surface/Ventilation Requirement.
m) Standards

All the drawings shall show the following particulars in the lower right hand corner: -

a) Project Title
b) Name of the Customer
c) Job No./PO No.
d) Title of the drawing
e) Suppliers reference No.
f) Scale
g) Date of Drawing
h) Total No. of Sheets
i) Rev. No. & Date
j) Brief details of revisions carried out
k) Space for Purchaser's drawing No.

14.0 **GENERAL**

The combined cycle power plant shall be provided with emergency power supply for safe shutdown of all auxiliaries in the power plant when no AC power is available. Bidder shall clearly describe in his Bid the features, which have been incorporated for emergency power supply using diesel generator sets.

14.1 **Diesel Engine Capacity Criteria**

Capacity: 2.5 MW Each
Quantity: Two (2 X 100% Capacity)

A. Each DG Set alone shall be capable to cater the emergency load requirement for the safe shutdown of the entire station and other auxiliary loads like, Colony Power Supply (approximately 2.5 MW), Control Room Air conditioning system, Administration Building lighting and air conditioning, Gas Station Emergency Supply, Some Street lights, etc. The bidder shall provide the exact requirement of the emergency load for the whole station during the "Black out" condition. Both DG Sets shall be of 100% capacity each to cater the whole load requirement.

B. The capacity of both the DG Sets together shall be capable to provide the "Black Start" of one power block. During the "Black Start", both DG Sets shall only supply the load for safe shutdown of the other block and for the Black Start of the first block. During this period, the entire auxiliary load including colony etc, can be kept isolated.

The final capacity of the each DG sets shall be sufficient to cater the highest of above stated requirements.

14.1.1 **General**

14.1.2 Diesel engine shall be complete with all the standard accessories. The diesel engine shall be suitable for [redacted] EVAPORATING COOLING TOWERS AND HEAT EXCHANGERS [redacted]

14.1.3 Diesel engine shall be capable of starting and operating for a few minutes without supply of cooling water at the time of start-up.

14.1.4 A flywheel shall be provided at the power take-off end to smoothen out the variation in engine torque. It shall be rigidly bolted to the crankshaft. The flywheel shall be statically and dynamically balanced, prior to fixing on to the crank shaft. The entire flywheel

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shall be housed in a flywheel housing to ensure safety of personnel.

.5 The DG set shall be housed in the DG set building. Minimum head room of (3) meter above the top of DG set.

.6 The generating sets shall be capable of continuous operation in parallel with the grid.

1.7 Contractor shall furnish the detailed break-up for arriving at the capacity of the DG set and also furnish overload capacity with a variation in ambient temperature.

.1.8 Critical speed of the machine shall not be lesser than 120% of the normal speed.

1.1.9 All couplings shall be capable of withstanding the maximum generator sudden short circuit torque.

4.2 **DESIGN AND CONSTRUCTION FEATURES**

4.2.1 **Emergency Diesel Engine**

Diesel engine shall be mounted on vibration dampening pads 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 jacket cooling water system along with necessary filters, silencers, ducts, piping and fittings, valves, instruments, etc. as required.

The generating unit shall be complete with all auxiliaries and its performance, torsional vibration, materials and workmanship, etc. shall be in accordance with the standard practices of diesel engine manufacture's association in USA. IS-1600, BS-5514 or equivalent. The engine shall be properly balanced so as to transmit only small unbalanced forces to the foundation.

Following are the fuel oil handling requirements for one DG set. The same shall be furnished for the other DG set as well. Additionally, interconnections between fuel oil tanks (Day Tanks & Storage Tanks) shall be provided with necessary valves to ensure that the HSD from any tank can be used for both the DG Sets.

14.2.2 **Fuel Oil System**

The diesel engine shall be designed to operate on high speed diesel (HSD) oil. For the HSD analysis refer section – B 'Project information'.

Diesel fuel oil system shall be complete in all respects but not limited to the following:

(a) Individual diesel oil day storage tank (day tank) for the engine of 990 litres capacity with a mechanical oil level indicator, a low oil level switch, a very low oil level switch and a high level switch with contact output for alarm/annunciation in the plant DCS. The day tank shall be indoor it shall be erected in DG set building.

The capacity of one HSD storage tank shall be of 10 cum OR HSD required to run the DG Set on full load, whichever is higher. It shall be provided outside the Emergency DG set building. All statutory requirements pertaining to the storage of the HSD tank shall be taken care of. One (1) no. HSD pump for each DG Set shall be provided to transfer HSD from the storage tank to the day tank.

(b) One (1) number hand operated diesel oil transfer pump suitable for wall or floor mounting to transfer oil from barrels to day tank additionally.

(c) Engine driven diesel oil booster pump, injectors etc. for the engine

(d) Thermostatically controlled electric heaters for diesel oil if ambient conditions warrant the same.

(e) 2 x 100% capacity duplex filters with differential pressure switch across the filter(s)

(f) Sufficient length of flexible hose pipe for the diesel oil transfer pump suction in order to enable transfer of diesel oil from barrels to the day tank. Adequate fittings to support this pipe when not in use shall be provided by the Contractor.

(g) The fuel oil system shall be designed to remain primed with diesel oil at all times. If required, an AC motor driven priming pump for intermittent operation with timer operated on auto starting facility shall be provided by the Contractor

(h) Complete interconnecting piping between diesel oil transfer pump and day tank, and day tank and engine along with all necessary valves, fittings, instrumentation and supports.

14.2.3 **Lube Oil System**

Diesel engine lube oil system shall be complete in all respects but not limited to the following:

(a) Engine driven gear type pump

(b) Water cooled lube oil cooler

(c) Thermostatically controlled electric heaters for lube oil, if ambient conditions warrant the same

(d) A priming system with one auto AC priming pump and one DC priming pump shall be provided for the DG set

(e) 2 x 100% capacity duplex filters with differential pressure indicator across filter

(f) All necessary piping, valves, fittings, instrumentation and supports.

14.2.4 **Jacket Water System**

Diesel engine jacket water system shall be complete with:

(a) Jacket suitable for closed cooling water system. The quality of the cooling water shall be either service water or passivated DM water available in the plant with suitable make-up arrangement & sea water for cooling towers.

(b) Necessary pipes, pipe fittings, isolation valves, temperature & pressure gauges & rubber bellow joints.

(c) Engine driven pump

(d) Thermostatically controlled jacket water preheater to enable quick starting and loading of the engine

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14.2.5 **Diesel Engine Starting System**

Engine Starting System

Starting of diesel engine shall be by electric starting system. Two sets of batteries and float and boost chargers shall be provided. Normally, one shall cater to the loads of AMF panel and the other to the starting loads of the engine. Each shall be a 100% stand-by to the other, so that in the event of one not being available, the other battery shall meet the load of the unavailable battery in addition to its own normal load. Each battery shall be suitably rated. A heavy duty selector switch shall be provided to select the two batteries to supply their respective loads or to select any one of them to supply the entire load of AMF Panel and starting load. Each battery shall have its own float and boost charger which shall be housed in a cabinet.

The electric starting system shall be complete and provided with:

a) Starter motor

b) 24V-DC starter batteries and battery chargers

c) Heavy duty flexible copper leads from battery to starter contactor and starter motor

d) Any other equipment / accessories required.

The battery shall be rated at 24V DC. The voltage drop during starting of DG set under various conditions in this specification shall be limited to ensure smooth starting of DG set. The BIDDER may, if required to meet these conditions, provide a battery with 30V DC instead of 24V DC.

Bidder shall ensure that the control circuitry for the DG set in AMF panel shall be suitable for the battery voltage. The battery and battery charger shall meet the following specific requirements besides those listed elsewhere in the specification.

i) Battery shall be adequately rated for atleast three (3) starts of DG set in quick succession.

ii) The battery charger shall be capable of boost charging the battery within 8 hours.

iii) The battery shall be disconnected from its load and trickle charger while it is being boost charged.

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iv) Battery charger shall have a regulator at the output to limit the voltage within safe limits.

.6 **Air Intake and Exhaust System**

(a) 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 pipes and pipe fittings, valves, pipe support structures, Ladder and 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.

4.2.7 The noise level generated by the diesel generator set shall not exceed 85 dBA at a distance of 1.5m in any direction from the engine. Two (2) sets of Earplugs (muffler) shall be provided for operating staff.

4.2.8 The height of the exhaust stack shall be based on the following formula:

$$H = h + 0.2(kVA)^{1/2}$$

Where,

H = Total stack height in metres
h = Height of diesel generator building in metres
kVA = Maximum capacity of alternator

14.3 **Governing System**

14.3.1 The governor characteristics shall comply with the requirements of 'Class-A1' governing of ISO-3046.

14.3.2 The governor shall be provided with an electrically operated speeder gear (motorised) for remote adjustment of generator frequency with speed limiter suitable for operation on DC voltage. This is to control speed of DG set from remote i.e. from plant control desk (PCD), from the DG switchgear and the AMF Panel.

14.4 **Generator**

14.4.1 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	:	6.6 kV
b)	Frequency	:	50 HZ (+3 to-5%)
c)	Power factor	:	0.80

14.4.3 Generator shall be directly coupled to the diesel engines and complete with brushless (rotating diode type) excitation system, automatic voltage regulator (AVR), control and interlocking systems, manual starting/tripping system, control cabinet/panel and all other accessories as per requirements of this specification.

14.4.4 The generator shall be provided with an Auto-on-Mains Failure (AMF) panel. Time delayed NO-VOLT relay contact shall be provided to give an impulse to each DG Set for DG set to start. The DG shall be capable of starting and developing rated voltage and speed automatically without any manual intervention.

Each DG Set shall have the selector switch for putting it on primary or stand-by. The breaker of primary DG set shall be automatically closed as and when it receives the closing permission. The stand-by DG set shall continue to run at no load (with developed voltage in ready to take load condition). The operator shall synchronised the stand-by DG set with the running DG Set to take additional load, if required, OR the operator shall switch off the stand-by DG set.

14.4.5 Alternator shall be provided with an integral speed indicator. Speed transducers shall be provided with output of 4-20 mA for remote monitoring of speeds.

14.4.6 The DG set shall be capable of three (3) starts in quick succession. A hand reset lockout relay shall be provided with suitably wired contacts such that it prevents starts in excess of three (3) in quick succession. Stopping of DG for a normal shut down shall be done manually by means of push button locally as well as from remote.

14.4.7 The line and neutral ends of each phase winding of the generator shall be brought out on six (6) suitably located terminals. Suitable clamping arrangement shall be provided for connecting the cables to the machine terminals. The terminals shall be suitably enclosed to prevent short

circuits by rodents, etc. Suitable cable glands shall be provided on the enclosure to facilitate entry of the cables.

14.4.8 230 V single phase space anti-condensation heaters of adequate ratings shall be provided in the lower part of the stator frame. The kW rating of the space heaters shall be indicated.

14.4.9 Separate terminal boxes shall be provided for phase and neutral side of leads. The terminal boxes shall be dust tight, weather proof phase segregated double walled (metallic as well as insulated barriers) having degree of protection of IP-54 as per IS: 13947

14.4.10 Elastimold terminals with protective covers shall also be acceptable. As far as possible connection between exciter and alternator shall be contained within the machine frame and connections carrying AC and DC current shall be segregated from each other.

14.4.11 Alternator vibration level shall not exceed the values as defined in IS:12075. Alternators in case driven by Diesel engine shall be able to withstand vibration level of 9mm/sec. as per BS 5000 Part III. Vibration level shall not exceed the permissible levels for Generator however the same shall in any case not exceed 250 micron peak to peak.

14.4.12 The generator shall be provided with complete 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 within +/- 10% of the rated voltage. It shall be possible to set/control the same from remote also. The type of insulation of the armature field winding of the exciter shall be Class-F and the temperature shall not exceed the values specified IEC-60034-1 for different parts.

14.4.13 The response ratio of the excitation system shall not be less than 0.50.

14.4.14 The excitation system shall be so designed and/or protected, that harmful over-voltage cannot occur at the main exciter commutator due to combined effect of maximum exciter field current and machine over-speed.

14.4.15 One local control panel with provision for local starting shall be provided for each DG set which shall incorporate all controls required for starting, monitoring, regulating and stopping DG set, specific provision for remote control and indication for DG set in the plant control room shall be provided. It shall be equipped with all necessary instrumentation to provide adequate surveillance of DG set under all operating conditions including 'Standby'. However generating set would normally be started/

stopped and controlled from the central control room. The local control panel shall be of robust construction, floor mounting, free standing type made of 2.0 mm thick cold rolled sheet steel. Neoprene gaskets shall be provided between all openings and joints.

14.4.16 A master relay shall be provided to monitor the following requirements to be met before each set can be started and indicating lamp shall be provided both at local and remote panel to indicate when all the requirements are met.

i) Pre-requisite conditions for compressed air or D.C. Supply (as the case may be) for safety are satisfied.

ii) Pre-requisite conditions for cooling water pump/system, lubricating oil pump/system, exhauster fans, fuel oil systems, pre-lube systems, ventilation system for safety are satisfied.

iii) Generator field breaker is open.

v) None of the tripping signal is present.

14.4.17 Emergency PCC shall have two incomers fed from DG sets & a bus-coupler. Various outgoings to meet the Em. Supply requirement of the station shall be supplied through this board having ACB with suitable over current & earth fault protection for >= 109kW feeders & for other Load break switch with fuse protection shall be provided. Spare modules of each type shall be provided on each bus section.

14.4.18 The distribution of the feeders on each bus section shall be such that both DG sets are equally loaded.

14.5 **Voltage Regulator**

14.5.1 The regulation system shall be provided with equipment for automatic and manual control. Necessary equipment shall be furnished for the following:

a) To prevent automatic rise of field voltage in case of failure of potential supply.

b) To initiate transfer from automatic to manual control of excitation on fuse failure in the generator potential signal.

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

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

14.5.4 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.

14.5.5 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.

14.6 **Tripping Conditions**

The DG shall be tripped under the following abnormal conditions:

(a) Over-speed of DG as sensed by over-speed trip device.

(b) Low lubricating oil pressure after the DG has attained 90% speed.

(c) High jacket water temperature.

(d) High lubricating oil temperature.

(e) Low fuel level in day tank.

(f) Incomplete start after a preset time.

(g) DC control supply failure.

(h) Excitation failure due to tripping of field breaker or failure to build up voltage.

(i) Engine trip due to generator fault.

All the sensing devices shall be provided on the DG and accessory relays on the control panel to achieve the above tripping conditions. These devices shall be suitable for operation on ungrounded DC system.

14.7 **Annunciators**

Window type annunciators shall be supplied and mounted on each DG control panel to give visual and audible indication for the following

conditions. The annunciation list shall be subject to approval of ENGINEER/ PURCHASER.

(a) High jacket water temperature

(b) Low jacket water pressure

(c) High lubricating oil temperature

(d) Low lubricating oil pressure and trip of the engine

(e) Low and high fuel oil tank level

(f) Engine over-speed and trip

(g) Starting air pressure low, if applicable

(h) Failure to start

(i) High differential pressure across lube oil filter

(j) Lubricating oil priming pump (if provided) in operation

(k) Voltage out of limit

(l) Excitation failure

(m) Generator fault

(n) Ground fault on the system

(o) DC control supply failure

(p) Overload operated

(q) Four (4) spare windows

The annunciation system shall be complete with facilities like 'Acknowledge'. 'Reset', 'Test', 'Audible Alarm', etc.

14.8 The AMF panel shall mainly consist of but not limited to the following:

(a) Three (3) nos. ammeters to read phase currents (Accuracy Class 1.0 or better)

One (1) no. voltmeter

(c) One (1) kilo wattmeter

(d) One (1) no. frequency meter

(e) One power factor meter

(f) One energy meter

(g) One (1) DC voltmeter for exciter field voltage

(h) One (1) DC ammeter with shunt for exciter field current

(i) Two (2) spring return to neutral raise/lower control switches or PBS with minimum 2 NO + 3 NC contacts for generator voltage and frequency/load (engine governor) control. Facilities for controlling these parameters from remote panels shall also be provided separately and individually

(j) Two (2) push buttons with minimum 2NO + 2 NC contact elements for starting and stopping the DG set. Facilities shall also be provided for manually starting and stopping the DG set from remote panels separately and individually.

(k) One (1) set of annunciator windows and associated control systems

(l) One (1) number temperature scanner to monitor the temperature of generator stator winding

(m) Three (3) single phase current transformers CL 5P20, 15 VA for connections to protective relays

(n) IDMT over current relay

(o) Voltage operated relay with 5-20% range along with a timer of range 1-10 seconds to be connected to secondary of PT provided across diesel generator neutral earthing resistance

(p) The DG set shall be provided with reverse power relays and reverse KVAR relays with suitable ranges

(q) Any other protection as recommended by the generator manufacturer like overvoltage relays, etc.

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(r) Under-voltage relays with alarm of DG set under-voltage condition

(s) Generator automatic voltage regulator (AVR)

(t) Accessories for generator neutral earthing shall include disconnectable type link in the alternator neutral circuit and with suitable resistance in a separate panel.

(u) One (1) set of all auxiliary relays and timers, as required.

14.9 **Instruments**

14.9.1 Dial type thermometers shall be provided for the following:

(a) Lube oil temperature at lube oil cooler outlet

(b) Lube oil outlet temperature from bearing

(c) Jacket water temperature at cylinder inlet and outlet

(d) Jacket water temperature at the outlet of oil cooler (if applicable).

14.9.2 Pressure gauges shall be provided for the following:

(a) At the discharge of all auxiliary pumps provided with the DG set

(b) For lube oil at the lube oil cooler outlet

(c) At the jacket water inlet to engine.

14.9.3 Tacho generator shall be provided.

14.9.4 Battery voltmeter shall be provided.

14.10 Bidder shall also include the following items in his scope of supply and services:

14.10.1 The diesel engine and generator shall be mounted on a common base frame. Necessary holding down bolts, vibration isolation system (The equipment is fixed on a concrete inertia block, which rests on the vibration isolation system consisting of springs and visco-dampers, nuts, shims, etc.) shall be provided by the Contractor.

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10.2 The diesel oil day tanks shall be suitably located by the Contractor. Necessary structures and platforms with hand rails and approach ladders if required shall be provided by the Contractor.

10.3 Contractor shall test the individual equipment at his works, after satisfactory completion of which the same shall be painted, packed and transported to site.

10.4 Supply and application of final painting at site, shall be provided by the Contractor. The complete equipment shall be painted to RAL7032.

10.5 Hoist or Chain pulley block with moving trolley shall be provided over the DG sets for the maintenance requirement. Lifting lugs or eye bolts shall be provided for ease of installation and maintenance.

11 SOUND PROOFING SYSTEM

11.1 The acoustic enclosure or acoustic treatment of the room shall be designed for minimum 25 dB (A) insertion loss or for meeting the ambient noise standards, whichever is on the higher side (if the actual ambient noise is on the higher side, it may not be possible to check the performance of the acoustic enclosure/acoustic treatment. Under such circumstances the performance may be checked for noise reduction upto actual ambient noise level, preferably, in the night time). The measurement for insertion Loss may be done at different points at 0.5 m from the acoustic enclosure/room, and then averaged.

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

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

11.4 DG shall be placed either in acoustic enclosure or acoustic treated DG room. The requirements of acoustic enclosure/room treatment are as following.

14.12 **Acoustic Enclosure**

The acoustic enclosure shall be fabricated from 2.0 mm thick CRCA sheet with steel section & frame of suitable size. The construction shall be modular type to facilitate dismantling as required for maintenance. The frame shall be of sufficient stiffness and rigidity. The enclosure shall be suitable for outdoor

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duty. DG set, fuel tank, control panel, adopter box if required shall be located inside the enclosure. A minimum clear space of 800 mm shall be kept inside the enclosure.

14.12.2 The exposed surface of lining shall be retained in place by minimum 1.0mm thick CRCA/ aluminium perforated sheet. Absorptive lining shall be provided between the perforated sheet and absorbing material. Necessary acoustic sealing shall be done in the panels/modular unit joints.

14.12,3 Enclosure shall be provided with adequate AC & DC lighting alongwith MCB etc. Enclosure shall be provided with adequate number of door and viewing glass.

14.13 **Acoustic Treatment of DG Room**

14.13.1 Acoustic treatment of DG room shall be done. The following requirements shall be complied in case of acoustic treatment.

(a) The acoustic treatment of wall, ceiling and other opening shall be done using galvanized steel sections. The framework shall be fixed on wall/ceiling using expansion fasteners.

(b) Bonded mineral wool slab of required density and thickness shall be used for sound absorptive layer. This shall be concealed with minimum 1.0 mm thick perforated aluminium sheet / CRCA. Suitable lining shall be provided between the bonded wool and perforated sheet.

(c) Removable type of acoustic paneling shall be done to facilitate maintenance.

(d) The sheet and all sections shall be powder coated shade of grey RAL 9002.

14.13.2 All hardware of mild steel shall be hot dip galvanized.

14.13.3 The door design shall be generally compatible to the enclosure design/acoustic treatment of room. 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.

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4.13.4 Suitable louvers with acoustic treatment shall be provided by the Bidder as required.

4.13.5 Ventilation system of adequate capacity shall be provided. The system shall comprise of tubular axial flow fans for air intake and air exhaust with splitter silencer. 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 by more than 5 degree centigrade above ambient when DG is running continuously at specified rating.

14.13.6 The construction of ventilation duct shall be from 1.6 mm thick CRCA perforated sheet. Other constructional details shall be similar to that of the enclosure/room acoustic treatment.

14.13.7 The exhaust air from radiator shall be discharge through modular duct of adequate size.

14.13.8 Any other facility required to achieve the desired acoustic level shall be in the bidder's scope.

14.14 **Performance Requirements**

The DG and accessories shall be designed to meet the following performance requirements:

14.14.1 The DG shall be capable of starting from cold condition , reaching synchronous speed and taking up load within the period specified from the "start" impulse and shall be capable of delivering continuously at the generator terminals rated output , with invisible exhaust.

14.14.2 With the DG running at no-load, rated voltage and speed, the transient voltage drop at its terminals shall not exceed specified percentage of rated voltage, on starting a maximum capacity induction motor direct on-line required to be started during this period.

14.14.3 DG Sets shall have the provision of synchronization with the main power supply (running parallel with the grid). Both DG Set shall have the provision of synchronization with each other and also with grid. The provision of back synchronization shall be provided to the DG sets, when the incoming normal power is restored.

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14.14.3 **Site Performance test**

The site performance test shall be carried out for DG set and its auxiliaries as per ISO 3046 standards. The following items of performance shall be guaranteed during site performance tests in respect of DG and the auxiliaries for the specified site conditions:

(a) Net electrical output at generator terminal

(b) Fuel oil consumption at ½ , ¾ and full load

(c) Lube oil consumption at full load

(d) Jacket water temperature to and from engine

(e) Lubricating oil temperature to and from engine

(f) Freedom from vibration and noise

(g) Governor response, over-speed trip and speeder gear capability

(h) Voltage regulator response

(i) Excitation at full load and under specified variation of voltage and speed.

14.14.4 All acceptance and routine tests as per the specification and relevant standards shall be carried out.

14.14.5 Type test reports for the following type tests shall be submitted.

(a) Measurement of resistance

(b) Phase sequence test

(c) Regulation test

(d) Measurement of open circuit and short circuit characteristics

(e) Efficiency test

Temperature rise test

Momentary overload test

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(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.

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SL. NO.	DESCRIPTION	UNITS	VALUES / REQUIREMENTS
1.0	**General**		
1.1	Diesel generator set type		Auto – On – Mains Failure (AMF)
1.2	Number of diesel generator sets		Two (2) Sets of required capacity as described in D1.14.1.
1.3	Fuel specification		High speed diesel oil – Refer Section-B
1.4	Speed of the machine	rpm	1500 (Maximum)
1.5	Governor class		Class – A1 : Governing type as per ISO 3046 / A1 type as per BS:5514
1.6	Duty		24 hrs continuous running, of which one hour at 10% overload rated speed
1.7	Noise level	dB(a)	Max 105 at one meter distance
1.8	Vibrations		Max 250 microns peak to peak with anti vibration pads.
1.9	Starting		Electrical self starting
1.10	Fuel tank capacity		990 Litres per day
1.11	Air Intake system		Dry air filter type suitable for site conditions.
1.12	Cooling system		Water cooled system
1.13	Noise level at half meter distance from DG acoustic enclosure/building	dB(a)	Minimum 25 insertion loss. However ambient level of 70 shall be achieved.
1.14	Painting		As per section C-13 of Volume - II
1.6	Governor type		Woodward type – EGB 10 or equal
2.0	**Generator Data**		
2.1	Generator output under site conditions and at output terminals (Exclusive of supply to DG set auxiliaries)		Approximately 2.50 MW – 2.75 MW for each DG Set. Subject to Owner / Owner's Representative approval. Capable to supply power to auxiliaries requiring emergency power for safe shut down of units and supply power to emergency lighting, UPS etc. + Colony Power requirements + Some lighting Requirement + Administration Building Requirements etc.
2.2	Rated voltage	kV	6.6
2.3	Type of insulation		Class – F with temperature rise limited to class-B
2.4	Type of enclosure		IP – 23
2.5	Method of neutral grounding		Non-effectively earthed through resistance continuously rated.

SL. NO.	DESCRIPTION	UNITS	VALUES / REQUIREMENTS
6	Period for taking load from start to impulse		Less than 30 seconds DOL starting
7	Parallel operation of DG set required		Yes (with main supply and with each other) with Facility of Back-synchronisation with the main grid supply
8	Engine starting system		Battery starting
9	Excitation system		Brushless
10	Manual starting of engine through local / remote push button		Required. (through push button on AMF panel in local position and through push button on plant control desk in remote position)
11	Trip device on main station supply restoration		Required
12	Speeder gear for remote variation of speed		Required
13	Method of engine jacket cooling		Water cooling with radiator for recooling
14	Paint shade for panels		RAL 7032
3.0	**Shop Tests**		
3.1	**Engine** Four (4) hours at full load followed by one (1) hour continuous overload of 110%		Required
3.2	**Generator** Type and routine tests as per standards IEC:34, IS 4712 and BS – 5000		All type test certificates to be furnished. All routine test to be conducted.
3.3	**Exciter** Type and routine tests as per standard IS – 722 and BS – 5000		Required
3.4	**Voltage regulator** Tests as per IS / BS Code		Required
4.0	**Codes and Standards**		
4.1	ISO 3046 – Specification for reciprocating internal combustion engine Part –I - IV)		
4.2	BS:5000		
4.3	IS:1601		
4.4	BS: 5514		
4.5	IEC:60034		
4.6	VDI2063 / ISO 8529 – Measurement and evaluation of mechanical vibrations of reciprocating piston engines and piston compressors.		

GSPC PIPAVAV POWER COMPANY LIMITED - 700MW COMBINED CYCLE POWER PLANT

Technical Deviation

BHEL Annexure - J

Sr No	Volume	Section	Clause	Page No. (x Of y)	Bidder Deviation / Clarification	GPPC's Comment	Clarification by BHEL during Bid Discussion
1	-------	-------	14.2.2 (d)	-------	Please note that heaters for HSD is not required and hence not provided	Not Agreed	BHEL confirmed that they will provide as per specification
2	-------	-------	14.2.2 (d)	-------	Please note that as per design practice of engine manufacturers heaters for lub oil is not required and hence not provided.	Not Agreed	Covered in Mechanical section
3	-------	-------	14.2.3 (d)	-------	Please note that DC motor driven priming pumps are not advisable as per engine manufacturers design practice. However Pneumatic motor driven pre lube pump is provided as per standard manufacturing practice.	Agreed	Noted by BHEL
4	-------	-------	14.9.1 b & c	-------	Please note that Lube oil outlet temp from bearing and jacket water temperature at cylinder head inlet & outlet is not provided by engine manufacturers as per design. Practice and hence will not possible to provide	Agreed	Noted by BHEL
	-------	-------		-------	-------	-------	
5	-------	-------	2.3	-------	The alternator shall be Class F with temp rise limited to class F.	Not Agreed	BHEL confirmed that they will provide as per specification
	-------	-------		-------	-------	-------	
6	-------	-------	14.2.2 (e)	-------	Please note that one duplex filter with 2 banks (one operating and one standby) shall be provided	Agreed	Noted by BHEL

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S.M. Humayun
Dt: 25/7/2007
PMC / TSG.

(TPE)

GSPC PIPAVAV POWER COMPANY LIMITED - 700MW COMBINED CYCLE POWER PLANT

Technical Deviation

BHEL Annexure - J

Sr No	Volume	Section	Clause	Page No. (x Of y)	Bidder Deviation / Clarification	GPPC's Comment	Clarification by BHEL during Bid Discussion
7	-------	-------	14.2.2. (f)	-------	Please note that 10 KL tank for bulk storage of HSD is provided. HSD from 10 KL tank to DG day tank (990 ltrs) shall be transferred by automatic transfer pump.	Agreed ✓	Noted by BHEL
8	-------	-------	14.2.3 (e)	-------	Please note that as per design practice of engine manufacturers duplex filters are not provided and simplex auto-self cleaning type filters are provided. The simplex type filters are superior than duplex filter and cleaning is not required for 12000 hours of operation.	Not Agreed	TCE/GPPC Agreed
9	-------	-------	14.2.5 DATA SHEET A1.14	-------	Please note that the DG ratings of more than 1.6 MW are not suitable for battery start. The engines of such capacity (2.5 MW) are suitable for Air start and hence air compressor shall be provided for starting.	Agreed with proper sizing of Air Receiving Tank suitable for minimum number of starts as specified	Noted by BHEL
	-------	-------	Item 1.9	-------			
	-------	-------		-------			
	-------	-------	Item 2.8	-------			
10	-------	-------	14.2.6 (i)	-------	Please note that as per engine manufacturers practice air filter cum silencer is mounted on turbocharger.	Agreed	Noted by BHEL
11	-------	-------	14.2.7, 14.11, 12 DATA Item 1.7	-------	The Noise level @1 meter from DG set shall be 109 dBA. However acoustic treatment for the DG room shall be provided to meet CPCB norms.	Not Agreed	BHEL confirmed that they will provide as per specification
	-------	-------		-------			
	-------	-------		-------			
	-------	-------		-------			
	-------	-------	Item 1.13	-------			

GSPC PIPAVAV POWER COMPANY LIMITED - 700MW COMBINED CYCLE POWER PLANT

Technical Deviation

BHEL Annexure - J

Sr No	Volume	Section	Clause	Page No. (x Of y)	Bidder Deviation / Clarification	GPPC's Comment	Clarification by BHEL during Bid Discussion
	-------	-------		-------			
	-------	-------		-------			
12	-------	-------	14.3.2	-------	Please note that as per engine manufacturers standard practice electrically operated speeder gear motor is not provided however Digital signal operation through DRU (digital reference unit for speed monitor).shall be provided	Agreed	Noted by BHEL
13	-------	-------	14.4.3	-------	The alternator will be coupled with engine by flexible couplings	Agreed	Noted by BHEL
14	-------	-------	14.4.5	-------	Please note that DG set speed indication is provided in the DG CP , which is also speed of the alternator	Not Agreed	BHEL confirmed that they will provide as per specification

(GPPC)

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S.M. Humayun
BHEL/ISG
25/7/2007

(TCE)

16.0 **LIST OF SUB-VENDOR**

Sl. No.	Package Title	Name of Vendors
A.	**Electrical**	
1	GENERATOR TRANSFORMER	BHEL CGL AREVA TELK ABB
2	UNIT AUXILIARY TRANSFORMER	BHEL CGL AREVA TELK ABB
3	AUXILIARY TRANSFORMERS	VOLTAMP AREVA CGL BHEL BBL
4	HT SWITCHGEAR	ABB AREVA SIEMENS
5	LT SWITCHGEAR (MCC, PMCC & PCC)	L&T SIEMENS SCHNEIDER CONTROL & SWITCHGEAR ABB
6	ACDB/DCDB/MLDB	L&T SIEMENS CONTROL & SWITCHGEAR ABB

Sl. No.	Package Title	Name of Vendors
8	BATTERY	AMCO HBL NIFE AMARA RAJA
9	BATTERY CHARGER	AMARA RAJA HBL NIFE UNILEC AUTOMATIC ELECTRIC LTD.
10	HT MOTORS	BHEL CGL ALSTOM ABB
11	LT MOTORS	BHARAT BIJLEE ABB CGL SIEMENS ALSTOM KIRLOSKAR ELECTIC
12	DC MOTORS	BHEL ABB L&T SIEMENS
13	PROTECTIVE RELAYS	L&T EASUN REYROLLE GE AREVA ABB SIEMENS
14	BUSDUCTS-HT (ISOLATED & SEGREGATED PHASE), SPVT CUBICLE	BHEL CONTROL & SWITCHGEAR POWER GEAR
15	NGR	BHARTIA CUTLER HAMMER CGL SR NARKHEDE ENGG LTD AMPCONTROLS

Sl. No.	Package Title	Name of Vendors
16	LT BUSDCUT	CONTROL & SWITCHGEAR POWER GEAR
17	HT POWER CABLES	RPG CABLES CCI UNIVERSAL NICCO CORP. LTD. TORRENT FORT GLOSTER
18	LT POWER CABLES	RPG CCI UNIVERSAL NICCO CORP. LTD. TORRENT FINOLEX RADIANT KEI DELTON CABLES FORT GLOSTER POLYCAB
19	CONTROL, SIGNAL, INSTUMENTATION & THERMOCOUPLE CABLES	POLYCAB THERMOPADS PET.LTD. RADIANT CABLE CCI RPG CABLES PARAMOUNT NICCO CORP.LTD. KEI CABLES UNIVERSAL FORT GLOSTER CORDS CABLES FINOLEX RELIANCE ENGINEERS LTD.
20	CABLE TRAYS AND ACCESSORIES	INDIANA RELIANCE PATNI SADHNA STERLITE

Sl. No.	Package Title	Name of Vendors
21	HT TERMINATION KITS	RAYCHEM
22	ELEVATORS	KONE ELEVATOR INDIA LTD. SCHINDLER INDIA UT LTD. OTIS ELEVATOR BHARAT BIJLEE HITACHI INDIA
23	MASTER CLOCK SYSTEM	SERTEL PUNJAB COMMUNICATIONS
24	DDCMIS	ABB-SYMPHONYMELODY/ SYMPHONY HARMONY WESTING HOUSE-OVATION SIEMENS-TELEPERM XP ADD TATA HONEYWELL-EXEPRION BHEL-MAX-DNA HITACHI-HIAC-7000 YBL-CENTUM CS-3000 FOX BORO-1/A SYSTEM
25	PLC	ALLEN BRADLEY GE FANUC SIEMENS ABB GROUPE SCHNIEDER HONEYWELL
26	TRANSDUCERS	SIEMENS ABB MECO AUTOMATIC ELECTTRIC LTD. ALSTOM SOUTHERN TRANSDUCERS (L&T)
	ELECTRICAL PANEL METER (AMMETER, VOLTMETER)	AUTOMATIC ELECTRIC MECO

Sl. No.	Package Title	Name of Vendors
		RISHAB INSTRUMENTS
28	SELECTOR SWITCHES & CONTROL SWITCHES	KAYCEE SIEMENS ALSTOM L&T
29	UPS (CONVERTER, INVERTER, CHARGER)	GUTOR EMERSON DB POWER ELECTRONIC SIEMENS FUJI
30	INTERPOSING RELAYS FOR COMMAND OUTPUT TO MCC	H&B ALSTOM OMRON JYOTI NATIONAL OEN
31	TERMINAL BLOCKS	PHOENIX WAGO ELMEX CONNECTWELL
32	LIGHT FITTINGS	CROMPTON GREAVES LTD. PHILIPS BAJAJ WIPRO GE
33	CATHODIC PROTECTION	CORRTECH INTERNATIONAL PVT. LTD.
34	WALKIE TALKIE	MOTOROLA PHILIPS KENWOOD
35	MOV	SYNDROPAK
36	**SWITCHYARD ITEMS**	
	CIRCUIT BREAKER	CROMPTON GREAVES ABB BHEL

Sl. No.	Package Title	Name of Vendors
		TELK SIEMENS AREVA
36.2	ISOLATOR	ELPRO AMEI
36.3	INSTRUMENT TRANSFORMERS (CTS/PTS/CVTS)	AREVA CROMPTON GREAVES ABB BHEL
36.4	SURGE ARRESTOR	ELPRO ABB WSI
36.5	CONTROL & RELAY PANELS	ABB SIEMENS AREVA EASON-REYROLLE
36.6	BUS POINT INSULATORS	MIL BHEL WSI IRIL
36.7	DISC INSULATORS	WSI BHEL IRIL
B.	**Mechanical**	
1.	Gas Turbine, Gas Turbine Generator & Accessories	All Advance Class Gas Turbine Manufacturer
1.1	Main & Auxiliary lube oil pumps	Buffalo Kirloskar. GE Allevelier Rexroth
1.2	Main & Auxiliary hydraulic pumps	Hartman Controls Inc.

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Sl. No.	Package Title	Name of Vendors
		Allevelier Rexroth Delta Corporation GE
1.3	Filters	Hilliard
		Microflo Filters
		PALL
1.4	Load coupling	Renk Tacke
		Koplex
		Ameridrivs
1.5	Enclosure for Gas Turbine and other modules	Indira Industries
		Lloyd Insulation
1.6	Inlet air filter	Donaldson
		Anfilco
		Luwa
		Flair
2.	C&I for Gas Turbine	As per Gas Turbine OEM Standard
3.	Gas Fuel Handling System	RMG
		Grand Prix
		Allan Process
		Axsia Howmar
		Petrogas
		Rotring Engineering
		Calorifier AG
		ETI, Oklahoma
		Woodland Instrument Pvt. Limited.
		Rohrleitungs-und Anlagenbau GMBH

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Sl. No.	Package Title	Name of Vendors
4.	GT Exhaust System	Indira Industries
		Fouress Engg.
		Kaefer India
		Burgmann
5.	HRSG	As Per EPC Contract
6.	Steam turbine and Generator	GE
		Toshiba
		Alstom
		Siemens
		Hitachi
		Mitsubishi
7.	HP/ IP / LP Bypass	CCI
		BTG
		Parcol
		Copes Vulcan
		Forbes Marshall "ARCA"
8.	Boiler Feed Pumps & Condensate Extraction Pumps	KSB Pumps
		Sulzer Pumps
9.	Condenser / Deaerator	As Per EPC Contract
10.	Water Treatment / System Effluent Treatment and Sewage Treatment Plant	Driplex
		Ion Exchange (India) Limited
		Metito Overseas
		V A Tech
		Thermax
11.	Chlorination plant	Pennwalt India Limited
		Capital Controls
12.	Chemical Dosing System	Ion Exchange (India) Limited

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Sl. No.	Package Title	Name of Vendors
		Milton Roy Asia LMI (P) Limited
		Thermax
13.	Rubber Expansion Joints	D Wren international Limited
		Cori Rubbers
14.	Air Conditioning and Ventilation System	Blue Star Limited
		Voltas Limited
		Carrier Aircon
15.	Fire Detection & Protection	Siemens Fire System
		Mather & Plate India Limited
		Vijay Industries & Projects Limited
		New Fire System
		Nitin Fire System
		Agni Fire System
17.	Induced Draught Cooling Towers	Gammons
		Paharpur Cooling Towers Limited
18.	EOT & HOT Cranes	Mukand Limited
		ACME Manufacturing
		Eddy Cranes
		Anupam
19.	Hoist	Reva Engg. Industries
		Hercules Hoist Limited
		Bombay Power Lift
		Armsel Group of Companies
		Eddy Cranes Engineers Limited
		Electromech
		Avon Cranes
20.	Air Compressors	Atlas Copco / Chicago Pneumatic

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Sl. No.	Package Title	Name of Vendors
		Ingersol Rand
21.	Plate Type Heat Exchangers	Alfa Laval (India) Limited
		GEA Ecoflex
22.	Miscellaneous Pumps (HT)	KSB Pumps Limited
		Sulzer Pumps (India) Limited
		Kirloskar Brothers Ltd.
23.	Miscellaneous Pumps (LT)	KSB Pumps Limited
		Sulzer Pumps (India) Limited
		Voltas Limited
		Beacon Weir
		Tushaco Pumps
		Mather & Platt
24.	Pipes (LP Piping)	Tata Steels
		Indian Seamless
		Jindal
		Maharashtra Seamless
		SAIL,
		Kalyani Seamless
25.	HP Piping	SHAW
		Deutsche Babcock
		Mannesmann Anglagenbau
		Sumitomo
		British Steel
		Marubeni
		Tata Steels
		Indian Seamless
		Jindal
		Maharashtra Seamless
		SAIL,

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Sl. No.	Package Title	Name of Vendors
26.	Hangers & Supports	SHAW
		Carpenter & Paternson Ltd.
		PSS
		Piping and Energy Products
		Flexider spA
		Trouvay & Cauvin
		Sarathi Engg. Enterprises
		Pipe supports India Limited (Formerly Myricks Piping Systems)
		Grinnel Corporation
27.	HP Valves	Audco India Ltd
		Deutsche Babcock
		KSB
		Keystone
		Dresser
28.	LP Valves & Specialties	AUDCO INDIA LTD
		KSB
		Keystone Valves
		Leader
		KBL
29.	Miscellaneous Valves	Edwards
		Yarway
		Dresser Valve Co.
		Fischer-Rosemount
30.	Pipe Fittings	True forge
		Teekay Tubes
		Tube Products Incorporated
		Precision Forgings

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Sl. No.	Package Title	Name of Vendors
		Bend Joints
31.	Vacuum Type Lube Oil Purifier	PALL
		Alfa Leval
32.	Electrostatic liquid cleaner	Ferrocare Machines Pvt.Ltd
33.	Butterfly Valves	L&T-AUDCO
		Keystone
		Néles – Jamesbury
		Tyco
		BDK Valves
34.	Mechanical Workshop equipment	General purpose lathes : HMT, Batliboi, beco.
		Drilling machines : HMT, Batliboi, BECO,
		Grinding machines : HMT, Batliboi
		Bending & shearing machines : HMT, Batliboi, VOLTAS
		Press, other machinery, general equipment for machine shop : Batliboi, HMT
		Welding : Advani, L&T
35.	Steam Line Items Like Steam Trap AND FILTERS etc.,	J.N. Marshall
		Uni Klinger
		Forbes (Spirax) Marshall
36.	Safety Valves	Tyco Sanmar
		Crossby
C.	**Instrumentation & Control**	
1.	DCS	Yokogawa Blue star Ltd.
		Emerson Electric
		Tata Honeywell

Sl. No.	Package Title	Name of Vendors
		ABB
		GE
2.	PLC	Allen Bradley (Rockwell Automation)
		Square D/Schneider
		Siemens
		GE Fanuc
		L&T – Modicon
		Omron
3.	Pressure Gauge	Switzer
		FORBES MARSHALL
		GENERAL INSTRUMENTS
4.	DP Gauge	Switzer
		FORBES MARSHALL
		GENERAL INSTRUMENTS
5.	Temperature gauge (Hg in Steel)	PYRO ELECTRIC INDIA PVT. LTD.
		General Instrument
		Forbes Marshall
		Goa Instrument Industries
6.	Level Gauge	Altop
		Techtrol
		Levcon
7.	Pressure Switch	Switzer
		Indfoss
		Dwyer
		SOR

Sl. No.	Package Title	Name of Vendors
		DELTA
		UE (United Engineering)
8.	DP Switch	Switzer
		General Instrument
		Indfoss
9.	Thermocouple	Pyroelectric
		General Instruments
		Altop
10.	RTD	Pyroelectric
		General Instruments
		Pyrotech
		Altop
11.	Transmitter	Rosemount
12.	Digital Indicator	Masibus
		Honeywell
13.	Junction Box	Pyrotech Control
14.	Level Switches	Magnetrol Levcon, V.Automat E&H
15.	Mass flow meter (Coriolis Principle & Ultra Sonic Principal)	Emerson - Rosemount E&H
16.	Vibration Monitoring Equipment	Bentley Nevada
17.	Pressure Reducing & Desuperheating Stations	Spirax Marshall Sulzer Keystone Fisher Sanmar Instrumentation Limited
18.	Solenoid Valves	Herion

Sl. No.	Package Title	Name of Vendors
		Asco
		Rotex
19.	Terminal Blocks	Phoenix
		WAGO
20.	AC TO DC COVERTOR	Phoneix
		Siemens
21.	Scanner	Procon
		MASSIBUS
22.	HART Management System	EMERSON
		MTL
23.	Large Video Screen (LVS)	Barco
		HP
		Compaq
24.	Computer Workstations	DELL
		IBM
25.	Stack Sampling system	Fisher Rosemount
		AMETEK
		CODEL
		Environment SA
26.	Steam and water sampling system	Fisher Rosemount
		Forbes Marshall
		ABB
27.	Control Valves	CCI
		Fisher Xomox Sanmar
		Neles Controls AG
		Arca Controls
		MIL Controls Ltd
		Instrumentation Limited
28.	Motor Operated Valve Actuators	Limitorque

Sl. No.	Package Title	Name of Vendors
		Rotork
		AUMA
29.	Electronic Drum Level Indicator (EDLI) / Hydrastep	Yarway
		Level State
		Clark Reliance
30.	Level Transmitter	V. Automate
		Fisher Rosemount
		E&H
31.	Clock System	Keltron
		Sertel Electronics
32.	Instrument Lab Equipments	Beamex
		Druck
		Yokogawa
		Scandura
		Fluke
		JOFRA
33.	Orifice Plate and Flanges.	Micropricision
		Instrumentation Limited, Palghat

Note: This list is indicative only and it is subject to Owner's approval. The intended user may verify the credentials of the vendors and their experience etc., before selecting the vendors to suit its needs.

PS-MKTG.

ISSUE P1

		GSPC PIPAVAV POWER COMPANY COMPANY				SECTION	C-12					
		TITLE 700 MW (2 X 350 MW) COMBINED CYCLE POWER PLANT AT PIPAVAV QUALITY ASSURANCE REQUIREMENTS				TITLE	MINIMUM INSPECTION REQUIREMENTS FOR DIESEL ENGINE					
SPEC. NO. TCE.4916A-H-500-001						DOC. NO.	QP-25				SHEET 1 OF 2	
SR. NO.	COMPONENT / OPERATION	CHARACTERISTICS CHECKED	TYPE / METHOD OF CHECK	EXTENT	REF. DOCUMENT / ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY				REMARKS	
							S	M		'O'		
1	2	3	4	5	6	7	8				9	
1.0	MATERIALS :											
1.1	Raw materials	Chem., Mech. properties, Dimns.	Review of docs.	100%	Material specification	TC				V		
		Soundness of forgings	UT	100%	Material specification	TC				V		
		Surface defects (castings)	MPI	100%	Material specification	TC				V		
2.0	IN-PROCESS INSPECTION :											
2.1	Pressure parts (Cylinder, Cylinder	Strength	Hydrotest	100%	Drawing	Inspection report				V		
	head/cover, etc.)											
2.2	Crank case	Leak test	Kerosene	100%	Drawing	Inspection report				V		
2.3	Machined components (Piston,	Surface defects	MPI/LPI	100%	Manufacturer's NDT procedure	NDT report				V		
	Cylinder set, etc.)											
2.4	Components with close tolerances	Dimensional check	Measurement	100%	Drawing	Inspection report				V		
	(Piston, Cylinder bore, etc.)											
2.5	Dynamic balancing of rotating parts	Residual unbalancement	Unbalancement	100%	Drawing and ISO 1940	Inspection report				W		

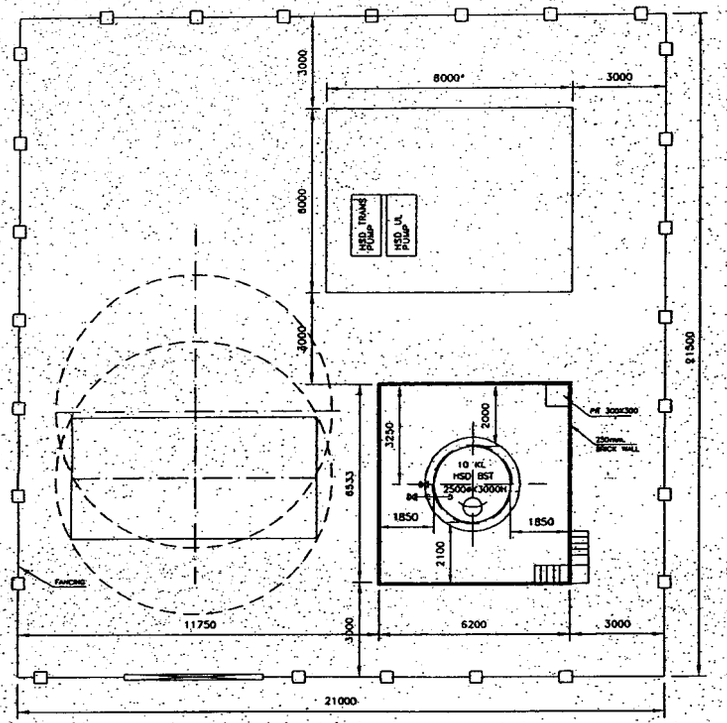
NOTE

A. STATUTORY REQUIREMENTS SHALL BE COMPLIED WITH BY THE VENDOR.
B. MATERIAL TESTS OF SAMPLES DRAWN BY TCE SHALL BE WITNESSED BY TCE.
C. FOR STAGES WITNESSED / DOCUMENTS REVIEWED BY TCE, COPIES OF RELEVANT DOCUMENTS SHALL BE FURNISHED TO TCE.
D. TCE'S IDENTIFICATION STAMP ON MATERIALS SHALL BE PRESERVED / GOT TRANSFERRED BY TCE AT APPROPRIATE STAGES.
E. THE EXTENT INDICATED IN COLUMN 5 IS IN VENDOR'S SCOPE. TCE MAY INSPECT AS PER THIS COLUMN OR RANDOM SAMPLES.
F. COLUMN 6 SHALL BE AS PER TCE APPROVED DRAWINGS / DATA SHEETS / SPECIFICATIONS WHEREVER APPLICABLE.
G. INSTRUMENTS FOR LEAK TESTS AND PERFORMANCE TESTS SHALL HAVE VALID CALIBRATION CERTIFICATE WITH TRACEABILITY TO NATIONAL LEVEL.
H. LEGENDS : S - SUB - VENDOR, M - MAIN VENDOR, O -OWNERS REPRESENTATIVE, W - WITNESS, V - DOCUMENTS REVIEW, H - HOLD POINT.

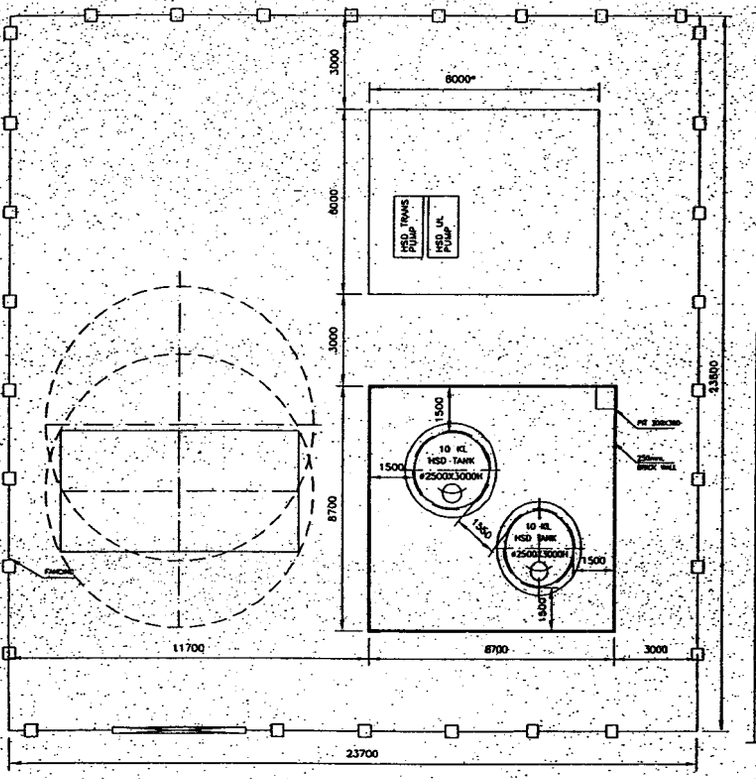
TCE CONSULTING ENGINEERS LIMITED

	GSPC PIPAVAV POWER COMPANY COMPANY					SECTION	C-12				
	TITLE 700 MW (2 X 350 MW) COMBINED CYCLE POWER PLANT AT PIPAVAV QUALITY ASSURANCE REQUIREMENTS					TITLE	MINIMUM INSPECTION REQUIREMENTS FOR DIESEL ENGINE				
SPEC. NO. TCE.4916A-H-500-001						DOC. NO.	QP-25			SHEET 2 OF 2	
SR. NO.	COMPONENT / OPERATION	CHARACTERISTICS CHECKED	TYPE / METHOD OF CHECK	EXTENT	REF. DOCUMENT / ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY S	AGENCY M	AGENCY	AGENCY 'O'	REMARKS
1	2	3	4	5	6	7	8				9
2.6	Fuel oil pumps, Injectors,	Calibration test	Measurement	100%	Drawing, Data sheets	Inspection report				V	
	Orifices, Nozzles, Instruments, etc.										
2.7	Fuel oil pumps, Lube oil pumps and	Performance parameters	Performance	100%	Drawing, Data sheets	Inspection report				V	
	Purification unit safety control device		check								
3.0	FINAL :										
3.1	Visual and dimensional inspection	Overall dimensions	Measurment	100 %	Drawing	Inspection report				W	
3.2	Performance testing of engine at shop	Performance parameters	Performance check at	100 %	ISO 3046, Data Sheets,	Performance test				H	
			full load & overload,		Drawing	report					
			Overspeed test,								
			Speed governor test								
3.3	Completeness	Paint thk., Identification, etc.	Visual, Measurement	100 %	Drawing	Inspection report				V	

TCE CONSULTING ENGINEERS LIMITED

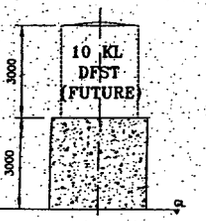


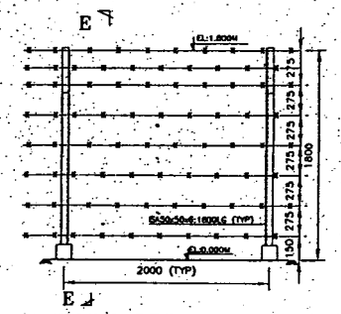
TANK FARM WITH 10KL HSD TANK

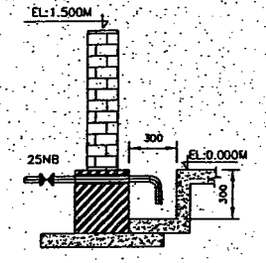


TANK FARM WITH 2X10KL HSD TANK

DETAILS		10 KL HSD DAY TANK
TANK SHELL O/D		2512
TANK HEIGHT		3000
ANCHOR POCKET P.C.D.		2612
NO. OF POCKET		4
FOUNDATION O/D		3100
FOUNDATION HEIGHT		3000
SUMP RADIUS (R)		750
SUMP OD.		620
SUMP DEP.		210
LOAD (WT.)	EMPTY APPROX.	3,300 kg.
	FULL WITH WATER	19,100 kg.
	OPERATIONAL	- kg





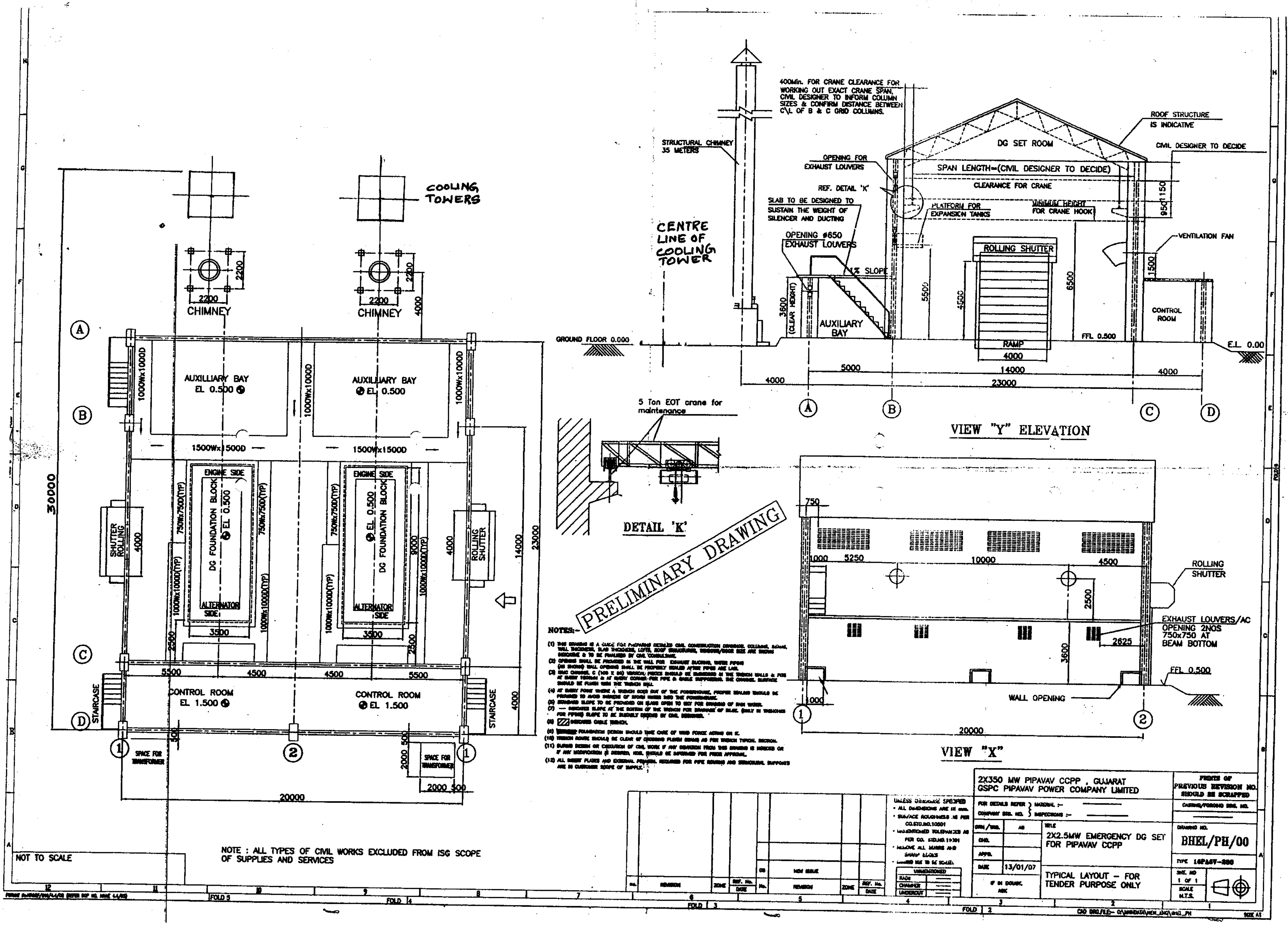


FENCING DETAILS. SECTION:"E"-"E" PIT DETAIL

NOTES:

1) ALL DIMENSIONS ARE IN MM & LEVELS ARE IN MTRS.
2) ANCHOR BOLT POCKET EQUI. SPACED AS PER QUANTITY INDICATED IN TABLE.
3) ALL CIVIL WORKS BY OTHERS. INCLUDING BITUMEN LAYERS ON TANK PAD.
4) GROUND LEVEL ELEVATION ASSUMED +0.00M
5) DEPTH OF THE FDN. IN THE GROUND TO BE DESIGNED BY ARCHITECT FOR LOADS GIVEN FOR INDIVIDUAL TANK IN TABLE ABOVE.
6) ** DECIDED BASED ON SOIL CONDITION. BY CIVIL DESIGNER.

PRELIMINARY DRAWING


COOLING TOWERS
CHIMNEY
AUXILIARY BAY EL 0.500
1500Wx1500D
DG FOUNDATION BLOCK
EL 0.500
ENGINE SIDE
ALTERNATOR SIDE
CONTROL ROOM EL 1.500
STAIRCASE
SHUTTER ROLLING
SPACE FOR TRANSFORMER
30000
20000
23000
14000
NOT TO SCALE
NOTE : ALL TYPES OF CIVIL WORKS EXCLUDED FROM ISG SCOPE OF SUPPLIES AND SERVICES
CENTRE LINE OF COOLING TOWER
STRUCTURAL CHIMNEY 35 METERS
400Min. FOR CRANE CLEARANCE FOR WORKING OUT EXACT CRANE SPAN, CIVIL DESIGNER TO INFORM COLUMN SIZES & CONFIRM DISTANCE BETWEEN C/L OF B & C GRID COLUMNS.
ROOF STRUCTURE IS INDICATIVE
CIVIL DESIGNER TO DECIDE
DG SET ROOM
SPAN LENGTH=(CIVIL DESIGNER TO DECIDE)
CLEARANCE FOR CRANE
OPENING FOR EXHAUST LOUVERS
REF. DETAIL 'K'
SLAB TO BE DESIGNED TO SUSTAIN THE WEIGHT OF SILENCER AND DUCTING
OPENING ø650 EXHAUST LOUVERS
PLATFORM FOR EXPANSION TANKS
MINIMUM HEIGHT FOR CRANE HOOK
ROLLING SHUTTER
VENTILATION FAN
CONTROL ROOM
AUXILIARY BAY
1% SLOPE
RAMP
GROUND FLOOR 0.000
FFL 0.500
EL 0.00
VIEW "Y" ELEVATION
5 Ton EOT crane for maintenance
DETAIL 'K'
PRELIMINARY DRAWING
NOTES:-
EXHAUST LOUVERS/AC OPENING 2NOS 750x750 AT BEAM BOTTOM
WALL OPENING
VIEW "X"
2X350 MW PIPAVAV CCPP , GUJARAT
GSPC PIPAVAV POWER COMPANY LIMITED
2X2.5MW EMERGENCY DG SET FOR PIPAVAV CCPP
TYPICAL LAYOUT – FOR TENDER PURPOSE ONLY
13/01/07
BHEL/PH/00
PRINTS OF PREVIOUS REVISION NO. SHOULD BE SCRAPPED

TECHNICAL SPECIFICATIONS

FOR

DG AMF CONTROL PANEL AND AUX DISTRIBUTION BOARD & LPBS

FOR

2.5MW , 6.6KV CONTINUOUS D.G. SETS

FOR

700 MW (2X 350MW) COMBINED CYCLE POWER PLANT
AT
PIPAVAV FOR GSPC PIPAVAV POWER COMPANY LIMITED.

CONTENTS

PREPARED BY	CHECKED BY	APPROVED BY
Sangeetha.M.A		
SANGEETHA.M.A	V.RAJENDRAIAH	M.KRISHNAMOORTHY

SECTION – I
GENERAL SITE CONDITIONS

Note : Please refer specification for DG Set

SECTION – II
APPLICABLE 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 published by the Bureau of Indian / British Standards

2. The Electrical Panels & accessories shall also be confirm to the latest Electricity Rules & other related Statutory agencies as regards safety, earthling and other essential provisions specified therein for installation and operation of Diesel Power Plant

3. **Applicable Standards: -**

IS-5, 1994	:	Color for ready mixed paints & enamels
IS-694, 1990	:	PVC Insulated cables for working voltage up to and including 1100 Volts.
IS-1248, Part - 1 to 9, 1991	:	Direct acting indicating analogue electrical measuring instrument & their accessories.
IS-2026, Part-1, 1991	:	Power Transformers (General)
IS-2551, 1990	:	Danger Notice Plates.
IS-2705, Part-1, 2,3,4, 1992	:	Current Transformers
IS-3156, Part-1, 2,3,4, 1992	:	Voltage Transformers
IS-3231, Part-0, 1,2,3, 1992	:	Electrical Relays for Power System Protection.
IS-5082, 1991	:	Wrought Aluminum & Aluminum alloy bars, Rods, Tools & Sections for Electrical purpose.
IS-5578, 1991	:	Guide for marking of Insulated Conductors.
IS-7372, 1995	:	Lead Acid storage batteries for Motor vehicles.
IS-8623, Part-1, 1993	:	Low voltage Switchgear & Control Gear assemblies.
IS-8923, 1990	:	Warning Symbol for dangerous voltages.
IS-9224, Part-2, 1991	:	Low Voltage Fuses : Supplementary requirement for fuses for Industrial applications.
IS-12065, 1987	:	Classification of degree of protection provided by enclosures of electrical equipments.
IS-13947, 1993 Part-1, 3,4	:	Specification for Low voltage Switchgear & Control Gears.

APPROVED MAKES OF PANELS: POWER CONTROL EQUIPMENT/ C&S/ LOTUS POWER GEAR/ KOEL/ JAKSON ENGRS LTD/BHEL ISG APPROVED VENDORS

SECTION – III
SCOPE OF SUPPLY

Sl.No.	Item	Quantity
1	DG AMF CONTROL PANEL for 2.5MW,6.6kV DG Set	2 SETS
2	DG AUXILIARY DISTRIBUTION BOARD	2 SETS
3	LOCAL PB STATION	20 NOS
4	COMMISSIONING SPARES	1 SET
5	SYNCHRONISING PANEL	1 SET

The DG AMF Panel shall be used for Auto Changeover of power from DG to emergency load by giving start commands to DG Set during Main power failure and initiating the stop commands to DG Set during restoration of main power. Panel shall have accessibility from both front & back. DG sets shall have the provision of synchronization with the main power supply (running parallel with the grid). Both DG set shall have the provision of synchronization with each other and also with grid. The provision of back synchronization shall be provided to the DG Sets, when the incoming normal power is restored.

CONTROL PHILOSOPHY:

See DG Set Specification attached.

1. COMPONENTS DETAILS FOR EACH DG AMF CONTROL PANEL

Sl. No.	Device Number	Component Description	Make	Type	Rating	Qty
A.	**POWER PANEL- required bus bar arrangement to be made in the panel.** Provision shall be given at the out going side of the AMF Panel to connect two sets of cables, one from Unit Switch Board-1 & one from Unit Switch Board-2. **OPTIONAL ADDITION PRICE FOR 6.6KV VCB OF SUITABLE RATING SHALL BE GIVEN.**					
1	CT	Current transformer for metering and protection	See encl. list	Protection co re CL5P20 Metering core CL 1	Core-1 500/1/1A, CL 5P20 Core-2 500/1/1A, CL0.2	3
2	PT	Potential transformer	See encl. list	Protection & Metering	6.6KV / √3 V 110 / √3 V 100VA, CL 0.2/ 3P	3
B.	**RELAYS**					
1	K	Generator Protection Relay Numerical	Areva/eq uivalent Approved make	MICOM P343/equival ent approved make		1
C.	**TRANSDUCERS**					
1	CTD	Current Transducer	See encl. list	Aux. Supply: 24 V DC	Dual Output: 4 – 20Ma Input: CT, Cl.1	3
2	PFTD	Power Factor Transducer	See encl. list	(For 3 Ph, 3 Wire System) Self-Powered.	Range: 0.8 Lag – 1-0.8 Lead Dual output: 4 – 20 Ma, Cl.1	1
3	KWTD	Watt Transducer	See encl. list	3 Ph,3Wire un-balanced load. Aux. Sup	Dual Output: 4 – 20Ma Input: 0 – 2500KW, Cl.1	1

Sl. No.	Device Number	Component Description	Make	Type	Rating	Qty
				ply: 24 V DC		
4.	VTD	Voltage Transducer	See encl. list	Aux. Supply: 24 V DC	Dual Output: 4 – 20Ma Input: 0 – 6600 V AC, Cl.1	3
5.	FTD	Frequency Transducer	See encl. list	Self Powered	Range: 45 – 50 – 55 Hz Dual Output: 4 – 20Ma Input: 0 – 55 Hz, Cl.1	1
D.	**TEMPERATURE CONTROLLERS**					
1	TC1	Temperature Controllers	ABB/YBL / L&T	PT 100 (RTO)	0 – 200^0 C 12- CHANNELS minimum	1
2	PLC	PLC	See encl. list	64 Inputs/ 32 Outputs minimum		1
E.	**MEASUREMENT INSTRUMENT DETAILS**					
1.	A	Ammeter-Digital	See encl. List	96 x 96 mm	Range: 0 – 500 A CTR 500/1A, CL 1	1
2.	V	Voltmeter-Digital	See encl. List	96 x 96 mm	Range: 0 – 6.6k V CL 1	1
3.	Kw	Wattmeter-Digital	See encl. List	96 x 96 mm	Range: 0 – 2500KW 500/1A, CL 1 PTR: 6600 V/√3 / 110 V/√3	1
4.	kWh	Watt Hour Meter- Digital	See encl. List	96 x 96 mm	6 DIGIT,500/1A ,**CL 0.2** PTR: 6600 V/√3 / 110 V/√3	
5.	PF	Power Factor Meter- Digital	See encl. List	96 x 96 mm	Range: 0.8 Lag – 1 – 0.8 Lead 500/1A ,CL 1 PTR: 6600 V/√3 / 110 V/√3	1
6.	Hz	Frequency Meter- Digital	See encl. List	96 mm^2 Reed Type	Range: 45 – 50 – 55 Hz Input: 110 V AC CL.1	1
F	**AUXILIARY CONTACTORS**					
1	K	Auxiliary / Power Contactors	See encl. List		24V DC / 230V AC with 4NO+4NC	30/ as reqd
G	**SELECTOR SWITCHES**					
1	S/S	Selector switches	See encl. List		16A DC,1/2 pole. 4 position ,lockable, Changeover etc as per the requirement.	6/ as reqd
H	**PUSH BUTTONS**					
1	S	PUSH BUTTONS	L&T/TEK NIC/SIE MENS	RED /GREEN / BLACK	2NO+2NC	10/ as reqd
I	**INDICATING LAMPS (LED TYPE)**					
1	H	IND LAMPS	L&T/TEK	LED TYPE	24 V DC / 220V DC	16/

Sl. No.	Device Number	Component Description	Make	Type	Rating	Qty
			NIC/SIEMENS		/230V AC	as reqd
J	**HOOTERS**					
1	H	Hooters	See encl. List	Industrial type	24V DC/220 VDC/ 230V AC.	3
K.	**CONTROL AND POWER FUSES, NEUTRAL LINKS WITH BASE**					
1	F	Fuses with base and N- links with base	See encl. List	HRC type	24VDC / 220V DC/230VAC	as req d
L	**MCB**					
1	Q	MCB with Base Plate	See encl. List		¾ pole,2 Pole,10A,6A, AC/DC AS REQUIRED	as req d
M	**OTHERS**					
1	AN	Annunciator	MiNiLEC	36ch static annunciator	220V DC	1 No.
2	T	Toggle Switch	KAYCEE	½POLE	10A	as req d
3	L	Limit Switch with Base	KAYCEE	2NO+2NC	24V DC /230V AC	as req d
4		Plug & Sockets, space heater	CROMPTON	2 Piin with Earth	10 A 230V AC	as req d
5	T	Any Matching Transformer if required	See encl. List		415V/110V 415V/24V 230V/24V	as req d
N.	**MOTORISED POTENTIOMETERS**					
1	**Motorized Potentiometer for Voltage Control**			250 Ohms, 10 turn, and Cycle time: 20–200 Secs. Adjustable, 24 V DC		1 No.
2	**Motorized Potentiometer for Speed Control**			100 Ohms, 10 turn, and Cycle time: 20–200 Secs. Adjustable, 24 V DC		1 No.
Provision shall be provided for starting / stopping , voltage raise / lower and speed raise / lower commands from remote along with the local operation (from your supplied panel)						

SYNCHRONISING PANEL

Sl. No.	Descreiption	Qty
1	Set of suitable PT's	1 set
2	Check Synchronising relay with guard relay	1 no.
3	Double Voltmeter	1 no.
4	Double Frequency Meter	1 no.

5	Voltage Raise/ Lower Selector Switch	1 no.
6	Speed Raise/ Lower Selector Switch	1 no.
7	Synchronisation ON/OFF Selector Switch	1 no.
8	Indicating lamps/ Dark lamps as required	1 set
9	Auxiliary relays etc as required	1 set

***** Rating and Quantity of above components are tentative. Actual rating and quantity shall be as per approved drawings and shall be in suppliers scope without any commercial implications. For makes of components also see attached GSPC list of approved vendors.**

COMMISSIONING SPARES

1. CONTROL FUSES – 10 NO.S
2. INDICATING LAMPS – 5 NO.S

2. D.G. AUX DISTRIBUTION BOARD- Each Distribution Board shall be as follows.

This shall supply auxiliary power to various auxiliary equipments for operation of Generator sets. The panel shall have 415 V AC, 3 Phase 3 Wire 50 HZ power as input and outgoing feeders for various auxiliary equipments. Auxiliary Power Supply requirement for this DG AUX MCC shall be generated in the MCC. 220V DC, if required can be made available. There shall be **two incomers** with 250Amps (minimum or as required) rated MCCB with one common bus. The MCCB's shall be electrically & mechanically interlocked such that only one is ON at a time. The panel shall mainly comprise of switch fuse units / DOL for various outgoing feeders.

No. of feeders are given in Section IV.

3. LOCAL PUSH BUTTON STATION

Local Push button starter consists of ON PB and Emergency stop PB with press to lock and key to release. LPB shall be suitable for floor mounting as well as wall mounting so that LPB can be erected at site suitably and LPB shall be front accessible

4. COLOUR CODING FOR PANELS:

The final paint shade shall be as per approved drawings/ approved QAP. Detailed painting procedures/ QAP shall be submitted for approval.

Notes.:

1. Final Ratings and Ranges shall be as per approved drawings
2. Spares are to be dispatched along with the main equipment
3. The list of components / feeders mentioned above is not exhaustive and the Supplier shall supply all the relevant items for the successful operation of the system.

SECTION – IV

DETAILED TECHNICAL SPECIFICATIONS

1. DG AMF CONTROL PANEL: Also see attached specification for 6.6kV Switchgear
2. **The DG AMF Control Panel shall have following provisions: -**
   - a) Starting and stopping of the DG set
   - b) Closing/Tripping of DG Breaker in Unit Switchboard-1 & 2
   - c) Facility to transfer speed and voltage control to unit control board
   - d) Local/ remote selector switch to facilitate remote starting and stopping.
   - e) Meters as per table above
   - f) Motorized potentiometer for remote voltage/speed control
   - g) Engine speed raise / lower for governor speed control
   - h) Auto in / Auto out selector switch
   - i) Suitable aux relays to facilitate control of DG Set from UCB

j) Any other controls and conditions for DG set not mentioned but recommended should be included.

3. **Following Provisions for remote control & indication shall be made on control panel**
   a) Starting and stopping of the DG set
   b) Speed control of DG Set
   c) Voltage control of DG Set
   d) Indication of DG Set under operation and Engine emergency stop
   e) Indication of fault on DG Set
   f) Current(3Ph), Voltage(3Ph), pf, frequency, kW

4. **Following pilot indicating lamps/ annunciations/ alarms shall be provided**
   a) Charger on / off
   b) Set shut down due to Engine over heating
   c) Set failed to start in 30 seconds followed by Shut down after three unsuccessful start
   d) A C Supply to charger ON
   e) D.C Supply healthy and 24 DC Supply Failure
   f) Incomer to switch gear from DG Closed/Off/Tripped.
   g) Low lube Oil pressure
   h) Low Fuel oil Level in service tank
   i) Jacket water temp High
   j) Engine Over Speed trip
   k) Electrical protection trip
   l) Winding temperature high –Alarm
   m) Bearing temperature high –Alarm
   n) Over current – breaker trip and alarm
   o) Any other controls and conditions for DG set not mentioned but recommended shall be included

5. **General Notes:**
   a) All transducers shall be of dual output and are wired up to the terminal blocks for connecting to the central control room equipment ECP & DDCMIS.
   b) 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.

III. **AUX. DISTRIBUTION BOARDS:** DESCRIPTION: Auxiliary Distribution Boards**(Non-Draw out design),** shall supply aux. power to various auxiliary equipment for operation of DG SET. The panel will have 415V A.C, 3Ph, 4 wire, 50 HZ supply as power input and outgoing feeders of 415/230V for various auxiliaries of DG Set. Incoming power to Aux DB will be from Emergency MCC. The Aux DB shall have two no.s MCCB incomers (Main & standby) of rating 250A, 50 KA, 415V, with castle key and electrical interlock, such that only one Incomer shall be in circuit at a time. Each incoming feeder shall be provided with Voltmeter with protective HRC fuses and a 3-position selector switch to indicate the three phase voltages on the bus side. Ammeter with 4-position selector switch and associated CTs shall be provided for each incoming feeder. Test push buttons for checking the control circuit shall be provided and shall be located inside the cubicle. Busbar sizing and its arrangement for Aux DB should be done considering the fault level of 50 KA.The Control circuits shall operate at suitable AC voltage of 110 V AC.

Necessary control supply transformers backed by primary & secondary fuses shall be provided. Change over arrangement to switch on to the other transformer with selector switch/ contactor in case one transformer fails. The auxiliary bus bar for control supply shall be segregated from the main (power) bus bar. The control supplies shall be monitored. Danger board shall be provided .

1. Incoming and outgoing feeder components & rating and quantity shall be as per approved drawing. Details of O/G Feeder of each Aux.DB for DG SET Auxiliary is as follows

a)	Incomers –250A	- 2 Nos.
b)	Lub oil priming pumps 415V, 3Ph, 3 KW (1+1)	- 2 Nos.
c)	Fuel priming pump 415V, 3Ph, 3 KW (1+1)	- 2 no.s
d)	Generator space heater (1+1) feeder rating 230V, 1Ph,10A	- 2 Nos.
e)	Battery charger (control supply) (1+1) feeder rating 230V,10A	- 2 Nos.
f)	Control supply 415/110v with 1.5 KVA transformer	- 2 Nos.
g)	Control supply (for heater etc)415/240v with 10 KVA transformer	- 2 Nos.
h)	240V AC Feeder of rating 10A	- 4 No.s
i)	Ventilation Feeders 415v, 3ph, 10A, DOL Feeder	- 4 Nos.
j)	Air compressors feeders 9kw(DOL) (1+1)	-2Nos
k)	Fuel transfer pump, 3 kw (DOL)2+1	-3nos
l)	JACKET WATER PRE HEATER- (1+1) 230v, 1Ph, 10A	-2nos
m)	Cooling water pumps-7.5kW(DOL) (1+1)	- 2 no.s

The above list and ratings are tentative. Supplier to consider all required feeders for all the auxiliaries of DG Sets.

3. Indication lamp ON, OFF, TRIP shall be provided for each outgoing feeder in Aux DB. All indicating lamps shall be LED type.
4. The control of individual motors shall be by means of combination of starter comprising of fuse switch unit, magnetic contactor, thermal overload relay with built-in single phasing preventor, current transformer, ammeter and auxiliary contactors etc. All Contactors, switches, fuses, bimetal relays and MCB's shall be suitable for delivering rated current at an ambient temperature of 50^0 C and with the mounting inside panel (IP 54) without any derating (switches AC 23 and Contactor AC3 duty). The Contactors wherever specified, having rated operational current above 250 A shall be provided with DC operating coils .
5. **Note:**
   a) Single phasing protection shall be provided in addition to thermal overload protection for all motors, including lower rating feeders.
   b) All meters, lamps & push buttons shall be flush mounted on panel front with connections from the inside. They shall have transparent, dust fight cover, removable from the front.
   c) Push buttons for testing control circuit shall be provided
   d) One No. Aux. Contactor shall be provided for each motor feeder with 2NO+2NC.
6. **PANEL CONSTRUCTIONAL DESCRIPTION:** The Indoor self standing panel shall have a rigid welded structural frame enclosed completely by CRCA sheets of minimum 2 mm thickness for no-load bearing members, 3mm thickness for load bearing members. And bottom channel 3mm. All doors panels' removable covers shall be gasketed properly with neoprene rubber gasket. The panel shall have removable front door with concealed hinges. Suitable shrouding arrangement shall be provided inside the panel for safety of maintenance personnel. The panels shall be with a base channel of at least 50 mm x 25 mm size fabricated out of 3mm thick hot rolled sheet steel painted black. Door swing shall be limited to 90^0 . Lifting hooks shall be provided; these shall be fixed to structural

members in the panels. Stiffeners shall be provided wherever necessary. Removable gland plate shall be provided for all the panels.

a) **Enclosure**: IP 54

b) **Operating height**: Maximum operating height shall be less than 1900 mm and minimum operating height more than 400 mm

c) **BUS BAR**: The main and neutral bus bars shall be of Aluminum alloy of E91 WP grade conforming to IS: 5082.The bus bars shall be fully insulated and sleeved for the full operating voltage and current. The cross section of the bus bars shall be so selected that with the passage of rated current at rated frequency, temperature rise of the bus bars shall not exceed 50^0, over ambient for silver plated joints and 35^0 in other cases. The short circuit with stand capacity of all bus bar shall be 50kA for 1 Sec. The bus bar shall be properly supported with high quality non-hygroscopic insulating material having good electrical and mechanical properties suitable for applicable voltage grade and mechanical strength to withstand without damages, effect of maximum available short circuit current. Moulded bus bar supports of fiber reinforcement plastic material shall be used. The support shall have sufficient creepage distance and anti-tracking properties. The Control bus bars shall be copper and mounted in the main horizontal bus bar chamber. The rating of the neutral bus bar in case of Aux DB shall be 50% of that of phase bus bar. The vertical bus bar shall also be totally enclosed from all the sides and bakelite barriers shall be provided behind the module. The control bus bar shall be fully segregated from power bus bar with separate removable cover. Control bus bar in case of Aux DB shall be of electrolytic grade copper. The bus bars shall be so arranged that they are easily accessible from the front of the cubicle. Arrangement and making of the bus bar and connection shall be as per IS: 375. Colour of bus bar shall be Red (R), Yellow (Y), Blue (B), Black (N), Green (earth).

d) **Earthing**: - Earthing bus 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 Customer's external existing 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.

e) **Panel wiring and termination**: Panel shall be supplied completely wired internally to equipment and terminal blocks and must be ready for purchaser's external cable connection, at the terminal blocks. All Control wiring shall be carried out with 1.5 mm^2, 1100 grade, single core stranded copper conductors with PVC insulation. 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. Elmex make terminals type CST6 shall be provided. These shall be suitably located for ease in external wiring. Flexible cable of adequate length shall be provided for the control devices to be mounted on the door /swiveling instrument plate. 20% spare terminals shall be provided.

7. **GENERAL:**

a) Each motor feeder shall be provided with 1 no. aux. Contactor with 2NO+2NC contacts.

b) All spare contacts of the main contactor and aux. Contactor are to be wired up to the terminals.

c) All bimetal overload relays shall be required with built-in single phase preventer including bimetal overload relay, which are used, for starting against heavy loads.

d) Each motor feeder should provide with two-position selector switch Auto – Manual stay put type. The location of the selector switch should be in the module itself.

e) Cadmium/Zinc coated aestivated hardware consisting of bolts, nuts, lugs, flat and spring washer etc., shall be supplied along with the panels for connection of external cables as well as incoming cables.

f) MCC 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 in cable alley such that wiring, buses and control devices do not get over heated.

8. **COLOUR CODING FOR PANELS & LOCAL BOXES**: The final paint shade shall be as per CUSTOMER approved drawings/QAP. Detailed painting procedures/QAP shall be submitted for customer approval.

SECTION – V
INSPECTION & TESTING

The DG AMF Control Panels and Aux. Distribution boards and Local Control Boxes are to be tested at manufacturer's work in presence of **BHEL/ Customer** representative. The extent of inspection and testing shall be as per relevant standards & approved QAP. QAP to be submitted by supplier for BHEL / **Customer** approval, and should cover all the test mentioned in testing schedule as per applicable standards. Reports of all relevant type tests to be submitted for customer approval. If any type test is not carried out, supplier to do so at his own cost. One Set of Manufacturer's Test certificates for major bought out equipments shall be made available during inspection by supplier.

SECTION – VI
DOCUMENTATION FOR APPROVAL AND FINAL SUBMISSION

SL. NO.	DESCRIPTIONS	DRG./ DOC SIZE	For approval within 1 week of LOI	Final submission after inspection & before dispatch
1.	Sizing calculation for Bus bar	A4	6 sets.	8 sets + CD
2.	SLD, GA /OGA with front view Component layout, Bus bar disposition & BOM, schematic diagrams and termination plan	A3/A2	6 sets.	8 sets + CD
3	Cable schedule for total system	A3/A2	6 sets.	8 sets + CD
4	Data sheet for Panel.	A4	6 sets.	8 sets + CD
5	Foundation fixing plan & loading details of panels	A3/A4	6 sets.	8 sets + CD
6	Type test reports for panels	A4	6 sets.	8 sets + CD
8	QAP OF panels	A4	6 sets.	8 sets + CD
9	Storage, erection, commissioning, O&M manual and catalogues of components	A4		8 sets + CD
10	Internal test certificate along with inspection call	A4		8 sets + CD
11	As commissioned drgs after commissioning for	A4/A3		8 sets + CD

	above control panel set			

1. **OGA/GA DRAWING SHALL CONTAIN FOLLOWING DATA FOR CIVIL ASSIGNMENT AND LAYOUT-**Control panel dimensional drawing shall have details of Elevation., Section/ Foundation / Mounting. Door open view. And also covers the following information.

a) Static loading of panel.

b) Location & configuration of incoming and outgoing terminal.

c) Location of Heaters.

d) Rating plate.

e) Earthing bus bar & its terminals.

f) Lifting Hooks with height and earthing bolt.

g) Protection class for panel.

h) Heat loss data i.e. heat dissipation from control panel surface.

i) Standards., Name plate details of equipment ,Device designation

j) Name of supplier and customer representatives

k) Make/ type/ rating of each items considered along with embossing details

9.0 **6.6 kV SWITCHGEAR**

The 6.6 kV switchgear and its accessories shall conform to all latest editions of national and international standards indicated in Data Sheet – A 3.9. Also, the Switchgear and its accessories shall comply with the requirements indicated in Data Sheet – A 3.9 and specific requirements indicated below.

9.1 For feeding the plant auxiliaries rated for 6.6 kV and service transformers, adequately rated switchgears shall be provided.

9.2 **Manual & Automatic Transfer of Loads**

9.2.1 The station switchgear shall be provided with manual live changeover scheme for planned changeover of supply from one incomer to another and vice versa.

9.2.2 Automatic fast changeover scheme for changeover of supply from one source to another in the event of supply failure from upstream end shall be provided. Changeover shall be blocked if incomer has tripped due to bus fault.

9.2.3 The closure of the unit supply breaker shall be supervised by a synchro-check relay permanently connected to and energised by the secondary voltages of the unit bus P.Ts. The high-speed transfer shall be completed in not more than 40 ms. If fast auto change over fails for whatever reason, an automatic "slow" transfer shall be initiated. The fast changeover scheme shall be such that the running motors are not tripped or there is only allowable inrush current due to motor re-acceleration.

The FBTS should have following transfer modes:

i) Fast Transfer

The bus voltage and incoming source voltage should be monitored on a continuous basis for magnitude and phase angle to ensure that transfer operation is carried out under conditions conducive to fast bus transfer as per high speed sync-check supervision and ANSI C50.41 (1982) criterion.

ii) In Phase Transfer

The breaker power contacts shall close when the decaying and drifting bus voltage synchronizes with the incoming source voltage

within acceptable voltage and frequency parameters. The Bus transfer system shall continuously process the bus voltage and the drifting phase angle dynamics to determine in real-time the exact moment of sending a command to the breaker-closing coil to achieve the above.

iii) Slow Transfer

The breaker power contacts shall close when the falling bus voltage shall reach an acceptable safe value. The auxiliary drives are selectively tripped simultaneously to limit the transformer inrush current.

iv) Momentary Paralleling Transfer

This is a "Make before Break" transfer for a very short duration of the order of few cycles where, under supervision of the bus voltage and incoming source voltage for magnitude and phase angle, the new source breaker is closed before opening the old source breaker. Normally not recommended for unplanned transfers and auto / protective transfers from the system safety considerations.

9.3 **Spare Feeders**

One motor and one transformer type spare feeder at each sections of Bus-A and Bus-B of 6.6 kV switchgears shall be provided (Highest size of motor and transformer).

9.4 **Short Circuit Current Ratings**

9.4.1 The level for the switchgear, circuit breakers, isolators, earth switch, bus bars, etc., shall be arrived at, on the basis of

(a) Short circuit current contribution from UAT plus short circuit contribution by the motors running on the bus.

9.4.2 A margin of 5% over higher of the above S.C current, thus calculated shall be applied and rounded off to the next higher standard ratings and this value shall be adopted for the breakers and switchgears. The momentary current ratings shall be 2.55 times this value.

9.4.3 Asymmetrical S.C current breaking capacity of the breaker shall consider the higher time constant for decay of current in the vicinity of power generating stations and the breaker offered shall be suitable for this duty.

9.4.4 Calculations for arriving at the time constant at this plant shall be furnished to justify breaker selection in accordance with IEC-62271-100 and contractor shall furnish calculation during detailed engineering stage to establish the adequacy of support insulators and busbar sizes for the declared continuous and short time current rating.

9.5 **Continuous Current Ratings**

9.5.1 The continuous current rating of the 6.6 kV unit switchgear buses, incomer breaker shall be the rated LV winding current of UAT's respectively with 20% margin rounded off to the next higher standard rating.

9.5.2 The continuous current rating of the feeders shall be based on the name plate current rating of the connected equipment with 20% margin rounded off as indicated in 9.5.1.

9.6 **Constructional Measurements**

9.6.1 The switchboard shall be indoor, free standing, floor mounted, metal clad having separate metal enclosed compartments for (a) control, metering and relaying devices, (b) circuit breakers, (c) phase bus bars, (d) instrument transformers and (e) power cable terminations and adjacent cubicles (panels) shall have sheets on either side to ensure complete isolation. The bottom of each panel shall be covered by sheet steel and necessary glands plates. Switchgear shall be suitable for extension on both sides. Height of switchgear panel shall not exceed 2100mm. The switchgear assembly shall be rodent and vermin proof.

9.6.2 Conductor shall be of high conductivity aluminium alloy for the horizontal busbars, vertical droppers and connectors to the fixed end of isolating contacts.

9.6.3 All circuit breaker compartments shall be provided with separate door so that circuit breaker front cover shall not be used as front door. All live parts shall be provided with isolating barriers between phases to avoid exposure to live parts.

9.6.4 Door enclosing the cable termination shall be with hinge. A fixed type, checkered net shall be provided between cable termination and door to avoid accidental contact to live termination. This arrangement is required to take Thermographic measurement using Infrared thermometer.

6.5 Required number of high speed trip relays, supervision relays, auxiliary relays, timers, contact multiplication relays, etc., shall be provided in the

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panels to meet the system requirements and to meet the system operation philosophy indicated in the specification elsewhere.

9.6.6 The circuit breaker shall be drawout type and it shall have test, service and isolated positions. In test position the circuit breaker shall be capable of being tested for operation without energising power circuits. At least 5 NO+5 NC spare contacts shall be wired to the terminal block after fully utilising for protection, interlocking, annunciation, etc.,

9.6.7 The current transformers shall be mounted in the fixed portion of the switchgear. Adequate space shall be available for termination using heat shrinkable type cable termination in cable compartment and for mounting of zero sequence current transformers (core balance current transformers).

9.6.8 Withdrawal of circuit breaker shall not be possible unless it is in open position and operation of circuit breaker shall not be possible unless it is fully in service position, or is fully in test position and drawn out position.

9.6.8.1 The withdrawn breaker shall only be inserted into the compartment only if the breaker is open.

9.6.9 Automatic safety shutters shall cover live parts when the breaker is withdrawn and all other standard safety features shall be provided.

9.6.10 All non-current carrying metal work of the switchgear shall be effectively bonded to the earth bus. Hinged doors shall be earthed through flexible earthing braid for each type of breaker.

9.6.11 The circuit and bus bar earthing facility with earthing trucks shall be provided for each type of breaker. Suitable mechanical interlocks shall be provided to prevent the closing of earth switch on live circuit.

9.6.12 Switchgear shall be supplied completely wired and inter panel wiring between cubicles of same switchgear shall be provided.

9.6.13 The sizes of wire in the panel shall be stranded copper conductor, 1.5 mm^2 for all circuit and 2.5 mm^2 for CT circuits.

9.6.14 Terminal blocks shall be of stud type, 650 volts grade, 10 amps rated complete with insulated barriers. Terminal blocks for CTs and VTs shall be provided with test links and isolating faciliting and CT terminals with short circuiting and earthing facility. All spare contacts and terminals of cubicle mounted equipment and devices shall be wired to terminal

blocks with 20% spare terminals. Not more than 2 wires shall be connected at a one terminal.

9.6.15 All protective relays shall be in draw out cases and all auxiliary, and timers shall be in non draw out cases with built in test facilities. Necessary test plugs shall be supplied loose and is included in the scope of supply. Externally operated hand reset indicators shall be provided on relays and timers as decided during the detailed engineering. Timers shall be of electromagnetic or electronic type only. Atleast 1NO + 1NC spare contacts of all relays / timers shall be wired to terminal block. All other relays shall be of self reset type unless otherwise specified.

9.6.16 Breaker control switches shall be pistol grip black and selector switches shall be oval or knob, black. Breaker control switches shall be 3 position spring return to neutral, instrument selector switches shall be of maintained stay put type.

9.6.17 Push buttons provided shall be shrouded.

9.6.18 Space heaters of adequate capacity shall be provided.

9.6.19 Each switchgear panel shall be provided with 230 Volts, 1 phase, 50 Hz, 5 amps, 3 pin receptacle with switch located in a convenient position.

9.6.20 Provision shall be made for receiving, distribution, isolating and fusing of auxiliary DC and AC supplies for controls, space heating, etc. Two numbers DC feeders shall be provided for 6.6kV switchgear with selector switch for selecting any one supply. DC supply supervision lamps (self coloured clustered LED type of size 22.5 mm) shall be provided and the same shall be on AC supply. Single phase loads for motor space heating etc., shall be distributed between different phases to keep the loading on all the phases uniform.

9.6.21 The ratings of instrument transformers shall be decided by Bidder based on connected load, lead burdens, changes during engineering stage and adequate margin at the time of handing over the plant:

(a) The CTs shall withstand momentary and short time current ratings of the associated switchgear. CTs and VTs shall be of the cast resin type and completely encapsulated.

(b) In case of smaller rated CTs (say 200 Amp and less) at the expected fault level the CT saturation may result in the non operation of the instantaneous short circuit protection. In such cases

separate protection CT core with higher ratio shall be selected to avoid saturation at high fault currents.

9.6.22 VTs shall be single phase, drawout type and housed in a separate sheet metal enclosure. VTs shall be provided with HRC fuses on both primary and secondary sides under voltage relays, timers, etc. for motor tripping and remote annunciation on supply failure. Each switchgear section shall have a three phase VT. Single phase VT shall be provided for 6.6 kV incomers for synchronization. Those terminals required to be connected to earth shall be earthed by an isolating link without a fuse. Fuses on primary side shall have rupturing capacity equal to the switchgear rating. Primary fuse replacement shall be possible with VT in isolated position only.

9.6.23 Switchgear panel shall be suitable for bottom cable entry and provided with removable gland plates. Adequate space shall be available for the termination of the heat shrinkable (of Raychem make) cable termination & mounting of the CT & CBCT.

9.6.24 Cable lugs for all power, control and instrumentation cables connections shall be supplied. The lugs shall be tinned copper/aluminium depending on cable conductor and of solderless crimping type. The cable glands shall be of double compression type brass glands.

9.6.25 All breakers shall be of identical ratings such that it is interchangeable, and suitable mechanical/ electromechanical interlocks shall be provided to ensure that earth switch is not closed/truck is not inserted with the bus live or cable side energised.

9.6.26 Bidder shall supply and mount transducers as per Main One Line diagram and philosophy of control defined elsewhere in the specification, in the individual switchgear panels.

9.6.27 For analog parameter i.e. A, p.f, KW, running hours etc shall be taken directly from the numerical relay through its communication port.

9.6.28 Rubber mats suitable for 7.2kV grade shall be provided at front and rear of switchgear.

9.6.29 Contractor shall furnish calculation during detailed engineering stage to establish the adequacy of support insulator and busbar sizes for the declared continuous & short time current ratings.

9.6.30 Current ratings of all switchgears, circuit breakers, CTs etc. shall be sufficient for carrying the connected load currents without exceeding the

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permissible temperature limits or reduction in service life. Use of two breakers in parallel to meet the required rating shall not be acceptable.

9.6.31 No trolley arrangement shall be provided.

9.6.32 Cubicle Components

1. Each circuit breaker cubicle shall be provided with the following minimum standard accessories:

(a) One control switch `Trip - Neutral - Close' spring return to neutral position.

(b) One control selector switch `Local - Remote' stay put type.

(c) Indicating lamps -

(i) `Red' for breaker `ON' indication and trip coil supervision.
(ii) `Green' for breaker `OFF' indication.
(iii) Blue' for breaker in 'Service' position.
(iv) 'Red' for breaker ON indication at the back of the switchgear at cable box door.
(v) 'White' for breaker closing spring 'Charged'.
(vi) 'Amber' supervision lamp for lockout relays.

The indicating lamps shall be self coloured clustered LED type of size 22.5mm.They shall be bright and visible from any angle. All indicating lamps shall be on DC.

(d) Mechanical trip push button to trip the breaker when control supply is lost. The push button shall be shrouded type. Mechanical close push button provided shall be accessible only after opening of the front door.

(e) Castle key interlocks shall be provided to prevent opening of cable compartment door when breaker is closed and bus bar compartment when any of the incomers to bus are closed.

(f) Closing from local shall be possible only in test position whereas closing from remote shall be possible in either service or test position. Tripping from local shall be possible only when local/remote selector switch is in local position. Tripping from remote shall be possible only when either breaker in service position or selector switch being in remote position.

(g) One electrical antipumping relay.

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(h) One double pole control supply switch and set of fuses.

(i) One breaker operation counter.

(j) Cubicle lamp, space heater with thermostat and plug point.

(k) Closing coils shall operate satisfactorily in the control voltage range of 85-110% and tripping coil shall operate satisfactorily in the control voltage range of 70-110%.

9.7 Metering & Protection

Adequate protection / metering shall be provided for the switchgear panels. Location of relays in the switchgear shall be at convenient height, such that it can be surfed by standing at ground. All relays except for LBB, PT fuse failure shall be numerical with RS232/RS485 port. Separate meters shall be provided for each of the feeders mentioned below, if the same is not available in the numerical relay. Relay setting software for setting all the numerical relays in 6.6 kV switchgear and generator protection panels shall be loaded in a dedicated operator station in the main control room. All numerical relays shall be time synchronized with the GPS master clock. On failure of any of the numerical relay a contact shall be generated, which shall provide the annunciation to the DCS. All the protective relays, except for auxiliary relays shall have – remote/local reset facility, and shall be suitable for efficient and reliable operation of the protective schemes. A combination of electromechanical & numerical communicable type relays for main protections is not acceptable. The Bidder shall include in his bid a list of installations where the relays offered are in trouble free operation for last two years. The minimum protections / metering shall be provided required for various typical feeders shall include, but not be limited to the following:

9.7.1 Incomers

Protections	Metering
Composite numerical feeder protection relay	All the metering of the electrical parameters shall be through the Power monitors.
Under voltage relay	
Local breaker backup protection	
Fuse failure relay	

9.7.2 Tie breakers

Protections	Metering
Composite numerical feeder protection relay	All the metering of the electrical parameters shall be through numerical relay
Local breaker backup protection	

9.7.3 Bus PT Feeders

Protections	Metering
Under voltage protection	Voltmeter with selector switch
Fuse failure protection	Voltage transducers–3 Nos.

9.7.4 Motor feeders

Protections	Metering
Composite motor protection relay (99)	All the metering shall be through the composite motor protection relays only.
Differential protection for motor feeders (rated 1000kW or above)	
Local Breaker backup protection	
Time delayed under voltage trip	

9.7.5 Service Transformer Feeders

Protections	Metering
Composite numerical transformer protection relay	All the metering shall be through the composite motor protection relays only.
Local Breaker backup protection	
Winding temperature and Buchholtz protection	

The switchgears shall be designed to offer adequate level of safety t operating/ maintenance personnel. Means shall be provided to prever

access to the live part to avoid accidents during service as well as maintenance period. Bidder shall bring out the safety means provided to achieve above. A detailed instruction plate suitable for wall mounting shall be provided for each switchgear/MCC room describing various safe operating procedure/safety precautions for safe operation and maintenance of the switchgear.

9.9 **Tests**

All relevant routine and acceptance tests shall be conducted as per applicable standards and typical type test certificates of identical switchgear shall be submitted to Owner.

9.10 Minimum electrical system requirements in respect of control, monitoring, measurements, annunciation, and synchronization are indicated in section no: D3.8.

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SL. NO.	DESCRIPTION	UNITS	VALUES / REQUIREMENTS
	6.6 kV SWITCHGEAR		
1.0	**Switchboard cubicles and Bus bar ratings**		
1.1	Nominal system voltage, phases and frequency	V, ph, Hz	6600 / 3 / 50
1.2	System neutral earthing		Non-effectively earthed
1.3	Maximum system voltage	V	7200
1.4	One minute power frequency withstand voltage	kV(rms)	20
1.5	1.2 / 50 microsecond impulse withstand voltage	kV(peak)	60
1.6	Maximum temperature of bus bars, droppers, connectors and contacts at continuous current rating under site ref. ambient temperature	°C	90
1.7	Material of bus bars		Aluminium
1.8	Material of bus bar insulation		Heat shrinkable PVC sleeve. Removable bus bar joints with shrouds of 7.2kV insulation
1.9	Bus bar support insulator		7.2 kV
1.10	Bus bar joints / connection		Silver faced
1.11	Bus bar rating		By Bidder
1.12	Short circuit current rating and duration	RMS	40kA for 3 sec.
1.13	Momentary withstand current	Peak	100kA
2.0	**Switchboard Constructional Details**		
2.1	Thickness of sheet steel enclosures, doors and covers	mm	Cold rolled 2
2.2	Thickness of gland plate for 1 core cable	mm	3.0, Non-magnetic material
2.3	Degree of protection		VT/relay compartments – IP52 Other compartments – IP42 Air conditioned area – IP31
2.4	Colour finished shade (Enamel / epoxy)		RAL 7032
2.5	Material of earthing bus		Galvanised steel – 50 x 10 mm G.S. flat

SL. NO.	DESCRIPTION	UNITS	VALUES / REQUIREMENTS
2.6	Clearance in air of live parts	mm mm	Phase to Phase – 120 Phase to Earth – 120
2.7	Cable entry		Bottom
3.0	**Breaker details**		
3.1	Circuit breaker type		Vacuum
3.2	Voltage, frequency and No. of phases	kV, ph, Hz	12 / 3 / 50
3.3	Rated operating duty		O-3 min-CO-3 min-CO
3.4	Total opening time		3 cycles
3.5	Total closing time		5 cycles
3.6	Trip free operating mechanism type		Motor operated spring charged. Manual trip and close facility to be provided.
3.7	Anti pumping feature		To be provided.
3.8	Short circuit current rating and duration	rms	40kA for 3 sec.
3.9	Momentary withstand current	kA(peak)	100
3.10	Auxiliary control voltage :		
	(a) For closing / tripping coil / spring charging motor	V, DC	220
	(b) For space heaters and lighting and plug point	V, Phase	230 V, 1 phase
4.0	**Current transformer details**		
4.1	Type		Cast resin bar primary
4.2	System voltage and frequency	V, Hz	6600 / 50.
4.3	Class of insulation		Class 'E' or better.
4.4	Short circuit withstand current and duration		40 kA for 3 sec.
4.5	Core balance CT for all outgoing feeders		Ratio 50 / 1 (As per consumer rating)
4.6	Accuracy class		0.2S

SL. NO.	DESCRIPTION	UNITS	VALUES / REQUIREMENTS
	Voltage transformer details		
5.1	Type		Cast resin
5.2	Rated voltage - Primary V		6600 / $\sqrt{3}$
	- Secondary V		110 / $\sqrt{3}$ / 110 / $\sqrt{3}$, 110/3 for open delta
5.3	Method of connection - Primary		Star
	- Secondary		Star / Open
5.4	Rated voltage factor		1.2 continuous
			1.9 for 30 seconds
5.5	Class of insulation		Class 'E' or better
5.6	One minute power frequency withstand voltage	kV(rms)	20
5.7	1.2 / 50 micro second impulse withstand voltage	kV(peak)	60
5.8	Accuracy class		0.2/3P
6.0	**Meters**		
6.1	Accuracy class		0.2 for energy meters
			1.0 for others
6.2	Type of meters		Digital
7.0	Spring charging motor supply voltage	V, DC	220 +10% & -15%
8.0	**Codes and Standards**		
8.1	Circuit breakers		IEC : 62271-100
8.2	Metal enclosed switchgear		IS : 3427
8.3	Current transformers		IS : 2705
8.4	Potential transformers		IS : 3156
8.5	Arrangement for switchgear bus bars, main connection and auxiliary wiring		IS : 5578 IS : 11353
	Bus bar support insulators		IS : 2544

SL. NO.	DESCRIPTION	UNITS	VALUES / REQUIREMENTS
8.7	Degree of protection		IS : 2147
8.8	Electrical relays for power system protection		IS : 3231
8.9	Electrical indicating instruments		IS : 1248
8.10	High voltage fuses		IS : 5792
8.11	AC electricity meters		IS : 722
8.12	Aluminium bus bars		IS : 5082
8.13	Code of practice for phosphating iron and steel		IS : 6005
8.14	(Off-load) isolators		IS : 6005
8.15	HRC fuses		IS : 1818
8.16	SF_6 gas		IEC : 60376 .