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**PURCHASE SPECIFICATION
FOR
SILENT DIESEL GENERATING (DG) SETS
(2 x 500 KVA)**

PROJECT :- **VYASI H.E.P.
(2 X 60 MW)**

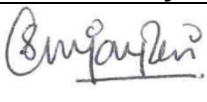
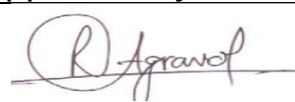
CUSTOMER :- **UJVN LTD.**

SPECIFICATION NO. :- **OR 12701**

REVISION NO.: Rev 01

DATE : 02.06.2020

DISTRIBUTION: PI - 4 copies
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**CONTROL EQUIPMENT ENGINEERING DIVISION
BHEL BHOPAL-462022**

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PART - I

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PART - I
GENERAL TERMS AND CONDITIONS

Part I covers the commercial and other various terms and conditions applicable for design, manufacture, testing, supply, installation and commissioning of DG Set and associated equipment as detailed below :

1.0 INTRODUCTION:

The DG set envisaged in this specification is for 2 x 500KVA Silent DG Set for 2 x 60 MW Vyasi Hydro Electric Power project located at Lakhwar (Uttarakhand)

The equipment should confirm to this BHEL specification No. OR12701 & OR12702 along with all attachments and annexures wherever called.

Any other hardware or item not detailed in this specification but necessary for proper functioning of DG Set at Oil Rig site should be in the supplier's scope.

Notwithstanding anything mentioned either in this specification or any future drawing approval or approval or MOM or inspection or correspondence by BHEL, ensuring safety, ergonomics, adequate safe working space for maintenance and operation, aesthetics and use of sound engineering practice, compliance with CPCB and other applicable norms, providing adequate clearances for components and assemblies and proper integration of various assemblies irrespective of whether the same is explicitly mentioned in specification or not shall be solely responsibility of supplier, and shall be taken care by supplier only, during all stages including design, drawing submission, manufacturing, Installation and commissioning. BHEL cannot be hold responsible if these aspects violated by virtue of any approval, MOM, correspondence or inspection by BHEL.

The technical details and specifications covered in "PART – II TECHNICAL DETAILS & SPECIFICATION OF THE EQUIPMENT"

Note : BHEL Tender General terms and Conditions BP200102 shall be applicable for this tender, however wherever any specific condition is mentioned in this document i.e. OR12701 & OR12702, same shall override the same/similar condition of BP200102.

2.0 DELIVERY SCHEDULE AND COMPLETION :

- 2.1 Delivery of Material :** Delivery period for material shall be within 12 weeks (F.O.R destination) from the date of approval of drawings / documents by BHEL/UJVNL after placement of Purchase Order. Delivery of consignment to be done on F.O.R destination basis at Vyasi HEP Village Lakhwar Dist Dehradun (Uttarakhand state). Freight and transit Insurance shall be in scope of supplier upto final destination. Invoice shall be to BHEL Bhopal and Consignee shall be Vyasi site (full address shall be furnished after placement of PO).

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2.2 **Erection & Commissioning at Vyasi HEP Site** : Supplier to depute their team for Erection & commissioning within 7 days from date of intimation by BHEL Bhopal.

3.0 **OFFER SUBMISSION :**

Offer to be submitted in Two bid system as per BHEL General Terms and Conditions of tender BP200102. PQR related documents to be submitted with Part-1 (Technical & unpriced commercial bid)

The bids shall be evaluated based upon **“Total Cost to BHEL”** for complete package (all items of tender including erection & commissioning) which will include taxes, duties, freight, insurance, loadings due to noncompliance of BHEL commercial terms etc., as applicable as per standard procedure of BHEL.

4.0 **PAYMENT TERMS :**

BHEL standard conditions for payment terms & payment schedule as per BP200102 shall be applicable. However following special conditions shall be applicable for release of payment in addition to mentioned in BP200102 :

4.1 **Material payment :**

80% of the material portion including taxes, duties, freight & insurance charges on receipt and acceptance of material at Vyasi HEP Site. Payment shall be released only after submission of Performance Bank Guarantee (PBG) by supplier.

Balance 20% payment for material portion shall be released after satisfactory final commissioning of equipment at Vyasi HEP Site after issuance of “Work Completion Certificate” by UJVNL/BHEL.

4.2 **Erection & Commissioning at Vyasi HEP Site payment :**

100% for Erection & Commissioning charges at Vyasi HEP Site against “Work Completion Certificate” issued by UJVNL/BHEL.

5.0 **ADDRESS FOR SENDING FINAL DOCUMENTS AFTER DISPATCH**

Technical documents & drawing after dispatch of items, covered in this specifications shall be forwarded to following addresses:

AGM (CEE) -HOD
Block III, Western Wing
Gr. Floor
BHEL Bhopal
Piplani, Bhopal (MP)
India 462022.

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6.0 ALL CORRESPONDENCE BEARING TENDER / PO NO. TO BE ADDRESSED TO :

Dy. Manager (MM) /MWX
 BLOCK IV ANNEXE
 BHEL, BHOPAL – 462021
 Tel. No.: 0091-755-2505088
 Email : **rakesh_kum@bhel.in**
 & copy to : **d.kumar@bhel.in**

7.0 ACCEPTANCE INSPECTION AT SUPPLIER WORKS :

Inspection shall be carried by BHEL & UJVNL representatives at Manufacturer works as per approved QAP and other approved documents for the project. **Refer details of Inspection in Part-2 of this specifications.**

All cost, Charges and expenses for the testing and inspection at supplier works shall be borne by supplier. All reasonable facilities for testing and inspections shall be provided by supplier free of charge. Travel and lodging expenses of BHEL / UJVNL inspector shall be borne by respective agencies. If the DG Set offered by supplier does not meet acceptance criteria, the same shall be rectified by supplier and fresh inspection call shall be given by supplier.

It is to be noted that inspection by BHEL / UJVNL shall not be in any way absolving supplier of its warranty/performance/contractual obligation.

8.0 PACKING :

DG Set shall be supplied mounted on enclosure as per specification. The enclosure shall be suitably packed to avoid transit damage and any water or dust ingress. The exhaust outlet shall be suitably sealed to avoid water/dust ingress during transit & storage. Separate boxes of loose items like battery, spares etc. shall be made for each DG Set. Each box shall have one packing list of items inside the box whereas one copy shall be pasted on the top of the box.

For safety of equipment exhaust system may be transported in dismantled condition, in box. The same shall be assembled at site by supplier.

Supplier shall take adequate precaution to ensure that proper preservation techniques are followed while packing to avoid any damage due to outdoor storing of DG Set after receipt at site, with specified climatic conditions.

Batteries for DG set shall be supplied in dry un-charge condition, to avoid deterioration before commissioning. Electrolyte and, charging at site at the time of commissioning, shall be in supplier's scope.

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9.0 LIQUIDATED DAMAGES PENALTY :

Refer BHEL general Terms and conditions BP200102 for penalty in case of delayed supply / execution and same shall be applicable.

10.0 DEFICIENCIES & DEFECTIVE GOODS:

BHEL / UJVNL shall inspect the equipment after receipt of the same at Site. Supplier may depute their representative, during joint Inspection. Should any deficiency or defect noticed in the goods during material receipt inspection same shall be replaced by the Supplier without any extra charge under no charge invoice. Any complaint in regard to the material will be notified to supplier who shall replace same promptly. The rejected/damaged material will have to be accepted back by the supplier who will bear it's to and fro freight also & the supplier will supply the items at site, free of cost and carry out repair/replacement at site without any charge.

11.0 WARRANTY (DEFECT LIABILITY PERIOD) :

- 11.1** Supplier will warranty the products to be free from defects in materials and workmanship and to comply with specification and intended use. The supplier will provide warranty for a period of 24 months from the date of Operational acceptance after Erection and Commissioning at Vyasi HEP site. The warranty applies to all supplier manufactured and supplied components.

Supplier shall furnish full contact details for giving warranty calls and shall ensure that their engineer/ representative reaches site fully prepared within 48 hours of warranty call. If required Supplier/ it's authorized representative, will be available for warranty calls at Supplier's account.

Free scheduled maintenance to be provided by OEM of Engine / their authorized service provider at Site as per Engine OEM recommended maintenance schedule & procedure during warranty period.

11.2 DESIGN PROBLEM:

After installation and commissioning, if the system is not operating as per specifications during warranty period, the same shall be attended by Supplier free of charge and warranty period shall be extended accordingly by 24 months however total aggregated warranty period shall be limited to 36 months.

If Supplier has a design situation that requires Supplier service representative to perform services, Supplier warranty services rendered shall be at no charge with all travel expenses related to warranty service calls at supplier's account. Recurring problem and repeated failure of component/s shall be considered as design problem.

If modification in the DG Set is envisaged, for proper functioning / integration of sub-assemblies of DG Set, supplier to carry out such modifications free of cost. All services for this purpose shall be rendered by supplier free of charge.

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11.3 COMMITMENT:

- a) The supplier will also undertake and confirm that for the equipment to be supplied, provision for supplying spares and services of the equipment 10 years after completion of warranty will be continued.
- b) The manufacturer shall give a commitment that the offered equipment is new and of recent manufactured/make.
- c) In case of equipment going out of production intimation shall be given 1 years in advance for a ONE TIME purchase of the spare parts.
- d) Irrespective of engagement of dealer/external service agency for field service of equipment covered in this contract the prime responsibility of providing warranty services lies with supplier.
- e) Supplier shall intimate full contact details of any subcontractor/s engaged by them during erection & commissioning at site.

12.0 PERFORMANCE BANK GUARANTEE (PBG) :

Supplier will furnish a Performance Bank Guarantee of 10% of the PO value with validity up to 3 month beyond warranty, along with invoice for 80% material payment. The Performance Bank Guarantee will cover all the items and terms in the P.O. and shall be issued from a bank acceptable to BHEL Bhopal. Supplier to obtain Bank Guarantee format along with list of acceptable Banks from BHEL Bhopal after PO placement.

13.0 INDEMNIFICATION:

During the performance of PO/ contract (entered into by BHEL & Supplier, consequent to this enquiry), the indemnity obligations of the supplier shall apply in events to any geographic location where the contract shall be executed/ performed by supplier, or following the Delivery Date, where Equipment is being used by or for the benefit of BHEL.

The contractor shall fully indemnify BHEL against all claims of whatsoever nature arising during the course of work under the contract.

The contractor shall comply with all applicable State and Central Laws, Statutory Rules, Regulations etc. such as Payment of Wages Act, Minimum Wages Act, Workmen Compensation Act, Employer's Liability Act, Industrial Disputes Act, Employers Provident Act, Employees State Insurance Scheme, Contract Labour (Regulation and Abolition) Act 1970, Payment of Bonus & Gratuity Act and other Acts, Rules and Regulations for labour as may be enacted by the Government during the tenure of the Contract and having force or jurisdiction at Site. The Contractor shall also give to the local Governing Body, Police and other relevant Authorities all such notices as may be required by the Law.

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The contractor shall ensure that no damage is caused to any person/property of other parties working at site. If any such damage is caused, it is responsibility of the contractor to make good the losses or compensate for the same.

14.0 END USER APPROVAL OF BIDDER / OFFERED MAKES BY BIDDER.

DG sets in this tender are intended for Emergency application where reliability to start in emergency situation is very important and DG sets are suppose to work on continuous basis during power shutdown condition. Considering criticality of operations, end user M/s UJVNL, has given their approved vendors/makes for DG sets and other items and same is provided in the tender document (Annexure-12). **For Bidders whose bids are found to be techno-commercially acceptable but not meeting approved vendor criteria, such Bidder's credentials & offered makes shall be forwarded to M/s UJVNL Dehradun for their acceptance. Price bids of such bidders will be considered for opening only after acceptance of M/s UJVNL.**

BHEL may ask bidders to submit additional documents to establish the credentials, if required by M/s UJVNL for unapproved vendors/makes.

Note : All other terms and conditions as mentioned in BHEL GTC document BP200102 shall be applicable.

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PART – II

TECHNICAL DETAILS & SPECIFICATION OF THE EQUIPMENT

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4. DESIGN CALCULATION
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TECHNICAL DETAILS & SPECIFICATION OF THE EQUIPMENT

1.0 SCOPE OF SUPPLY & WORKS :

This specification covers design, manufacturing, assembly, shop testing, quality assurance, quality control, packing, delivery to site, labour, tools, guiding and supervision of erection & commissioning at site, site testing and training of **two (2) Nos. 500 KVA DG Sets** as per the specifications hereunder, complete with all associated and essential auxiliaries & accessories, spare parts and warranting a trouble free safe operation of the installation at Vyasi HEP, Uttarakhand.

This Clause specifies the principal equipment and components to be supplied and work to be done by the supplier. However the supplier is bound to provide complete works, even if the equipment or works to be done are not mentioned specifically in this Section and required for the fulfilment/completeness of the system. The scope of work shall be comprehensive functional system complete in every respect including but not be limited to following :

Sl. No.	Description	Total Qty.
1.0	500 KVA, 415V Silent DG Sets (along with associated auxiliary equipment/systems, AMF Control Cum Synchronizing Panel/board, Daily diesel fuel tanks along with associated piping, instruments and control system etc.) as per technical specification consisting of following major equipment	02 sets
1.1	Diesel engines suitable to give an alternator output of 500 KVA (min. 400KW) at site complete with fuel system (piping, daily fuel tank etc.), lubrication system, cooling system, air intake and exhaust system including all exhaust piping, insulation and its support structure, battery and battery charger, instruments and protection system, annunciators, coupling arrangements, etc;	02 sets
1.2	Engine starting system(Automatic mains failure starting system panel)	02 sets
1.3	500 KVA, 50Hz alternator with exciter, automatic voltage regulator)	02 sets
1.4	Acoustic enclosures for DG Sets as per the requirement of this specifications and to meet the norms of the latest provisions of the Central Pollution Control Board norms.	02 sets
1.5	Panels for generator having air circuit breakers ,state of the art control and protection complete with relays, meters, switches etc.	02 sets
1.6	Fuel tanks & fuel systems including fuel transferring pump, piping, valves, fuel level indication /alarm/trip etc.	02 sets
1.7	Set of auxiliaries not specified above but all necessary for the satisfactory operation of the system.	02 sets
2.0	Main diesel fuel tank along with associated piping, instruments, fuel transfer and control system etc.) as per technical specification	01 set

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3.0	Mandatory Spares as per Annexure-5 of technical specification	01 set
4.0	Tools & Instruments as per Annexure-6 as per technical specification	01 set
5.0	Erection & Commissioning of DG Sets (2x500KVA) & its accessories at Vyasi Site as per scope of work covered in technical specification	01 set

Note :

- 1.0 Single Line Diagram No 12900057003 Rev02 to be referred for DG set interfacing with the power system.
- 2.0 There shall be coordination and provision of necessary contacts and ports for integration with plant SCADA system.
- 3.0 Power and control cables between the generating set and individual distribution and control cubicle shall be provided by supplier according to the site and interconnection requirements.
- 4.0 The 500 kVA diesel generator sets with all accessories shall be capable of performing all intended duties and it is the responsibility of the Contractor to supply the equipment as per relevant IEC/IS.

2.0 REFERENCE STANDARDS:

The equipment shall comply with the latest reference standards unless otherwise specified in following sections. A general list for the reference standards is given in **Annexure-10**.

3.0 DESIGN AND OPERATIONAL REQUIREMENTS OF DG SET

3.1 SPECIAL DESIGN AND LAYOUT CONDITION

2 Nos. 500 KVA, 415 VAC, 50Hz silent diesel generator sets shall be required to provide the necessary emergency supply to the 415V switchgear in case of failure of the supplies from SATs & SSTs. The diesel generator sets for power house together with all necessary auxiliaries shall be installed in the diesel generator room in Power house.

Both the DG Sets shall get the command for starting and stopping the DG Sets through the PLC system of the HT/LT system (i.e. Common Control Board) after interlocking the necessary interlocking the respective breakers. The DG Sets shall be capable of operation on auto/manual mode and shall be able to be operated on remote/local operation.

The details of layout and size of the room required for the diesel generator sets shall be provided by the supplier. The whole equipment shall be designed for long and trouble free operational life. During the life span, the equipment shall be operated under varied load conditions.

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3.2 TECHNICAL DATA (RATING)

a) ENGINE & ACCESSORIES

Type	Diesel, Four stroke, Sound proof
Power output, continuous rating	To match rated capacity of generator at rated power factor (0.8 lagging)
Overload rating	In accordance with BS-5514,DIN 6270 (Internal Combustion Engines, Definitions of Output) 110% for one hour
Speed	1500 rpm
Altitude of installation	EL 535 m (approx.) for 500 KVA, 0.415 KV DG Set
Ambient temperature	40°C
Cooling system	Radiator type
Lubrication system	Forced feed
Fuel supply system	Engine mounted shaft driven fuel supply pump
Starting	Electric starter, 24V DC supplied by own batteries of not less than 180 AH for DG set.
Governor	Electronic with A-One class governing.
Noise level	Max. 75dbA at one meter distance as per CPCB Norms with Acoustic Enclosure
Capacity of daily fuel tank.	990 litters for each 500 KVA DG sets
Capacity of bulk fuel tank	110 hours continuous running for both 500KVA DG sets together (Bidder to submit capacity of Bulk fuel tank with bid)

b) GENERATOR

Nominal voltage	415 V $\pm$ 5%
No. of phases	3- Ph 4 wire
Frequency	50 Hz $\pm$ 3%
Rotational speed	1500 rpm
Electrical system	TN according to IEC 60364-3
Rated output	Not less than 500 kVA at site conditions

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Power factor (lagging)	0.8
Duty	Continuous
Class of insulation	F or better
Temperature rise of windings	Temperature rise Limited to Class- B, According to IEC 60034-1 (resistance method)
Ambient temperature	-5 deg C to 40 deg C
Stator winding connection	Y-connection
Short circuit time rating	3 sec.
Voltage adjustment	±5.0 %
Wave form	Sinusoidal as per IS 4722
Excitation	Self excited, self ventilated, brushless
Enclosure	Screen protected, drip proof
Cooling	Self ventilated fan cooled.

The generator shall be capable of delivering continuously at full load, rated frequency and power factor and at any voltage between 105% and 95% of rated voltage without any part exceeding the maximum allowable temperature rise. It shall also be capable of operating continuously with 20% unbalanced load. The generator shall be capable of withstanding for not less than 15 seconds a current 50% excess of its rated current after having attained the thermal equilibrium corresponding to the rated load, the voltage being maintained as near the rated values as possible consistent with the maximum capacity of the prime mover i.e. engine. The engine shall be capable of delivering an output of 10% in excess of its rated output at its rated speed for a period of one hour in any period of 12 hours consecutive running, without undue heating of the engine or any other mechanical part.

c) GOVERNER

Each engine shall be provided with appropriate governor to maintain the speed within the value stipulated for class A-1 (precise standard) governing in BS: 5514 and suitable DIN standard. The governor shall have drooping characteristics to ensure proper load sharing. It should be possible to control the speed to facilitate the parallel operation and for this purpose speed raise/lower control switch shall be provided on the generator control panel. The governing system shall be complete with devices and shall be compatible with auto synchronizer for parallel operation. A suitable over speed trip mechanism shall be provided to automatically shut off the supply of fuel in case the engine speed reaches 110% of rated speed.

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d) EXCITATION SYSTEM

Each alternator shall be provided as Self excited, self ventilated, brushless type. The capacity of the exciter shall be adequate to meet the full load and overload ratings of the alternator particularly under short circuit conditions. The exciter shall have an automatic demagnetizing arrangement for the field circuit and insertion of field circuit in the event of an internal fault. Such an arrangement shall be capable of reducing the induced voltage to a safe limit.

e) AUTOMATIC VOLTAGE REGULATOR

Each alternator shall have necessary inherent regulation and for close regulation there shall be an automatic voltage regulation having regulation of 0.5% at all loads between no load to full load and power factor 0.8 lagging to unity. The AVR for each generator shall be panel mounted where a control knob will be provided for control of voltage for synchronization and voltage raise/lower feature should be compatible with auto synchronizer for parallel operation.

f) EXHAUST SYSTEM FOR DG SETS

Each DG set shall be provided with sturdy Exhaust piping of MS B class exhaust pipes conforming to IS:3589 (Make : Jindal/Surya/TATA/JSW/SAIL/ESSAR with welding joint including bends, clamps, fasteners, flanges, special hardware etc. Exhaust pipes to be provided with high quality glasswool / mineral wool, wire chicken mesh over insulation and 26 gauge or higher thickness aluminum sheet cladding over the exhaust pipes from Silencer to Atmosphere. Complete exhaust system shall be supported with MS support structure duly coated with two coats of primer and two coats of enamel or better paint system. Stainless steel Flexible bellows complete with counter flanges, heat resistant gaskets, hardware etc shall be provided for connecting engine exhaust to the exhaust piping / silencer piping. **Height of the exhaust system shall be such that it should meet the CPCB Norms for the rated DG sets. Calculations for Height of the exhaust system shall be submitted by bidder with technical offer.** Exhaust system shall have sufficient length from DG set to release the exhaust gases to outside atmosphere.

3.3 DESIGN AND CONSTRUCTION

The DG set shall be within the permissible limits of sound and smoke emission as per the latest norms of Central Pollution Control Board (CPCB) or MoEF as applicable for the rating and location.

Unless otherwise agreed upon, the general arrangement shall be as follows:

The combined diesel engine and generator with all required accessories shall be mounted on a structural steel base frame and plate. All base plate mounted components shall be completely piped and wired in the shop. Vibration isolation shall be provided for the base plate mounted units and all outgoing pipes and tubes. The diesel engine with the generator shall be engineered and

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designed to be free from all harmful critical speed within the normal operating range. The DG sets shall be connected to the earthing network for the generators by the Supplier. The DG sets shall be soundproof to the maximum extent possible.

The generator shall be brush-less alternator, directly flanged to the engine, with closed damper cage and a reactive current compensator.

The voltage regulator shall be electronic type having regulation of 0.5% at all loads between no load to full load and power factor 0.8 lagging to unity, with means for unattended parallel operation.

The diesel engine shall be four-stroke.

The governor shall be electronic with adjustable speed droop 0-10%, suitable for unattended parallel operation.

Suitable lifting lugs shall be provided on each diesel generator assembly.

Complete independent earthing, if required, along with neutral grounding of the DG Sets shall be carried out.

The DG set shall not mal-operate in the event of earthquake and shall be designed for the seismic value of the location of installation given in General Technical Specification **OR12702**.

3.3.1 ENGINE STARTING/SHUT-DOWN

a) AUTOMATIC STARTING

The 500 KVA, 415 V diesel generators will be connected to 415V SSB-1/SSB-2 as shown in the single line diagram (refer drawing No. 12900057003). Automatic starting of the diesel generator shall be through a starting signal from the PLC of the HT/LT system (i.e. Common Control Board) after ensuring necessary interlocks.

The unit shall start and build up voltage automatically within 10 seconds and shall be capable of transferring the load within 30 seconds. The stop command shall be through PLC of the LT system after restoration of SST incomers normal AC supply.

b) AUTOMATIC SHUT-DOWN

Automatic shut down of the DG Sets shall be under following conditions:

- Low voltage
- Low frequency
- Over speed
- High water temperature
- Low radiator water level
- Low oil pressure

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- High oil temperature
- Low fuel level
- Reverse power

The shut down of the diesel engines shall be by means of fuel shut-off solenoid.

3.3.2 DEHUMIDIFICATION ARRANGEMENT

The alternator and exciter shall be provided with suitable space heating arrangement, so that the excessive humidity does not reduce the insulation level of the equipment to an undesirable value. Such an arrangement shall entail space heating of the alternator and the exciter to max. 15 deg. above ambient temperature with arrangement to measure space temperature. The space heaters shall be suitable for single-phase 50 Hz AC supply from an independent source, which should automatically switch off before starting of unit. However once the dehumidification unit is switched on, it shall be controlled automatically with a thermostat. The dehumidification unit shall be designed to avoid hot spot.

3.3.3 INSTRUMENT PANEL

The diesel generator shall have a separate engine instrument panel. The panel shall be mounted on the framework of the generating set and shall contain at least the following:

- Oil pressure gauge
- Water temperature gauge
- Oil temperature gauge
- RPM Indication

3.3.4 AUXILLARY EQUIPMENT

The following auxiliary equipment shall be included in the supply for each DG set:

- The generating sets shall be housed inside a high quality 1.6 mm thick CRCA sheet metal fabricated acoustic enclosure designed for a max. 75 dBA sound level at one meter distance as per CPCB norms which shall have features like modular construction along with surface treatment like degreasing, pickling, phosphating, passivation etc.
- A high quality insulation material of minimum 100 mm thickness with 64 kg/m³ density or as per manufacturer's standards in accordance with relevant IS: 8183 or equivalent IEC code shall be used for maximum sound absorption to meet the latest norms of the Central Pollution Control Board.
- The lubricating oil system shall include a full flow oil filter and lubricating oil cooler. The lubricating oil cooler shall be water cooled with the main engine cooling system. Heater with thermostat may be provided for heating the lubricating oil.

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- The cooling system shall be air cooling system.
- A high efficiency residential silencer along with associated piping and flexible bellows, which shall be roof mounted and completely concealed in the roof of the acoustic enclosure, shall be provided.
- Louvers and outside air grilles for the inlet and outlet air shall be provided and installed by the Contractor. The louvers shall open when the engine starts and stay open during remaining time of the engine.
- 24 V DC starting system through axial type starter motor, complete with high capacity lead acid starting batteries, battery racks mounted on the floor, and heavy duty interconnecting cables with termination.
- Heavy duty dry type air filters with replaceable elements suitable for use in dust or sand laden conditions.
- Fuel and lubricating oil filters with replaceable elements.
- The fuel system shall include a main oil tank common for both DG sets and a day (one each) tanks. The day tanks shall be located in the diesel generator room, in a suitable position selected by the Employer. Both tanks shall include all fittings, fuel fill point, contents indicator, breather, filters, and all the necessary valves, piping and connections, as appropriate to make a complete workable system. Also there shall be included a fuel transfer pump to pump fuel from the main oil tank to the day oil tanks. For this purpose an electrical motor driven fuel transfer pump of adequate size shall be supplied, including high and low level float switches in the day tanks enabling easy transfer of fuel from the main oil tank. In addition, a semi-rotary hand operated fuel transfer pump shall be included in the supply, to act as a backup to the electrically driven pump. A firetrap valve and a shutdown valve shall be provided in the pipeline to the day tanks. The size of the main oil tank shall be sufficient for continuous running at full power for at least **110 hours for both 500KVA DG sets** and that of **day tank capacity 990 liter for 500 KVA each** continuously at the site conditions. An adequate low-level alarm device shall be provided for the main and day oil tanks, as well as an over filling safety device. The complete fuel oil system shall be designed to avoid any air pockets in any part of the pipe work, fuel pumps, sprayers, injectors, filter systems etc. No air relief cock is permitted. However, where air relief is essential, screwed plug, air vents may be provided. The contractor shall submit the guaranteed value of fuel consumption in gm/bhp/hr at rated load and rated speed of the diesel engine which shall be taken into account for the evaluation of bid. Maximum Distance between Main Tank and Day tank shall be 30 mtrs approximately and supplier to consider piping accessories etc accordingly. **Supplier to inform the size of Main Diesel Tank with technical offer along with Engine Datasheet for per hour fuel consumption data. Approval of Fuel Tank design etc from CCOE Nagpur or any other applicable Govt. Statutory body shall be in the scope of supplier. Supplier to confirm this in the technical bid.**

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- Starting batteries shall not be less than 180 Ah rating for each DG set. If larger capacity is required for three consecutive starting cycles at the most unfavorable conditions, larger batteries have to be installed.
- A static battery charging system , constant voltage current limiting type. The charging system shall be operated from the AC single-phase supply to maintain charge of the batteries while plant is stationary. The system shall be able to cope with at least $\pm 10\%$ voltage variations in the supply voltage. In all cases, the batteries shall be kept fully charged but protected against overcharging. Battery charger shall be mounted inside the control panel of respective DG Sets.
- A pre-lubricating pump, with adjustable time e.g 10-99 hrs between lubrications as required for the site conditions.
- Air core reactor shall be connected in the generator neutral point to earth to neutralize the zero sequence current from the generator in case of parallel operation with the network.

3.3.5 CONTROL, PROTECTION AND ALARM-ANNUNCIATION PANEL WITH AMF

A separate freestanding panel containing diesel engine controls and auxiliary controls shall be provided. The panel shall be fabricated from sheet steel of thickness not less than 2 mm. The panel shall be indoor type with degree of protection IP-54 or better, free standing floor mounted type with front hinged door and rear removable un-drilled and removable bottom/top gland plates for incoming and outgoing connections. The sheet metal after cutting, punching moulding & cleaning shall pass through 7 bath tank process for degreasing, rusting, phosphating & passivation before powder coating (thickness- 60 microns) and paint of shade **RAL-7032 (light grey, glossy finish) for both exterior & interior except internal component mounting plate which shall be brilliant white (dull finish)**. The panel shall be complete with air circuit breakers, all necessary internal wiring ,control circuit relays and terminations, provision of space heater and illumination lamp. The panel shall be fully modular, compartmentalized design to ensure safety and reliability and type tested at recognized test lab for latest relevant standards. All circuit components, control switches, automatic mains failure system (AMF), indicator lamps and push buttons shall be clearly identified by nameplates. At least the following equipments shall be accommodated in the panel:

A. SWITCHGEAR

- Air circuit breakers
- Neutral Isolating Contactor
- Neutral CT's and 0.415 KV CT's

B. METERING & INSTRUMENTATION

- Ammeter for the battery chargers input current

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- DC Volt meter & Ammeter for the battery charger voltage & Current
- Voltmeter with selector switch for mains
- Voltmeter with selector switch for alternator
- Ammeter one each per phase
- Power factor meter
- Frequency meter
- kW meter
- kWh meter
- 16 point Annunciator.
- Running hour meter

C. PROTECTION RELAYS (Multi function microprocessor based type-344 or higher of AREVA/7UM62 or higher of Siemens/REG316 or higher of ABB)

- Under voltage
- Over voltage
- Earth fault
- Over current
- Reverse Power
- Under/over frequency
- Phase sequence
- Negative phase sequence
- Field failure

D. INDICATORS

- DG ON
- DG OFF
- DG TRIP
- Battery charger Off
- Emergency stop
- Mains ON
- Mains Off
- DC supply ON

E. CONTROLS

- Voltmeter SS for Mains & DG
- Ammeter SS for Mains & DG
- Auto/Test/Manual SS
- DC control supply ON/OFF
- Battery charger ON/OFF
- Space Heater ON/OFF
- Start PB
- Stop PB
- Main Breaker ON/OFF
- Speed raise/lower
- Voltage raise/lower
- Test PB

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- Accept PB
- Reset PB

F. OTHER TRIPPING AND INTERLOCKING RELAYS

- Interlocking relays
- Master trip relays

A common audible alarm shall be incorporated in the control panel to operate in event of fault protection shut down. Alarm shall remain in operation until manual reset after fault condition has been corrected. Each alarm shall be identified by its own flag/light.

Provisions of common alarm shall be connected to the remote control system. For this purpose, a potential free contact shall be provided.

The following alarms shall be included in the common alarm:

- All alarms included in the shut down of the generator
- Low starting battery voltage
- Fail to start in automatic mode
- In case of any engine safety device (trip alarms) operating, the engine will be shut down automatically and simultaneously associated circuit breaker will trip by a direct tripping command, without depending upon the operation of reverse power relay. In addition, provision should be made to shut down the engine in case of electrical fault.

Control

The diesel generator shall have four different control modes-off, test, manual & automatic.

Off mode

In off mode the diesel generator set shall , if running, stop without time delay and remain stopped.

Test mode

In test mode it shall be possible to manually start the diesel generator directly. Then the automatic starting sequence is energized and the generator synchronized to the energized main bus. The generator runs parallel to the electrical system and automatically loaded up to an adjustable value. On the manually stop command the generator shall be disconnected from the main bus and stopped after a cooling period.

Manual mode

In the manual mode ,the engine shall be started manually by the operator by pressing the start push button on the generator panel.

The closing of C.Bs shall be done manually with the help of manual synchronizer and check synchronizing relay.

The DG set shall be shut down manually pressing the stop push button.

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Automatic mode

When switching over to automatic mode after a test run the voltage adjuster shall return automatically to the basic setting for emergency operation.

In automatic mode the diesel generator shall be automatically started in case of starting signal (power failure) and shall be maintained running unit auxiliary control circuit detects main supply. The diesel generator shall be running for adjustable time for cooling purposes after the generator has been disconnected from the network. In automatic mode the diesel generator shall , if necessary, run three automatic attempts to start with a rest period duration recommended by the manufacturer. Start and stop periods shall be time adjustable. If the engine fails to start, the control shall lock the starting procedure, and light an indicating light.

A red Mushroom Head stop push button shall be provided on the generator terminal cubicle for emergency stopping of the diesel generator set. All necessary provisions shall be provided for manual adjustments of the speed and voltage of the diesel generator set on the generator terminal cubicle.

In automatic mode , the operating procedure in case of power failure shall be as follows, however the contractor shall co-ordinate his design of control and supervision of the diesel generator set and circuit breaker connecting DG sets to the 415V mains bus with the design of the control system.

The diesel engine shall start if mains power outage is detected on the 415V station service switchgear & starting signal has been given by the auxiliaries control system.

The diesel generator shall supply voltage to the 415V station service switchgear. To facilitate this connection, all breakers shall automatically operate to connect this part of the system and disconnect parts of the system, which may not be supplied with the diesel generator set. To prohibit wrong connection an electrical interlock shall be provided. The closing of the breaker in the 415V station service switchgear connecting the DG sets to the electrical network shall be automatic.

At recovery of mains power, upon receiving a stop signal from the auxiliaries control system, the DG sets shall automatically disconnect from the main bus. After adjustable cooling period the engine shall stop.

The disconnection from the main bus shall not occur, until voltage has been recovered for about 5 mins on mains 415 V bus. When the generator is disconnected from the main bus, all breakers shall automatically restore the system in the normal way. The time it takes to change over from the diesel generator to the mains power shall be as short as possible.

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3.3.6 POWER CABLING, CONTROL & INSTRUMENTATION CABLING

All interconnecting power cables, control cables & Instrumentation cables between DG set and its associated equipment (which are in the scope of supply of supplier) are to be supplied by supplier.

All power, control & cables to be as per National/International standards for intended applications. Refer OR12702 (GTS) for more details.

All cable cross section sizing should be done keeping in view of safety margins as per standards / as specified in tender documents.

All Cables are to be laid & terminated by supplier during E&C of the DG sets at Site.

All cable length must be sufficient enough for intended application with margins for minimum two repairs of end terminations. Cable Lengths should be decided considering maximum distance between various equipment shall be approx.. 30 mtrs

3.3.7 FINISH

The DG sets shall be finished with two coats industrial primer and finally with two coats industrial high gloss paint. Details of Painting scheme for various items of DG set to be submitted by bidder with technical offer, however final painting scheme shall be approved by BHEL/UJVNL during drawing approval.

4.0 DESIGN CALCULATION

The supplier shall prepare and submit to the BHEL a “Design Memorandum” of the proposed equipment/system fulfilling the contract specification/requirement for customer approval immediately after P.O. placing and prior to submission of drawings and documents. The memorandum shall include the design philosophy, methodology, system description, input parameters for design, standard and codes, design and selection criteria, equipment data, material specification, major technical features, basic arrangement/layout etc. The calculations of the DG set output shall indicate the deration considered for site conditions and various internal consumptions & sequence of loads.

The Supplier shall submit the design calculations covering at least the following, along with offer-

- Calculations for selecting the engine capacity based on the site of installation and also after deration factors deleting the auxiliary power consumption e.g. radiator fan, cooling fan, battery charger, etc.
- Calculations for selecting the engine capacity based on the black start of the generating unit.
- Automatic mode starting/stopping logics.
- Calculations of the capacity of the oil tank as per requirement.

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- Voltage drop calculations for alternator terminal voltage drop when motor for largest size (160 KW) is started. Type of starting and base load conditions shall be provided by BHEL.

The supplier shall also provide other calculations as required by the Engineer for his approval of the supplier's design.

5.0 COMPONENTS:

The general technical specification for various equipment/panels/boards/items to be fitted in the boards/cubicles are given in General Technical Specification (Doc. No. **OR12702**). Requirement of other components (Fuses, links, heater, illumination, door switches, terminals, etc) shall be as per approved schematic drawing.

6.0 TESTS AND INSPECTION:

Inspection and testing (for Diesel Engines, Alternators, Combined DG Sets, AMF cum Synchronizing Panel, Main Diesel Tank) at Manufacturer's works shall be done as per approved Quality Assurance Plan. Routine Tests, Type Tests and Acceptance Tests shall be carried out at manufacturer's works as per relevant latest BS/IS/IEC specification. Test requirements are specified in the following clauses. Format for QAP (blank) is enclosed herewith as **Annexure-9** for bidder's reference. However the bidder/manufacturer has to make their own QAP considering all the required tests as per relevant latest BS/IS/IEC standard and in line with technical specification in the prescribed format and submit the QAP for BHEL's Customer approval. Final inspection and tests will be witnessed by BHEL's Customer before dispatch.

The bidder must clearly indicate the details of testing equipment and other testing facilities available in their works. The tests reports shall be got approved from the BHEL's Customer before dispatch of the equipment.

The bidder is required to furnish the complete type test reports for all the type tests as stipulated in relevant/applicable BS/IEC/IS standards conducted in any approved laboratory/Institute and certified & issued by reputed certifying agency for the similar specification of equipment as per technical specification under scope of supply for BHEL/BHEL's Customer review and acceptance along with the offer. The type test reports/certificates must not be older than 5 years. In case complete type tests are not conducted earlier or reports submitted are incomplete and are found not meeting the specification / relevant standard requirements, then the offer will not be considered for technically acceptable.

The acceptance tests shall be carried out by manufacturer as per the tests stipulated in relevant/applicable BS/IEC/IS standards for witnessing by BHEL & BHEL's Customer during final inspection.

6.1 Type Tests:

The type tests as specified here below shall have carried out at the Manufacturer's works, in accordance to the latest revision of the relevant standards. The type test reports shall be submitted to the customer for their acceptance.

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Reports for at least following type tests shall be submitted :

A. Diesel Engine

The Certificate/Reports for successful type testing of similar type of diesel engine as per following type tests shall be submitted for BHEL/UJVNL's reference.

- i) 100% Load test for 11Hours
- ii) 10% Load test for 1 Hour
- iii) Governor test
- iv) SFC (Specific fuel consumption)
- v) Lube oil consumption
- vi) Exhaust temperature

B. Alternator

The Certificate/Reports for successful type testing of similar type of alternator/ generator as per following type tests shall be submitted for BHEL/UJVNL's reference.

- i) Measurement of Resistance
- ii) Phase Sequence test
- iii) Regulation test
- iv) Measurements of open circuit and short circuit characteristics
- v) Efficiency tests
- vi) Temperature rise tests
- vii) Momentary overload tests
- viii) Over speed tests
- ix) High Voltage tests
- x) Insulation Resistance test (both before and after High Voltage tests)
- xi) Noise level as per IS:12065
- xii) Vibration Test as per IS:12075
- xiii) Degree of Ingress Protection tests

C. AMF Control Cum Synchronizing Panel

The Certificate/Reports for successful type testing of similar type of AMF Control Cum synchronizing Panel enclosure as per following type tests shall be submitted for BHEL/UJVNL's reference.

- i) Short circuit withstand test
- ii) Temperature rise test
- iii) Ingress protection test

6.2 Routine Tests

The equipment shall be routine tested as per BS/IEC/ISO 8529 and other International standards at the works of the Contractor. The Contractor shall submit the site quality plan for testing the DG set at Contractors factory/works. The reports of routine tests shall be submitted to BHEL for BHEL/BHEL's customer representative before raising inspection call for final witness test.

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6.3 Final Witness Tests

A. Diesel Engine

- i) RPM, Torque, Fuel rate
- ii) Lube Oil pressure at Low Idle & High Idle RPM
- iii) Low & High Idle RPM
- iv) Fuel Pressure
- v) Lube Oil Temperature
- vi) Water Temperature
- vii) Intake manifold air pressure
- viii) Blow-By
- ix) Governing %
- x) Exhaust temperature
- xi) Fuel Consumption (SFC to be calculated at 100%, 75% & 50% rated capacity)
- xii) BHP calculation at 100%, 75% & 50% rated capacity
- xiii) Load/unload test for 1 Hour

B. Alternator

- i) Visual & Dimension
- ii) Winding Resistance
- iii) Insulation resistance conducted before/after HV
- iv) High Voltage test
- v) Measurements of open circuit and short circuit characteristics
- vi) Phase Sequence test
- vii) Voltage balance
- viii) Test with the AVR

C. AMF Control Cum Synchronizing Panel

- i) Visual Inspection
- ii) Components check as per BOM
- iii) Operational & Functional test

D. Assembled DG Set

- i) Visual test for assembled DG Set
- ii) Loading, unloading and continuous running of DG Set for 4 hours
- iii) Fuel consumption test

6.4 Field Tests

All field tests including tests during installation, pre-commissioning, commissioning, performance and field acceptance tests shall be conducted by the Contractor, in the presence of representative of the BHEL/BHEL's Customer (UJVN LTD.).

Procedure to be adopted for conducting the operational, pre-commissioning, commissioning, performance and field acceptance tests shall be submitted well in advance before start of relevant testing, for approval of the Customer.

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The equipment/system shall be deemed to be commissioned and ready for trial run only after successful operation for a “test service period” specified in sub clause -C of 6.4 “Performance Testing”. In the event of any failure, this period shall be repeated for any number of times till the successful operation as described above is achieved.

A. Tests during installation and pre-commissioning

- Installation check of all components installed according to as-built drawings and engineering
- Functional test of sub systems
- Functional test of complete system

B. Commissioning Tests

After installation of the equipment and prior to operation of the diesel generator set, at least the following tests shall be performed:

- Megger test of insulation between windings, between each winding and ground, and between control circuit live parts and ground
- Resistance measuring of each winding
- Phase sequence test
- Load test for 2 hours at rated capacity
- Starting time test
- Functional tests of all control circuits
- Measurement of Vibration and Noise level
- Measurement of open circuit characteristics
- Measurement of short circuit characteristics
- Functional test of all safety devices
- Voltage regulation test

The contractor may propose to perform additional tests, which he considers advisable or necessary. The cost of performing such tests shall be borne by the contractor.

The contractor shall prepare written documents in a form approved by the employer of all test results and submit them to the employer after performing the test.

The site test for each DG Set shall be conducted with the purpose of ascertaining that installation had been done in a sound manner and no defects have been caused during shipment and subsequent handling.

Following site tests shall also be carried out:

- Fuel consumption check of Diesel Engine (Fuel shall be arranged by supplier and LOAD shall be arranged by the Customer)
- Any other test, if specifically mentioned in ISO 8528.

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C. Performance testing

After completion of commissioning the test service period of seven (7) days shall follow. During this test service period, the system/installations must perform satisfactorily. The Contractor shall be responsible for the equipment during test service and also for the way it is operated. However, Employer's personnel will operate the equipment under the Contractor's guidance during test service period.

D. Field acceptance tests

The DG sets shall be tested for successful and efficient operation in respect of all functions as specified in this specification. Verification of performance shall be done and recorded in site test report. The system shall be accepted only after performance is demonstrated as specified.

7.0 MANDATORY SPARE PARTS:

Mandatory Spare parts shall be supplied along with DG Sets as per list of Mandatory Spares (**Annexure-5**) and the item wise prices for each item shall be quoted. Any additional spares if any recommended by the Manufacturer shall also be offered separately. The purchaser has right for including/not including the same in the final scope of supply. Price break-up to be given by bidder in Price bid for each spare.

8.0 TOOLS AND INSTRUMENTS:

The supplier shall supply all necessary tools, devices, equipment, testing instruments etc. for installation, repair and maintenance of DG Sets. The supplier shall supply testing instruments of internationally reputed make having proven acceptance in the field for use during testing and commissioning and operation stage. The make and detailed specification of these instruments, tools and testing devices shall be clearly given by supplier in the offer. The list of such equipment/items is given in **Annexure-6**. If the supplier feels to add more as per their experience and necessary for the installation, repair and maintenance of DG Sets then the same shall also be included in the scope of supply.

- One (1) set of Mechanical tool kit
- One (1) set of Electrical tool kit & Instruments.

Price break-up to be given by bidder in Price bid for each tool.

9.0 GENERAL REQUIREMENTS:

9.1 ENVIRONMENTAL REQUIREMENTS:

In compliance with ISO 140001 & OHSAS 180001, the equipment supplied shall not contain any material which is detrimental to the safety of environment. Guide lines for the end user for handling & disposal of any harmful packing material shall be given in the instruction manual.

In addition, the supplier shall conform to all applicable regulations as well as the statutory requirements of the Govt of India regarding the execution of

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construction and installation work, and shall follow all instructions issued by the competent Authorities and the Purchaser.

9.2 ERECTION & COMMISSIONING AT SITE:

The contractor shall furnish all labour , supervision tools, supplies and all other provisions or materials necessary to assemble, erect, install, test and commission the equipment in a thorough workman like manner following the best modern practices. The equipment and all its components shall be placed with great care and accuracy and shall be aligned correctly to provide an installation consistent with the close tolerances used in the erection of modern equipment. The proper elevations and centre lines to which equipment is to be set shall be established by the contractor.

All necessary materials and labour for performing all the above tests shall be provided by the contractor. All test equipment and instruments shall be furnished by the contractor and will remain the contractor's property after the fulfilment of all field tests.

The contractor shall furnish a complete outline of the proposed methods and procedures to be followed on testing of DG sets. The list of equipments and instruments to be used should also be included in the above and submitted to the employer for review and approval during detailed engineering/during approval of QAP.

All civil work required for foundation shall be carried by customer, however the contractor is required to submit all foundation drawings and supporting steels embedment/pads etc. well in advance.

Manufacturer shall depute his expert engineers to site for installation/erection & commissioning of DG Sets. Lump sum charges for installation/erection & commissioning of DG Sets including all charges shall be quoted. Normal tools, tackles instruments required for erection /commissioning shall be provided by BHEL site office. Special instruments/devices/tools required for erection & commissioning shall be carried by vendor's engineer with him on returnable basis.

9.3 Deleted

9.4 Deleted

9.5 TECHNICAL DEVIATION:

The bidder shall indicate the technical deviations, if any together with the justification as per format attached (**Annexure-7**, Schedule of Technical Deviations). **If no technical deviation is asked by bidder in their offer then it will be presumed that the bidder will be fully complying to all the clauses of this technical specification.**

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9.6 PACKING & SHIPPING:

The packaging and storage of equipment shall be strictly in accordance with internationally accepted standards.

All the Equipment and associated items shall be properly packed in sturdy packing so as to avoid any damage to the equipment/materials and to withstand rough handling during transportation and long term storage. Mandatory spares shall be packed in separate box indicating clearly "Mandatory Spares" complying sturdy packing.

Each package shall carry the proper identification tag such as name of manufacturer, name of purchaser, address, order no. item number, name, brief specification, size, net and gross weight duly stenciled thereon. A layer of water proof material shall be applied to the surface of the equipment and over the packages.

Supplier shall give Package/Consignment Data as per format given in "**Annexure-8**" one month before dispatch of items.

The Supplier shall submit all necessary instructions for proper & correct storage of parts at site and shall define all precautions required to maintain the packing in good condition.

Copy of these instructions shall be attached to each package, and shall be accessible when parts are stored in their storage areas. These instructions shall also appear in the equipment operation and maintenance guide.

9.7 Deleted

9.8 HANDLING & STORAGE :

The Supplier shall provide all the necessary instructions (descriptive manual, drawings and diagrams, etc.) for unloading, unpacking and handling, Storage & Preservation of DG sets and associated auxiliaries and equipment. The Supplier shall also provide all the necessary drawings for part handling during maintenance, as well as the tools or accessories required.

9.9 FIRST FILL OF CONSUMABLES (OIL, GREASE, COOLANT etc.)

All the first fill of consumables such as oil, grease, radiator coolant etc. which will be required to put the equipment, covered under the scope of the specifications, into successful trial operation, shall be furnished by the bidder except Diesel Fuel. The supplier shall arrange for shipment of these consumables simultaneously with the equipment.

9.10 SPECIAL CONDITION :

BHEL reserves the right for minor alterations / modifying the scheme/drawings during manufacturing/testing, if required by customer due to some unforeseen reasons. The supplier shall have to make the corresponding minor changes in the equipment as required for fulfilling the system requirement.

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10.0 ENCLOSURES & ANNEXURES :

i.	OR 12702	-	General Technical Specification
ii.	Annexure-1	-	Documents/Drawings Submission Schedule
iii.	Annexure-2	-	Schedule of Guaranteed & Technical Particulars
iv.	Annexure-3	-	Scope of Supply
v.	Annexure-4	-	Price Bid format
vi.	Annexure-5	-	List of Mandatory Spares
vii.	Annexure-6	-	List of Tools and Instruments
viii.	Annexure-7	-	Schedule of Technical Deviation
ix.	Annexure-8	-	Package/Consignment Data
x.	Annexure-9	-	Format for QAP
xi.	Annexure-10	-	List of Reference Standards
xii.	Annexure-11	-	Check List
xiii.	Annexure-12	-	Preferred Make - LT Switchgears
xiv.	Single Line Diagram 415V AC Supply System	-	Drg No. 12900057003 Rev02

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