



BHOPAL

R & M JOB FOR BOP OF PATRATU TPS  
(2x 110 MW) FOR JSEB

PDX-06-317

TECHNICAL SPECIFICATION FOR  
REFURBISHMENT OF ELECTRICAL EQUIPMENTS

REV. 01

# TECHNICAL SPECIFICATION FOR REFURBISHMENT OF ELECTRICAL EQUIPMENTS

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Prepared by:



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<b>01.00.00</b>	<b>INTENT OF SPECIFICATION</b>		
<b>01.01.00</b>	<p>This specification is intended to cover the comprehensive condition assessment, overhauling/ servicing/ refurbishment, replacement of defective parts, rewinding (Motors only) testing &amp; commissioning and putting in trouble free operation of transformers, Bus duct system and motors of unit 9 &amp; 10. The specification lists the minimum requirements. <b>Bidder shall visit the site and inspect &amp; assess the amount of work involved in overhauling/ replacement of the equipment mentioned in this specification, before quoting.</b></p>		
<b>01.02.00</b>	<p>Contractor shall make the joint inspection with BHEL/Owner Engineer to ascertain the snag in the transformers, Bus duct system and motors of unit 9 &amp; 10 which are proposed to be overhauled/ refurbished. These snags shall be entered in a joint protocol for each equipment.</p>		
<b>01.03.00</b>	<p>Contractor shall also get approval of all protocols/repair form formats and the methodology of work for each type of equipment before commencement the above work. These documents shall be used during the overhauling &amp; testing of the equipment and shall form the basis for acceptance of work.</p>		
<b>01.04.00</b>	<p>It is not the intent to specify all details of overhauling, servicing, replacement of parts/ equipment/ material including design and construction of part/ equipment/ material. However, the part/ equipment/ material shall conform, in all respects, to high standards of design, engineering and workmanship and shall be capable of performing in continuous commercial operation for the prevailing site conditions, up to the expected life of the part/ equipment/ material in a manner acceptable to the BHEL/ Customer, who will have discretion to reject any work or part/ equipment/ materials which in their judgment are not in full accordance therewith.</p>		
<b>01.05.00</b>	<p>It shall be the responsibility of the Contractor to source replacement parts from original equipment manufacturer (OEM) to the extent possible. In case OEM have stopped manufacturing these or OEM is unable to supply these parts, alternative equivalent parts shall be offered, these parts shall be of proven make/ quality and shall meet in all respects the performance specification of original part and shall have satisfactory durability for the prevailing site conditions. The make of alternative equivalent parts/ equipment/material shall be approved by BHEL/ Customer.</p>		
<b>01.06.00</b>	<p>The Contractor shall furnish all material or work as a whole, in compliance with the requirements of this specification.</p>		
<b>01.07.00</b>	<p>Since unit #10 shall be commissioned first all jobs related to unit #10 and common system shall be taken on priority.</p>		
<b>02.00.00</b>	<p><b>SITE CONDITIONS</b></p> <p>All replacement/New parts/equipment/material shall be designed and suitable for operation under the following site conditions.</p> <p>Maximum ambient temperature - 45° C</p>		
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	<p>Minimum ambient temperature - 04<sup>0</sup> C</p> <p>Design temperature - 50<sup>0</sup> C</p> <p>Design relative humidity - 100%</p> <p>Altitude above sea level - Less than 1000 M.</p>		
<b>03.00.00</b>	<b>SCOPE OF WORK</b>		
<b>03.01.00</b>	<b>Overhauling of Transformers</b>		
03.01.01	Two (2) nos., 220/11 kV, 68.5/96.00/137.5 MVA, Ynd11, OFTC, ON-OB-OFB, outdoor transformer of BHEL make (Generator transformer for Unit #9 & 10). The work includes shifting of unit # 8 transformer to unit # 9 and unit #9 to Unit #8.		
03.01.02	Two (2) nos., 230/6.9 kV, 30 MVA, Yd11, OLTC (MA, Germany make), ON, outdoor transformer of TELK make (Station transformer for Unit # 9 & 10).The work includes overhauling of OLTC and supply of new RTCC panel .		
03.01.03	Two (2) nos., 11KV /6.9 kV, 20 MVA, Dd0, OFTC, ON, outdoor transformer of CGL make (Unit Auxiliary transformer for Unit #9 - 1 No. & unit # 10 – 1 No.). The work includes overhauling of OLTC and supply of new RTCC panel for unit # 9.		
03.01.04	Sixteen (16) Nos., 11KV/0.433 V, 1/1.6 MVA, Dyn11, OFTC, ON, outdoor transformer (Auxiliary transformer for unit # 9-5 Nos., unit # 10 -11 Nos.).		
03.01.05	Complete labor, hardware, tools and tackles as required for overhauling work. Any required lifting & hoisting equipment, container for oil storage shall be covered in this scope.		
03.01.06	All spares required for overhauling of transformers, oil filtering machine of suitable rating (1 No. Min. 5 KL Capacity & 1 No. 2 KL Capacity), Nitrogen gas for Capping.		
03.01.07	Testing & commissioning of transformers and putting these in successful operation.		
<b>03.02.00</b>	<b>Overhauling &amp; Rewinding of Motors</b>		
	<u>HT MOTORS</u>		
03.02.01	Four (4) Nos., 6.6 kV, 4000KW, 2986 RPM, BHEL make Boiler Feed water pump motor (Unit # 9-2 Nos. & unit # 10 –2 Nos.).		
03.02.02	Six (6) Nos., 6.6 kV, 800KW, 744 RPM, BHEL make I.D. Fan motor (Unit # 9-3 Nos. & unit # 10 - 3 Nos.).		
03.02.03	Four (4) Nos., 6.6 kV, 760KW, 1490 RPM, BHEL make P.A. Fan motor (Unit # 9 -2 Nos. & unit # 10-2nos.).		
03.02.04	Six (6) Nos., 6.6 kV, 610 KW, 742 RPM, BHEL make C.W. pump motor (Unit # 9-3 Nos. & unit # 10-3 Nos.).		
03.02.05	Four (4) Nos., 6.6 kV, 400KW, 1487 RPM, BHEL make F.D. Fan motor (Unit # 9-2 Nos. & unit # 10-2 Nos.).		
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03.02.06	Six (6) Nos., 6.6 kV, 200 KW, 1486 RPM, BHEL make C.E pump motor (Unit # 9-3 Nos. & unit # 10-3 Nos.).		
03.02.07	Twelve (12) Nos., 6.6 kV, 200 KW, 986 RPM, BHEL make Bowl Mill motor (Unit # 9-6 nos. & unit # 10-6 Nos.).		
	<u>LT MOTORS</u>		
03.02.08	Eighty –Seven (87) Nos. LT motors of various rating from 5 KW up to 160 KW (Unit # 9-47 Nos. & unit # 10- 40 Nos.). Detail list attached at Annexure-I B.		
	<u>DC MOTORS</u>		
03.02.09	Two (2) Nos., 220VDC, 11 KW, 720 RPM, Emergency oil pump motor (Unit # 9 –1 No. & unit # 10 - 1 No.).		
<b>03.03.00</b>	<b>Supply of New Motors</b>		
03.03.01	Two (2) Nos., 220 V DC, 4.8KW, 700 RPM, Seal oil pump motor (Unit # 9 –1 No. & unit # 10 - 1 No.).		
03.03.02	Two (2) Nos., 220V DC, 100 W, 5000 RPM, load control motor (Unit # 9 –1 No. & unit # 10 - 1 No.).		
03.03.03	Two (2) Nos., 3.7 KW, 2850 RPM, Scanner Fan motor (unit # 10-2 Nos.).		
<b>03.04.00</b>	<b>Overhauling &amp; Servicing of Bus Duct System</b>		
03.04.01	11 kV ,8000A isolated phase Bus Duct system including 1000A Tap Off Bus Duct, PT & SP cubicle, CT, NGT for Unit # 9 & Unit # 10. Existing Bus-duct Air Pressurization System shall be ignored.		
<b>04.00.00</b>	<b>SCOPE OF SUPPLY</b>  Procurement and supply including transportation to site of replacement parts/Equipment/ Material required for refurbishment of equipment listed above, the quantity of these shall depend on site assessment, testing, actual refurbishment requirement and shall vary from equipment to equipment .  The indicative lists of replacement parts needed are given below. The list is not exhaustive any other items which are not mentioned here but found defective during actual execution of refurbishment, shall be part of the supply. Replacement of any item or part of items or all the items in the list shall depend on the defect found in the items after opening of the equipment and joint inspection of the equipment by Contractor/ BHEL. The defective items required to be replaced shall be clearly listed in the equipment repair form. The quantity & list of major items to be replaced has been indicated in SOR. Contractor shall quote unit rate for all items in SOR. However all gaskets & silica gel have to be replaced with new. All the components offered shall be compatible as regard mechanical fitment and shall have electrical parameters as per existing component or specification given here.  CT/ PT/ NGT/ NGR shall be checked for defect and if required to be replaced, shall be supplied by BHEL/JSEB.		
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04.01.00	<p><b>Scope of Supply for Transformers:</b></p> <ul style="list-style-type: none"><li>a. Gaskets (including top covers &amp; bushings)</li><li>b. Core bolt insulation</li><li>c. Oil Temperature Indicator (OTI)</li><li>d. Winding Temperature Indicator (WTI)</li><li>e. Conservator- Oil level indicator (MOG)</li><li>f. 220 kV Lightning Arrester &amp; LA counter (Generator and Station transformer only)</li><li>g. Marshalling box-spares like switches, contactors, fuses, space heater, terminal Block, Terminal box, thermostat, new copper wiring, panel light, plug socket etc</li><li>h. HV, LV Bushings and Turret CT.</li><li>i. Current transformers -Terminal boxes, terminal plate, connecting cables</li><li>j. New Fans to be supplied. Pump - Bearing replacement and overhauling, terminal block, terminal box, connecting power &amp; control cables (Generator transformers only)</li><li>k. Buchholz relay system</li><li>l. OLTC - Worn out contacts, contactor, remote/local selector switch, drive motor, cam switch, door switch, changeover relay, new wiring, safety switch, limit switch, potentiometer, Push button, position indicator, Aux. supply transformer etc. (UAT unit # 9 and # 10 only). New OLTC shall be supplied for the Station transformer of Unit # 9.</li><li>m. Silica Gel</li><li>n. Paint &amp; Varnish</li><li>o. Worn out mechanical part of valves</li><li>p. Off load tap changer - Worn out contacts and overhauling.</li><li>q. Rating &amp; Diagram plate.</li></ul>	
04.01.01	New RTCC panels shall be supplied for Station Transformer 4A & 4B and UAT for Unit # 9.	
04.01.02	Station Transformer of Unit # 9 was affected by the fire in LV cable box. LV & HV Bushings are damaged and shall be supplied.	
04.02.00	<p><b>Scope of Supply for Overhauling &amp; Rewinding of Motors:</b></p>	
04.02.01	<p>For Induction Motors &amp; DC Motors</p> <ul style="list-style-type: none"><li>a. Moulded Copper conductor coils/Enameled copper winding wires/copper flat, inter turn insulation, slot insulation. Slot wedges, insulating varnish, binding wire, brazing material, Socket, Lug etc.</li><li>b. Brush Holder &amp; Brushes (For DC Motors Only)</li><li>c. Fan &amp; Fan cover (For LT Motors only)</li><li>d. Bearings (anti friction/ Hydro dynamic)</li><li>e. Pipe &amp; other mechanical items – for on line greasing facility for bearings (For HT Motors only)</li><li>f. Space heater, winding RTD &amp; bearing RTD for local/ remote.</li><li>g. Terminal blocks for Main, space heater &amp; RTD connection</li><li>h. Paint &amp; Varnish</li><li>i. Rating plate</li></ul>	
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<b>04.03.00</b>	<b>Scope of Supply for Bus Duct System</b>		
04.03.01	Main & Tap Off Bus Ducts <ol style="list-style-type: none"> <li>For main &amp; Tap off bus Duct Support - 12 KV porcelain insulators. Spares for support insulator installation e.g. Neoprene cork, resilient pad, MS galvanized sleeve &amp; Screws, SS thread insert etc.</li> <li>For termination at Generator Transformer &amp; Unit Auxiliary Transformer end - Rubber Bellow assembly, 30 SWG copper lamination, 3mm thick copper pressure plate, 1mm thick bi metallic strip, 6 mm thick Neoprene Gasket, HTS galvanized M12 Hexagonal screws, MS galvanized Nut &amp; bolts etc.</li> <li>For Inspection opening -Neoprene gasket &amp; Hardware</li> <li>For Disconnecting Links -12.7mm thick 510mm dia Bus bar AL plate &amp; Hardware.</li> <li>For shorting bar at Generator &amp; at Generator Transformer end - Hardware</li> <li>For Earthing - 100mmX13 mm Aluminium Flat, Earthing pad &amp; Hardware</li> </ol>		
04.03.02	Generator Phase & Neutral side- Current Transformers <ol style="list-style-type: none"> <li>Current transformers if found defective shall be supplied as free issue item by BHEL/ JSEB. However all services/ required testing shall be in contractors scope.</li> <li>Terminal Boxes, terminal plate, connecting cables for CT Secondary connection, 10 mm thick glass textile sheet, 6 mm thick neoprene cork sheet, fibre glass sleeve &amp; Hardware.</li> </ol>		
04.03.03	Generator PT & SP Cubicle <ol style="list-style-type: none"> <li>PT-1 for metering &amp; protection, PT-2 for AVR, Lightning Arrestor, surge protection capacitor, if found defective shall be supplied as free issue item by BHEL/ JSEB. However all services/ required testing shall be in contractors scope.</li> <li>11KV, 3A, HRC fuse, 3nos each for PTs</li> <li>9 nos., 650V, 36KA, 10A , HRC fuse, for metering , AVR &amp; protection</li> <li>Primary disconnect &amp; sliding finger contact assembly Secondary disconnect assembly</li> <li>12 KV, Roof Bushing</li> <li>15KV Porcelain Support Insulator</li> <li>Heating element, terminal box, terminal plate, connecting cables for Space heaters</li> <li>Thermostat 30 °C to 90°C, 5A, 240 V</li> <li>Terminal Boxes, terminal plate, connecting cables for Marshalling Box</li> <li>Neoprene gasket &amp; Hardware</li> <li>6 mm dia, 400mm long copper flexible with socket at both ends</li> <li>10 gauge copper conductor for body earthing</li> <li>24W, 240V Fluorescent Lamp</li> </ol>		
04.03.04	Generator Neutral grounding cubicle <ol style="list-style-type: none"> <li>NGR, if found defective shall be supplied as free issue item. However all repairs shall be in contractors scope</li> <li>15 KV Porcelain Support Insulator</li> <li>Thermostat 30 °C to 90°C, 5A, 240 V</li> </ol>		
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- d. 2A, 240V HRC fuse with 15A base & carrier
- e. 30 A, 8way, 440V Terminal Block
- f. 5A, 240 V switches
- g. 15A, 240 V Disconnecting Link with Base & carrier
- h. 24W, 240V Fluorescent Lamp
- i. Heating element, terminal box, terminal plate, connecting cables for 150 W, 240V Space Heater
- j. Neoprene gasket & Hardware

**05.00.00**

**SCOPE OF SERVICES**

**05.01.00**

**Residual Life Assessment & Condition Assessment of Transformers**

Comprehensive electrical testing shall be done on all transformer to investigate the health of transformers and to ascertain scope of work. A detailed report of RLA/CA shall be submitted before start of work of overhauling of transformers. This testing shall include following minimum tests. Any additional tests required to assess the health of the transformer shall also be done.

- a. Capacitance & Tan Delta Test on Transformers.
- b. Capacitance & Tan Delta Tests on Bushings (Not applicable for LT Transformers).
- c. Frequency Response Analysis.
- d. Recovery Voltage Measurement.
- e. DC Winding Resistance Measurement.
- f. Measurement of Magnetizing Current.
- g. Measurement of IR & PI Values.
- h. Transformer Turns Ratio Measurement.
- i. Step Voltage Test.
- j. Detection of Oil Leakages in the System.
- k. Detection of Blockages in the Cooling Circuit (By Thermo Vision).
- l. Tests on Oil
  - DGA
  - Furfural Test
  - Sp. Resistance
  - Tan Delta
  - Water Content
  - Acidity
  - IFT
- m. Pressure Test for Oil Leakage.

The RLA/CA study shall be conducted by an experienced agency, who has prior experience of conducting RLA on transformers of 150 MVA, 220 kV Class. Approval of testing agency shall be obtained from BHEL/ Customer beforehand by submitting their credentials. All test instruments required for this testing shall be brought to site by the vendor. All tests shall be conducted in one go, preferably within one day & report shall be submitted within 15 days from completion of testing.

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**05.02.00**

**Scope of Services for Transformers**

Complete renovation/refurbishment/ of all transformers shall generally include following work:

- a. Comprehensive RLA/ CA studies shall be conducted.
- b. Disconnection of HV & LV jumpers and confirm the healthiness of both.
- c. General cleaning of Transformer
- d. Electrical tests of the transformer before, during and after overhauling including IR value & PI, of windings ratio test, magnetic balance, no load, vector group, winding resistance measurement at different tap position.
- e. Testing of oil and carrying out DGA analysis.
- f. Internal inspection of the transformer tank.
- g. Replacement of all gaskets (including top cover) after dismantling of the associated parts and reassembly
- h. Washing of core with hot oil, checking of core insulation, tightening of core bolts. Confirm earthing of core & tank as per recommendation by OEM. Old oil shall be used for hot oil washing.
- i. Cleaning of radiator bank. Identification of leakages & its rectification. Pressure test of radiator bank. Replacement of all Gaskets.
- j. Checking & refurbishment of Marshalling Box & checking the connection tightness. Ensure sealing/ protection against rain water ingress. Replacement of Gaskets. Cable gland, Hardwares.
- k. Checking & testing of bushing CT's. Ensure sealing/protection against rain water ingress.
- l. Servicing of OLTC/OCTC and checking operation. Measure winding resistance of all the three phases before start of the work. Make the OLTC/OCTC to travel over the entire range at least once. Return the OLTC/OCTC to its normal position. In case of abnormal variation suspect problem in contact & rectify the same.
- m. Testing of Temperature gauges.
- n. Checking of Transformer alarms.
- o. Checking & cleaning of LA & its counter.
- p. Turret modification & HV line lead modification.
- q. Replacement of silica gel.
- r. Inspection, Checking , cleaning & tightening of HV & LV connections.
- s. Overhauling of Fan motors including replacement of Bearings, greasing, rewinding (if required) etc (Generator transformer only).
- t. Over hauling of oil pumps and checking its operation (generator transformer only).
- u. Inspection/replacement of cooling circuit connections, overload relays etc. Check cut in/cut off of fans as per interlock on Auto (Generator transformer only).
- v. Checking & cleaning of Buchholz relay & checking of its operation.
- w. Transportation of new transformer oil from stores to site and empty oil drum from site to stores shall be arranged by contractor
- x. Transformer oil filtration (including vacuum pulling to achieve desired parameters ensure all valve in the oil are open. BDV testing to be done after filtration of oil however DGA analysis shall be done where old oil is used after filtration.
- y. Painting of transformer external surface after proper cleaning (2 coats of paint over 1 coat of primer). Internal painting of transformer tank to be done after thorough cleaning.
- z. Transportation of necessary equipment and testing devices to site.

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- aa. Any other work not listed here but felt necessary for completion of the job.
- bb. Testing of bushings including Tan delta test. Replacement by new one, if required.
- cc. Final check, testing & commissioning on overhauled Transformer shall include following:
- i) Breather silica gel ( Blue when dry )
  - ii) Oil In breather housing cup
  - iii) All valves for their correct opening and closing sequence
  - iv) Oil Level in conservator tank
  - v) Oil level in bushing
  - vi) Release air wherever necessary
  - vii) Cooling accessories (pump motors, Fan motors etc.) for direction and O/L setting
  - viii) Buchholz, oil level indicator, pressure gauges, thermometer, Temperature indicator, etc. operation
  - ix) Earthing of main tank, marshalling box, Tap changing gear, diverter, pump, fan motor etc.
  - x) Neutral earthing
  - xi) Checking Earth resistance of Electrodes
  - xii) Earthing of Bushing Test tap
  - xiii) Check oil leakage for 24 hours
  - xiv) Testing of OTI/WTI with hot oil
  - xv) Check working of WTI/ RTD repeaters at control room
  - xvi) IR of core to earth
  - xvii) IR test on control wiring, tap changer motor & control, cooling system (Motor fan, motor pump, control wiring), Main winding.
  - xviii) Special Oil test e.g. Moisture in PPM, BD value in KV, Resistivity at 90°C (Ohm- cm), Tan delta at 90°C
  - xix) Magnetisation current
  - xx) Final IR test after connection of transformer to the system
  - xxi) WTI & OTI setting check for alarm & trip
  - xxii) Record the no load current after charging
  - xxiii) Record Temperature at the time of charging at OTI , WTI & ambient
  - xxiv) Maximum Temperature after 24 Hours
- dd. On load tap changer (OLTC) check shall comprise
- i) Visual inspection of equipment
  - ii) Hand operation on all taps
  - iii) Complete wiring of the circuits
  - xxv) Limit switch
  - xxvi) Over running device
  - xxvii) Remote panel wiring
  - xxviii) Overload device of driving motor
  - xxix) Local operation (electrical)
  - xxx) Remote operation (electrical)
  - xxxi) Tap position indicator
  - xxxii) Step by step contactor
  - xxxiii) Out of step relay
  - xxxiv) Continuity check between line and line with multi-meter on all taps and phases



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xxxv) Measurement of winding resistance on all taps

xv) Voltage ratio test on all taps

**Generator Transformer Unit # 9 & Unit #10**

- a. Shifting of Unit #8 transformer to maintenance area in A-B bay including Opening of 11 KV Bus duct connection, 220 KV jumper connection, dismantling of three numbers radiator banks, cooling fans (5nos each bank), oil circulating pumps (2nos each bank), opening of marshalling box connection of unit # 8.
- b. Shifting of Unit # 9 transformer to unit # 8 Location including Opening of 11 KV Bus duct connection, 220 KV jumper connection, dismantling of three numbers radiator banks, cooling fans (5nos each bank), oil circulating pumps (2nos each bank), opening of Marshalling box connection of unit # 9 and shifting of transformer to unit # 8 location, Reassembly of all opened accessories. Primary & secondary reconnection.
- c. Shifting of Unit # 10 transformer to maintenance area in A-B bay including Opening of 11 KV Bus duct connection, 220 KV jumper connection, dismantling of three numbers radiator banks, cooling fans (5 Nos each bank), oil circulating pumps (2nos each bank), opening of marshalling box connection of unit # 10.
- d. Comprehensive electrical tests as listed above for condition assessment of transformers. Additional tests not listed above but required shall also be carried out.
- e. Identify & repair the oil leakage from radiator bank, transformer tank, interconnecting pipes, conservator tank, Lightning arrestor, HV & LV bushing
- f. Replacement of worn out mechanical parts of valves, all gaskets
- g. Draining of oil from the tank, sludge removal & cleaning of transformer tank, core using Hot oil.
- h. Checking/Repair/testing of winding & core insulation core bolt insulation, Winding to terminal connection, earthing connection etc. Re-insulation of connecting leads, wherever required.
- i. Tightening of core bolts
- j. Placement of core inside tank and reconnecting all the termination links, replacement all gasket.
- k. Checking, overhauling & repair of radiator bank closing, opening, drain valves, oil circulating pumps, replacement of old bearing, rewinding of defective/ burnt out motor winding and replacement of worn out mechanical parts. Replacement of cooling fans.
- l. Replacement of WTI, OTI, MOG, Buchholz relay system, silica gel breather.
- m. Servicing & necessary repairs of Off load tap changer.
- n. Checking, overhauling, repair, testing of marshalling box including replacement contactor, wiring, terminal block, fuse, fuse base, space heater, Thermostat, panel light & plug socket etc. Minor repairs or modification on MOB.
- o. Replacement of 220KV lightning arrestor & LA counter
- p. Vacuum pulling & Filtration, filling of transformer oil. Replacement of oil if testing of filtered oil shows lower BD value & higher acidity, New Oil will be supplied by BHEL/ JSEB. Shifting of new oil from JSEB store to site and shifting old oil to JSEB stores. Supply of Nitrogen for capping & dry out process.
- q. Inspection & testing of current transformers on 220KV phase & Neutral side, including replacement of terminal boxes, terminal plate, connecting cables etc.
- r. Painting of transformer & accessories exterior - shade 632 of IS-5
- s. Testing & commissioning of completely assembled transformer.

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t. Any other work felt necessary for completion of the job.

Station Transformer Unit # 9 - 4B & Unit # 10 - 4A

- a. Comprehensive electrical testing for condition assessment of transformer as mentioned above. Unit # 9-4B transformer was affected in fire caused on the 6.6 KV power cables. Damage in 220 KV bushing and 6.6 KV bushing are visible & these shall be replaced along with LV Cable Box duly filled with resin compound. Healthiness of the transformer shall be checked before starting repair work. For unit # 10 - 4A change of Bushings shall be done only after testing shows them to be defective.
- b. For Station Transformer Unit – 9, optional price for rewinding and replacement of OLTC with new OLTC shall be indicated in the offer.
- c. Opening of 6.6 KV cable connection, 220 KV jumper connection, opening of Marshalling box connection and shifting of transformer to Maintenance area in A-B bay. Transformer overhauling can also be performed in situ provided it shall be well protected with Tarpaulin shed to avoid ingress of foreign material & dust inside the transformer tank.
- d. Inspection & repair of oil leakage from transformer tank, radiator bank, interconnecting pipes, conservator tank, 220KV lightning arrestor, 220KV & 6.6 KV bushing assembly.
- e. Checking, overhauling, repair and replacement if required of Buchholz relay, silica gel breather, OLI, WTI, OTI, Bushing CT's (HV, LV & Neutral), oil level indicator, gauge glass etc.
- f. Draining of oil from the tank, De tanking of winding, Removal & sludge cleaning of transformer core & inside of tank, checking/repair/testing of core & winding insulation, core tightening bolts, core bolt insulation, winding to terminal connection, earthing connection etc. Placement of core inside tank and reconnecting all the termination links, replacement all gaskets including transformer tank top cover. Cleaning of internal surface of the tank.
- g. Checking, overhauling & repair of radiator bank closing/ opening, drain valves including replacement of gasket, worn out mechanical parts of valves.
- h. Checking, overhauling, repair, testing of marshalling box including replacement contactor, wiring, terminal block, fuse, fuse base, space heater, thermostat, panel light & plug socket etc.
- i. Checking and if required replacement of 6.6 KV & 220 KV bushing damaged in fire.
- j. Checking, overhauling, repair and replacement if required replacement of 220KV lightning arrestor & LA counter.
- k. Vacuum pulling & Filtration, filling of transformer oil. Replacement of oil if testing of filtered oil shows lower BD value & higher acidity, shifting of new oil from JSEB store to site and shifting old oil to JSEB store. New oil will be supplied by JSEB.
- l. Checking of OLTC / OCTC as described above.
- m. Checking, overhauling, repair, replacement if required of OLTC drive mechanism including , drive motor, door switch, changeover relay, motor contactor, remote /local selector contactor, cam switch, safety switch, limit switch, motor protective relay, push button, position indicator potentiometer, Aux. supply transformer etc.
- n. Erection, testing & commissioning of Remote tap changing control panel (RTCC) in electrical control room

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- o. Inspection, repair, testing of Current transformers on 220KV phase & Neutral side, including replacement of Terminal Boxes, terminal plate, connecting cables etc. Replacement of Current transformer if found defective.
- p. Testing & commissioning of completely assembled transformer
- q. Other unforeseen work necessary for rehabilitation of the transformer.

**Unit Auxiliary Transformer Unit # 9 & Unit #10**

- a. Comprehensive electrical testing for condition assessment of transformer as mentioned above. UAT incomers had history of tripping, the details of which are available at site, this shall be referred to along with test reports UAT for unit #10 which are annexed at annexure - II.
- b. Opening of 6.6KV & LV cable connection, opening of marshalling box connection and shifting of transformer to maintenance area in A-B bay. Transformer overhauling can also be performed in situ provided it shall be well protected with Tarpaulin shed to avoid ingress of foreign material & dust inside the transformer tank.
- c. Inspection & repair of oil leakage from transformer tank, radiator bank, interconnecting pipes, conservator tank, 6.6 KV & LV bushing assembly
- d. Draining of oil from the tank, De-tanking of winding, removal & sludge cleaning of transformer core & inside of tank, checking/repair/ testing of core & winding insulation, core tightening bolts, core bolt insulation, winding to terminal connection, earthing connection etc. Placement of core inside tank and reconnecting all the termination links, replacement all gaskets.
- e. Checking, overhauling & repair of radiator bank, including radiator valve, radiator air release plug, radiator oil drain plug, closing/opening, drain valves including replacement of gasket, worn out mechanical parts of valves.
- f. Checking, overhauling, repair and replacement if required & testing of WTI, OTI, Buchholz relay system, off load tap changer, silica gel breather.
- g. Checking, overhauling, repair, testing of marshalling box including replacement contactor, wiring, terminal block, fuse, fuse base, space heater, Thermostat, panel light & plug socket etc.
- h. Vacuum pulling & Filtration, filling of transformer oil. Replacement of oil if testing of filtered oil shows lower BD value & higher acidity, shifting of new oil from JSEB store to site and shifting old oil to JSEB stores.
- i. Checking of OLTC / OCTC as described above.
- j. For Unit #9 -Checking, overhauling, repair, replacement if required of OLTC drive mechanism including , drive motor, door switch, changeover relay, motor contactor, remote/local selector contactor, cam switch, safety switch, limit switch, motor protective relay, push button, position indicator potentiometer, Aux. supply transformer etc.
- k. For Unit #9 - Erection, testing & commissioning of Remote tap changing control panel (RTCC) in electrical control room
- l. Replacement / replenishment of the shortage spares of the transformer.
- m. Testing & commissioning of completely assembled transformer
- n. Other unforeseen work necessary for rehabilitation of the transformer

**Auxiliary Transformers – Unit # 9 & Unit # 10**



**R & M JOB FOR BOP OF PATRATU TPS  
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Total sixteen numbers transformers shall be overhauled. Five numbers shall be covered with unit # 9 renovation and eleven numbers shall be covered with unit #10 renovation. List of transformers are listed at Annexure-IA.

- a. Comprehensive electrical testing for condition assessment of transformer as mentioned above.
- b. Opening of 6.6 KV & LV cable connection, opening of marshalling box connection and shifting of transformer to nearby maintenance shed
- c. Inspection & repair of oil leakage from transformer tank, radiator bank, interconnecting pipes, conservator tank, 6.6 KV & LV bushing assembly
- d. Draining of oil from the tank, De tanking of winding, Removal & sludge cleaning of transformer core & inside of tank, checking/repair/ testing of core & winding insulation, core tightening bolts, core bolt insulation, winding to terminal connection, earthing connection etc. Placement of core inside tank and reconnecting all the termination links, replacement all gaskets.
- e. Checking, overhauling & repair of radiator bank, including radiator valve, radiator air release plug, radiator oil drain plug, closing/opening, drain valves including replacement of gasket, worn out mechanical parts of valves.
- f. Checking, overhauling, repair and replacement if required & testing of WTI, OTI, Buchholz relay system, off load tap changer, silica gel breather
- g. Checking, overhauling, repair, testing of marshalling box including replacement contactor, wiring, terminal block, fuse, fuse base, space heater, thermostat, panel light & plug socket etc. If condition of marshalling box is bad then replacement with new.
- h. Vacuum pulling & filtration, filling of transformer oil. Replacement of oil if testing of filtered oil shows lower BD value & higher acidity, shifting of new oil from JSEB store to site and shifting old oil to JSEB stores. Oil replacement is envisaged in 13 nos. transformers & oil filtration in 3 nos. transformers.
- i. Testing & commissioning of completely assembled transformer
- j. Other unforeseen works necessary for rehabilitation of the transformer.

**05.03.00**

**Scope of Services for Motors**

Complete rewinding & overhauling of motors shall generally include following work:

- a) Bidder should submit the case study (Problems faced by customer and proposed solutions) of each motor and R&M methodology.
- b) Joint Inspection with BHEL/owner's engineer to assess defects and enter in joint protocol /repair formats.
- c) Decoupling , Dismantling ,opening of foundation bolts , removal from foundation
- d) Removal of motor from plant and shifting to Bidder's workshop for overhauling & rewinding.
- e) Rewinding of Induction motor stators with new coils & Class F insulation. Salvage of copper to be considered by bidder.
- f) Repair if required on rotor including re-brazing of rotor end rings. Rotor re-caging if required shall be done with prior approval of BHEL.
- g) Test on Re-wound stator of Induction motor before applying insulating varnish. Test includes IR , PI value & winding resistance.
- h) High Pot test for one minute at 2x rated voltage +1 KV of voltage level recommended for new winding.



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	<ul style="list-style-type: none"> <li>i) Dynamic balancing of rotor.</li> <li>j) Rewinding of Field &amp; armature of DC motors. Repair of commutator, if required. Replacement / repair of brush holders. Replacement of Carbon brushes.</li> <li>k) Embedment of BTD &amp; Winding RTD, space heater, Terminal blocks/Plates etc</li> <li>l) Overhauling of motor including replacement of Bearings and Re-babbiting as the case may be.</li> <li>m) Provision for Online greasing arrangement, BTD and DTI and space heater for HT Motors.</li> <li>n) Repair/Replacement if required of mechanical parts e.g. IBC/OBC, Scavenging disc, End shield, Fan, Oil Sealing arrangement, Fan cover, Bearing housing, Key way, Terminal box, shaft etc.</li> <li>o) For BFP Motors – Pre loaded float seal arrangement with Labyrinth. Modification on Bearing housing and the shell seating.</li> <li>p) For PA Motors - Motors bearing replacement / modification subject to CA. The motor rewinding shall be with Service factor 1.1.</li> <li>q) For BFP Motors – For starting of BFP motors, Pony motors system shall be made operative at site with prior approval of BHEL/ Customer.</li> <li>r) Painting –</li> <li>s) Testing of motor after assembly as per IS:325 and IS:4029</li> <li>t) Transport of assembled motor to site.</li> <li>u) Proper handling, packaging and transportation (like locking of rotor, proper resilient pads and support) shall be under bidder scope.</li> <li>v) Putting the motor on foundation, after minor modification in foundation if required, Measurement of vibration of motor in decoupled condition.</li> </ul>		
<b>05.04.00</b>	<b>Scope of Service for Bus Duct System &amp; CT</b>		
<b>05.04.01</b>	<b>Bus Duct</b>  Complete Servicing of Bus Duct system shall generally include following work: <ul style="list-style-type: none"> <li>a. Joint Inspection with BHEL/owner's engineer to assess defects in support insulators, enclosure support ring, Bus Bar Aluminium weld joint, disconnecting link, inspection opening, End shorting links, Rubber Bellow assembly, Expansion joint, steel support structure etc and enter in joint protocol/repair formats.</li> <li>b) Testing of IR &amp; high Pot test prior to start of overhauling.</li> <li>c) Cleaning of support insulators &amp; Bus duct interior. Physical Checking of support insulators for minor crack / discolorations of porcelain due to dust collection/condensation of moisture etc. Electrical test of insulator found defective during physical inspection. Replacement of insulator which have either failed electrical test or physical observation.</li> <li>d) Checking Tightness of connecting bolts with torque wrench, Flexible used at generator end &amp; GT/UAT end terminal for abnormal Temperature rise/ discolouring and clearance between phase &amp; enclosure throughout the duct length.</li> <li>e) Dismantling &amp; installation of replacement parts e.g. support insulator, link, support rings, Neoprene cork Gasket, resilient pad, Rubber Bellow, Textile sheet, fibre glass sleeve &amp; Hardware.</li> </ul>		
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05.04.02	<p>f) Application of multipurpose grease on jointing surfaces, painting of Bus Duct &amp; Bus duct Enclosure exterior– Light grey shade 631 of IS-5.</p> <p>g) Checking &amp; Testing of Earthing system including replacement of defective earthing pad, flats &amp; hardware.</p> <p>h) Commissioning test including IR value &amp; AC high voltage test.</p>		
	<p><b>Current Transformer</b></p> <p>Complete Testing of CT in Bus Duct system shall generally include following work:</p> <p>i. Joint Inspection with BHEL/owner's engineer to assess defects in Current transformer, Terminal Boxes, terminal plate, connecting cables for CT Secondary connection etc and enter in joint protocol/ repair formats</p> <p>ii. Electrical Test e.g. power frequency dry withstand, over-voltage interturn etc, as per relevant IS for adequacy of CT.</p> <p>iii. Replacement of defective current transformer, Terminal Boxes, terminal plate, connecting cables. Current transformer if required to be replaced shall be free issue item by BHEL/JSEB.</p> <p>iv. Commissioning Test on new current transformer – Insulation resistance, Verification of terminal marking &amp; polarity, Power frequency dry withstand test on primary &amp; secondary winding, Ratio test.</p>		
05.05.00	<p><b>Scope of Service for LAPT Panel</b></p> <p>Complete Servicing of LAPT panel in Bus duct system shall generally include following work:</p> <p>i. Joint Inspection with BHEL/owner's engineer to assess defects due to dust collection/condensation of moisture, abnormal temperature rise in Primary disconnect &amp; sliding contact assembly, Secondary disconnect assembly, support insulator, bushing, Lighting arrestor, surge protection capacitor and enter in repair formats.</p> <p>ii. Insulation resistance test &amp; other electrical test as per relevant IS to check adequacy of support Insulator, bushing, PT, LA and surge protection capacitor.</p> <p>iii. Replacement of defective sliding contact, support insulator, bushing, surge protection capacitor, Discharge resistor.</p> <p>iv. Checking &amp; Testing of space heater - Dismantling of defective space heater parts &amp; installation of new heater element, cable, terminal plate, Terminal Box, Marshalling box.</p> <p>v. Replacement of old HRC fuse, Terminal plate, connecting cables, Fluorescent lamp, thermostat with new.</p> <p>vi. Painting of PT &amp; SP cubicle – light grey shade 631 of IS-5</p> <p>vii. Commissioning Test for PT – Insulation resistance, Verification of terminal marking &amp; polarity, Power frequency dry withstand test on primary &amp; secondary winding, Ratio test as per relevant IS.</p> <p>viii. Commissioning Test for Surge capacitor - Measurement of capacitance, sealing test, dielectric loss angle test as per relevant IS.</p>		
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- ix. Commissioning Test For LA – Dry power frequency spark over test as per relevant IS.

**05.06.00**
**Scope of Services for Generator Neutral Grounding Cubicle**

- i. Joint Inspection with BHEL/owner's engineer to assess defects due to dust collection/condensation of moisture/abnormal temperature rise in NGT, NGR, Bushing, support insulator and enter in repair formats.
- ii. Insulation resistance test & other electrical test as per IS to check adequacy of support Insulator, bushing, NGT & NGR.
- iii. Replacement of defective support Insulator, bushing, NGT, NGR. NGT & NGR if found defective shall be supplied BHEL /JSEB as free issue item.
- iv. Checking & Testing of space heater - Dismantling of defective space heater parts & installation of New heater element, cable, terminal plate, Terminal Box.
- v. Replacement of old HRC fuse, disconnecting link, Fuse base & carrier, switches, Terminal block, connecting cables, Fluorescent lamp, Thermostat with new.
- vi. Painting of Neutral grounding cubicle – light grey shade 631 of IS.
- vii. Commissioning Test - resistance measurement of all winding, polarity & phase relation, dielectric test.

**06.00.00**
**GENERAL REQUIREMENT**
**06.01.00**
**Codes and Standards**
**06.01.01**

All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable IEC/IS except where modified and/or supplemented by this specification, as mentioned below:

S. No.	Standard No.	Title
1	IS 5	Color for ready mix paint
2	IS 325 & 996	Motors
3	IS 335	Transformer Oil
	IS 1448	
4	IS 1886	Code of practice for installation & maintenance of transformers
5	IS 2026	Transformers
6	IS 2147	Degree of protection provided by enclosures for LV switchgear & control gear
7	IS 2099 & 3347	Bushings
8	IS 2312	Fans
9	IS 2705	Current Transformers
10	IS 3637	Gas & Oil Operated Relays
11	IS 3639	Fittings & accessories for power transformers
12	IS 5561	Power Connectors.
13	IS 5578 & 11353	Marking & arrangement for switchgears, bus bars, main connectors and auxiliary wiring.

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- |    |          |   |
|----|----------|---|
| 13 | IS 6103  |   |
| 14 | IS 6104  |   |
| 15 | IS 6262  |   |
| 16 | IS 6600  | Guide for loading of oil immersed transformers                              |
| 17 | IS 6792  |   |
| 18 | IS 8468  | On Load Tap Changer   |
| 19 | IS 9434  |   |
| 20 | IS 10028 | Code of Practice for selection, installation & maintenance of transformers. |

Any other international code or standard may be used in lieu of above, with prior approval of the Owner.

**06.02.00**

**Annexures**

All Annexures appended to this specification shall form part of this specification and supplement the requirements specified herein.

**06.03.00**

**Guaranteed Performance**

The Equipment overhauled shall be guaranteed for proper operation for a period of 12 months from commissioning against any bad workmanship, sub standard material used by the contractor. If equipment fails within the guarantee period repair job shall be carried out free of cost including transportation to & from, loading / unloading, packing etc. of any spare needed to complete the repair, with all terms & conditions of the original contract.

**06.04.00**

**Deviation**

Should the bidder wish to deviate from this specification in any way; he shall draw specific attention to such deviation.

All such deviations shall be clearly mentioned on the deviation sheet enclosed as Annexure - VII with reference to the respective clause of the specification. The deviation listed elsewhere in the text of the tender will not be considered.

If there are no deviations, then Annexure - VII shall be submitted with NIL DEVIATION.

**06.05.00**

**Quality Assurance**

Bidder shall furnish his procedures for quality assurance. However, said standard procedures shall be submitted to the BHEL for approval. The bidder shall enclose quality assurance plan along with offer. Schedule and procedure for overhauling of various equipments shall be submitted before execution.

The procedures shall be in such a form as to clearly indicate the repair/ overhauling sequence and major inspection points and to reference Bidder's test and inspection procedures.

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The Quality Plan shall identify the procedures, the Contractor intends to use to manage and control the Contract, including:

- a. The duties and responsibilities assigned to staff ensuring quality of work for the Contract;
- b. Hold and notification points;
- c. Submission of engineering documents required by the Specification;
- d. The inspection of replacement materials and components on receipt;
- e. Reference to the Contractor's work procedures appropriate to each activity;
- f. Stage inspection during repair/overhauling;
- g. Final inspection and test.

The BHEL will inform the contractor as to which of the inspection points and tests will be witnessed. As a minimum a final inspection of the equipment will be made prior to shipment for items being replaced and prior to commissioning for items being overhauled at site.

Bidder shall be required to submit their MQP & FQP in format attached in specification for approval of BHEL.

**06.06.00**

### **Monitoring**

During the course of the Contract the BHEL reserves the right to monitor the implementation of the Contractor's quality assurance arrangements.

The Contractor's compliance with equipment, documentation, drawing, delivery, construction, installation and commissioning schedules shall be monitored by the BHEL. Monitoring may be by means of a program of formal audits and/or surveillance of activities at the work locations. Where deficiencies requiring corrective actions are identified the Contractor shall implement an agreed corrective action program. BHEL shall be afforded unrestricted access at all reasonable times to review the implementation of such corrective actions.

For site work the BHEL / Owner Engineer may monitor all aspects of the Contractor's daily work including that of subcontractors and assess the achievement of milestones as detailed by schedule deliverables.

BHEL reserves the right to monitor the subcontractors and the Contractor shall ensure that all subcontracts include, and subcontractors are aware of, this requirement.

**06.07.00**

### **Control of Subcontractors**



Prior approval shall be taken from BHEL before sub-contracting any work under this specification. The sub-contractor shall meet the qualifying requirements for each package mentioned elsewhere in this specification. The credentials indicating past experience, list of tools & tackles available, list of personnel being deputed for the job with their profile and detailed plan for execution of job shall be submitted for approval of sub-vendor.



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	<p>The Contractor shall be responsible for specifying the quality assurance requirements applicable to subcontractors and suppliers, for reviewing the implementation of subcontractors' quality assurance arrangements and for ensuring compliance with the requirements.</p> <p>The Contractor shall ensure that all appropriate technical information is provided to subcontractors and suppliers. The Contractor shall, for the supply of items, plant or equipment (including those subcontracted), arrange for suitable protection for the product at all stages including delivery and installation at the site.</p> <p>The Contractor shall submit, for information, a detailed program defining the basis of control to be applied to each subcontract or supply order.</p>		
<b>06.08.00</b>	<b>Records</b>		
	<p>Records of equipment to be overhauled shall be agreed with the BHEL prior to setting-to-work of each phase, i.e. inspection &amp; testing before dismantling, dismantling, repairs / testing, assembly, painting, testing, trial runs.</p>		
<b>06.09.00</b>	<b>Servicing, Supervision and Checking of work on site</b>		
	<p>The carrying out of all work on the Site included in this Contract shall be supervised throughout by a sufficient number of qualified representatives of the Contractor who have had thorough experience of the repair, overhauling and commissioning of similar Works.</p> <p>The Contractor shall ascertain from time to time what portions of the work on the Site the BHEL/Owner Engineer desires to check, but such checking shall not relieve the Contractor from the liability to complete the Works in accordance with the Contract or exonerate him from any of his guarantees.</p> <p>If the BHEL/Owner Engineer shall certify that defects have shown themselves in the Works, the Contractor shall, for the purpose of the maintenance after the completion of the Works provided for by the Conditions of Contract, keep on Site supervisory staff of such numbers and for such periods as the BHEL / owner Engineer may require.</p> <p>The Contractor is to keep the site, on which he works or stores, reasonably clean removing all waste material resulting from the Works as it accumulates and as reasonably directed. On completion of the Works the Site is to be left clean and tidy to the satisfaction of the BHEL/Owner Engineer. Any damage done to buildings, structures and plant or property belonging to the Owner's assets is to be made good at the Contractor's expense.</p>		
<b>06.10.00</b>	<b>Paint &amp; Finish</b>		
	<p>All external &amp; internal parts shall be finished and painted to produce a neat and durable surface which would prevent rusting and corrosion. The equipment shall be thoroughly degreased, and sharp edges and scales removed and treated with one coat of primer and two coats of enamel paint shade as indicated in the Project specifications.</p>		
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<b>06.11.00</b>	<b>Vendor Approval</b>  All the sub vendors for the contractor's bought out items shall be approved by the Purchaser/Owner. The contractor's proposal for vendor approval shall be accompanied by details of vendor's facilities at his works, process capability, QC systems followed, experience list and his own assessment and recommendation. Such vendor approval shall not relieve the contractor of his contractual obligations.  It shall be the responsibility of the contractor that all bought out items conform to the requirements of this specification. The contractor shall submit to Purchaser/Owner unpriced copies of all purchased orders immediately after the issue of purchase order		
<b>06.12.00</b>	<b>Equipment Life</b>  The replacement equipment/parts shall be designed for a minimum operating life of 30 years under the conditions of operation described elsewhere. Assurance shall be given in the bid that all plant components are adequate for this lifetime. If there are any exceptional items of the plant on which an assurance of meeting this clause cannot be given, the life of such components and the difficulties associated with them shall be stated in the bid.		
<b>06.13.00</b>	<b>Packing &amp; Transportation</b>  All the supplied equipment shall be suitably protected, coated, covered in wooden box to prevent damage or deterioration during transit, handling and storage at site till the time of erection		
<b>07.00.00</b>	<b>OVERHAULING /REPAIR PRODEDURES</b>		
<b>07.01.00</b>	<b>Documentation</b>		
<b>07.01.01</b>	<b>Equipment Repair Form</b>  Equipment Repair Form shall be prepared for each equipment after joint inspection by contractor & BHEL/Owner engineer which shall list the perceived problems, the operating environment, the urgency of the repair, past problems where applicable, the required repair, missing parts,. During repair, actions and findings shall be recorded on Equipment repair form which shall become Service Order for each equipment. It shall contain records of all work done, problems noted, checks and measurements taken during the work, repairs carried out, and final tests conducted prior to trial run. A copy of test results and/or the Equipment Service Order shall be supplied to the BHEL.		
<b>07.02.00</b>	<b>Expanded Work Scope</b>  If test & inspections indicate problems beyond the initial scope of the requested repair, BHEL shall be contacted and given a description of the problems, plus an estimate of their effect on handing over and costs.		
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<b>07.03.00</b>	<b>Inspection</b>  The Contractor shall do the initial tests set out in the specification & indicated by the repair form, plus any other tests required to assess the condition of various part of the equipment under this package. The intent of the initial tests shall be to determine and record the probable cause of failure, If any, to document certain pre-repair parameters, and to determine what work is required to be done.		
<b>07.04.00</b>	<b>Dismantling</b>		
07.04.01	<b>Markings</b>  End brackets and frames shall be clearly match-marked by punch or metal number stamp		
07.04.02	<b>Parts Storage</b>  Bolts and small parts shall be stored in dedicated and identified containers; parts from other jobs shall not be kept with them.		
<b>07.05.00</b>	<b>Cleaning &amp; Painting</b>  All the parts shall be thoroughly cleaned by sand blasting or chemical process to make smooth surface free of scaling, grease, rust etc and all external rough surfaces shall be filled.  The internal surface in contact with insulation oil shall be painted with heat resistance, oil insoluble insulating varnish.  The entire external surface after cleaning shall be given the coat of high quality red oxide or yellow chromate primer, followed by filler coat,  Painting shall be done after attending oil leakage and through cleaning.  If there is a requirement of welding, the same shall be done after consulting with BHEL Engineer.  Leaking joints shall be rectified by tightening the bolts to the correct pressure or by replacing the gaskets.  All paints shall be applied in strict accordance with the paint manufacturer's instructions.  All painting shall be carried out on dry and clean surfaces and under suitable atmospheric and other conditions in accordance with the paint manufacturer's recommendations.		
07.05.01	<b>Paint Process</b>  a. All steelwork, plant supporting steelwork and metalwork, except galvanized surfaces or where otherwise specified, shall be shot blasted to BS 4232 (second quality finish).		
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- b. All surfaces shall then be painted with one coat of epoxy zinc rich primer (two pack type) to a film thickness of 50 microns. This primer shall be applied preferably by airless spray and within twenty minutes but not exceeding one hour of shot blasting.
- c. All rough surfaces of coatings shall be filled with approved two pack filler and rubbed down to a smooth surface.
- d. The interior surfaces of all steel tanks and oil filled chambers shall be shot blasted in accordance with BS 4232 (first quality finish) and painted within a period of preferably twenty minutes but not exceeding one hour with an oil resisting coating of a type and make to the approval of the Engineer.
- e. The interior surfaces of mechanism chambers, boxes and kiosks, after preparation, cleaning and priming as required above, shall be painted with one coat zinc chromate primer, one coat phenolic based undercoating, followed by one coat phenolic based finishing paint to a light or white color. For equipment for outdoor use this shall be followed by a final coat of anti-condensation paint of a type and make to the approval of the Engineer, to a light or white color. A minimum overall paint film thickness of 150 microns shall be maintained throughout.
- f. All steelwork and metalwork, except where otherwise specified, after preparation and priming as required above shall be painted with one coat metallic zinc primer and two coats of micaceous iron oxide paint to an overall minimum paint film thickness of 150 microns.
- g. Galvanized surfaces shall not be painted in the works.
- h. All nuts, bolts, washers etc, which may be fitted after fabrication of the plant shall be painted as described above after fabrication.

**07.06.00**

### **Earthing Connections**

All cubicles shall be connected to a GI earth busbar running throughout the length of the panel. All doors and movable parts shall be connected to the earth bus with flexible copper connections.

Provisions shall be made to connect the earthing busbar to the plant earthing grids at two ends. All non-current carrying metallic parts of the mounted equipment shall be earthed.

CT and PT secondary neutrals shall be earthed through removable links.

The earth bus shall have sufficient cross section to carry the momentary short circuit & short time fault currents to earth as specified in specifications, without exceeding the allowable temperature rise.

All metallic cases of instrument & other panel mounted equipments shall be connected to earth bus by independent stranded copper wires of size not less than 4 mm<sup>2</sup>. Insulation



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<b>07.07.00</b>	<p>color code of earthing wires shall be green. Earthing wires shall be connected to terminals with suitable clamps &amp; connectors.</p> <p>All hinged doors shall be earthed through flexible earthing braid.</p> <p><b>Labels and Plates</b></p> <p>All overhauled Equipment and associated spares shall be provided with prominent, engraved identification plates.</p> <p>All name plates shall be of non rusting metal or three (3) ply laminated with white engraved lettering on black back ground, inscription &amp; lettering sizes shall be subjected to BHEL's approval.</p> <p>Suitable plastic sticker labels shall be provided for easy identification of all equipments, located inside the panel/module. These labels shall be positioned so as to be visible &amp; shall give the device number, as mentioned in the module wiring diagrams.</p>		
	<p><b>08.00.00 OVERHAULING PROCEDURE &amp; CRITERIA FOR TRANSFORMER</b></p>		
	<p><b>08.01.00 Insulating Oil</b></p> <p>The oil level shall be checked. Oil analysis and Dissolved Gas Analysis shall be carried out on oil samples of all transformers after filtration of oil. If the results are found unsatisfactory, the oil of the transformer shall be replaced and BHEL/ JSEB shall provide necessary oil.</p>		
08.01.01	<p><b>Oil Filtration</b></p> <p>Transformer oil is usually contaminated during storage due to ingress of moisture and solid impurities. Hence, oil shall be vacuum filtered separately at 50°C to 60°C using a suitable filtration machine and a spare clean tank before filling in the transformer. Details of filtration shall be as per IS: 1886. Electric strength and moisture content shall be determined as per test procedure in IS: 335. Ensure all valves in the oil are open during filtration.</p>		
08.01.02	<p><b>Oil filling</b></p> <p>The transformer shall be filled under vacuum with oil which has been purified and degassed.</p>		
<b>08.02.00</b>	<p><b>Temperature</b></p> <p>The life of the transformer is highly dependent on the temperature prevailing in the core and windings under operation.</p>		
08.02.01	<p><b>Temperature Indicators</b></p> <p>Oil Temperature Indicator (OTI) and winding Temperature Indicator (WTI) shall be replaced with the new ones if required in all transformers.</p>		
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The level of oil in the pockets holding thermometer bulb shall be checked and the oil replenished, if required. The capillary tubing shall be fastened down again, if it has become loose. Dial glasses shall be kept clear and if broken shall be replaced to prevent damage in the instrument. Temperature Indicators shall be calibrated with standard thermometer immersed in hot oil bath if found to be reading incorrectly

#### Oil Temperature Indicator (OTI):

All transformers shall be provided with a 150 mm dial type thermometer for top oil temperature indication. The thermometer shall have adjustable, potential free alarm and trip contacts, maximum reading pointer and resetting device and shall be mounted in the Marshalling Box. A temperature sensing element suitably located in a pocket in the top oil shall be furnished. This shall be connected to the OTI by means of Capillary tubing. Accuracy class of OTI shall be  $\pm 2^{\circ}\text{C}$  or better. The OTI shall have a full scale deflection of 0 to  $150^{\circ}\text{C}$  and shall have linear graduations to read every  $2^{\circ}\text{C}$ .

#### Winding Temperature Indicator (WTI):

A device for measuring the hot spot temperature of the winding shall be provided. The accuracy class of winding temperature indicator shall be  $\pm 2^{\circ}\text{C}$  or better. It shall comprise the following:

- Temperature sensing element
- Image coil and bushing current transformer
- Auxiliary CT's if required to match the image coil, shall be furnished and mounted in the marshalling box.

150 mm dial type local indicating instrument with maximum reading pointer shall be mounted in marshalling box. It shall have two adjustable potential free contracts, one for winding temperature high alarm and one for trip, in addition to the contacts required for control of cooling equipment.

#### Automatic ambient temperature compensation

All contacts shall be adjustable on a scale and suitable for connection in 220V DC circuit. These shall be accessible on removal of the cover.

The WTI shall have a full scale deflection of 0 to  $150^{\circ}\text{C}$  and shall have linear graduations to read every  $2^{\circ}\text{C}$ .

In addition to the above, the following remote indication equipment shall be provided for unit transformers: (Instruments to be supplied loose for mounting on remote control panel)

- Signal transmitter(s)
- Digital type remote winding temperature indicator for transformers of rating 16MVA and above. It shall be suitable for flush mounting on panel in the control room. The shape, size and make of the temperature indicator shall be coordinated.



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Signal transmitter shall have additional facility to transmit signal for recording winding temperature at Purchaser's Data Acquisition System (DAS) for which a Duplex platinum RTD with nominal resistance of 100 ohms at zero shall be provided. It shall have independent temperature sensing element, image coil, auxiliary CT's etc. For each transformer, only one such RTD along with other devices mentioned above shall be furnished.

- Digital type tap position indicator, if OLTC is applicable.
- RAISE/LOWER switch for OLTC mechanism, if OLTC is applicable.

If it is required then WTI and OTI alarm contacts shall be provided with parallel resistors of value 47 kilohm as specified in Project Specific Requirement based on C&I vendor specification. The resistor shall be of metal-oxide type with  $0.25 W \pm 1\%$  and the total tolerance less than 5%.

**08.03.00**

**Cooling Circuit**

Inspection/replacements of cooling circuit connections, overload, contractor etc.

Fan blades are cleaned to remove dust. Old Bearings shall be replaced by new Bearings and lubricated properly. Other precautionary measures such as checking of correct operation of pumps, gauges, indicators etc.

**08.04.00**

**Buchholz Relay**

The Buchholz shall be operated for fault. Buchholz relay shall give alarm / trip due to the oil level below the Buchholz relay. The mal operation of Buchholz relay shall be removed.

A double float type Buchholtz relay conforming to IS: 3637 shall be provided. All gas evolved in the transformer shall collect in this relay. The relay shall be provided with a test cock suitable for a flexible pipe connection for checking its operation. The device shall be provided with two potential free contacts, one for alarm on gas accumulation and the other for tripping on sudden rise of pressure.

A suitable gas collecting device shall also be provided with each transformer, which shall be mounted in a conveniently accessible position. The gas collector of the relay shall be connected to gas sampling device with a copper tube. The above should also have a proper arrangement for draining the oil from the relay.

**08.05.00**

**Radiators**

Cleaning of radiator tank internally as well as externally of all transformers. Identification of leakages and its rectification. The external cooling surfaces of all transformers shall be cleaned from dust, insects, leaves or other airborne dirt by water flushing at high pressure.



The internal cooling surface shall be flushed with clean oil on the formation of sludge. If the sludge does not loosen, firstly flush with petrol, and then with hot oil.



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<b>08.06.00</b>	<b>Bushings</b>  <p>The CT Bushings of all transformers shall be checked and tested properly and complete refurbishment shall be done. Ensure sealing/protection against rain water ingress.</p> <p>Clean the bushing Porcelain and examine them for cracks and chips. Very slight chips may be ignored but any serious damage shall require new porcelain which may be obtained from the manufacturer. In some case porcelain only may be changed while in other case the conductor rod is cemented into the porcelain and the entire bushing required to be changed.</p> <p>New Porcelain Bushing shall conform to the requirements of IS 2099. The rated short circuit current withstand capability of the bushing shall be same as that for corresponding winding. The rating and size of new bushing shall replicate yhe old one or according to the rating suitable for transformer.</p>		
<b>08.07.00</b>	<b>Cable Boxes</b>  <p>The seating arrangements for filling holes shall be checked. The screw plugs are sealed with a bituminous compound, the compound shall be examined for cracks. If the compound has cracked it shall lead to accumulation of water around the plug. Gaskets joints should be examined and tightened whenever required.</p>		
<b>08.08.00</b>	<b>External Connections</b>  <p>All connections shall be tight. If they appear blackened or corroded under the connection and clean down the bright metal emery paper. Remake the connection and give it a heavy coating of grease. Heavy current connections shall be properly maintained. If the metal has the characteristic blush tings which indicate that it has been hot, then in most cases the connection shall be not be connections satisfactory. Either it has become loose or dirty, or the connection is not suitable for carrying current.</p>		
<b>08.09.00</b>	<b>Earthing Connections</b>  <p>The earth connections shall be properly maintained. A small copper loop to bridge the top cover of the transformer and the tank may be provided to avoid earth-fault current passing through the fastening bolts when there is a lightning surges, high voltage surge or failure of bushings.</p>		
<b>08.10.00</b>	<b>Conservator and Magnetic Oil Gauge</b>  <p>The inside of the conservator shall be cleaned or flushed with oil. The oil level indicator (OLI) shall be kept clean. When conservator is stripped for cleaning, the mechanism of the oil shall be inspected and cleaned.</p> <p>The transformer oil conservator shall be provided with oil level indicator. At an oil temperature of 45°C, the conservator shall be half filled. If the level exceeds the value "full", oil must be drained off. If the value is "low", oil must be filled in. Normal oil level shall be at 35°C mark.</p>		
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<b>08.11.00</b>	<b>Breather</b>  The predominantly pink silica gel shall be removed and replaced. Clean the breather and replace the dry crystals and renew the oil in the sealing cup at the bottom.		
<b>08.12.00</b>	<b>Explosion Vent</b>  The diaphragm, which is fitted at the exposed end of the vent shall be inspected and replaced. If damaged.  The explosion vent shall be double diaphragm type along with a gauge glass in the intermediate chamber.		
<b>08.13.00</b>	<b>Gasket</b>  The tightness of all bolts, fastening gaskets shall be checked. The bolts shall be tightened evenly round the joints to avoid uneven pressure. All gaskets shall be replaced.		
<b>08.14.00</b>	<b>Small Pipe Work</b>  The pipe work shall be inspected. Leaks shall be removed whenever required.		
<b>08.15.00</b>	<b>Marshalling Box</b>  The Marshalling Box of all transformers shall be checked properly and complete refurbishment shall be done. The door provided shall be lockable type with glass front.  The box shall cover all the auxiliary devices except those which must be mounted on transformer. The correct tightness of wiring of all control alarms, indications and relay shall be checked. Marshalling box shall have complete protection against rain water.  The CT wiring with polarity mark therein for connection to through relay in the switchgear panel shall be checked. The cable entries shall be from bottom with detachable gland plates for facilitating the termination of others" cables separately..  A sheet steel, weather, vermin and dust proof marshalling box shall be furnished with each transformer to accommodate:- <ul style="list-style-type: none"> <li>• Temperature indicators</li> <li>• Control and protection equipment for the electrical control of tap changer, if applicable.</li> <li>• Control and protection equipment for the cooler control, and</li> <li>• Terminal boards for incoming and outgoing cables.</li> </ul> Sheet steel used shall be at least 2.0 mm thick. The box shall be free standing, floor mounted type and have sloping roof. The degree of protection shall be IP:55 in accordance with IS 13947 Part 1.  The temperature indicators shall be so mounted that the dials are not more than 1600 mm from ground level.		
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The marshalling box shall have a glazed door of suitable size for convenience of temperature indicators reading.

All cables shall enter the kiosk from the bottom and the gland plate shall be not less than 450 mm from the base of the box. The gland plate and the associated compartment shall be sealed in suitable manner to prevent the ingress of moisture, rodents, insects etc. from the cable trench. Gland plates, cable lugs, cable glands, etc. shall be furnished as per the requirements for the scope of supplies for cables and cable terminations.

The marshalling box shall be supplied with space heater and cubicle lighting with ON-OFF switches and associated fuses.

It shall be located in such a way that the front shall not face the transformer. It shall be mounted at least 500 mm above the ground level.

**08.16.00**

### **On Load Tap Changer**

**08.16.01**

#### **Servicing of OLTC**

In spite of overall servicing, few portions shall be carefully inspected which is enumerated below.

Diverter Switch – Servicing of diverter switch contacts. Checking the oil level in the diverter switch chamber, and replacement of diverter switch oil when the same is found unsuitable for future use.

#### **Motor Driving Mechanism:**

1. Clean dirt accumulated between contact rings of notching controller.
2. Do not use oil/grease on contact rings of notching controller.
3. Check the condition of anti-condensation heater.
4. If the contacts of contactors are silver faced, no touching up shall be done, but should be replaced when they are worn out. Copper contacts may be lightly touched up with a file when they become rough. The pole face of electromagnet shall be kept clean.
5. Do not oil/grease the contacts surface of radial multi-contact switches, unless a special contact lubricant is used.

Selector Switch – Check the mechanical movement of moving contacts.

#### **Checking of OLTC operation**

Measure winding resistance of all the three phases before starting of the work. Make the OLTC to travel over the entire range at least once. Return the OLTC to the normal position. Measure the winding resistance once again. In case of abnormal variation, suspect the problem in contact and rectify the same.

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**08.16.02**

**RTCC Panel**

RTCC panel shall be suitable for remote control of OLTC for 30 MVA, 230 KV/6.6 KV station transformer having +/- 10% change in HV winding in steps of 0.625% (17 steps). panel shall be made from 14SWG CRCA sheet, and shall be provided base frame with mounting holes & bolts, anti vibration pad, lifting lugs, lockable door with key, removable undrilled Gland plate, earthing terminal, Cubicle lamp, space heater, thermostat etc. indication lamp for tap changing in process, six window annunciator, digital type tap position indicator, auto /manual, control supply and heater switches, Raise /lower push button, AVR relay shall be mounted at the front of the panel. RTCC shall control tap changing operation using time delay and aux. relays. All control wiring shall be done by 2.5 sq mm PVC stranded copper wire. Internal surface of the panel shall be painted with white glossy paint and outer surface shall be painted with polyurethane paint shade 632 of IS-5. Annunciation with hooter shall be provided for Tap changing in progress, drive motor trip, tap change struck, control supply failure, time delayed under voltage.

**08.17.00**

**Current Transformer**

Contractor shall perform necessary test to check its working. Contractor shall inspect all the necessary parts like core, primary and secondary coil and its insulation, Porcelain, Cover, tank, terminal box and remaining parts thoroughly. Any minor damage in part shall be repaired. If major defect are noticed during physical inspection or Due to test, CT shall be replaced by new one.

On replacement of old, all the necessary technical data shall be recorded like rating, accuracy class (protection or metering) and burden for the purchase of new CT. New CT shall match the dimension of old CT.

The data to be recorded from constructional point of view shall be material of winding, material of core, sealing breathing, type of terminal box, junction box, primary terminals, insulator, mounting structure and grounding terminal.

The technical data of various CT's according to the transformer are:-

Generator Transformer unit # 9 & 10



- (i) 600/1 A, Class PS, Secondary Resistance less than or equal to 4 Ohms,  $V_K$  more than or equal to 1000 Volts. For Generator transformer differential Protection.
- (ii) 600/1 A, Class PS, Secondary Resistance less than or equal to 4 Ohms,  $V_K$  more than or equal to 600 Volts. For Generator transformer Neutral Protection.
- (iii) 600/1 A, Class 5P20, 20VA for Generator transformer Neutral Protection. Station Transformer (ST) for Unit # 9 - 4B & Station Transformer (ST) for Unit # 10 - 4A
- (iv) 300/1 A, Class PS, Secondary Resistance less than or equal to 2 Ohms,  $V_K$  more than or equal to 1500 Volts. for transformer Differential Protection
- (v) 300/1 A, Class PS, Secondary Resistance less than or equal to 2 Ohms,  $V_K$  more than or equal to 1200 Volts. in transformer Neutral

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<b>08.18.00</b>	<b>Lightning Arrester</b>  Lightning Arresters shall be suitable for Outdoor duty and shall be made from metal oxide discs, connected in series without any spark gaps. Surge counter to register the no of Lightning strokes to lightning arresters which lightning arrester is subjected and leakage current indicator to monitor the state of health of nonlinear resistor discs shall be provided. Insulators, as per IS 5621, cantilever strength shall not be less than 350 kg. All lightning arrester power terminals shall be a four hole Aluminum NEMA pad. All lightning arresters shall be provided with an earthing terminal. The earthing terminal shall be made of two 14 mm diameter holes, 38 mm spacing, and steel pad. Two (2) earthing terminals shall be located at the bottom of each supporting structure to allow bolted connection to the switchyard earthing grid conductor. The earthing terminals shall be made of two 14 mm diameter holes, 38 mm spacing.		
<b>09.00.00</b>	<b>OVERHAULING /REWINDING PROCEDURE &amp; CRITERIA FOR MOTORS</b>  Contractor shall assess the condition of motor before rewinding & overhauling as follows: <ol style="list-style-type: none"> <li>Record operational history of the Motor.</li> <li>Measure coupling gap &amp; no. of shims provided on the motor before decoupling &amp; dismantling of the motor.</li> <li>Disconnection of the cables and other measuring devices mounted on the motor.</li> <li>Measure all the specific requirements which includes motor used for driven equipments, duty, mounting, insulation, no. of turns per coil, type of coil and insulation used in stator &amp; rotor slots.</li> </ol>		
<b>09.01.00</b>	<b>Winding Removal</b>		
09.01.01	<b>Winding Data</b>  Winding data shall be recorded so as to permit replicating precisely the original configuration. Changes that do not affect the magnetic densities or current densities by more than 2% are permissible, as well as changes that reduce the current density (increase cross sectional area per turn). Otherwise, the total cross sectional area of a turn, the turns per coil, the end turn extension, the span and connection of the coils shall not be changed without authorization from the BHEL.		
09.01.02	<b>Core Loss</b>  A core loss test shall be done on all stators both before and after stripping and iron repair, to check for damaged interlaminar insulation. The tests shall be done at a flux density of 85,000 lines per square inch rms. Exciting current and watts loss shall be recorded each time, as well as a physical check carried out for hot spots. If data from previous tests are available, the results shall be compared. Testing at other flux densities may be done if previous data is not available.		
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09.01.03	<p><b>Burn Out.</b></p> <p>For LT motors winding shall be burned out in a controlled temperature burnout oven where the part temperature is limited by means of fuel control and supplementary (water spray) cooling to 360°C (680°F) for organic (C3) or 400°C (750°F) for inorganic (C5) interlaminar insulation. If a higher temperature is deemed necessary, repairer shall reference communication or documentation from the motor manufacturer indicating that the core iron can safely withstand the temperature. Windings may be stripped chemically if burnout facilities are not available. Other stripping methods may be used with BHEL approval.</p>		
<b>09.02.00</b>	<p><b>Core Preparation</b></p>		
09.02.01	<p><b>Cleaning</b></p> <p>The stripped core shall be cleaned of all foreign materials, such as insulation debris, and dried.</p>		
09.02.02	<p><b>Iron Damage</b></p> <p>All obvious iron damage and significant frame damage, plus any problems indicated by core loss tests, shall be reported to the BHEL before proceeding further.</p>		
09.02.03	<p><b>Method of Repair</b></p> <p>Method of Repair to damaged cores shall be discussed with BHEL and shall be chosen from the following:</p> <ol style="list-style-type: none"> <li>Grinding - Selective grinding with a small sharp power tool, followed by inspection, to verify no surface shorting of the laminations exists.</li> <li>Spray between laminates – Separating laminations and reinsulating with spray on interlaminar insulation.</li> <li>Mica between laminations - Inserting split mica between the laminations.</li> <li>Restacking - Restacking, with deburred laminations and new interlaminar insulation. For LT motors only. V For HT motors stator recaging is not envisaged.</li> </ol>		
<b>09.03.00</b>	<p><b>Rewinding</b></p>		
09.03.01	<p><b>Winding Details</b></p> <p>Contractor shall prepare dimensional drawing of the old coil mentioning no of turns, size of conductor, insulation, weight of copper used etc. Contractor shall also prepare existing phase wiring &amp; connection diagram, showing number of coils per slots, no of slots, pitch of the coil etc. The total cross sectional area of a turn, the turns per coil, the span and connections of the coils shall not be changed without authorization from the BHEL. Contractor shall note down length of core, stator bore size, depth of core stampings, type of slot, depth of slot etc. Submit all the data to the BHEL for future</p>		
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- 09.03.02 record. New coil shall be made using electrolytic grade copper of specified grade as per relevant standard. Contractor shall prepare drawing of new coil mentioning all details as asked above for old coil.
- 09.03.03 Conductor
- Enameled copper wire for rewinding of LT motor stator & armature of DC motor. E.C. grade copper strip for rewinding of HT motor stator & Field winding of DC motors.
- 09.03.04 Thermal Class
- Class F shall be used throughout in spite of any other old insulation. Insulation class of Field winding in DC motors shall be of insulation class similar to existing or better
- 09.03.05 Winding Temperature Sensors
- Contractor shall note down & furnish existing RTD's location in the winding for HT motors, All HT motors shall be provided with minimum six numbers new RTD 's , which shall be installed at probable hot spot location in the winding. New temperature sensing devices (RTD) shall be comparable to those previously used. In LT motors winding sensor may be located in the end turns and new sensor shall be of the same type as original.
- 09.03.05 Insulation Materials
- Insulations shall include, as a minimum, the following components:
- Turn insulation - Multiple build coating turn insulation of polyamide, polyimide or a combination of both over polyester, or equivalent for LT motor stator & DC motor armature. Glass covered class F insulation for conductor in HT motor.
  - Slot Liner - Slot liner extending at least one quarter inch past each end of the slot.
  - Separator - Center strip or separator between the top and bottom coil sides in a slot.
  - Wedge - A top piece of Fibre glass wedge to hold the coils in the slot (where needed, a bottom filling piece shall be used to make up any extra space in the slot).
  - Phase Barriers - Phase barriers between end turns of different phases (these shall be trimmed to permit clear airflow).
  - Varnish - Class F varnish baking, providing epoxy gel coat varnish, again baking the entire winding. Varnish or resin, shall conform to the specifications of the manufacturer.



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09.03.06	<b>End Turns</b>  The end turn shall be fully compacted so that there are no loose wires/moulded coil. Both set of end turns, plus leads, and jumpers, shall be laced tightly together so that each coil is tied securely to the two adjacent coils. Each HT coil shall be provided with stress grading & corona protection.		
09.03.07	<b>Connections</b>  Connections shall be insulated, have no sharp edges, and be brazed with materials that will not corrode in the specified operating environment.		
09.03.08	<b>Winding Test</b>  Before impregnation, the winding shall be tested to verify that there are no wrong connections or shorted turns. This may include a surge comparison test, a high potential test, and winding resistance test. Voltage used shall be as indicated in relevant standard or as approved by BHEL. Any defect found shall be corrected and winding again retested before impregnating.		
09.03.09	<b>Impregnation</b>  The rewind stator shall be impregnated using Dr. Beck make resin or varnish in one of the following ways, depending of the size of motor: <ul style="list-style-type: none"> <li>a. Dip-and-Bake - Double dip-and-bake cycle using resin or varnish and a temperature-controlled bake oven. (Baking times and temperatures shall be recorded in the Motor Service Order.)</li> <li>b. Trickle - A trickle epoxy or polyester treatment where the resin is poured into the end turns and slots of a vertically inclined stator, which has been heated with controlled electric current to assist in curing the resin.</li> <li>c. VPI - Vacuum Pressure Impregnation (VPI) treatment.</li> </ul> Except VPI method all other method shall be got approved by BHEL		
09.04.00	<b>Rotor Test and Repair</b>		
09.04.01	<b>Testing</b>  All rotors shall be given a test for damaged bars, whether the motor is suspect in this area or not. This test shall apply a stable single-phase voltage to the stator of the assembled motor while the shaft is slowly turned through at least one revolution. Variation of stator current in excess of three percent is an indication of a rotor defect. Other methods, as shown below can also be used, particularly if the stator winding is defective.  When electrical or mechanical problems with the rotor are suspected, more sophisticated tests shall be used, including one or more of the following:		
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09.04.02	<p>a. Growler tests.</p> <p>b. Current analysis or vibration analysis of a loaded motor.</p> <p>c. Physical examination.</p> <p>d. Ultrasonic examination of the bars and end rings.</p> <p>e. Core loss tests (axial current thorough shaft).</p> <p>Repair</p> <p>Since repair of squirrel cages can be expensive, no work shall be done in this area without BHEL approval.</p>		
09.05.00	<b>Specific Requirement</b>		
09.05.01	<p>Shaft</p> <p>In case inspection indicates that there may be a shaft problem, it shall be informed to BHEL. Shaft problem in LT motors shall be repaired or replaced with BHEL's approval. If there is any risk or uncertainty in the proposed repair method, this shall be discussed with the BHEL prior to proceeding. The repaired shaft shall meet the following criteria:</p> <p>a. Total Indicated Run-out - Not more than 0.051 mm (0.002 inch) for up to 41.3 mm (1.625 inch) shaft diameter and not more than 0.003 inch for larger diameters at any location with reference to the bearing journals.</p> <p>b. No Cracks - The shaft shall have no cracks. If ultrasonic, magnetic particle, dye penetrant or other testing methods are needed to verify this, test results shall be documented in repair records.</p> <p>c. Straightness - The shaft shall be straight, parallel and undamaged at the bearing areas. If any measurable but acceptable deviation is found, this is noted, it shall be documented in repair records.</p> <p>d. Journal Repairs - Make journal repairs by welding, metalizing or plating, followed by machining and grinding, per manufacturer's specifications.</p> <p>e. Fit To Rotor - The shaft shall be a tight fit to the rotor iron. If there is looseness, the shaft shall be built up and turned for proper interference fit, or shall be replaced.</p> <p>f. Shaft Material - New shafts shall be machined from materials with equivalent or better properties as original e.g. yield, tensile, fatigue and cycle strength. For special applications, the contractor shall consult with the manufacturer and report recommendations to BHEL.</p> <p>g. Tolerances - Shaft extension dimension tolerances shall be within the limits specified for Motors as per IS Standards.</p> <p>h. Shaft repair are not envisaged for HT motors, however if inspection indicate that there may be a shaft problem, it shall be informed to BHEL in writing.</p>		
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09.05.02	<b>Anti Friction Bearings</b>  Anti friction bearings shall always be replaced. New bearings shall be of the same type as originally used, unless otherwise approved by the BHEL. If the bearing type, size, sealing, shielding or configuration is changed, this shall be noted on a separate nameplate. If the original bearing race showed pitting from shaft current, the causes and remedy for the same shall be brought into the notice of the BHEL and shall be discussed with. The bearing shall be heated in oil, without use of direct flame, to approximately 94 deg C to permit it to be slid easily onto the shaft up to the shoulder. Lubrication of the bearings shall be in accordance with the motor manufacturer's recommendations if available.		
09.05.03	<b>End Brackets</b>  Repairs to end bracket bearing housings shall be by building up the metal and machining to size and parallel to rabbet. Welding, plating and Sleeving are the accepted methods. Epoxies and other compounds shall not be used to lock bearings.		
<b>09.06.00</b>	<b>Other Devices</b>		
09.06.01	<b>Fans</b>  Fans shall be checked for cracks and fit to the shaft or rotor. Fans shall be firmly fixed to the shaft or rotor by the original factory method, unless there has been corrosion between dissimilar metals, in which case a new method shall be proposed to the BHEL. Welding to the shaft is not permitted. Repairs to fans shall only be made after discussion with BHEL. New fans for LT motors shall be as supplied by the original manufacturer if available. Supply of New Fans for HT motors are not envisaged.		
09.06.02	<b>Bearing Temperature and Vibration Sensors</b>  Temperature and Vibration Sensors shall be installed in the motor as originally found or as otherwise specified by the BHEL. Bearing sensors shall be of the same type as original and shall be located to sense the highest bearing temperature.		
09.06.03	<b>Leads</b>  Leads shall be flexible, multi-stranded, and have at least the same cross sectional area as the original leads. Temperature class must meet the requirements of the insulation system being installed. Main power and accessory leads shall be indelibly marked using the same marking systems as the incoming motor. If this is illegible, then the system described in relevant IS shall be used and a notice describing the system attached to the terminal box. Lugs, if used, shall be suited for the application and have all cable strands in the lug. No cable strands may be cut off or bent back to facilitate insertion in the lug. If crimp lugs are used, the correct make & type of die shall be used for the particular lug and the correct compression applied.		
09.06.04	<b>Terminal Boxes</b>  Terminal Boxes shall be returned to original condition. Missing bolts and gaskets for both the cover and the motor-to-box joint shall be replaced. Motor Leads insulation, sleeves,		
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09.06.05	<p>terminal hardware shall be replaced. On explosion proof motors, the junction boxes shall be sealed off from the main body of the motor by sealing compound approved for this application. No paint or gasket shall be left on the flanges of boxes for explosion proof motors.</p> <p><b>Space Heaters</b></p> <p>Space Heaters shall be tested for insulation resistance for one minute at 500 volts. Minimum of 10 meg ohm insulation resistance value shall be acceptable. P.I. shall be within 1.2 – 1.4 range. They shall be tested for correct functioning. If found defective, new space heater of same wattage, material of construction and shape shall be installed.</p>		
09.06.06	<p><b>Reassembly</b></p> <p>The assembly of the motor is the reverse of the disassembly process and the following points shall be observed:</p> <ol style="list-style-type: none"> <li>Match marks shall line up.</li> <li>On reinsertion of the rotor, take care not to damage the journals or the stator windings and laminations.</li> <li>Dowels and fitted bolts shall go back into the same holes that they came from.</li> <li>On motors with insulated bearings, the insulation shall be checked and noted.</li> <li>On vertical motors, the endplay shall be the same as the original manufacturer's setting, unless the BHEL and repairer agree that a modified setting would give better performance.</li> <li>Motors for use in hazardous environments shall have all explosion-proof features maintained and be recertified.</li> </ol>		
09.06.07	<p><b>Rotor Balancing</b></p> <p>The motor rotor shall be dynamically balanced in a balance stand before assembly. It shall be balanced with half key in the key way. If material is removed, structural integrity shall be maintained. If material is added, it shall be able to withstand the centrifugal forces and be positioned either in the manufacturer's designated position &amp; locked in place or positioned in a location where centrifugal force will tend to keep the material in place. Weights may be attached to metallic parts only. . The rotors shall be balanced to acceptable norm.</p>		
10.00.00	<b>OVERHAULING PROCEDURE &amp; CRITERIA FOR BUS DUCT SYSTEM</b>		
10.01.00	<p><b>Support Insulator</b></p> <p>In case inspection indicates that there may be a support insulator problem in Bus Duct &amp; other associated equipment, it shall be informed to BHEL. Insulator shall be repaired or</p>		
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replaced with BHEL's approval. If there is any risk or uncertainty in the proposed repair method, this shall be discussed with the BHEL prior to proceeding.

Insulators shall be made of porcelain, Symmetrical shed type having long creepage distance to suit highly polluted atmosphere. They shall be of good quality, shall be homogeneous free from imperfection tough and impervious to moisture. The glazing shall be of uniform brown in colour free from blisters, burns and other defects. The insulators shall have Creepage distance. The assembly of porcelain with metal parts shall be perfect and any thermal expansion differences for the range of temperature operation shall not loosen the parts and cause any undue effects on the electrical. Mechanical strengths. Each cap and insulator base shall be of high grade cast steel or malleable steel casting and shall be machine faced smoothly and galvanized

**10.02.00**

**Bus Duct Joint**

Aluminium welding joint in the bus duct shall be inspected for defect and if required these shall be repaired by qualified welder only.

**10.03.00**

**Seal Off Bushing**

Replace seal off bushings, if found defective on test & visual inspection, at Generator line side, Generator Neutral side, Main Transformer Side, Unit Aux. Transformer side, PT & SP Panel Side, NGT Panel Side.

**10.04.00**

**Rubber Bellow Assembly**

Replace rubber bellows, if found defective, at machine ends (generator), transformers/PT&SP Panel/NGT).

**10.05.00**

**Bus Duct - Inspection Opening**

Replace Neoprene gasket & Hardware.

**10.06.00**

**Disconnecting Links**

Check for proper fit of the link in the slot and pitting marks due sparking. If there is substantial pitting of the contact, metal part of the link shall be replaced.

**10.07.00**

**Neutral Grounding Transformer**

Contractor shall perform necessary test to check its working. Contractor shall inspect all the necessary parts like core, primary and secondary coil and its insulation, Porcelain, Cover, tank, terminal box and remaining parts thoroughly .Check insulation of transformer winding, Test for break down voltage of the dielectric in the tank , terminal points for sparking, replace desiccant in the breather with new one. Visual inspection of seal off bushing, support insulator for crack, discoloration, pitting and shall be replaced if defect are detected.

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**10.08.00**

**Neutral Grounding Resistor**

Measure value of the resistance of Neutral grounding resistor and if value differ from specified value individual resistor element shall be checked and replaced. Support bushing for resistor element shall be checked for crack and replace if crack or sparking mark are found.

**10.09.00**

**Lightning Arrestor**

Contractor shall perform necessary test to check its working. If major defect are noticed during physical inspection or tests, LA shall be replaced by new one. The lightning arrester shall be station type.

**10.10.00**

**Surge Protection Capacitor**

Replace with new ones with technical detail as mentioned in annexure- I

**10.11.00**

**Current Transformer**

Contractor shall perform necessary test to check its working. Contractor shall inspect all the necessary parts like core, primary and secondary coil and its insulation, Porcelain, Cover, tank, terminal box and remaining parts thoroughly. Any minor damage in part shall be repaired. If major defect are noticed during physical inspection or Due to test, CT shall be replaced by new one.

On replacement of old, all the necessary technical data shall be recorded like rating, accuracy class (protection or metering) and burden for the purchase of new CT. New CT shall match the dimension of old CT. The CT shall be Window Type CT. BHEL/JSEB shall supply new CT.

The data to be recorded from constructional point of view shall be material of winding, material of core, sealing breathing, type of terminal box, junction box, primary terminals, insulator, mounting structure and grounding terminal.

**10.12.00**

**Potential Transformer**

Contractor shall perform necessary test to check its working. The Contractor shall inspect all the necessary parts like core, primary and secondary coil and its insulation, Porcelain, Cover, tank, terminal box and remaining parts thoroughly. Any minor damage in part shall be repaired. The major defect in PT shall lead to replacement of old by new one.

On replacement of old, all the necessary technical data shall be recorded like rating, accuracy class (protection or metering) and burden for the purchase of new PT. New PT shall match the dimension of old PT. The PT shall be electromagnetic type. BHEL/JSEB shall supply new PT

The data to be recorded from constructional point of view shall be material of winding, material of core, sealing, breathing, type of terminal box, junction box, primary terminals, insulator, mounting structure and grounding terminal.



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<b>10.13.00</b>	<b>Terminal/ Marshalling Boxes</b>  Terminal Boxes shall be returned to original condition. Missing bolts and gaskets for both the cover and the Equipment-to-box joint shall be replaced. Leads insulation, sleeves, terminal hardware shall be replaced.		
<b>10.14.00</b>	<b>Space Heaters</b>  Space Heaters shall be tested for insulation resistance for one minute at 500 volts. Minimum of 10 M ohm insulation resistance value shall be acceptable. P.I. shall be within 1.2 – 1.4 range. They shall be tested for correct functioning. If found defective, new space heater of same wattage, material of construction and shape shall be installed.		
<b>11.00.00</b>	<b>TESTS</b>  The Equipment shall be completely overhauled, wired, adjusted and tested at the site as per the relevant standards. The minimum following tests shall be carried out on the overhauled Transformer & Bus Duct system: <ul style="list-style-type: none"> <li>i. Power Frequency voltage withstands dry tests on the main circuit.</li> <li>ii. Insulation resistance test for enclosure circuit</li> <li>iii. Voltage withstands tests on auxiliary and control circuits.</li> <li>iv. Any other test required by the BHEL's engineer</li> </ul> Test for over hauled Transformer & Bus Duct system are listed in the scope of work above.		
<b>11.01.00</b>	<b>Acceptance &amp; Routine Test</b>  All acceptance and routine tests as stipulated in the relevant standards shall be carried out by the contractor in the presence of the BHEL's representative free of cost for all the new equipment/parts/spares.		
<b>11.01.01</b>	<b>Type Test</b>  Type test certificate as per relevant standards shall be furnished for all the new equipment/parts/spares. The type tests must have been conducted not earlier than five years from the date of bid opening. Type Test certificates shall be furnished for similar design. Alternatively, type tests shall be conducted afresh with no cost to owner.		
<b>11.02.00</b>	<b>Tests for Rewound Motors</b>		
<b>11.02.01</b>	<b>LT motor</b> <ul style="list-style-type: none"> <li>a. Rewound LT motor, prior to running, shall be given an insulation resistance test to ground at 500 volts DC. The minimum value shall be 200 megohm corrected to</li> </ul>		
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40° C. If mutually agreed between contractor & BHEL, DC high potential test shall be conducted, recommended voltage shall be 1700 V DC plus 3.4 times the motor voltage rating. Reading corrected to 40°C, which are less than 20 megohms, shall be discussed with BHEL.

- b. Winding resistance test
- c. Rewound motors shall be tested for one minute at 14.2 kV AC.
- d. Insulation resistance test for space heater and RTD

11.02.02

HT motor

- a. Rewound HT motor prior to running shall be given an insulation resistance test with 5KV motorized megger.
- b. P.I. Value test with 5KV motorized megger
- c. Tan delta & capacitance test
- d. Winding resistance & inductance test
- e. Surge comparison test of each phase winding
- f. Overhang portion of coils to be tested for high voltage at 10 KV AC for one minute. Slot portion of each coil to be tested for high voltage at 18 KV for one minute.
- g. High Voltage test on complete stator winding at 14.2 KV AC for one minute phase to earth & phase to Phase.
- h. Insulation resistance test for space heater and RTD

11.02.03

Running Test

After the insulation tests, the motor shall be run at no load at rated terminal voltage. The test shall determine that:

- a. No Load Amps. No load current unbalance at balanced rated voltage shall be less than 2%.
- b. Vibration. Horizontal, vertical and axial readings shall be taken at each bearing and results recorded for BHEL's review.

11.02.04

Other Test - During Rewinding



- a. Resistance of coil check
- b. Interturn surge comparison test

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11.02.05	c. HV test of stator coils slot portion. d. Tan delta & capacitance measurement at 20%, 40%, 60%, 80%, & 100% of rated voltage. e. IR measurement at 2.5 KV before & after HV slot portion Other Test - On completed stator		
11.02.06	a. Ring loop test Other Test - On assembled motor		
12.00.00	a. No load run at full RPM on reduced voltage, current balance measurement b. Measurement of bearing temperature during steady state conditions. <b>DOCUMENT SUBMISSION</b> Bidder has to submit the documents as mentioned in Annexure - VII. 1. The bid submitted without the documents required at bid stage will be considered non responsive and shall be liable for rejection. 2. Documents to be submitted after order (Six (6) hard and one (1) soft copy) a) For Approval. b) For Reference /Information. 3. As built/final documentation, test certificate, installation manual & catalogue before dispatch (Ten (10) hard and Two (2) soft copy) this is essential for issuing dispatch clearance for material.		
13.00.00	<b>TECHNICAL QUALIFYING CRITERIA</b>		
13.01.00	<b>For Transformers</b> a. The bidder should have executed overhauling of at least one transformer of 137.5 MVA, 220 kV Class and above rating in last 7 years. Documentary evidence shall be provided in the bid to indicate the same. b. Please furnish list of overhauled transformers of 220 kV voltage class in the last seven years which are working satisfactorily with name of the client, power plant, unit rating, technical details etc. c. Bidder shall have site testing equipments e.g. 5 KV motorised megger, high voltage testing set, Low resistance ducer for measuring contact resistance, resistance bridge for measuring winding resistance, capacitance & tan delta measuring bridge, Oil BD value testing set, etc. to conduct commissioning tests for Transformer. Bidder has to give list of testing equipment which they propose to deploy at the site.		
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**13.02.00**

**For Motors**

- a. The bidder should have the experience of successfully rewinding & repairing at least 20 nos. motors with voltage rating of 6.6 KV & above in last two years. Out of this at least two motors shall be 3500 kW & above.
- b. Please attach the successful completion certificate from the end user for rewinding & repair of 6.6 KV & higher voltage motors in last three years.

The bidder should give an undertaking that the overhauling job shall be carried out in a workshop equipped with following facilities:

- a. EOT crane of 10 tonne or above suitable for loading & unloading of highest capacity motor of 4000 KW. EOT crane shall have inching facility for removal & pushing of rotor.
- b. Baking oven suitable for curing & drying of stator of the highest capacity motor of 4000KW
- c. 2 Nos. of Automatic coil winding machine
- e. Dynamic Balancing stand suitable for balancing rotor of the highest capacity motor of 4000 KW.
- f. Testing facilities in the workshop for all the tests mentioned in the specification elsewhere Including High pot testing set, 5KV motorized megger.

Upon award, bidder would be required to submit detail of such workshop for BHEL's approval.

**Note:**

In case, bidder himself does not have the experience of having executed the overhauling of one of the packages mentioned above i.e. either transformers or motors of ratings mentioned under clause nos. 13.01.00 & 13.02.00 respectively, the bidder may quote for the job with pre-bid tie-up arrangement with a party having experience in the relevant field and meeting all the requirements of the respective work as per above clauses. It is essential that the bidder himself should meet the requirements of at least one package out of the above two.

The bidder is required to mention the specific work for which pre-bid tie-up arrangement has been made. A notarized copy of agreement to this effect should be submitted along with the bid. The bidder is required to submit the credentials of the party, with whom pre-bid tie-up is done, along with completion certificates and copy of work orders for works executed by them during last 7 years.

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**ANNEXURE – IA: TECHNICAL DETAIL OF TRANSFORMERS**
**A. Generator Transformer**

Sl. No.	Description			
1	Name of the Manufacturer	BHEL		
2	Year of Manufacturer	1984		
3	No. of Transformer	2 (1 in Unit 9 & 1 in Unit 10)		
		OFAF	ONAF	ONAN
4.	Rated Output (MVA)	137.5	96.00	68.5
5.	Rated Frequency (Hz)	50		
6	Rated Voltage	HV-242		LV-11
7.	Rated Current (A)	HV		LV-7217.1
8.	No. of Phases	HV-3		LV-3
9.	Type of Cooling	OFAF		
10.	Vector group	Ynd11		
11.	BIL (KV <sub>P</sub> )	HV-900	HV-Neutral 38 RMS	LV- 75
12.	Percentage Impedance (%)	12.7		
13.	Oil Quantities	Volume in Litres		Weight in Tonnes
	Transformer total			
	Cooling Plant			
	OLTC			
14.	Weights in Tonnes			
	Core & windings			
	Complete Transformer including oil			
	OLTC with oil			
	Transport with oil ( Heaviest package)			
	Transport with oil ( Heaviest package )			

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**B. Station Transformer**

Sl. No.	Description			
1	Name of the Manufacturer	TELK , Kerala		
2	Year of Manufacturer	1982		
3	No. of Transformer	2 ( IVB in Unit 9 & IV A in Unit 10)		
		OFAF	ONAF	ONAN
4.	Rated Output (MVA)	NA	NA	30
5.	Rated Frequency (Hz)	50		
6	Rated Voltage (No load ) (KV)	HV-230		LV-6.9
7.	Rated Current (A)	HV- 75.3		LV-2510
8.	No. of Phases	HV-3		LV-3
9.	Type of Cooling	ONAN		
10.	Vector group	Yd11		
11.	BIL (KV <sub>P</sub> )	HV-	HV-Neutral	LV-
12.	Percentage Impedance (%)			
13.	Oil Quantities	Volume in Litres		Weight in Tonnes
	Transformer total	27500		24.8
	Cooling Plant			
	OLTC			
14.	Weights in Tonnes			
	Core & windings	38		
	Complete Transformer including oil	88		
	OLTC with oil			
	Transport with oil ( Heaviest package)			
	Transport with oil ( Heaviest package )			

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**C. Unit Auxiliary Transformer**

Sl. No.	Description			
1	Name of the Manufacturer	Crompton greaves		
2	Year of Manufacturer	1994 (unit #10)		
3	No. of Transformer	2 (one in Unit 9 & one in Unit 10)		
		OFAF	ONAF	ONAN
4.	Rated Output (MVA)	NA	NA	20
5.	Rated Frequency (Hz)	50		
6	Rated Voltage (No load ) (KV)	HV - 11		LV-6.9
7.	Rated Current (A)	HV - 1049.7		LV-1673.5
8.	No. of Phases	HV - 3		LV-3
9.	Type of Cooling	ONAN		
10.	Vector group	Dd0		
11.	BIL (KV <sub>p</sub> )	HV-75	HV-Neutral	LV - 60
12.	Percentage Impedance (%)			
13.	Oil Quantities	Volume in Litres	Weight in Tonnes	
	Transformer total	12700	11.115	
	Cooling Plant	4025	3.520	
	OLTC	885	0.775	
14.	Weights in Tonnes			
	Core & windings	20.5		
	Complete Transformer including oil	47.95		
	OLTC with oil	1.4		
	Transport with oil ( Heaviest package)	32.00		
	Transport with oil ( Heaviest package )	26.00		

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D. List of 6.9 KV/ 0.433 KV, 1 MVA Auxiliary Transformers (16 Nos.)

Sl. No	Covered in Unit #10 Renovation (11 Nos.)	Covered in Unit # 9 Renovation (5 Nos.)
1	Unit service transformer unit # 10	Unit service transformer unit # 9
2	Station service transformer unit #10	Station service transformer unit # 9
3	Cooling tower transformer 10A	Cooling tower transformer 9A
4.	Cooling tower transformer 10B	Cooling tower transformer 9B
5.	ESP Transformer unit #10	ESP Transformer unit # 9
6	Coal Handling transformer 4 A	
7.	Coal Handling transformer 4 B	
8.	CW Transformer for unit # 9 &10	
9.	BCW Transformer for unit # 9 &10	
10.	Ash Handling Transformer for unit # 9 &10	
11.	Standby Transformer for unit # 9 &10	

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**ANNEXURE – I B: LIST OF MOTORS**
**Unit # 10**
**Total no. of LT & DC motors – 45 Nos.**

S.No.	Description	Rating	Qty.	Remarks
1.	C.T. Fan Motor	55 KW, 1485 rpm,	18 Nos.	
2.	CTP Motor	55 KW, 1485 rpm,	2 Nos.	
3.	Raw water pump Motor	97 KW, 1480 rpm,	3 Nos.	
4.	Make up water pump Motor	50 KW, 1485 rpm,	3 Nos.	
5.	LDO pump Motor	8 KW, 2900 rpm,	2 Nos.	Flame proof
6.	F.O. pump Motor	18.5 KW, 1465 rpm,	4 Nos.	Flame proof
7.	S.O.P. Motor	95 KW, 1485 rpm,	2 Nos.	
8.	Seal Air Motor	37 KW, 2970 rpm,	2 Nos.	
9.	E.O.P. Motor	11 KW, 1450 rpm,	1 No.	
10.	E.O.P. Motor	11 KW, 720 rpm,	1 No.	220 V DC motor
11.	Seal Pump Motor	7.5 KW, 720 rpm,	1 No.	
12.	Seal Pump Motor	4.8 KW, 700 rpm,	1 No.	220 V DC motor
13.	Vacuum Pump motor	7.5 KW, 720 rpm,	1 No.	
14.	Turning gear motor	30 KW, 1460 rpm,	1 No.	
15.	Scanner fan Motor	3.7 KW, 2850 rpm,	2 Nos.	To be Replaced with New Motor
16.	Load control Motor	100 W, 5000 rpm	1 No.	220 V DC motor. To be Replaced with New Motor

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**Unit # 9**

**Total No. of LT & DC motors – 50 Nos.**

S.No.	Description	Rating	Qty.	Remarks
1.	C.T. Fan Motor	55 KW, 1485 rpm	18 Nos.	
2.	BCW pump Motor	160 KW, 1485 rpm	5 Nos.	
3.	BCW drain pump Motor	157 KW, 1485 rpm	5 Nos.	
4.	LP Ash water pump Motor	110 KW, 1480 rpm	2 Nos.	
5.	CMR pump Motor	120 KW, 1480 rpm	2 Nos.	
6.	Seal Air Motor	37 KW, 2970 rpm	2 Nos.	
7.	S.O. P. Motor	95 KW, 1485 rpm,	2 Nos.	
8.	Service Air Comp Motor	88.5 KW, 1445 rpm	3 Nos.	
9.	Control Air Comp Motor	37 KW, 1470 rpm	4 Nos.	
10.	E.O.P. Motor	11 KW, 1450 rpm	1 No.	
11.	E.O.P. Motor	11 KW, 720 rpm	1 No.	220 V DC motor
12.	Seal Pump motor	7.5 KW, 720 rpm	1 No.	
13.	Vacuum Pump motor	7.5 KW, 720 rpm	1 No.	
14.	Seal Pump	4.8 KW, 700 rpm	1 No.	220 V DC motor, To be Replaced with New Motor
15.	Load control Motor	100 W, 5000 rpm	1 No.	220V DC motor, To be Replaced with New Motor
16.	Turning gear motor	30 KW, 1460 rpm	1 No.	

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**H.T. Motors 6.6 KV**

**Unit # 10**

Sl. No	Specification of H. T. Motors (6.6 KV) of Unit 9& 10	Bearings	Qty.	Remarks
1.	Boiler Feed Pump : 4000 KW,6.6kv, 2986 rpm, 400 Amp, Delta Connection, Hz-50, Effi.-96.6, Type –ATD, 4000 Ton, Insulation – B Class, BHEL (Hyderabad).	(DE & NDE) Journal Bearing	2 Nos.	
2.	C. W. Pump : 610 KW,6.6kv, 742 rpm, 76 Amp, Star Connection, Type – RKPRS325 -170, Frame-HDS-50-FP-55, Insulation – F Class, BHEL (Bhopal).	DE-NU226 NDE-6226	3 Nos.	
3.	BOWL MILL: 200 KW, 6.6kv, 986 rpm, Rating – Continuous, Insulation – B Class, 23.8 Amps, Frame, RKPRS15250IP55, BHEL (Bhopal).	DE-NU226 NDE-226 +6226	6 Nos.	
4.	I. D. FAN: 800 KW,6.6kv, 744 rpm, 92.6 Amp, Star Connection,		3 Nos.	
5.	F. D. FAN: 400 KW,6.6kv,1487 rpm, 42.7 Amp, Star Connection,		2 Nos.	
6.	C. E. P. MOTOR : 200 KW, 6.6kv,1486 rpm, 22Amp, Star Connection,		3 Nos.	
7.	P. A. FAN: 760 KW, 6.6kv,1490 rpm, 81 Amp, Star Connection,		2 Nos.	

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**H.T. Motors 6.6 KV**
**Unit # 9**

Sl. No	Specification of H. T. Motors (6.6 KV) of Unit 9& 10	Bearings	Qty.	Remarks
1.	<b>Boiler Feed Pump:</b> 4000 KW, 6.6kv, 2986 rpm, 400 Amp, Delta Connection, Hz-50, Effi.-96.6, Type – ATD, 4000 Ton, Insulation – B Class, BHEL (Hyderabad).	(DE & NDE) Journal Bearing	2Nos.	
2.	<b>C. W. Pump:</b> 610 KW, 6.6kv, 742 rpm, 76 Amp, Star Connection, Type –RKPRS325-170, Frame-HDS-50-FP-55, Insulation – F Class, BHEL (Bhopal).	DE-NU226 NDE-6226	3Nos.	
3.	<b>BOWL MILL:</b> 200 KW, 6.6kv, 986 rpm, Rating – Continuous, Insulation – B Class, 23.8 Amps, Frame, RKPRS15250IP55, BHEL (Bhopal).	DE-NU226 NDE-226 +6226	6Nos.	
4.	<b>I. D. FAN:</b> 800 KW, 6.6kv, 744 rpm, 92.6 Amp, Star Connection,		3Nos.	
5.	<b>F. D. FAN:</b> 400 KW, 6.6kv, 1487 rpm, 42.7 Amp, Star Connection,		2 Nos.	
6.	<b>C. E. P. MOTOR:</b> 200 KW, 6.6kv, 1486 rpm, 22Amp, Star Connection,		3Nos.	
7.	<b>P. A. FAN:</b> 760 KW, 6.6kv, 1490 rpm, 81 Amp, Star Connection,		2 Nos.	

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**ANNEXURE – I C: TECHNICAL DETAILS OF BUS DUCT SYSTEM**

Sl.No.	Type	Description
	System Detail	
	Rated Voltage Nominal	11KV
	Rated Voltage high	12KV
	Rated frequency	50Hz $\pm$ 5%
	Fault Level	160 KA Asymmetrical
		36 KA Symmetrical
	Isolator links	3Nos
A	BUS DUCT	
	Bus Bar & Enclosure interior	Matt Black
	Enclosure exterior	Light Grey ( Shade No. 631 of IS-5 )
1.	Generator phase Terminals To generator Transformer – Main Bus Duct	
(i)	Bus Bar	350 A/C 16 mm thick Aluminium. Octagonal
(ii)	Enclosure	850 mm I.D. 6.35 mm thick. Aluminium
(iii)	Length	R Phase – 39000 mm Y Phase – 37000 mm B Phase – 35000 mm
(iv)	Rated Current	8000A
2	Tap off #1 to PT & SA panel	
(i)	Bus Bar	152.4 mm x 12.7mm thick Aluminium flat
(ii)	Enclosure	550 mm I.D., 6.35 mm thick. Aluminium
(iii)	Length	R Phase – 3000 mm Y Phase – 3000 mm B Phase – 3000 mm
(iii)	Rated Current	1000A
3	Tap off # 2 to Unit Aux. Transformer	
(i)	Bus Bar	152.4 mm x 12.7mm thick Aluminium flat
(ii)	Enclosure	550 mm I.D., 6.35 mm thick. Aluminium
(iii)	Length	R Phase – 1500 mm Y Phase – 1500 mm B Phase – 1500 mm
(iv)	Rated Current	1000A

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4	Generator Neutral Terminal shorting chamber to Generator Neutral grounding Cubicle	
(i)	Bus Bar	152.4 mm x 12.7mm thick Aluminium flat
(ii)	Enclosure	550 mm I.D., 6.35 mm thick. Aluminium
(iii)	Length	Single Phase – 3000 mm
(iv)	Rated Current	1000A
B.	CURRENT TRANSFORMER	
1.	Generator Phase Side Ring type CT	
(i)	For Generator Differential Protection	3 Nos., 8000/5 A, Class PS, Secondary Resistance less than or equal to 1.5 Ohms, $V_K$ more than or equal to 205 Volts.
(ii)	For Generator metering (Y&B phase) & Automatic voltage regulation (R phase)	3Nos., 8000/5 A, 75VA, Class 0.5
2	Generator Neutral Side CT	
(i)	For Generator Differential Protection	3 Nos., 8000/5 A, Class PS, Secondary Resistance less than or equal to 1.5 Ohms, $V_K$ more than or equal to 205 Volts.
(ii)	For Generator Forward & reverse power protection	3 Nos., 8000/5 A, 75VA, Class 0.5
(iii)	For Generator protection	3Nos., 8000/5 A, 75VA, Class 5 P20
(iv)	For Generator & Generator transformer Differential protection	8000/5 A, Class PS, Secondary Resistance less than or equal to 1.5 Ohms, $V_K$ more than or equal to 900 Volts., $I_{ex} = 30$ mA at, $V_K/4$
C.	PT & SP Cubicle	
1.	PT	
(i)	PT-1 for, Automatic Voltage regulation, single phase with built in HV HRC fuse	150 VA, 11000 V/ $\sqrt{3}$ on primary side and 110 V/ $\sqrt{3}$ on secondary side Class 0.5
(ii)	PT-2 for metering & protection, single phase with built in HV HRC fuse	200 VA, 11000 V/ $\sqrt{3}$ on primary side and 110 V/ $\sqrt{3}$ on secondary side, class 0.5 /3P

(iii)	Primary HV HRC Fuses 11 KV, 1000MVA for PT- 1, PT-2	3 Nos. each, 3A,
(iv)	Secondary fuses, 650 V, 36KA ,3nos each for AVR, metering & protection	9 Nos.,10A
(v)	PT primary disconnect & sliding contact assembly	6 Nos.
(vi)	PT Secondary disconnect	6 Nos.
2.	Surge arrestor	
(i)	Single pole LA	3 Nos., 12 KV, 10 KA
(ii)	Single pole non- inflammable synthetic liquid impregnated surge protection capacitor with built in discharge resistor	3 Nos., 12 KV, 0.25 Microfarad
3.	Roof Bushing 12 KV	3 Nos.
4.	Support insulator 15 KV porcelain	9 Nos.
5.	Space heater 150 W, 240V	3 Nos.
6.	Thermostat 30°C to 90° C, 5A, 240 V	3 Nos.
7.	Fluorescent lamp 20W, 240 V with lamp guard	3 Nos.
8.	Marshalling Box	1 No.
D.	Generator Neutral grounding Cubicle	
1.	Neutral Grounding Transformer, Synthetic liquid filled, non- inflammable ,single phase 11 kV/ 220 V, 50 Hz, 75 KVA for 15 minute ,37.5 KVA for continuous.	1 No.
2.	Neutral Grounding Resistor, 650 V, 0.4 Ohm, 50 KW for 15 minute	1 No.
3.	Seal off Bushing 12 KV	1 No.
4.	Support insulator (Porcelain)	1 No
5.	Disconnecting link	1 No.
6.	Space heater 150 W, 240V	1 No.
7.	Thermostat 30°C to 90° C, 5A , 240 V	1 No.
8.	Fluorescent lamp 20 W, 240 V with lamp guard	1 No.

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**ANNEXURE - II A: REFERENCE DRAWING FOR TRANSFORMERS**

Sl. No	Description	Drawing No.	Rev.	Drawing Prepared by
1.	Generator transformer Foundation and reinforcement details	5215-C-2101	0	DESEIN
2	Station transformer Foundation and reinforcement details	5215-C-2102	0	DESEIN
3	Unit Auxiliary transformer Foundation and reinforcement details	5215-C-2108	0	DESEIN
4	Layout plan & details of transformer yard areas	5215-C-2109	0	DESEIN
5	Rating plate for T7941- Unit Auxiliary transformer	T62B848H	-	Crompton Greaves
6	Diagram plate for T7941- Unit Auxiliary transformer	T62B849H	-	Crompton Greaves
7	Wiring diagram for T.J. Box- Unit Auxiliary transformer	T31B1279H	-	Crompton Greaves
8	Schematic diagram of Manual push button control of tap change gear (ASEA)	T31B1248H	1	Crompton Greaves
9	Schematic Diagram for T.J. Box for UAT	T31B1280H	-	Crompton Greaves
10	Thermo junction Box	T34B795Q	-	Crompton Greaves

The above drawings are available at site and may be obtained during execution of the order.

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**ANNEXURE - II B: REFERENCE DRAWING FOR BUS DUCT**

Sl. No	Description	Drawing No.	Rev.	Supplied By
1.	Layout of bus duct and Auxiliary equipments	881/30465	B	Best & Crompton Eng. Ltd.
2	Termination at Generator Phase Terminals	981/30481	A	Best & Crompton Eng. Ltd.
3	Termination Details at Generator Transformer	981/30482	A	Best & Crompton Eng. Ltd.
4	Grounding Layout	981/30483	A	Best & Crompton Eng. Ltd.
5	Termination at Generator Neutral Terminals	282/30522	A	Best & Crompton Eng. Ltd.
6	Support Insulator Assemblies	1180/30371	A	Best & Crompton Eng. Ltd.
7	Details of Shorting Bar	1180/30371	A	Best & Crompton Eng. Ltd.
8	General Arrangement of PT & SP Cubicle	581/35010	B	Best & Crompton Eng. Ltd.
9	Wiring Diagram of PT & SP Cubicle	581/35011	A	Best & Crompton Eng. Ltd.
10	General Arrangement Wiring Diagram of NG Cubicle	581/35012	A	Best & Crompton Eng. Ltd.

The above drawings are available at site and may be obtained during execution of the order.

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**ANNEXURE – III A: TYPICAL TRANSFORMER REPAIR FORM**

Sl. No.	Description	
1	Type	
2	Manufacturer	
3	Serial No.	
4	Reference Standard	
5	Vector Group	
6	Rated Output (MVA)	
7	Rated Voltage (Nom/Max.) KV	
8	HV winding	
9	LV winding	
10	Rated Current A	
11	HV winding	
12	LV winding	
13	Phase No	
14	Frequency Hz	
15	Type of Cooling	
16	Replacement of Oil Yes/No	
17	Filtration of Oil Yes/No	
18	Replacement of Silica gel Yes/No	
19	Replacement of OTI / WTI Yes/No	
20	Replacement of Fan motor Yes/No	
21	Replacement of Gaskets Yes/No	
22	RTCC Panel Yes/No	
23	Refurbishment of Marshaling Box Yes/No	

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**R & M JOB FOR BOP OF PATRATU TPS  
(2x 110 MW) FOR JSEB**

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**ANNEXTURE - IIIB: TYPICAL MOTOR REPAIR FORM**

REPAIRER:				Date:	
Motor Designation	Facility	Dept.	Process	Description	M.M. + I.D.
Manufacturer			Type	Power	
Volts	Amperes		Speed	Frame Size	
Serial No.			Bearings	Lubricant Grade	
Other Details					
Service Requirements:					
Reason Sent for repair:					
Required Work:					
Past problems with machine:					
Missing Parts:					
Special Instructions: Manufacturer O&M Manuals, if available					
Contact:				Phone:	
Reference:					

**Notes:**

1. Contractor shall furnish list of spares used along with evidence of replaced parts.
2. BHEL/Owner engineer's approval to be sought for any special works e.g. rotor recaging, stator core replacement, transformer core repair, transformer rewinding etc.
3. Formats are indicative only, bidder can furnish other formats for approval.

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### ANNEXURE – IV: PROJECT INFORMATION

OWNER	: Jharkhand State Electricity Board Patratu Thermal Power Station, Patratu (Jharkhand State), India.
CONSULTANT AT THE TIME OF INITIAL DESIGN, ENGINEERING, ERECTION & COMMISSIONING	: Desein Consulting Engineers Limited 73/1, St. Mark's Road Bangalore – 560 001.
PROJECT	: PATRATU THERMAL POWER STATION 2 x 110MW -Unit Nos. 9 & 10– Of Stage II Overhaul Project
LOCATION	: At Patratu, Jharkhand State, India.
NEAREST AIRPORT	: Ranchi
ROAD APPROACH	: Accessible by road from Hazaribagh & Ranchi
NEAREST RAILWAY STATION	: Patratu & Ranchi
NEAREST PORT	: Kolkata
SEISMIC ZONE	: Zone II as per Indian Standard IS: 1893 (Current Issue)
RAINFALL (ANNUAL TOTAL MEAN)	: 1200 mm (Maximum rainfall occurs during June to September)
AMBIENT AIR TEMPERATURE	
a) Maximum dry bulb	: 45.0 Deg. C
b) Minimum dry bulb	: 2.0 Deg. C
c) Reference temperature for design of electrical equipment/ devices	: (+) 50 Deg. C
RELATIVE HUMIDITY	
a) Maximum	: 80%
b) Minimum	: 20%
c) Relative humidity for design of equipment/devices	: (+) 100%
CLIMATIC CONDITION	: Hot, dry and dusty but healthy climate.
TROPICALISATION	: All equipment supplied against this specification shall be given tropical and fungicidal treatment in view of the severe climatic conditions prevailing at site as described above.
WIND DATA	
a) Wind load as per IS 875 (Part-3) 1987	
i) Basic wind speed	: 50 km/hr.
b) Prevailing wind direction	: Tending South
ELECTRICAL	
Auxiliary Power Supply	
Auxiliary electrical equipment pertaining to this project shall be suitable for operation at the following supply system:	
a) For AC motors above 175 kW	: 6600 V ( $\pm 10\%$ ), 3 phase, 50 Hz, ( $\pm 5\%$ ) non-effectively earthed neutral
b) For AC motor rated 175 kW and below	: 415V ( $\pm 10\%$ ), 3 phase, 3 wire, 50 Hz, ( $\pm 5\%$ ) non-effectively earthed

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**R & M JOB FOR BOP OF PATRATU TPS  
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- c) AC Control and protective device : 110 V ( $\pm 10\%$ ), 1phase, 2 wire, 50Hz AC supply with one point earthed
- d) For DC motors, control and protective devices : 220V ( $\pm 15\%$ ), 2 wire, unearthed DC supply from battery/battery charger
- e) For lighting fixtures, space heaters, for motors rated above 30 kW and indicators/recorders : 240V, 1 phase, 2 wire AC 50 Hz with neutral lead effectively earthed
- f) For solid state controls and annunciation : (+) 24V/48V ( $\pm 10\%$ ), 2 wire, negative earthed DC supply (For instrumentation and control)
- g) Uninterruptible power supply : 230V, 1 phase, 50 Hz, AC supply with one lead earthed (for I&C)
- h) Construction power supply : 415 V, 3 phases, 3 wires, 50 Hz, AC supply will be provided by JSEB. Details will be discussed later.

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**ANNEXURE - V (a): QAP**

		BHEL		MANUFACTURING QUALITY PLAN				Date:		Project: 2 X 110 MW PATRATU TPS		
		PO. NO		DT:		PDX-06-314		Page 1 of 1				
SI No.	Components	Characteristic	Class	Type of check	Quantum of check	Reference DOC	Acceptance Record	Format of record	Agency			Remarks
									P	W	V	
Prepared by		LEGEND: P: Performed By, W-Witness By TS-Technical Standard M: Manufacturer V: Verify ,B-BHEL,C-Customer IR-Inspection Report, BR-balancing Report TC: Test Certificate						Approved By  BHEL				

**(SEAL AND SIGNATURE OF BIDDER)**

Prepared by:

**Tractebel** Engineering  
**SVEZ**

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**R & M JOB FOR BOP OF PATRATU TPS  
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**ANNEXURE - V (b): FQP**



**FIELD QUALITY PLAN**

PROJECT: 2x110 MW TPS PATRATU  
FOR JSEB

ITEM :  
SUB:

QP NO:  
REV: 0  
DATE:  
PAGE: 1 OF 1

PACKAGE:  
CONTRACT NO.  
CONTRACTOR:

SL. NO.	CHARACTERISTICS/ITEMS	TYPE OF CHECK	INSTRUMENT	CLASS	QUANTUM/ FREQUENCY OF CHECK	REF. DOC. AND ACCEPTANCE STANDARD	FORMAT OF RECORDS	REMARKS
1	2	3	4	5	6	7	8	9
MANUFACTURER/ SUBCONTRACTOR		CONTRACTOR				FOR BHEL USE	DOC. NO. PDX 06 314, REV: 0	
SIGNATURE						REVIEWED BY	NAME AND SIGN OF APPROVING AUTHORITY AND SEAL	

**(SEAL AND SIGNATURE OF BIDDER)**

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BHOPAL

**R & M JOB FOR BOP OF PATRATU TPS  
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**ANNEXTURE - VI: CHECKLIST FOR BID OFFERS**

Bidder to ensure the completeness of the below mentioned checklist, without which the offers shall be treated as Non-Responsive.

S. No.	DESCRIPTION	YES/NO
1	Compliance to complete scope of work	
2	Compliance to Relevant Codes and Standards	
3	Compliance to Technical and Specific Requirements	
4	Compliance to Quality Assurance	
5	Compliance to Test Procedures	
6	Compliance to Data/ Drawings/ Documents/Manuals etc.	
7	Provision of Spares considered	
8	Provision for Special Tools & Tackles considered	
9	Compliance to Packing, Shipping & Storage	
10	Prices for Supply Part furnished.	
11	Prices for Service Parts furnished.	
12	Complete QAP	
13	Complete Schedule of Deviations (Annex-VII)	

**(SEAL AND SIGNATURE OF BIDDER)**

Prepared by:

**Tractebel** Engineering  
**SVEZ**

Ref No.  
71138  
E/21/  
0472

Date of Issue  
10/09/2008



BHOPAL

**R & M JOB FOR BOP OF PATRATU TPS  
(2x 110 MW) FOR JSEB**

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**TECHNICAL SPECIFICATION FOR  
REFURBISHMENT ELECTRICAL EQUIPMENTS**

**REV. 01**

**ANNEXURE – VII: SCHEDULE OF DEVIATION**

If the proposal has got any deviation from the technical specification, the Bidder shall tabulate these deviations clause by clause in this schedule.

Against each and every deviation from the Technical Specification, the amount by which the Bid Price will thereby be increased or decreased in case of withdrawal of deviation shall be intimated clause by clause in this schedule. In case the amount is not mentioned in this Schedule against any of this deviation mentioned in deviation sheet, it will be taken for granted that the same does not involve any change in the Bid Price.

Add more sheets, if required.

Clause No.	Deviations

We hereby confirm that only the above mentioned deviations are there from Purchaser's tender specification. Apart from these deviations, all other technical stipulations of specification are acceptable to us and are taken care of in the Contract Price.

**(SEAL AND SIGNATURE OF BIDDER)**

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## TECHNICAL SPECIFICATION FOR REFURBISHMENT ELECTRICAL EQUIPMENTS

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### ANNEXURE - VIII: DRAWINGS & DOCUMENTS REQUIREMENTS FOR TRANSFORMERS

#### A) Drawings & Documents to be submitted with Bid (1 H + 1 S)

- i. Checklist for Bid Offers, Annexure- VI
- ii. Schedule of Deviation, Annexure-VII
- iii. Bidder's General Information, Annexure-IX
- iv. Document required as per bidder technical qualifying criterion
- v. Manufacturing/ Field, motor repair& rewinding Quality Plan, Annexure V (a), V(b)
- vi. List of major overhauling & renovation work done in Bus duct system, Transformers & Motors in thermal power station having 110MW & above rating unit in last three years with name of client, PO Number, year, Project, type & rating of GT, ST & UAT, type & rating of Bus duct system etc.
- vii. List of major rewinding order executed in last three years for motor of voltage rating 6.6 KV, 200 KW and above with name of client, PO number, Project, Value of order. Order copy of rewinding of motors of 6.6 KV, 4000KW & above in last one year.
- viii. Detail of overhauling work done in Generator Transformer 11KV/220KV 137.5MVA, Isolated Bus duct of 11KV, 5000A or above rating in last five year. Along with letter from the clients that overhauled transformer, Bus duct systems are working satisfactorily.
- ix. Detail of site test equipment available with bidder and which will be deployed at Patratu site
- x. Detail of test facilities available at motor rewinding workshop.

#### B) Drawings & Documents to be submitted after Order (6 H + 1 S)

##### B.1) For Approval

- i. Format for Equipment repair form for each type of equipment e.g. motor, transformer, bus duct, LAPT etc.
- ii. Joint Inspection report listing defect observed in each equipment to be overhauled/ refurbished.
- iii. Filled up Technical Datasheet, equipment repair form, test results in proper format for all refurbished equipment
- iv. Manufacturing/Field/motor repair& rewinding Quality Plan, Annexure-V
- v. Routine & Acceptance Test Certificates for major bought out items e.g. HV//LV bushing, Bushing CT, RTCC, LA, surge protection capacitor, insulating material, copper conductor etc.
- vi. GA & foundation plan, control & Schematic wiring diagram, BOM, Technical data sheet for RTCC panel.

##### B.2) For Reference

- i. Type Test Reports, as per list furnished with Bid.
- ii. Dimensional drawing of Coil for each HT motor

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**TECHNICAL SPECIFICATION FOR  
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- iii. Rewinding detail for motors including no of slots, pitch, copper conductor size, no of turns, phase connection diagram etc.

**C) Final Documentation to be submitted before Handover of refurbished equipment (10 H + 2 S)**

- i. Filled up Technical Datasheet ,equipment repair form , test results, site testing & commissioning report in proper format for all refurbished equipment
- ii. Vendor Catalogues for major bought out items.
- iii. Routine & Acceptance Test Certificates
- iv. GA & foundation plan , control & Schematic wiring diagram, BOM, Technical data sheet O&M manual for RTCC panel

Final Documentation shall be submitted in neatly bound volumes.

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