SCOPE OF WORK FOR PACKAGES FOR RATE CONTRACT WITH SUBCONTRACTORS OF SAS

A) OVERHAUL PACKAGE OF 210 MW TG SET OF LMW DESIGN

1.0 Capital overhauling of HP/IP/LP turbine & Generator ,Valves, Strainers

Schedule A. General Activities of overhauling of TG:

1.1 Complete removal of insulation from HP, IP, LP, cross-over pipes, LP front and rear gland pipes. Removal of insulation of pipes as required. Cleaning of all insulation material, transportation of the same to the designated location.
1.2 Complete dismantling of all turbine bearing top pedestals and oil guards.
1.3 Measurement of coupled run-out, turbine float during dismantling.
1.4 Complete dismantling of bearing (1 to 7) after measurement of interference, bearing SOC and TOC.
1.5 Measurement of journal slope, bearing height, bearing heights etc during dismantling and assembly.
1.6 Measurement /correction if possible of journal slopes of swing value of rotor system during dismantling and assembly
1.7 Measurement of turbovisory pick up gaps during dismantling.
1.8 Final assembly of turbovisory pick ups including doweling of pick ups. Dismantling and reassembly of all casing thermocouples.
1.9 Replacement of bearing & thrust RTD s as required.
1.10 Decoupling of HP-IP,IP-LP, & LP- Gen, HP- MOP
1.11 Alignment checking of HP-IP,IP-LP, LP-Gen. HP- MOP during dismantling
1.12 DPT & UT of TG bearing 1 to 7
1.13 Preliminary alignment correction of HP-IP, IP-LP, LP-Gen. Bearing matching with pedestal. Replacement of bearings if required
1.14 Final alignment of rotor system after final boxed up.
1.15 Reaming of HP & IP,IP-LP,LP-Gen, HP-MOP as required coupling of HP-IP, IP-LP, LP-GEN, HP-MOP. Measurement of final coupled run out.
1.16 Setting of all bearing SOC and TOC. Replacement of bearings as require
1.17 Measurement of bearing bore.
1.18 Setting of all the bearing interferences
1.19 Removal of fins from oil guards and refining of oil guards. Matching of oil guards
1.20 Assistance during oil flushing. Cleaning of the MOT strainers up to synchronization/ Loading of the sets.
1.21 Normalization of all the bearing.
1.22 Putting the M/C on Barring Gear
1.23 Modification of JOP pipe line after fitting valves as required
1.24 Assistance during commissioning/ steam rolling and subsequent loading of the unit.
1.25 Cleaning of total area like insulation material, debris, scrap, from power house to suitable places.

Schedule B. HP Cylinder:

1.0 Dismantling/ assembly of casing thermo couple.
2.0 Dismantling of casing parting plane nuts. For this, Induction heating machine shall be arranged by BHEL. However, the subcontractor shall provide all assistance from loading/unloading of the equipment, opening of casings and closing, etc. All manpower required for the same including rigging gangs and helpers and T&P shall be provided by the subcontractor. Loosening of loop pipes.
3.0 Dismantling of leak off lines of control valves,
4.0 Lifting of HP top casing
5.0 Dismantling/ lifting of HP casing top liners.
6.0 Measurement of HP casing steam flow path, free run out of rotor.
7.0 Lifting of HP rotor and bottom internals.
8.0 Removal of all gland and diaphragm seals. Sand blasting of seals. Replacement of internal seals as required. Replacement of HP front modified liner nozzle pick seals and subsequent matching as required.
9.0 Alumina/sand blasting/Water mixed with sand jet cleaning of HP rotor.
10.0 Alumina/sand blasting/Sand jet cleaning of HP top and bottom internals.
11.0 Facial run-out of HP rotor at IP end and correction by scrapping as required.
12.0 Dismantling of HP rotor front stub shaft and correction of run-out.
13.0 Kerosene test of elastic ring. Replacement of elastic ring including face machining as required.
14.0 Removal of all parting plane studs. Removal of seized studs by drilling/gas cutting. Arrangement of hardness testing machine for measurement of hardness of fasteners above M64.
15.0 Sole plate cleaning of MBP after lifting of MBP after lifting of MBP and application of lubricating compound at sole plate.
16.0 Centering of HP internals (top & bottom) including elevation transfer.
17.0 Measurement of parting plane stud length.
18.0 Seal cutting/tape checking of HP internals, top and bottom. Setting of butt clearance. Replacement of seals of internals, glands as required.
19.0 Adjustment of thermal clearance of HP internals.
20.0 Steam flow path checking and rectification.
21.0 Correction of steam flow path by grinding of liners/diaphragm at one end and complete welding at other end. Correction of casing bump. Welding rod to be provided by the firm.
22.0 Checking of deformation of diaphragm by straight edge.
23.0 Blue matching of loop pipe parting plane.
24.0 Repair of flange heating jacket by welding and pneumatic testing of jackets as per norms.
25.0 Assistance to BHEL during MPI of HP rotor.
26.0 Overhauling / repair of casing amortizer. Replacement of boroscopic plugs ,as required.
27.0 Cutting of casing drain and ensure freeness of the pipe. Final welding of pipe.
28.0 Parting plane tightening with induction heating machine to check gaps. Parting plane gap measurement. Repair of parting plane, grinding of parting plane as required. Building of parting plane, stud heating grooves enlargement as required.
29.0 Mock box-up of HPC. Final box up of HPC. Final tightening of studs.
30.0 Final box up of end chamber after seal cutting, assembly of gland steam pipelines.

Schedule C: IP Cylinder:

1.0 Dismantling/ assembly of casing thermo couple.

2.0 Dismantling of casing parting plane nuts. For this, Induction heating machine shall be arranged by BHEL. However, the subcontractor shall provide all assistance from loading/unloading of the equipment, opening of casings and closing, etc. All manpower required for the same including rigging gangs and helpers and T&P shall be provided by the subcontractor. Loosening of loop pipes.
3.0 Dismantling of leak-off lines of control valves.
4.0 Lifting of IP top casing.
5.0 Dismantling/ lifting of IP casing top liners.
6.0 Measurement of IP casing steam flow path. Measurement of free run out of IP rotor.
7.0 Lifting of IP rotor and bottom internals.
8.0 Removal of all gland and diaphragm seals. Sand blasting of seals. Replacement of IP gland & internal seals as required.
9.0 Alumina/sand blasting/Water mixed with sand jet cleaning of IP rotor.
10.0 Alumina/sand blasting/ Sand jet cleaning of IP top and bottom internals. Assistance to BHEL while carrying out MPI of IP rotor stage blades.
11.0 Facial run-out of IP rotor both end and correction by scrapping as required.
12.0 Kerosene test of elastic ring. Replacement of elastic ring including face machining as required.
13.0 DPT of casing, journals, fasteners, diaphragms as required. Arrangement of hardness testing machine for measurement of hardness of fasteners above M64. Loop pipe blue matching.
14.0 Centering of IP internals (top and bottom) including elevation transfer.
15.0 Seal cutting IP internals, top and bottom. Setting of butt clearances.
16.0 Parting plane matching & bore measurement of IP glands. Replacement of seals of internals as required.
17.0 Adjustment of thermal clearance of IP internals.
18.0 Steam flow path checking and rectification.
19.0 Measurement of parting plane stud length. Complete removal of parting plane studs, control valve studs. In-Situ drilling/ gas cutting as required.
20.0 Correction of steam flow path by grinding of liners/ diaphragms at one end and complete welding at other end. Correction of casing bump.
21.0 Checking of deformation of diaphragm by straight edge.
22.0 Blue matching of loop pipe parting plane.
23.0 Repair of flange heating jacket by welding and pneumatic testing of jacket at 6 kg/cm2. Replacement of boroscopic plugs, as required.
24.0 Parting plane tightening with induction heating machine to check gaps. Parting Plane gap measurement. Repair of parting plane, grinding of parting plane as required. Building of parting plane, stud heating grooves enlargement as required.
25.0 Mock box up of IPC. Final box up of IPC. Final tightening of parting plane studs .
26.0 Final box up of end chamber after seal cutting, assembly of gland steam pipelines

Schedule D: **LP Cylinder**:

1.0 Loosening of parting plane nuts. Lifting of LP top casing
2.0 Dismantling &Lifting of LP top internals (Diaphragm & Liners)
3.0 Measurement of free run-out of LP rotor. Measurement of LP steam flow path.
4.0 Dismantling/ Lifting of LP rotor & bottom internals.
5.0 Water mixed with sand cleaning of LP rotor.
6.0 Sand cleaning of LP internals.
7.0 Measurement of free and facial run out. Corrections of facial run out.

8.0 Stelliting of LP 26th, 27th, 30th and 31st stages. Assistance to BHEL while carrying out MPI of LP rotor stage blades.
9.0 Replacement of damping wires of in other LP stages if possible.
10.0 Replacement of safety gasket.
11.0 Centering of LP internals including glands including elevation transfer.
12.0 Setting of thermal clearance, diaphragm key clearance etc of internals.
13.0 Steam flow path checking rectification.
14.0 Parting plane matching of casing, diaphragms, LP glands. Measurement of bores of LP glands.
15.0 DPT of casing, diaphragm and rotor as required.
16.0 Minor repair of diaphragm blades for thinning and cracks.
17.0 Seal cutting of LP internals, tape checking, replacement of gland & diaphragm seals as required.
18.0 Mock Box up of LP. Final box-up of LP.
19.0 Final assembly of cross over pipes, gland pipes.

Schedule E: Governing System:

1.0 Dismantling of all governing pipe lines in front bearing assistance during setting of governor characteristics.
2.0 Revisioning /overhauling/servicing of
a) Emergency governors including strikers
b) Speed Governor pilot block
c) Intermediate pilot valve
d) Differentiator
e) Control Valve Servomotor
f) Load limiter
g) Speeder gear
h) valve for oil injection

Schedule F: Main Oil Pump:

1.0 Complete dismantling of MOP
2.0 DPT of casing & impeller
3.0 Replacement of bearings
4.0 Dismantling of MOP NRV. Replacement of worn out part including bearing
5.0 Replacement of Quill Shaft, gears as required
6.0 Setting of MOP float
7.0 Final box-up of MOP
8.0 Final alignment of HP-MOP

Schedule G: Control Valves:

1.0 Dismantling of HP CV (04 nos.) and IPCV (04nos.) along with column.
2.0 Dismantling /servicing of columns. Replacement of worn out component of columns as required (8 nos.)
3.0 Replacement of valve seats of HP & IP control valves (1 to 4) as required including machining of seats.
4.0 Blue matching of all valve seats of HP & IP control valves.

5.0 Replacement of worn out Part s of all HPCVs & IPCVs like liner ,spindle, relief valves etc as required
6.0 DPT of strainer, spindle, valve seat,

Schedule H: Cam Distribution System:

1.0 Dismantling of HPC & IPC Cam Shaft Assembly along with rack
2.0 Replacement of bearings, shaft as required.
3.0 Replacement of cam and subsequent locking
4.0 Setting of Cam Bearing interference

Schedule I: Barring Gear:

1.0 Dismantling of Barring Gear
2.0 Matching of mating surface
3.0 Replacement of bearing/other components as may be required.
4.0 Alignment of Barring Gear with motor.
5.0 Strengthening of Barring Gear Support.

Schedule J: ESV and IV along with Servomotor:

1.0 Dismantling of ESV & IV servomotor
2.0 Servicing of servomotors including replacement of worn out components.
3.0 DPT of ESV & IV Strainer. Replacement of strainer as required.
4.0 Lapping of Valve Seat
5.0 Replacement of worn out component like valve, spindle etc.
6.0 DPT of Disc spring of ESV & replacement as required
7.0 Blanking of IV with blanking plate for Boiler Hydro Test
8.0 Replacement of valve seat including machining required.
9.0 Setting of all ESV/IV limit switches.

Schedule K: Generator overhauling work scope :

1.0 Generator air tightness check to identify leakage area during barring
2.0 Disconnecting excitation cable at slip rings, removal of brush gear assembly.
3.0 Removal of bearing No. 6 & 7 pedestal covers and bearing top halves after checking clearances. Checking of coupled run-out.
4.0 De-coupling of LP-GEN, checking of initial alignment and free run-out of coupling and journals.
5.0 Dismantling of Seal body, Seal liners, oil catchers, end shields, fan shields after recording all requisite clearances & IR value.
6.0 Measurement of air-gap & magnetic offset.
7.0 Thread out of rotor.
8.0 Hydraulic Test of stator winding after removing water header spool pieces. Repair, replacement of rubber grommets, Teflon pipes, joints and insulation covers etc as per requirement and to attend the trouble of leaking conductors.
9.0 Removal, dismantling, cleaning with nylon brush of cooler tube , painting of water boxes , hydraulic test at adequate pressure and fitting back to original position including replacement of rubber items.

10.0 Opening of generator manholes and cleaning of casing from inside.
11.0 Inspection of looseness of slot wedges and re-wedging as per requirement.
12.0 Checking and replacement of RTDs as per requirement.
13.0 Checking of stator windings, spacers, brazing cords, support brackets, fasteners etc and correction of defects as per requirement.
14.0 Dismantling of stator water terminals bushing & headers bushing for inspection of porcelain insulators, replacement of all rubber items/gaskets and re assembly including filling of silicon putty and re-insulation taping around the bushing.
15.0 Assistance to BHEL while carrying out of ELCID TEST of generator stator core and rectification of defects.
16.0 Checking & cleaning of stator core and overhang winding, lamp heating and varnishing of the same.
17.0 Final Hydraulic test of Stator windings.
18.0 Improving of stator winding IR & PI value by puffing hot dry air compressed air through stator water line.
19.0 Removal of rotor fan hub (E/S), replacement of CC bolts, sealing washers, rotor gas tightness check and remounting of fan hub.
20.0 Rotor purge test and cleaning of ventilating canals by high pressure compressed dry air/Nitrogen Gas as per OEM Standard/Designers recommendation, if required.
21.0 Checking of IR, PI, DC Resistance, AC impedance of rotor winding, dielectric dissipation factor test, Digital RSO test. Partial discharge & DC high voltage/step voltage test, Tan delta & capacitance measurement of stator winding. Measurement of DC resistance of each parallel path of phase winding. All the electrical tests are to be carried out by the vendor along with arrangement of instruments with operator.
22.0 DPT of bearing babbit, seal babbit, coupling bolts, retaining rings, RR Nuts and fan blades.
23.0 Dry out and varnishing of rotor
24.0 Cleaning of slip ring holes. Matching/groove cutting/ polishing of slip rings, rotor journals with coir ropes and coupling faces. Dimensional measurement of slip rings and rotor journals OD.
25.0 cleaning and parting plane matching of Bearings, oil guards, oil catchers, sealing covers and seal bodies
26.0 Replacement of oil catchers/Machining of guard fins as per requirement and setting of clearances with rotor.
27.0 Checking for matching for bearing with respective to housing and rotor journals. Requisite clearance/interference and dimensional measurement are to be maintained.
28.0 Threading in of Rotor and placement on bearing no. 6 & 7 after achieving IR value of pedestal bearing no.7
29.0 Alignment of LP Rotor-Gen, measurement of air gap, magnetic offset etc.
30.0 Re-assembly of Generator which includes fixing of rotor fan blades, end shield, fan shields, oil catchers, shaft seals, oil & water pipelines etc. after ensuring proper IR values.
31.0 Box up of bearing no. 5 & 6
32.0 Coupling of LP- Generator including stretching of coupling bolts. Coupled run-out checking.
33.0 Placement of bearing pedestal No. 7 and box-up of bearing.
34.0 Oil flushing of bearings with filters, normalization of lube oil and seal oil system.
35.0 Cleaning of brush gear, adjustment of brush holders, replacement of brushes and other maintenances, if required on brush gear. Box-up of brush gear assembly and reconnection of excitation cables.
36.0 Air tightness test of generator in barring gear and arrest leakages.
37.0 Rectification of all defects arising in the components overhauled during barring gear and rolling operation.

38.0 Generator dry-out by rolling the machine in air.
39.0 Repair / replacement of gas trap.
40.0 Cleaning /repairing and re visioning of all vent valves of hydrogen cooler lines, filters, DPR, POR, valves of seal oil system, damper Tank, seal oil tank and magnetic filter of stator water line.
41.0 Checking of healthiness of stator water expansion tank.
42.0 Cleaning of damper Tank & hydraulic seal oil tank.
43.0 Cleaning / replacement of LLD and Hydrogen Drier, replacement of silica-gel with new one.
44.0 Cleaning / Servicing of Hydrogen cooler water inlet & outlet valves.
45.0 Cleaning & checking of generator phase & neutral side bushing. Dismantling of terminals bushing (Phase & neutral) for inspection of porcelain insulators, replacement of all rubber item/gasket and re assembly including filling of Silicon putty and re-insulation taping around the bushing.
46.0 Slip ring machining, polishing and grove cutting, as may be required.

Schedule K: Commissioning:

1.0 Tightness check of control valves. Tightness test of ESV.
2.0 Oil injection test of emergency governor.
3.0 Oil flushing of turbine and generator lubrication system.
4.0 Cleaning of the MOT strainer regularly till synchronization & loading of machine.
5.0 Normalisation of bearing and machine putting on barring gear.
6.0 Governor characteristic checking setting of opening of HP & IP Control valves & Overspeed Trip test.
7.0 Assistance in Protection test of Turbine. Rectification of defects found during commissioning incorporated area.
8.0 Setting of Load Limiter/ Speed Governor to work in free governor mode operation during the load. Testing of the machine at full load for 24 hrs.
9.0 Assistance for taking of the vibration characteristic of all the bearings at different rpm and load. Assistance for turbine trim balancing at 3000 rpm as per requirement, this will be considered necessary, if vibration levels are higher than the design value.
10.0 Cleaning of total turbine area and removal of dirt, debris and left over O/H materials from Unit area and from below the turbine to scrap yard.

Schedule L: Control and Instrumentation Work :

Overhauling of actuators (Hydraulic/Pneumatic) of HP/LP Bypass and other critical valves and limit switch setting of the actuator.

SCOPE OF WORK:

1.0 Dismantling, servicing and re-fitting of the actuators of HP Bypass valves (BP1 & BP2) and their operation checking after coupling with the valve and refitting of position feedback transmitter: **02 nos.**
2.0 Dismantling, servicing and re-fitting of the actuators of LP Bypass valves (LBP1 & LBP2) and their operation checking after coupling with the valve and refitting of position feedback transmitter: **02 nos.**
3.0 Dismantling, servicing and re-fitting of the actuators of HP Bypass spray control valves (BPE1, BPE2 & BD) and their operation checking after coupling with the valve and refitting

of position feedback transmitter: **03 nos.**

4.0 Dismantling, servicing and re-fitting of the actuators of LP Bypass spray control valves (LBPE1 & LBPE2) and their operation checking after coupling with the valve and refitting of position feedback transmitter: **02 nos.**

5.0 Complete servicing of both oil units, their line NRVs and accumulators: **02 nos.**

6.0 Complete oil flushing and commissioning of HP/LP bypass system.

7.0 Dismantling, servicing and re-fitting of the actuators of CRH NRV and their operation checking after coupling with the valve and refitting of limit switch: **02 nos.**

8.0 Dismantling, servicing and re-fitting of the actuators of Extraction NRV (ES #1, 2, 9, 10, 11) and their operation checking after coupling with the valve and refitting of the limit switch: **05 nos.**

9.0 Dismantling and re-fixing of bearing RTDs, Turbine metal temp T.C.s for HP, IP & LP.

10.0 GC-2 level switches and control system to be set right.

NOTE: The bidder will have to arrange, expert supervision , for overhauling of HPLP bypass valves, actuators and oil unit duly approved by BHEL/customer site engineers within their lump sum quoted price.

Schedule M: OVERHAULING OF CRITICAL VALVES & ACTUATORS:

List & no. of valves to be overhauled:

Sl. No.	Description	Quantity
1	**HP-LP Bypass Group Valve**: HP Bypass valve ARS-72 with actuators & its bypass valves.	04 nos.
2	LP Bypass valve NR64-500EK with actuators & its bypass valves.	04 nos.
3	HP Bypass spray valve BPE & BD valves with actuators including isolating valves and bypass manual valve	3 nos. + 4 nos. + 01 no. + 02 nos.
4	LP Bypass spray valve NR50-100 with actuators, manual bypass valve and root valve.	02 nos. + 02 nos. + 01 no.
5	Oil unit of HP/LP bypass system.	02 nos.
6	**Extraction Steam valve Group**: CRH-NRV RSK 360/10 valve with actuators.	02 nos.
7	CRH-NRV Equalizer CR-3 & CR-4 valve with actuators.	02 nos.
8	Servicing of extraction steam valves & NRVs with actuators ES#1, 2, 9, 10, 11 & their manual isolating valves.	10 nos.
9	Servicing of all the HP heater and LP heater's extraction steam valves & their bypass valves with actuator such as ES #3, 4, 5, 12, 13 & 14.	06 nos.
10	Servicing of PRDS steam conditioning (TAS-2) (replacement if required), steam valve (TAS-1) and spray control valves (air operated) main & bypass (motor operated) valves with actuators including root valve BFDA#5 and BFDA#3 and manual valves and NRV.	10 nos.
11	HP Heater group bypass valves FW #1&2 and FW #8&9* with actuators servicing.	04 nos.
12	HP Heater total bypass valves BFD #7, 8 & 9 with actuators including equalizer valves. Servicing and to provide extra	03 nos. + Equalizer (03

	isolating valves in the equalizer line.	nos.)
13	Main Steam Stop Valves & their bypass valves with actuator MS #1, 2, 3, 4, 5 & 6 – servicing.	06 nos.
14	Feed Control Station valve& their bypass valve with their actuators LCV #24A, 24B & 25, BFD #13, 15, 16, 18, 19, 21 and to provide extra isolating valves in the equalizer line	09 + 06 nos. (equalizers)
15	Auxiliary Steam line valve and its actuator AS #7, 8, 39, 40 & 42	05 nos.
16	Boiler Feed Pump valve – Pneumatic operated recirculation valve, suction valves of BFP #1A, 1B & 1C	06 nos.

Activities / scope of work (HP/LP bypass & other valves)

1.0 Overhauling of valves and actuators (servicing/replacement)
2.0 Erection and removal of scaffolding as required.
3.0 Removal of insulation of valves as required and re-application.
4.0 Dismantling of valves and actuators.
5.0 Cleaning & DPT of seats and other critical parts.
6.0 Seat cutting, lapping & blue matching of seats.(Seat cutting machine shall be arranged by BHEL. Operator for the same shall be arranged by the vendor)
7.0 Reconditioning & fitting of components.
8.0 Assembly of valves and actuators (including machining work as required).
9.0 Mounting, coupling limit switch/torque switch setting of actuators and ensuring trouble free operation of valves after actuator setting from local & remote mode.
10.0 Fine tuning & desk operation valves.
11.0 Servicing of oil units of HP-LP Bypass including maintenance of oil pumps.
12.0 Servicing of Servo valves, Blocking Units, Oil units etc.
13.0 Oil flushing and commissioning of HP-LP Bypass system.
14.0 Servicing of Servo valves ST 10/63.
15.0 Servicing of Blocking units BL 10/70.
16.0 HP welding, stress relieving and radiography of the pipe/valve joints as per IBR guidelines, wherever necessary.
17.0 Other required work as per standard norms to carry out the above work.
18.0 Welding of valve tag and writing the valve no.
19.0 Spray painting of the valve & actuator.
20.0 Cleaning of work site & removal of debris to an identified place.

2.0 SLOW SPEED BALANCING OF HP, IP & LP ROTORS (Assistance only) as optional work

SCOPE OF WORK:

1.0 Unloading/unpacking and installation of the balancing machine at site. Installation of the whole machine on preplanned and erected rails.
2.0 Coupling of LP / IP/HP rotor with adaptor shaft , as necessary.(Adaptor shaft to be arranged by customer).
3.0 Placement of LP /IP/HP rotor on the balancing machine and assembly.
4.0 “Slow Speed Balancing" of LP/IP/HP rotor.

5.0 Dis-assembly and lifting of LP / IP / HP rotor and placement on stand.
6.0 Dismantling of balancing equipment, packing and loading for onward transportation.

B1) OH PACKAGE OF 120 /125MW TG SET OF KWU DESIGN (HMN Series)

Schedule A. General OH of Turbine, Bearing 1 to 7 including seal inspection I

1.0. Removal of Pedestal cover and Bearing Halves (Bearing no. 01 to 07).
2.0. Removal of LP outer- outer casing.
3.0. Coupled run out checks of all rotors and couplings.Swing check of HPF & exciter.
4.0. Decoupling of HP/IP,IP/ LP, HP/MOP & LP/ GEN., Gen-exciter & Alignment Checking, free runout check.
5.0. Roll check of HP, IP & LP before dismantling.
6.0. Ultrasonic / DP Test of bearings. Necessary test equipment& consumables to be brought by bidder.
7.0. Checking clearances Bearings (01 to 07), rectification of oil clearance value by scrapping off, replacement, if necessary adjustment, repair, replacement of bearing,
8.0. Alignment of HP-IP, IP-LP, HP-MOP, LP-GEN & Gen-exciter. This will include adjustment in packers, bearings, keys and their blue matching lubrication of keys packers etc. as per requirement.
9.0. (a) Casing centering of HP & IP Turbine including adjustment of casing keys packers and their blue matching and lubricating of bearings Key packers as per requirement.
(b) Checking of Axial displacement and bump of HP, IP Rotors adjustment in axial keys of HP-IP casing lubrication etc. as per requirement. Horn drop check of HP & LP casing.
10.0. Resetting of all bearing oil seals and pedestal oil guard rings including repair/replacement as per requirement. Refitting of all Brgs & setting of Brgs .Pads,Yoke Keys etc
11.0. Adjustment of thrust bearing trip device and over speed trip device.
12.0. MOP overhauling repair/replacement of gear coupling, bearing, impeller etc. as per requirement.
13.0. Coupling of LP-IP, IP-HP, HP-MOP, LP-GEN & GEN-EXCITER including minor polishing of coupling holes.
14.0. Swing check of HP rotor and necessary rectification as per requirement to the extent possible
15.0. Thrust pad check of thrust bearing and repair/replacement if necessary
16.0. Box up of all bearings (01 to 07).
17.0. Oil flushing and resetting of throttles including cleaning of filters, thrust bearing, duplex filters, MOT basket strainers.
18.0. Governing Characteristics checking & correction to the extent possible at site
19.0. Barring gear overhauling. Inspection and resetting of nozzles and assembly.
20.0. Dismantling Hydrogen seals on both side and checking the seal liners by DPT, and replacement seal ring if required including adjustment of oil catchers etc.
21.0. Assembly of Turbine side and Exciter side seal body,H2 seals, and seal assembly piping.
22.0. Inspection of last stage blades, internals of steam space like compensator bellows, wherever visible circular supports etc. any repair/replacement as per requirement.
Gland boxes, inspection, of sealing strips of both halves & adjustment in Gland box keys as per requirement.
23.0. Rolling check of LP T along with necessary adjustments in keys, lubrite plate etc. as per requirement.
24.0. Boxing up of upper part of outer-outer casing. of LP Turbine.

25.0. Checking, adjustment and minor repair of all MS & HRH lines hangers from 2 hangers before strainer to Turbine, CRH lines hangers from Turbine to 2 hangers after CRH NRV and
26.0. LPBP valve all hangers from HRH taping to condenser.

Schedule B.

OVERHAULING OF HYDRAULICALLY OPERATED VALVES OF TURBINE, LPBP SPRAY INJECTION VALVES (ALONG WITH THEIR ACTUATORS).

B.1. HP STOP & CONTROL VALVES, IP STOP & CONTROL VALVES ,LP BYPASS STOP & CONTROL VALVES, LP BYPASS WATER INJECTION VALVES

1.0. Before dismantling of the stop and control valve governing characteristics of stop/control valves should be taken and any discrepancy on the valve side should be attended during overhaul.
2.0. Erect scaffolding at valves as required and remove insulation.
3.0. Removal of measuring instruments. Take reference dimensions.
4.0. Drain actuator housing. Remove oil lines and steam leak off line.
5.0. Heat and remove valve body cover bolts.
6.0. Disassemble valve completely.
7.0. Open coupling between valve and servomotor.
8.0. Detach actuator housing from valve body cover.
9.0. Dismantling of servomotor internals and cleaning of all internals. Carry out DPT as per requirement.
10.0. Disassemble actuator and valve completely.
11.0. Complete revision of the servomotor, replacement/repair of components, if required.
12.0. Determine condition of valve and decide on maintenance work to be attended. Carry out DP Test of valve internals (body, seat, disc., spindle etc.) as per requirement.
13.0. Clean and de-scale component parts.
14.0. Inspect valve stem and pilot disc. Check stem for run out. Carry out DP test of valve internals (body, seat, disc, spindle etc.) as per requirement.
15.0. Inspect sealing faces at the valve seat and disc. Lap up as necessary.
16.0. Check clearances and install the actuator and valve body.
17.0. Inspect pistons springs, discs and sealing faces.
18.0. Reseal and assemble actuator.
19.0. Attach actuator and valve body cover
20.0. Attach actuator and valve body cover to valve body and heat bolts.
21.0. Connect up stem.
22.0. Associate with BHEL/CUSTOMER during installation of measuring instruments and indicators of the valves.
23.0. Start oil pumps and check valves for leak and proper functioning. Attend the defects if found any.
24.0. After completion of the job governing characteristics should be set as per standard values in association with BHEL/CUSTOMER.
25.0. Do Hot tightening of valve flanges, glands and bonnets at part load and full load of machine.

B.2. OVERHAULING OF CRH NRV:

1.0. Making necessary scaffolding and approach platform for CRH NRV.
2.0. Removal of existing insulation cladding sheet and insulation in the top cover area of NRV.
3.0. Removal of oil pipe line from NRV servomotor, Decoupling of servomotor from valve spindle and removal of servomotor from position.

4.0. Opening the top cover of CRH NRV by making proper lifting arrangement and removal of all internals like flap, spindle etc.
5.0. Cleaning of all internals including pressure seal area and checking for any erosion mark in gasket seating areas. Carry out DPT as per requirement.
6.0. Repair and replacement of defective component.
7.0. Build up and repair of eroded portion by grinding and matching.
8.0. Box up of NRV with new pressure seal gasket/components.
9.0. Tightening of the cover to the required torque and hot tightening of the same after charging.
10.0. Fixing the servomotor in position, Coupling the servomotor with NRV spindle and fixing of oil pipes of servomotor.
11.0. Attending to leakages after charging.
12.0. Removal of temporary platforms and scaffoldings.

Schedule C. OVERHAULING OF HP BYPSS MAIN VALVES & SPRAY VALVES BPE1, BPE2, BD VALVES (WITHOUT SEAT CUTTING)

1.0. Decoupling and removal of actuators as may be required.
2.0. Dismantling of valves.
3.0. Cleaning / checking/ DP/ ultrasonic Testing of valve components and repair to the extent possible at site.
4.0. Lapping of seats and disc.
5.0. Assembly of valves.
6.0. Placement and coupling of actuators.
7.0. Assistance for commissioning of valves.

Schedule D. LP TURBINE MODULE OVERHAULING

1.0. Inspection of LP casing P/P half, removal of LP outer outer casing.
2.0. Roll check for LPT inner outer.
3.0. Supporting the LP inner-inner outer casing at the bottom. Open PP upper half casing & carry out open inner-inner p/p & lift the upper half.
4.0. Recording of clearances of inner & outer casing and rotor fins.
5.0. Inner-inner rolling test, inner opening, recording clearances.
6.0. Flow path correction as per requirement by fin cutting /shroud grinding.
7.0. Removal of rotor & cleaning of rotor & upper casing (manually/sand blasting/ Alumna blasting as required.Only manual cleaning is possible for lower half of casing.
8.0. Inspection of LP rotor, components and inner casing for their healthiness. DPT as per required. Check ovality of inner- inner with and without tightening of P/P bolts.
9.0. Thoroughly cleaning the bottom casing and place back the rotor
10.0. Checking & Recording of all clearances of LP.
11.0. Box up inner-inner and inner outer casing.
12.0. Recording of all clearances with inner outer casing and box up.
13.0. Closing LP outer casing after recording clearances.
14.0 Setting & centering of gland boxes as per recommended clearances
15.0 Replacement of eroded balancing weights.

Schedule E: HP TURBINE MODULE OVERHAULING

1.0. Removal of insulation and all connecting pipe lines of HP module including opening of breech nuts, exhaust flange, cutting of gland steam pipes, drain lines etc. In case , breech nuts are stuck up , the inlet pipe or breech nut may be required to be cut by grinding /gas cutting .
2.0. Supporting of Turbine shaft to casing.
3.0. Lifting of complete HP module from pedestal and placing on fixture and unload the rotor on rotor support.
4.0. Rolling check and Bump check support rotor in inner casing after measuring relevant clearances.
5.0. Tilting of complete module and placing it in vertical position.
6.0. Removal of threaded ring from barrel and removal of inner casing guide keys.
7.0. Removal of rotor with inner casing from barrel with the help of attachments etc. placing the same on fixture in horizontal position.
8.0. Inspection of barrel threaded ring, U-ring, I ring and repair / replacement as required to the extent possible at site.
9.0. Opening of inner casing after properly supporting. For this, Induction heating machine shall be arranged by BHEL. However, the subcontractor shall provide all assistance from loading/unloading of the equipment, opening of casings and closing, etc. All manpower required for the same including rigging gangs and helpers and T&P shall be provided by the subcontractor. Loosening of loop pipes.
10.0. Measurement of related clearances during dismantling.
11.0. Removal of rotor from bottom half and inspection of fins.
12.0. Parting plane studs, length measurement , DPT/MPI and replacement as necessary.
13.0. Cleaning of rotor blades by manual cleaning /sand blasting/ Alumina blasting etc.
14.0. Placing top half casing on bottom half , checking parting plane gap & ovality in loose & tight condition. Checking inner casing centering w.r.t. outer casing by dummy shaft and finalise key sizes.
15.0. Placing of bottom half inner casing on fixture leveling it, placing, rotor, check radial & axial clearance. Repeat the same with upper half.
16.0. Heat tightening of all P/P studs as per the recommendations.
17.0. Rolling check and bump check after tightening and correction if any.
18.0. Supporting of rotor with inner casing and insertion of inner casing into barrel after placing the U Ring.
19.0. Fitting of centering keys, placing & then tightening the threaded nut as per required values.
20.0. Lifting the assembled barrel and place in horizontal position, support rotor on rotor supports.
21.0. Fixing of all gland seals and cover etc. maintaining the requirement clearances.
22.0. Rolling and bump check after complete assembly and support the rotor to barrel.
23.0. Assembled module to be lifted and placed on pedestal. Fixing all radial and axial keys.
24.0. HPT inlet breech nuts & exhaust flanges connection along with associated pipe lines.

Schedule F: IP TURBINE OVERHAULING

1.0 Removal of complete insulation of IP turbine and connected pipes and disconnecting of piping including cutting/rewelding/stress relieving of pipe joints as required, note down control dimensions.

2.0 Loosening of outer casing parting plane bolts and removal of top half of casing. For this, Induction heating machine shall be arranged by BHEL. However, the subcontractor shall provide all assistance from loading/unloading of the equipment, opening of casings and closing, etc. All manpower required for the same including rigging gangs and helpers and T&P shall be provided by the subcontractor. Loosening of loop pipes.
3.0 Roll check, centering check and bump check of inner casing as applicable.
4.0 Opening of IP inner casing parting plane bolts and lift upper casing.
5.0 Measuring of flow path clearances.
6.0 Lift the rotor.
7.0 Lift the IP inner bottom casing also as required .
8.0 Measure parting plane studs length and replace as required, for inner and outer casings.
9.0 DPT, UT and MPI of p/p studs as necessary.
10.0 Checking of parting plane for deformation ,ovality checking and necessary correction
11.0 Clean rotor and casing halves (manually, water washing, Alumina blasting as required, carry out inspection visual, DP, MPI, UT as required.) Replacement of stationary fins to the extent possible. Ensure L- rings are free.
12.0 Assisting in replacement of IPT inner casing thermocouples.
13.0 Check ovality of inner casing before and after tightening the parting plane without rotor including heat stretching of the studs.
14.0 Centering of Outer casing with respect to Rotor, check the p/p of outer casing.
15.0 Place the lower inner half in position.
16.0 Box-up of IP inner casing after recording clearances, PP bolts tightening , roll check, centering check, bump check and align the casing.
17.0 Box up of outer casing after recording relevant clearances , PP bolts tightening , roll check, centering check, bump check and align the casing.
18.0 Connect the pipe lines, couple the rotor with HP & LP rotors etc.

Schedule G: OH OF GENERATOR:

1.0. Dismantling and removal of Exciter. After swing check, decoupling and alignment checking. Removal of Exciter/PMG Assy. from position
2.0. Dismantling and removal of Generator end shields, H2 coolers, seal assembly and pipe lines. DP/UT of H2 seals liners and replacement of liner as required.
3.0. Dismantling and removal of bearing no.5, 6 & 7. Checking of insulation and replacement as required. DP/UT of all Bearings
4.0. Threading out of Generator rotor & after completion of works thread –In.
5.0. Inspection and cleaning of Generator stator/ rotor& Exciter/PMG
6.0. ELCID Test of Generator will be done by BHEL and all assistance including arrangement of cables, switch boards, cut-outs etc. to be provided by the contractor.
7.0. Stator wedge tightness, Core looseness, overhang portion strengthening work, match joint spacer work shall be carried out by BHEL and all assistance to be provided by the contractor.
8.0. Checking /Revisioning of Diode wheel & replacement of fuses as required.
9.0. Physical checking of multi contact pins for healthiness.
10.0. Gas leak test of Generator Rotor & Exciter Rotor CC bolts and attending leakage by replacement of CC bolts as required.
11.0. Stator winding cleaning by CTC before glue injection and varnishing. Required quantity CTC and other cleaning agent along with cloth to be arranged by contractor.
12.0. DP/UT checks of rotor retaining rings and fan blades.
13.0. Assistance during various generator electrical test.

14.0. Inspection & Replacement of all Terminal bushings along with gaskets.(6 Nos)
15.0. UT check of Generator seal rings and replacement as required.
16.0. Dismantling/cleaning of H2 coolers ,exciter coolers, Hydraulic Test & attending leakage by plugging of tubes.
17.0 Glue injection and varnishing of stator wdg.
18.0 Varnishing of Gen. Rotor.
19.0 Insertion of Generator Rotor and Boxing up of Generator.
20.0 Air tightness test of Generator casing at 4 kg/cm2. for 24 hrs.
21.0 Color matching of Generator bearing.
22.0 Replacement of oil catcher fins as necessary.
23.0 Replacement of any of defective components of Generator & Exciter and varnishing of same.
24.0 Checking of the Generator stator palms for any feeler gap.
25.0 Matching of exciter pedestal with the exciter base frame and revisioning of exciter bearing including replacement as required. Re-matching of Exciter anchor plate and tightening of anchor
bolts to required elongation.
26.0 Revisioning of PMG Assembly, Varnishing and assembly
27.0 Assistance during the N.F.T of Generator end winding. & checking of terminal nose joint.
28.0 Removal of Exciter dome, Stator top half & removal of rotor & complete overhauling
29.0 Revisioning of Exciter/PMG Assy. Assistance during testing, cleaning & varnishing
30.0 Swing check of exciter and necessary correction.

SCHEDULE H:

SCOPE OF WORK FOR OH OF HRH STRAINER:

1.0. Cutting of Strainer drain pipe.
2.0. Removal of Strainer, Repair / Replacement of Strainer as per requirement.
3.0. Cleaning of components, inspection, DPT of components, Repair of weld joint of element with blanking plate.
4.0. Assembly of Strainer.
5.0. Welding of drain pipes and DP Test of weld joints.

SCOPE OF WORK FOR OH OF MS STRAINER:

1.0. Cutting of Strainer drain pipe.
2.0. Removal of Strainer, Repair / Replacement of Strainer as per requirement.
3.0 Cleaning of components, inspection, DPT of components, Repair of weld joint of element with blanking plate.
4.0 Assembly of Strainer.
5.0 Welding of drain pipes and DP test of weld joints.

2. ASSISTANCE DURING MPI & NFT OF LPT ROTOR FREE STANDING BLADES 2x2 Stages, (Optional work)

1.0 Cutting of welding of locking plates of both sides of LPT Rotor free standing blades.
2.0 Removal of locking plates of both sides of blades.
3.0 Removal of all clamping pieces.
4.0 Removal of blades with proper marking.
5.0 Thorough cleaning of blades and their grooves in the rotor by suitable means so as to

remove corrosion products, if any.

6.0 Inspection of blades roots and their grooves in the rotor.
7.0 Crack detection of all blades by MPI (Coil method) -100%
8.0 Fitting of all blades (cleared by MPI) in the position with technological pieces.
9.0 Fitting of technological pieces in place of clamping pieces.
10.0 Measurement & recording of Natural Frequency of blades.
11.0 Removal of technological pieces.
12.0 Replacement of technological pieces by new clamping pieces.
13.0 Fitting of locking pieces in position.
14.0 Welding of locking plates as per drawing.

NOTE: If any defect is observed in blades then it is to be replaced by new one. If the natural frequency of any of the blades is found to be beyond permissible range & it can not be improved upon even after proper cleaning of the blade root & its groove in the rotor, then the blade has to be replaced by new one.

3. REPLACEMENT OF LPT BELLOWS (optional work):

1.0 Removal of covers of both outer bellows (L&R) and DPT of the bellows.
2.0 Opening of manholes in steam admission pipes (L&R) and inspection of the inner bellows.
3.0 Cutting and taking out the outer compensator with pieces of steam admission pipe.
4.0 Cutting of lip joint between LP inner inner casing and inner compensator on both left and right side.
5.0 Removal of damaged inner compensator and inner protection pipe.
6.0 Detach/cutting of outer protection cover of LP Heater extraction compensator from LP inner outer casing from condenser side and cutting of pipe joint below the compensator. (applicable for extraction compensator work only)
7.0 Check outer compensators by DPT for damage cracks etc.
8.0 Removals of eccentric bushes of bottom half of LP inner inner casing.
9.0 Record elevations and other references of LP inner inner casing w.r.t. LP inner outer casing.
10.0 Removal of axial keys.
11.0 Removal of bottom half of LP inner inner casing.
12.0 Inspection of LPH 3 extraction compensator for any damage etc. and replacement as required.
13.0 Edge preparation of all pipe joints and LP inner inner casing as per drawing.
14.0 Welding of LPH-3 compensator to the LP inner inner casing as per drawing.
15.0 Placement of LP inner inner casing in position and centering of the same w.r.t. LP inner outer casing and other references and fitting of eccentric bushes.(applicable foe extraction
16.0 compensator work only)
17.0 Placement of left/right side inner compensators in position.
18.0 Alignment and preparation of welding joints of inner compensators on left/right side and welding the same as per procedure including the welding to flanges of steam admission pipes.
19.0 Alignment and preparation of welding joints of outer compensators on right/left sides and welding the same as per procedure including adjustments in length of steam admission pipes. Fillet welding of inner protection pipes to the outer compensators.
20.0 Welding of LPH-3 compensator to pipe and welding of compensator cover as per procedure.

21.0 Welding and NDT: Use E 7018 welding electrodes for welding of all joints. Radiographic inspection of all butt joints and 100% DPT of all balance joints and fillet welds.

22.0 Any other job required to be done to complete the above job is deemed to be included in this scope of work.

4. Assistance for Slow speed balancing of HP/IP rotor (optional work)

SCOPE OF WORK:

1.0 Unloading/unpacking and installation of the balancing machine at site. Installation of the whole machine on preplanned and erected rails.

2.0 Coupling of IP/HP rotor with adaptor shaft , as necessary.(Adaptor shaft to be arranged by customer).

3.0 Placement of IP/HP rotor on the balancing machine and assembly.

4.0 “Slow Speed Balancing" of IP/HP rotor.

5.0 Dis-assembly and lifting of IP / HP rotor and placement on stand.

6.0 Dismantling of balancing equipment, packing and loading for onward transportation.

B2). SCOPE OF WORK FOR CAPITAL OVERHAUL OF 120 /125 MW TG KWU DESIGN (KN SERIES)-

PART –A OVERHAULING OF TURBINE

1.0 Removal of insulation & turbine console to enable dismantling.

2.0 Record all control dimensions and all relevant readings before dismantling along with EIC of customer.

3.0 Removal of oil lines , steam pipe lines.

4.0 Removal of HP front ,HP Rear Bearing pedestal covers , oil glands

5.0 Removal of bearings after recording all requisite clearances/ run out/float etc as necessary.

6.0 Record couple run out readings of HP-IP and LP turbine rotors. Record couple run out of LP- Generator.

7.0 Decouple HP-IP and LP rotor . Decouple LP-Generator .

8.0 Record alignment readings of HP-IP and LP . Record alignment readings of LP-Generator.

9.0 Record HP-IP front and rear casing centering reading during dismantling.

10.0 Removal of HP-IP outer casing parting plane after loosening / removal of cap nuts .Locking of bottom cylinder before loosening of bolts.

11.0 Removal / Lifting of HP-IP inner casing and Guide Blade carriers , gland housing after removal of all parting plane cap nuts by induction heating.

12.0 Record all axial/radial clearances. Recording of steam flow path readings

13.0 Removal of rotor.

14.0 Inspection of rotor, inner casing, all guide blade carriers and glands,

15.0 Arrangement for cleaning of turbine rotor, all bottom and top internals by sand blasting .

16.0 Sand blasting is with in the scope of bidder for which at least three no of sand blasting guns with accessories shall be deployed simultaneously .

17.0 Record all dimensions after cleaning by sand blasting.

18.0 Removal/Refining/ Replacement of front , rear, balance piston and intermediate glands (stationary) as required. Steam or oil gland is found to be severely damaged it shall be replaced.

19.0 Fin tip machining to be done as required. This includes removal of fins & caulking wires, refitting & caulking of new fins, and machining of fin tips to required dimension.

Machining facilities will be provided by customer.

20.0 Bearing 1 & 2 , DPT & UT testing to be done. Measurement of all bearing bore.

21.0 Replacement of bearings as required.

22.0 The nozzle wheel to be checked thoroughly by DPT for any damage . Minor repair to be done as required.

23.0 Turbine over running clutch device inspection and servicing.Worn out parts are to be replaced as required.

24.0 Turbine bearings HP- IP turbine front & rear , bearings are to be inspected and all worn out parts are to be replaced and assembled back after thorough cleaning.

25.0 The freeness of all parts to be checked and then assembled.

26.0 Positioning of bearing No 3,4 and 5 and assembly of all internals as required. DPT and UST& inspection and replacement of bearings as required is with in the scope .

27.0 Positioning of Bearing No1 and No2 and Centering of turbine. Assembly of all internals with centering and float adjustments of individual guide Blade Carriers, glands and inner casing Steam flow path and other adjustments of individual guide Blade

28.0 Carriers, glands and inner casing. Changing of eccentric bushes if required during centering.

29.0 Blue matching of Top and bottom outer / inner casings including individual guide blade carriers. 26

30.0 Rotor total axial movement to be checked and corrected as possible at site.

31.0 Boxing up of all internals after thorough checking of all measurements (axial/radial/steam path clearances) and rotor freeness checking. Heat tightening of inner casing by induction method.Assembly of inner casing thermocouple.

32.0 Boxing up of outer casing after checking of all relevant dimensions, readings ,float and all other parameters.Heat tightening by induction heating equipment. Connection of all steam, pipe lines including seal welding.

33.0 Checking of rotor free and facial run outs at every position.

34.0 Thrust bearing adjustment.

35.0 Replacement of bearing RTDs, Thrust pad RTDS under supervision of customer C & I Engineer.

36.0 Final bump check of rotor . Final centering of boxed up casing at front and rear gland.

37.0 Final alignment of HP-IP and LP.

38.0 Final alignment of LP-GEN.

39.0 Reaming , honing of coupling holes & coupling bolt machining as required is within the sc

40.0 Alignment between turbine and generator.

41.0 Coupling of HP-IP and LP turbine rotors . Coupling of LP-Gen Rotor. And checking of coupled run out . Box up of bearing pedestal covers after ensuring requisite internal clearances/interferences on TG bearings. Assembly of all oil lines.

42.0 Assistance during Oil flushing and necessary arrangements for it.

43.0 Putting TG on barring gear and providing manpower assistance for successful operation of barring gear. Assistance during Commissioning /Post commissioning observation of the TG set for 72 Hours stable rated load operation of the TG set.Assistance during post synchronization vibration analysis and attending all defects and completion of all jobs.

NOTE :-

Wheel chamber pressure gauge / thermocouple mounted on turbine , removal of bearings RTD's and refitting is within the scope.

PART B : OTHER ASOCIATED WORKS OF TURBINE:

1.0 REFINNING / IN SITU MACHINING OF TURBINE ROTOR FINS : This includes removal of fins & caulking wires, refitting of new fins and caulking wire. Fin tip machining shall be done in situ in the turbine casing on oil hydraulic barring gear. All T &P s including tool post , consumables like cutting tool , coolants etc as required is in the scope of successful bidder. However Refining / in situ machining of turbine rotor inter stage blade fins and stator fins is not within the scope.

2.0 Servicing of TG HP stop and Control valves (2 sets). Servicing means dismantling , checking of valve internals, record all dimensions, blue matching of valve & valve seat and box up. Worn out parts are to be replaced with new one as required.

3.0 Servicing of TG IP stop and Control valve (2 sets). Servicing means dismantling , checking of valve internals , record all dimensions, blue matching of valve & valve seat and box up. Worn out parts are to be replaced with new one as required.

4.0 Inspection and cleaning of MS strainer (2 sets).Replacement of strainer element if found damage.Inspection and cleaning of HS strainer (2 sets). Replacement of strainer element if found damage .

Note: - 1. Machining facility will be provided by customer as available.However, rotor fin machining is to be DONE IN SITU.

2 For UST equipment, accessories and operator is to be provided by the successful bidder within scope.

Following are within scope of successful bidder.

1.0 Assistance during Post Synchronisation 72 Hours stable rated load operation of the TG and attending all defects during operation.

2.0 Cleaning of bearing oil line orifices , setting of lube oil pressure, replacement of jacking oil hoses as and when required Assistance during oil flushing , steam rolling & synchronization.

3.0 Cleaning of work area

4.0 Attending to all defects during rolling , synchronisation and achieving of full load and stable operation.

5.0 All stipulations and terms and conditions of the NIT including meeting Statutory Requirements and compliance with all activities including conditions as in Annexure-SAS-I and all other annexures of the NIT.

6.0 Delay analysis if any report shall be submitted to BHEL RE/RM.

GENERATOR:

1.0 Dismantling of bearing pedestals, bearings, CRO of LP-GENERATOR, decoupling of LP Generator, dismantling of H_2 SEALS, top & bottom end shields, threading out of rotor.

2.0 Removal of TG enclosure as may be required. Thorough cleaning of generator stator and rotor Through cleaning of the flexible & eyes etc. as may be required. Adequate quantity of acetone/cleaning agent/any other consumables is in the scope of the vendor.

3.0 Isolating damaged portions of windings. Debrazing and Rebrazing of damaged eyes by flame heating Required space for brazing will have to be made by cutting stator frame & the same will be welded back after completing the repair process. Brazing materials shall be provided by customer, however gas torches / nozzles of different sizes as per job requirement including making available experienced brazer/gas sets is included in the scope of the vendor.

4.0 Replacement of damaged eyes on Exciter end — minimum 4 nos. or more with new copper & new insulation.

5.0 Curing of insulation.
6.0 Replacement of damaged flexibles – 24 nos. alongwith new fasteners.
7.0 Replacement of damaged air filters.
8.0 Replacement of stator winding insulated cooling pipes near output leads.
9.0 Replacement of fire detectors.
10.0 Replacement of damaged stator RTD cables from stator frame to JB. Replacement of 2 nos. RTD's of generator stator.

11.0 Following electrical tests are to be conducted on generator rotor and stator:-

Generator STATOR & ROTOR:

- Assistance during ELCID Test including providing cables of requisite quantity .
- Assistance during Tan delta / Capacitance test.
- Assistance during Stator HV test.
- Assistance during Impedance measurement.
- Assistance in Partial Discharge (Corona Probe) within vendor scope.
- Assistance End winding stator Natural Frequency Test within vendor scope.
- Assistance RSO Test within vendors scope.

Note: Manpower & logistics assistance for any other tests to be conducted is within the scope of the vendor.

1.0 TG bearings inspection.TG bearings replacement as may be required.UST of TG bearing bearings clearances checking , bearings inside bore measurement / journals OD measurement, fan blade / generator stator to rotor radial clearances / air gap records , oil guard radial clearances & refining / machining at customer workshop , facial run out checking of generator rotor / free run out checking of generator rotor is included in the scope.

2.0 Reconnection of Generator from Bus duct & NGT .Reassembly of water and oil pipe lines. Checking and cleaning of ducts. Checking / replacing bearing insulation, checking of sealing of bearing sleeves and if required replacement of oil seal strips, checking of labyrinth rings. Checking of shaft seal insulation, seal rings and labyrinth rings and replacement of worn out parts. Cleaning of brush gear assembly, Checking of proper staggering of brush gears. Cleaning and removal of varnish from rotor retaining rings, DPT/UST on rotor retaining rings. Varnishing of generator stator and rotor and heating of stator and rotor. Varnishing materials to be provided by customer, however sufficient quantity of bulbs/halogen lamps to be arranged by vendor. Threading in of generator rotor, assembling of end covers, bearings and placement of rotor of bearings. Checking of IR values of rotor shaft, labyrinth rings, seal rings and seal body. Mounting of brush gear assembly .Restoration of oil and water pipelines to Generator.

3.0 COMMISSIONING ACTIVITIES: Bearings clearances / interferences setting adjustment as per requirement , LP-Gen. alignment checking / rectification to the extent possible in box up condition of turbine , Coupling , CRO checking , bearings box up , Assembly of all oil lines. Oil flushing and necessary arrangements for it. Putting TG on barring gear and providing manpower assistance during commissioning/synchronization. Assistance during post synchronization vibration analysis and machine parameters observation for 72 hours.

C) OH PACKAGE OF 190/200/210/ 250 MW TG SET OF KWU DESIGN:

1. COH OF HP/IP/LPT, ALL VALVES AND STRAINERS INCLUDING GENERAL OH OF TURBINE.

SCHEDULE 1 : ALIGNMENT, ROLLING CHECKS, CASINGS CENTERING ETC.

1.0. Removal of turbine cladding as required .
2.0. Removal of pedestal covers and bearing halves of bearing no. 1 to 7.
3.0. Recording of deck spring heights and locking of deck springs as applicable.
4.0. Coupled run out checks of all rotor & couplings and swing check of rotor at HP front.
5.0. Decoupling of HP-IP, IP-LP, LP-GEN and HP-MOP couplings.
6.0. Removal of LP outer casing upper half.
7.0. Free run out and alignment checks on all rotors, journals and couplings as per requirement and matching / scraping etc. on journals and coupling halves as per requirement and to the extent possible.
8.0. Ultrasonic and DP testing of bearings 1 to 7 and repair/replacement as per requirement..
9.0. Checking of bearing clearances and rectification by scraping, matching or replacement of bearing / liner to the extent possible and as per requirement. Supervision and assistance in machining of bearing or bearing liner as required during replacement.
10.0. Checking facial run out of HP and IP Rotor coupling faces and scraping, blue matching as required to correct the run out. Alignment of HP-IP, IP-LP, LP-Generator, HP-MOP. This will include adjustment in packers, bearing pedestals, bearing supports, lubrication of packers, keys their blue matching as per requirement. Alignment correction of LP-GEN. to be carried out by adjusting / shifting Generator Stator / Rotor etc.
11.0. Rolling checks and required casing centering for HP, IP and LP Turbines which include adjustment, replacement of casing keys, their blue matching , lubrication etc. Record Bump check of HP and IP Rotors and necessary adjustment within available clearance.
12.0. Adjustment/centering of LP gland boxes as per recommended clearances including removal and refitting of LP gland boxes for seat cutting / replacement as required.
13.0. Box up of LP outer casing.
14.0. Horn checks of HP and IP casing and rectification by Shims / Packers as required.
15.0. Resetting of all bearings, oil seals and pedestal oil guard rings including repair/replacement of strips as per requirement. Refitting of all bearings and setting of bearing pads & keys etc. as per requirement.
16.0. Servicing of over speed trip and thrust bearing trip devices including adjustment / repair / replacement if any. Inspection of LPT Extraction Bellows.
17.0. MOP overhauling, this includes repair/replacement of components as per requirement and alignment etc.
18.0. Recording of catenary values and releasing of deck springs as applicable.
19.0. Coupling of HP-MOP, HP-IP, IP-LP, LP- Generator, Reaming, Honing of coupling holes as per requirement.
20.0. Swing check of HP Front Rotor and necessary matching etc. in coupling as per requirement.
21.0. Rotor float and thrust pad check of thrust bearing and repair/replacement if any.
22.0. Barring gear nozzle inspection, repair / replacement of fins and resetting as per requirement.
23.0. Box up of all bearings and pedestals.

24.0. Cleaning of rack filters and basket strainers during oil flushing as per requirement. During Oil flushing will be as per quality of the oil in the circuit.
22.0. Assistance during commissioning.
23.0. Checking, adjustment and minor repair of all MS & HRH lines hangers from 2 hangers before strainer to Turbine, CRH lines hangers from Turbine to 2 hangers after CRH NRV and LPBP valve all hangers from HRH taping to condenser.
24.0. Fitting of turbine cladding removed for O/H.

SCHEDULE – 2 : OVERHAULING OF HP TURBINE MODULE :

1.0. Removal of HPT insulation.
2.0. HPT Roll check and recording casing centre.
3.0. Removal of HPT rear bearing and placing back in position without thrust pads.
4.0. HPT Bump check.
5.0. Loosening or cutting of HPT inlet breech nuts, opening of exhaust elbows and gland steam pipe lines. Cutting , rewelding including stress relieving & radiography of M.S lines as may be necessary.
6.0. Cutting of associated pipe lines such as drains, impulse lines etc.
7.0. Preparation for lifting of HPT Module.
8.0. Lifting of complete HP Module from pedestal and placing on stand.
9.0. Dismantling of HPT rear gland box, removal of front glands, recording roll check and bump check values at every state, removal of inserts.
10.0. Locking of HPT rotor in the casing.
11.0. Tilting of complete module and placing in vertical position.
12.0. Removal of threaded ring from barrel recording key clearances.
13.0. Removal of rotor with inner casing from barrel with the help of attachments etc. and placing on the same on fixture in horizontal position and inspection and cleaning of "U" seal ring and "I" seal ring also repair / replacement as required.
14.0. Removal of HPT inner casing parting plane studs. For this, Induction heating machine shall be arranged by BHEL. However, the subcontractor shall provide all assistance from loading/unloading of the equipment, opening of casings and closing, etc. All manpower required for the same including rigging gangs and helpers and T&P shall be provided by the subcontractor.
15.0. Removal of top half inner casing and recording flow path reading.
16.0. Lifting of HPT Rotor and removal seal segments from casing halves.
17.0. Alumina/ sand blasting of HPT Rotor, inner casing halves and other components.
18.0. Inspection, repair of casing / rotor fins, gland fins.
19.0. Length measurement and DPT of HPT inner casing parting plane studs and replacement as required.
20.0. HPT inner casing and inlet assembly "U" seal ring pre-compression check, DPT, visual inspection / replacement before assembly.
21.0. Placement of top half on bottom half and checking of parting plane gap and ovality before and after heat tightening the studs.
22.0. Checking of inner casing centering w.r.t. barrel with dummy shaft and finalizing radial key sizes.
23.0. Place HPT Rotor over the inverted upper half casing and record all axial and radial clearance.
24.0. Fixing of sealing segments and placement of HPT Rotor.
25.0. Recording flow path reading and assembly with upper half inner casing. Repeat with bottom half.
26.0. Heat tightening of inner casing parting plane studs.
27.0. Roll check and bump check of HP Rotor with inner casing and centering.
28.0. Locking of inner casing with rotor.

29.0. Insertion of HP Rotor with inner casing into barrel.
30.0. Fitting of casing keys, threaded ring or lock ring as applicable.
31.0. Making HPT Module Horizontal.
32.0. Fixing of gland box and seal segments, recording roll check and bump check at every stage.
33.0. Lifting of HPT Module land placement on TG Pedestal & subsequent loading to bearings.
34.0. HPT Roll check and Bump check.
35.0. HPT horn drop checking and correction.
36.0. HPT inlet breech nuts & exhaust elbows connection along with associated pipe lines.

SCHEDULE – 3 : OVERHAULING IP TURBINE MDOULE :

1.0 Removal of complete insulation of IP Turbine and dismantling of associated and required piping.
2.0. Checking of axial and radial clearances in the assembled condition after noting down the control dimensions.
3.0. Removal of gland box seals on both sides, checking of axial and radial clearances and repair/replacement of any components of gland boxes, as per requirement.
4.0. Loosening of outer casing parting plane bolts and removal of the top half casing. For this, Induction heating machine shall be arranged by BHEL. However, the subcontractor shall provide all assistance from loading/unloading of the equipment, opening of casings and closing, etc. All manpower required for the same including rigging gangs and helpers and T&P shall be provided by the subcontractor.
5.0. Rolling test and float test of IP rotor with respect to inner casing after centering the casing.
6.0 Loosening of inner casing parting plane bolts and removal of top half of casing. For this, Induction heating machine shall be arranged by BHEL. However, the subcontractor shall provide all assistance from loading/unloading of the equipment, opening of casings and closing, etc. All manpower required for the same including rigging gangs and helpers and T&P shall be provided by the subcontractor.
7.0. Measurement of flow path clearances, and necessary replacement/repair of fins of rotor and casing as per requirement.
8.0. Measurements of parting plane stud lengths, testing and replacement as per requirement.
9.0. Removal of Rotor.
10.0. Facial run out checks on HP coupling half, IP coupling halves and LP coupling halves and necessary scraping / matching to the extent possible as required.
11.0 Casing parting plane ovality check and necessary correction on casing parting plane for minimum contact of 10 mm from the stud hole.
12.0 Removal of inner bottom casing if required.
13.0. Cleaning by alumina /sand blasting of inner casing and Rotor, inspection of seal strips of the inner casings and repair / replacement of fins, as per requirement.
14.0 Placement of top half of inner casing / outer casing (without rotor) on bottom half for checking ovality of casing after tightening of the parting plane studs. Ensure that L-Rings are made free.
15.0. Removal of casing top half after checking the ovality of the casing.
16.0. Placement of rotor in the ZERO position in the inner casing and necessary grinding/machining of casing and rotor fins etc. and adjustment in keys, packers etc. as per requirement during checking of axial /radial clearances of blades/fins.
17.0. Final box up of inner casing after thorough cleaning, checking for minimum axial and radial clearances by rolling checks, bump check, horn drop check of inner casing and necessary rectification as per requirement.

18.0. Checking for axial and radial clearances of seal strips of sealing segments of the outer casing (both top and bottom half) and necessary adjustment/grinding as per requirement.
19.0. Placing of top half of IP outer casing on the bottom half after cleaning and boxing up of the outer casing.
20.0. Checking of the axial / radial clearances of seal strips and boxing up of gland boxes after necessary grinding etc. as per requirement.
21.0. Final checking of axial / radial clearances in the assembled condition and necessary rectification as per requirement.
22.0. Final connection of associated piping etc.
23.0. Assistance for removal and replacement of IPT thermocouples and putting new ones as per instruction and requirement of C&I.

OVERHAULING OF LPT:

1.0 Carrying out dismantling roll check of Inner-outer casing.
2.0 Supporting of LP Inner outer casing bottom after roll check of inner outer casing.
3.0 Removal of top half of inner-outer casing after loosing of parting plane bolts.
4.0 Carrying out dismantling roll check of Inner-Inner casing.
5.0 Opening of inner-inner outer casing parting plane bolts and lifting of inner –inner top half.
6.0 Recording of relevant axial and redial clearances at parting plane.
7.0 Removal of Front and rear gland boxes.
8.0 Removal of LP Turbine rotor and placing on support.
9.0 Cleaning of LPT Rotor and Inner-inner casing (Alumina/Sand blasting as required.)
10.0 Cleaning of Inner-inner casing bottom half using emery paper (as required)
11.0 Ovality check of inner-inner casing with and without tightening of parting plane bolts.
12.0 Inspection of last stage blades, internals of steam space like compensator bellows wherever visible, circular supports etc. any repair/replacement as per requirement.
13.0 Removal of top half of front and rear gland boxes, inspection of sealing strips of both halves and rotor along with adjustment in Gland box keys as per requirement.
14.0 Rolling check of LP Turbine along with necessary adjustments in keys, lubrite plate etc. as per requirement.
15.0 Placing of rotor in LPT inner-inner casing Bottom half & recording of clearances.
16.0 Assembly of front and rear gland boxes.
17.0 Placing of LPT inner-inner top half and box up of both halves.
18.0 Placing of LPT Inner-outer casing top-half in position.
19.0 Tightening of parting plane bolts of Inner-outer casing.
20.0 Roll check of LPT assembly with Inner-outer casing in boxed up condition.
21.0 Carrying out necessary alignment of casing, as required.
22.0 Replacement of eroded balancing weights.

PART-II

OVERHAULING OF HYDRAULICALLY OPERATED VALVES OF TURBINE, LPBP SPRAY INJECTION VALVES ALONGWITH THEIR ACTUATORS

1. HP STOP & CONTROL VALVES, IP STOP & CONTROL VALVES ,LP BYPASS STOP & CONTROL VALVES, LP BYPASS WATER INJECTION VALVES

1.0 Before dismantling of the stop and control valve governing characteristics of stop/control valves should be taken and any discrepancy on the valve side should be attended during overhaul.

2.0 Erect scaffolding at valves as required and remove insulation.
3.0 Removal of measuring instruments. Take reference dimensions.
4.0 Drain actuator housing. Remove oil lines and steam leak off line.
5.0 Heat and remove valve body cover bolts.
6.0 Disassemble valve completely.
7.0 Open coupling between valve and servomotor.
8.0 Detach actuator housing from valve body cover.
9.0 Dismantling of servomotor internals and cleaning of all internals. Carry out DPT as per requirement.
10.0 Disassemble actuator and valve completely.
11.0 Complete revision of the servomotor, replacement/repair of components, as required.
12.0 Determine condition of valve and decide on maintenance work to be attended. Carry out DP
13.0 Test of valve internals (body, seat, disc., spindle etc.) as per requirement.
14.0 Clean and de-scale component parts.
15.0 Inspect valve stem and pilot disc. Check stem for run out. Carry out DP test of valve internals (body, seat, disc, spindle etc.) as per requirement.
16.0 Inspect sealing faces at the valve seat and disc. Lap up if necessary.
17.0 Check clearances and install the actuator and valve body.
18.0 Inspect pistons springs, discs and sealing faces.
19.0 Reseal and assemble actuator.
20.0 Attach actuator and valve body cover
21.0 Attach actuator and valve body cover to valve body and heat bolts.
22.0 Connect up stem.
23.0 Associate with BHEL/CUSTOMER during installation of measuring instruments and indicators of the valves.
24.0 Start oil pumps and check valves for leak and proper functioning. Attend the defects .
25.0 After completion of the job governing characteristics should be set as per standard values in association with BHEL/CUSTOMER.
26.0 Do Hot tightening of valve flanges, glands and bonnets at part load and full load of machine.

B. OVERHAULING OF CRH NRV:

1.0 Making necessary scaffolding and approach platform for CRH NRV.
2.0 Removal of existing insulation cladding sheet and insulation in the top cover area of NRV.
3.0 Removal of oil pipe line from NRV servomotor, Decoupling of servomotor from valve spindle and removal of servomotor from position.
4.0 Opening the top cover of CRH NRV by making proper lifting arrangement and removal of all internals like flap, spindle etc.
5.0 Cleaning of all internals including pressure seal area and checking for any erosion mark in gasket seating areas. Carry out DPT as per requirement.
6.0 Repair and replacement of defective component.
7.0 Build up and repair of eroded portion by grinding and matching.
8.0 Box up of NRV with new pressure seal gasket/components.
9.0 Tightening of the cover to the required torque and hot tightening of the same after charging.
10.0 Fixing the servomotor in position, Coupling the servomotor with NRV spindle and fixing of oil pipes of servomotor.
11.0 Attending to leakages if any after charging.
12.0 Removal of temporary platforms and scaffoldings.

3. OVERHAULING OF HP BYPSS MAIN VALVES & SPRAY VALVES BPE1, BPE2, BD VALVES (WITHOUT SEAT CUTTING)

1.0. Decoupling and removal of actuators as may be required.
2.0. Dismantling of valves.
3.0. Cleaning / checking/ DP/ ultrasonic Testing of valve components and repair to the extent possible at site.
4.0. Lapping of seats and disc.
5.0. Assembly of valves.
6.0. Placement and coupling of actuators.
7.0. Assistance for commissioning of valves.

SCOPE OF WORK FOR OH OF HRH STRAINER:

1.0. Cutting of Strainer drain pipe.
2.0. Removal of Strainer, Repair / Replacement of Strainer as per requirement.
3.0. Cleaning of components, inspection, DPT of components, Repair of weld joint of element with blanking plate.
4.0. Assembly of Strainer.
5.0. Welding of drain pipes and DP Test of weld joints.

SCOPE OF WORK FOR OH OF MS STRAINER :

1.0. Cutting of Strainer drain pipe.
2.0. Removal of Strainer, Repair / Replacement of Strainer as per requirement.
3.0 Cleaning of components, inspection, DPT of components, Repair of weld joint of element with blanking plate.
4.0 Assembly of Strainer.
5.0 Welding of drain pipes and DP test of weld joints.

1. OH OF GENERATOR:

a) Russian design Generator:

1.0. Conducting Air Tightness Test on entire Generator and its pipe lines and other components of gas system.
2.0. Removal, dismantling and cleaning of all four gas coolers, Hydraulic Test of each gas cooler and plugging of leakage tubes as required.
3.0. Removal of Brush Gear cable and Brush gear assembly.
4.0. Removal of seal oil and Lub oil pipe lines.
5.0. CRO Readings to be taken. Decoupling of LP Gen. and taking alignment reading for reference, checking of FRO.
6.0. Removal of TE and EE seal covers and seal body and seal rings.
7.0. Bearing no.5 and 6 top pedestal cover removal.
8.0. Bearing no.5 and 6 top and bottom half removal after checking the clearances of bearing as per BHEL protocol. Replacement of Bearing no.5 and 6 as required.
9.0. Removal of Inner oil catcher at both ends.
10.0. Checking of pedestal insulation of Bearing no.6.
11.0. Checking of seal rings of EE and TE and replacing as required.
12.0. Removal of EE and TE End shields and Fan shields.
13.0. Measurement of Air gap and Magnetic Center as per BHEL protocol as necessary.
14.0. Removal of Bearing no.6 pedestal after giving support to the rotor.
15.0. Removal of rotor fan blades.

16.0. Threading out TG rotor and placing it on the stand.
17.0. Cleaning of stator, thorough inspection of stator, stator core, stator cooling gas circuit and hydrogen cooler water pipes, stator overhang bracket bolts, core bar bolts and other fasteners inside the stator are to be inspected for tightening and proper locking of nuts and bolts.
18.0. Inspection of stator and slot wedge, checking for tighten sand tightening of loose wedges by de-wedging and re-wedging by using suitable packers below the wedges, tightness mapping chart to be prepared before and after carrying out actual wedge tightening work. Checking of looseness of braiding in overhang portion.
19.0. Replacement of winding RTD's as required.
20.0. Hydraulic testing of stator winding as per BHEL protocol and attending any leakages thereby in Teflon tubes or copper pipes. In case of it requires removal of putty boxes, re-assembly of the boxes to be done.
21.0. Pneumatic testing of stator winding as per BHEL protocol.
22.0. Draining of stator water from the windings.
23.0. Assistance in Carrying out ELCID Test on the stator core & RSO test on rotor.
24.0. Measurement of PI value of stator and bringing it to a value more than 2 by Hot air blowing, as required.
25.0. Assistance in Tan Delta and Partial discharge test on the Generator to be carried out.
26.0. Carrying out Rotor Purge Test.
27.0. Die Penetration test and UT of Rotor retaining rings after removal of Paint in the retaining rings.
28.0. Die Penetration test of the Fan blades after removal of paint. DPT and UT of seal rings.
29.0. Conducting DP and Ultrasonic test of Bearing no. 5 and 6.
30.0. Heating the stator suitably, glue injector in the winding overhang portions as required. Varnishing of stator winding after completion of work and drying out of varnish.
31.0. Blue matching of Bearing no.6 pedestal with foundation.
32.0. Blue matching of Bearing no.6 with pedestal and then with shaft journal.
33.0. Pedestal insulation checking and rectification if found less.
34.0. Adjustment of oil catcher and deflector plate as per BHEL protocol and replacement of fins of oil catcher as required.
35.0. Cleaning of all lub oil and seal oil pipe lines and seal body. DP test to be done on all welding joints of pipe lines.
36.0. Air tightness test of Rotor as per BHEL Protocol and if leakage is there rectification of the same by opening CC Bolts.
37.0. Taking rotor IR value and rectification of the same if found less. Replacement of CC bolt to be done as required.
38.0. Insertion of TG rotor inside stator.
39.0. Assembly of end shields and fan shields.
40.0. Assembly of seal rings, seal cover and seal body.
41.0. Assembly of bearing no.6 and its pedestal.
42.0. Assembly of seal oil and Lub oil lines at both ends after slope checking.
43.0. Alignment of LP-Generator and coupling of LP-Gen.
44.0. Assisting in assembly of Brush Gear and alignment of Brush Gear as per BHEL Protocol. Brush holder adjustment.
45.0. Assisting in Brush Gear cable termination.
46.0. Assembly of Gas coolers.
47.0. Disconnection of Phase and neutral links from GT.
48.0. Cleaning of all impulse lines of Generator.
49.0. Cleaning of seal oil and stator water coolers and carrying out Hydraulic test of the same. Plugging of the leaky tubes or replacement of cooler to be done.
50.0. Cleaning of filters of stator water system and seal oil system.

51.0. Cleaning of stator water magnetic filter.
52.0. Cleaning of expansion tank of stator water and replacement of gaskets as required.
53.0. All Gaskets, O rings and rubber cords to be replaced with new ones.
54.0. Gas Tightness checking and inspection of Phase and Neutral Bushing and Attending any leakage thereby. Replacement of Gaskets/insulators of all the 9 nos. of bushings(as required). Thorough cleaning of phase and neutral bushing area.
55.0. Commissioning of seal oil system and attending any leakages as required.
56.0. Generator air tightness checking as per BHEL Protocol & attending leakages .
57.0. Checking of stator water bushing and replacement of gaskets and O rings.
58.0. Taking final readings of CRO as per protocol.
59.0. Assisting in measurement of Rotor/Stator IR, PI, DC resistance & impedance values.

b) Siemens design Generator with exciter

1.0. Dismantling and removal of Exciter. After swing check, decoupling and alignment checking. Removal of Exciter/PMG Assy. from position
2.0. Dismantling and removal of Generator end shields, H2 coolers, seal assembly and pipe lines. DP/UT of H2 seals liners and replacement of liner as required.
3.0. Dismantling and removal of bearing no.5, 6 & 7. Checking of insulation and replacement as required. DP/UT of all Bearings
4.0. Threading out of Generator rotor & after completion of works thread –In.
5.0. Inspection and cleaning of Generator stator/ rotor& Exciter/PMG
6.0. ELCID Test of Generator will be done by BHEL and all assistance including arrangement of cables, switch boards, cut-outs etc. to be provided by the contractor.
7.0. Stator wedge tightness, Core looseness, overhang portion strengthening work, match joint spacer work shall be carried out by BHEL and all assistance to be provided by the contractor.
8.0. Checking /Revisioning of Diode wheel & replacement of fuses as required.
9.0. Physical checking of multi contact pins for healthiness.
10.0. Gas leak test of Generator Rotor & Exciter Rotor CC bolts and attending leakage by replacement of CC bolts if required.
11.0. Stator winding cleaning by CTC before glue injection and varnishing. Required quantity of CTC and other cleaning agent along with cloth to be arranged by contractor.
12.0. DP/UT checks of rotor retaining rings and fan blades.
13.0. Assistance during various generator electrical test.
14.0. Inspection & Replacement of all Terminal bushings along with gaskets.(6 Nos)
15.0. UT check of Generator seal rings and replacement as required.
16.0. Dismantling/cleaning of H2 coolers ,exciter coolers, Hydraulic Test & attending leakage by plugging of tubes
17.0 Glue injection and varnishing of stator wdg.
18.0 Varnishing of Gen. Rotor.
19.0 Insertion of Generator Rotor and Boxing up of Generator.
20.0 Air tightness test of Generator casing at 4 kg/cm2. for 24 hrs.
21.0 Color matching of Generator bearing.
22.0 Replacement of oil catcher fins as necessary.
23.0 Replacement of any of defective components of Generator & Exciter and varnishing of same.
24.0 Checking of the Generator stator palms for any feeler gap.
25.0 Matching of exciter pedestal with the exciter base frame and revisioning of exciter bearing including replacement as required. Re-matching of Exciter anchor plate and tightening of anchor bolts to required elongation.
26.0 Revisioning of PMG Assembly, Varnishing and assembly

27.0 Assistance during the N.F.T of Generator end winding. & checking of terminal nose joint.
28.0 Removal of Exciter dome, Stator top half & removal of rotor & complete overhauling
29.0 Revisioning of Exciter/PMG Assy. Assistance during testing, cleaning & varnishing
30.0 Swing check of exciter and necessary correction.

C. Siemens design Generator without exciter:

1.0. Removal of four hydrogen coolers, cleaning of coolers by Acid cleaning conducting hydraulic test & attending leakages by plugging the cooler tubes
2.0. Repair /replacement of cooler vent line valves as per requirement. Cleaning of coolers space. Apply of black bituminous paint on water box.
3.0. Re-assembly of hydrogen coolers with replacement of gaskets, liner, bends pipes etc.
4.0. Removal of Turbine side and Exciter side End shields.
5.0. Removal of extension shaft.
6.0. Generator rotor threading out.
7.0. Air leak test of Rotor & attending leakage by repair/ replacement of CC bolts
8.0. Rotor externally cleaning and rotor retaining rings and varnishing.
9.0. DPT/UT test for retaining rings, bearings & H2 Seals. Repair replacement of the same as required
10.0. Stator cleaning, inspection, varnishing.
11.0. Assistance during Stator wedge tightness checking and re-tightening.
12.0. Stator overhang bracket bolts, core bar bolts and other fasteners is to be attended. Replacement of RTDs is to be carried out).
13.0. Assistance during Stator ELCID Test & RSO Test of Rotor.
14.0. Inspection of stator bushing.
15.0. Visual Inspection of stator overhang portion .
16.0. Slip ring shaft air leak test & attending leakage.
17.0. Rotor threading in & box up of generator.
18.0. Checking of final air gap, adjustment & stator shifting for achieving alignment etc as per requirement.
19.0. Assembly of Turbine side and Exciter side End shields and replacement of rubber cord. Assembly of H2 seal (TE and EE end) inspection rectification & replacement as required.
20.0. Seal oil flushing & seal oil charging & air tightness test of assembled generator & attending leakages.
21.0. LP -gen. alignment and correction & coupling of rotors.
22.0. Assembly and run out setting of extension shaft.
23.0. Inspection/replacement of Stator terminal bushing as required.
24.0. Replacement of oil catcher fins as necessary.
25.0 ASSISTANCE TO BE PROVIDED FOR THE FOLLOWING TESTS:

a) N.F.T. of Generator end winding & Tan Delta/PD
b) R.S.O. Test of Generator rotor
c) ELCID Test & Wedge tightness test of Generator stator

2. REPLACEMENT OF LPT BELLOWS (optional work)

1.0 Removal of covers of both outer bellows (L&R) and DPT of the bellows.
2.0 Opening of manholes in steam admission pipes (L&R) and inspection of the inner bellows.
3.0 Cutting and taking out the outer compensator with pieces of steam admission pipe.

4.0 Cutting of lip joint between LP inner inner casing and inner compensator on both left and right side.
5.0 Removal of damaged inner compensator and inner protection pipe.
6.0 Detach/cutting of outer protection cover of LP Heater extraction compensator from LP inner outer casing from condenser side and cutting of pipe joint below the compensator.(applicable for extraction compensator work only)
7.0. Check outer compensators by DPT for damage cracks etc.
8.0. Removals of eccentric bushes of bottom half of LP inner inner casing.
9.0. Record elevations and other references of LP inner inner casing w.r.t. LP inner outer casing.
10.0. Removal of axial keys.
11.0. Removal of bottom half of LP inner inner casing.
12.0. Inspection of LPH 3 extraction compensator for any damage etc. and replacement as required.
13.0. Edge preparation of all pipe joints and LP inner inner casing as per drawing.
14.0. Welding of LPH-3 compensator to the LP inner inner casing as per drawing.
15.0. Placement of LP inner inner casing in position and centering of the same w.r.t. LP inner outer casing and other references and fitting of eccentric bushes.(applicable foe extraction compensator work only)
16.0. Placement of left/right side inner compensators in position.
17.0. Alignment and preparation of welding joints of inner compensators on left/right side and welding the same as per procedure including the welding to flanges of steam admission pipes.
18.0. Alignment and preparation of welding joints of outer compensators on right/left sides and welding the same as per procedure including adjustments in length of steam admission pipes. Fillet welding of inner protection pipes to the outer compensators.
19.0. Welding of LPH-3 compensator to pipe and welding of compensator cover as per procedure.
20.0. Welding and NDT: Use E 7018 welding electrodes for welding of all joints. Radiographic inspection of all butt joints and 100% DPT of all balance joints and fillet welds.
21.0. Any other job required to be done to complete the above job is deemed to be included in this scope of work.

3. Assistance for Slow speed balancing of HP/IP rotor (optional work)

SCOPE OF WORK:

1.0 Unloading/unpacking and installation of the balancing machine at site. Installation of the whole machine on preplanned and erected rails.
2.0 Coupling of IP/HP rotor with adaptor shaft, as necessary.(Adaptor shaft to be arranged by customer).
3.0 Placement of IP/HP rotor on the balancing machine and assembly.
4.0 “Slow Speed Balancing" of IP/HP rotor.
5.0 Dis-assembly and lifting of IP / HP rotor and placement on stand.
6.0 Dismantling of balancing equipment, packing and loading for onward transportation.

5. Assistance during MPI & NFT OF LPT Rotor free standing blades 2x2 Stages (optional work)

1.0 Cutting of welding of locking plates of both sides of LPT Rotor free standing blades.
2.0 Removal of locking plates of both sides of blades.
3.0 Removal of all clamping pieces.
4.0 Removal of blades with proper marking.
5.0 Thorough cleaning of blades and their grooves in the rotor by suitable means so as to remove corrosion products, if any.

6.0 Inspection of blades roots and their grooves in the rotor.
7.0 Crack detection of all blades by MPI (Coil method) -100%
8.0 Fitting of all blades (cleared by MPI) in the position with technological pieces.
9.0 Fitting of technological pieces in place of clamping pieces.
10.0 Measurement & recording of Natural Frequency of blades.
11.0 Removal of technological pieces.
12.0 Replacement of technological pieces by new clamping pieces.
13.0 Fitting of locking pieces in position.
14.0 Welding of locking plates as per drawing.

NOTE: If any defect is observed in blades then it is to be replaced by new one. If the natural frequency of any of the blades is found to be beyond permissible range & it can not be improved upon even after proper cleaning of the blade root & its groove in the rotor, then the blade has to be replaced by new one.

6. Overhauling of MS/HRH strainers.

SCOPE OF WORK FOR OH OF HRH STRAINER:

1.0. Cutting of Strainer drain pipe.
2.0. Removal of Strainer, Repair / Replacement of Strainer as per requirement.
3.0. Cleaning of components, inspection, DPT of components, Repair of weld joint of element with blanking plate.
4.0. Assembly of Strainer.
5.0. Welding of drain pipes and DP Test of weld joints.

SCOPE OF WORK FOR OH OF MS STRAINER :

1.0. Cutting of Strainer drain pipe.
2.0. Removal of Strainer, Repair / Replacement of Strainer as per requirement.
3.0 Cleaning of components, inspection, DPT of components, Repair of weld joint of element with blanking plate.
4.0 Assembly of Strainer.
5.0 Welding of drain pipes and DP test of weld joints.

D) OVERHAULING PACKAGE OF 500 MW TG SET (KWU)

01 COH OF HP/IP/LPT, GENERATOR AND EXCITER, ALL VALVES AND STRAINERS INCLUDING GENERAL OVERHAUL OF TURBINE.

A. GENERAL OVERHAULING WORK

(INSPECTION OF ALL BEARINGS, (BRG.1 TO 7), ALIGNMENT, SWING CHECK OF ROTOR, ROLL CHECK & BUMP CHECK OF CASINGS, MOP OVERHAUL, and DECK SPRING ADJUSTMENT ETC."

1.0. Removal of turbine cladding as necessary.
2.0. Removal of LP Turbine outer casing parting plane bolts and removal of outer casing.
3.0. Measurement of oil guard clearances for all bearing pedestals, loosening of bearing 1 to 4 pedestal covers and lifting of pedestal covers. Bearing yoke/Yoke key clearance recording.

Removal of yoke, Measurement of oil catcher clearance, Bearing top half removal and Measurement of Bearing oil clearances. Carrying out Repair/Replacement of Keys, oil guard ring strips, oil catcher ring strips etc. as per requirement. Necessary workshop facilities will be provided by CUSTOMER free of cost.

4.0. Removal of all components from Generator and Exciter End for inspection of bearings 5 to 7. Measurement of oil guard clearance, Measurement of oil catcher clearance, Bearing top half removal and Measurement of bearing oil clearances. Carrying out Repair/
Replacement of Keys, oil guard ring strips, oil catcher ring strips etc. as per requirement.

5.0. Recording of coupled run out (CRO) of HP-IP, IP-LP, LP-GEN, GEN-Exciter coupling/
Journals/shafts etc. Necessary components required to be removed for taking CRO at LP-Generator and Gen.-Exciter couplings/journals shall be done . Carry out swing check at HPT Front journal and Exciter End journal. Necessary components required to be removed for taking swing check in Exciter end journal..

6.0. Measurement of reference control readings at HP, IP, LP, Generator etc. & measurement of Thrust bearing total float. Carry out necessary scrapping, lapping and corrections as per requirement.

7.0. Measurement of LP front and rear gland clearances and carrying out necessary corrections etc. as per requirement.

8.0. Decoupling of HP-IP, IP-LP, LP-Gen., Gen-Exciter and HP-MOP couplings. Recording of misalignment readings. Checking of HP, IP, LP, Generator & Exciter Rotor journals/couplings/shafts free run out.

9.0. Checking of axial and radial run out of coupling faces etc. wherever possible. Carry out face correction on coupling faces as per requirement.

10.0. Carry out Roll check of LP Turbine. Carry out necessary corrections/adjustments by repairing/replacing of keys, packers, eccentric pins etc.

11.0. Checking of centering of HP and IP Turbine. Carry out Roll check, bump check and Horn drop test of HP and IP Turbine. Carry out necessary corrections/adjustments by repairing/replacing keys, packers etc.

12.0. Complete dismantling of main oil pump assembly (MOP). Thorough cleaning of all components. If required bottom casing to be removed from pedestal for replacement of complete pump assembly. DP Test of components as per requirement and carry out necessary repair/replacement/revision of the components etc. as per requirement. Assembly of main oil pump in front bearing pedestal and carry out alignment of main oil pump with turbine shaft, adjustment and correction if any. Coupling of main oil pump with turbine shaft.

13.0. Inspection and measurement of bearing clearances for all bearings 1 to 7. Removal of top and bottom halves of bearings. Carry out DP Test/Ultrasound Test for all bearing halves. (Ultrasound Test Kit / DP Test Kit along with accessories to be brought by BHEL). Measurement of bore for all bearings. Carry out necessary scrapping/lapping/polishing on bearings/supports/journals etc. as per requirement. Carry out necessary scrapping/
Grinding etc. on the bases of Cylindrical/Spherical supports of the bearings to correct the taper ness etc. as per requirement.

14.0. Carry out alignment of HP-IP, IP-LP, LP-Generator and Gen.-Exciter coupling within the allowable limits by doing necessary corrections in bearing supports etc.

15.0. Rotor system catenaries check at all bearings. Comparison of existing height of individual deck spring elements with erection value. Adjustment of deck spring height to achieve design/erection catenary's values etc ,deck spring adjustments etc. Necessary T and P, manpower etc. required FOR DECK SPRING CHECKING & SETTING.. INCLUDING necessary scaffolding in each column around deck springs to carry out the jobs. (applicable for spring deck machines)

16.0. Coupling of HP-IP, IP-LP, LP-Generator and Gen.-Exciter coupling including necessary reaming and honing of coupling holes as per requirement. Machining of coupling bolts as per coupling hole size as required can be carried out at CUSTOMER workshop.

17.0. Checking facial run out of HP and IP Rotors coupling faces and scraping, Blue matching as required to correct the run out. Alignment of HP-IP, IP-LP, LP-Generator, Gen.-Exciter, HP-MOP. This will include adjustment in packers, bearing supports lubrication of packers, keys their blue matching as per requirement.

18.0. Rolling checks and required casing centering for HP, IP and LP Turbines. This includes adjustment/replacement of casing keys, their blue matching, lubrication etc. Record Bump check of HP and IP Rotors and necessary adjustment within available clearance.

19.0. Adjustment/centering of LP Gland boxes as per recommended clearances including removal and refitting of LP gland boxes for seal cutting replacement as required.

20.0. Taking coupling run out (CRO) of HP-IP, IP-LP, LP-Gen., Gen.-Exciter coupling. Carry out swing check at HP front journal and Exciter end journals. Carry out necessary adjustment/scrapping/corrections as per requirement.

21.0. Horn drop checks of HP and IP casing and rectification by shims / packers as required.

22.0. Resetting of all bearings oil seals and pedestal oil guard rings. This includes repair/replacement of strips as per requirement. Refitting of all bearings and setting of bearing pads and keys etc. as per requirement.

23.0. Servicing of over-speed trip and thrust bearing trip devices including adjustment/repair/ replacement if any. Inspection of LPT extraction bellows.

24.0. Thorough cleaning of bearing halves, Box up of Bearings, Yokes, Bearing Pads, Oil catcher etc. for all bearings 1 to 7. Maintaining necessary bearing clearances. Fixing the rotor in Zero position for C&I instrument calibration.

25.0. Box up of all components in Generator and Exciter end which was removed for the above jobs.

26.0. Thorough cleaning of bearing pedestals and Box up of all bearing pedestals. Inspection of all jacking oil hoses, seal oil hoses and replacement as per requirement. Checking of shaft lift at individual journals and carry out necessary adjustment.

27.0. Removal of oil throttles from Lub oil supply line to each bearing pedestals. Fixing of line filters in all Lub oil supply lines. Carry out oil flushing with intermediate cleaning of line filters, Lub oil duplex filter and MOT basket strainers etc. as per requirement.

28.0. Coupling of HP-IP, IP-LP, LP-Generator, Gen.-Exciter, HP-MOP rotors including reaming honing of coupling holes and changing of coupling bolts as per requirement.

29.0. Swing check test of HP front rotor and necessary matching etc. in coupling as per requirement.

30.0. Rotor float and thrust pad check of thrust bearing and repairs/replacement as required

31.0. Barring gear nozzle inspection, repair/replacement of fins and resetting as per requirement.

32.0. Box up of all bearings and pedestals.

33.0. Checking, adjustment and minor repair of all MS and HRH lines hangers from 2 hangers before strainers to Turbine, CRH lines hangers from Turbine to 2 hangers after CRH NRV and LPBP valve all hangers from HRH tapping to condenser.

B. LP TURBINE MODULE OVERHAULING:

1.0. Removal of LP Turbine outer casing parting plane bolts and removal of outer casing.

2.0. Erection of LP Parting plane joint covering.

3.0. Carry out Roll check of LP Turbine.

4.0. Jacking of LP Inner outer casing bottom half. Removal of LP Turbine Inner outer casing parting plane bolts and eccentric bolt. Removal of Inner outer casing.

5.0. Removal of LP Turbine Inner-inner casing parting plane bolts and removal of Inner-inner casing.

6.0. Checking of flow path clearance of LP Turbine (both axial and radial) etc.

7.0. Removal of Front and Rear gland box top half. Removal of gland segments. Repair / Replacements of gland fins etc.
8.0. Removal of LP Rotor and placing on the stand.
9.0. Dry Alumina blasting /sand blasting of LP Rotor and casings. Arranging dry Alumina and necessary blasting equipments shall be in the scope of CONTRACTOR , Clearing of rotor, Inner-outer casing, Inner-Inner casing and all other components as per requirement.
10.0. Checking cleanliness and thoroughness of the drain slits on the last stage fixed blades of the LPT.
11.0. DPT of the slits of the last stage blades are to be done.
12.0. Visual inspection and DPT of steam inlet pipe bellows/all LP Extraction Bellows/LP Turbine Front and Rear Bellows and carry out necessary repair/replacement as per requirement.
13.0. Carry out necessary visual inspection of Condenser dome wall stiffening structure and spray trays etc. inside condenser and carry out minor repairs as per requirement.
14.0. Replacement of LP Rotor on Inner casing and Box up of Inner-inner and Inner-Outer casing by hot tightening etc. as per requirement.
15.0. Carry out roll check of LP Turbine and necessary correction in keys, Packers and Eccentric Bolts etc. as per requirement.
16.0. Replacement of eroded balancing weights.
17.0. Checking of radial/axial clearances of LPT and setting as per drawing./ recommendation.
18.0. Replace parting plane O Ring and Box up of LP Turbine outer casing.
19.0. Placement /Fitment of LP front and rear gland box top half and carrying out necessary adjustments.

C. O/H OF 500 MW HP TURBINE:

1.0. Removal of HPT insulation.
2.0. HPT roll check and recording casing center.
3.0. Removal of HPT rear bearing and placing back in position without thrust pads.
4.0. HPT bump check.
5.0. Loosening of HPT inlet breach nuts, exhaust elbows and gland steam pipe lines.Cutting of breech nut/ inlet pipes, rewelding , stress relieving ,radiography as required.
6.0. Cutting of associated pipe lines to HPT.
7.0. Preparation for lifting of HPT module.
8.0. Lifting of complete HP module from pedestal and placing on stand.
9.0. Dismantling of HPT rear gland box, removal of front glands, recording roll check and bump check values at every stage, removal of inserts.
10.0. Locking of HPT rotor in the casing.
11.0. Tilting of complete module and placing in vertical position.
12.0. Removal of threaded ring / lock ring from barrel recording key clearances.
13.0. Removal of rotor with inner casing from barrel with the help of attachments etc. and placing on the same on fixture in horizontal position and inspection and cleaning of "U" seal ring and "I" seal ring also repair/replacement as required.
14.0. Removal of HPT inner casing parting plane studs. For this, Induction heating machine shall be arranged by BHEL. However, the subcontractor shall provide all assistance from loading/unloading of the equipment, opening of casings and closing, etc. All manpower required for the same including rigging gangs and helpers and T&P shall be provided by the subcontractor.
15.0. Removal of top half inner casing and recording flow path reading.
16.0. Lifting of HPT rotor and removal seal segments from casing halves.

17.0. Alumina /sand blasting of HPT rotor, inner casing halves and other components. Alumina powder shall be arranged by contractor.
18.0. Inspection, repair of casing / rotor fins, gland fins by cutting as per requirement.
19.0. Length measurement and DPT of HPT inner casing parting plane studs and replacement as required.
20.0. HPT inner casing and inlet assembly ”U” seal ring pre-compression check, DPT, visual inspection/replacement before assembly.
21.0. Placement of top half on bottom half and checking of parting plane gap and ovality before and after heat tightening the studs.
22.0. Centering check of inner casing w.r.t. barrel with dummy shaft and necessary corrections in keys.
23.0. Removal of HPT inner casing parting plane studs .
24.0. Place HPT Rotor over the inverted upper half casing and record all axial and radial clearance.
25.0. Fixing of sealing segments and placement of HPT rotor.
26.0. Recording flow path reading and assembly with upper half inner casing.
27.0. Heat tightening of inner casing parting plane studs.
28.0. Roll check and bump check of HP rotor with inner casing and centering.
29.0. Locking of inner casing with rotor.
30.0. Insertion of HP Rotor with inner casing into barrel.
31.0. Fitting of casing keys, threaded ring.
32.0. Making HPT module horizontal.
33.0. Fixing of gland box and seal segments, recording roll check and bump check at every stage.
34.0. Lifting of HPT module and placement on TG pedestal and subsequent loading to bearings.
35.0. HPT roll check and bump check.
36.0. HPT horn drop checking and correction.
37.0. HPT inlet breach nuts and exhaust elbows connection along with associated pipe lines.

D. OVERHAULING OF 500 MW IP TURBINE MODULE :

1.0. Checking of axial and radial clearances in the assembled condition after noting down of control valves.
2.0. Checking of the axial and radial clearances.
3.0. Loosening of outer casing parting plane bolts and removal of top half of the casing. For this, Induction heating machine shall be arranged by BHEL. However, the subcontractor shall provide all assistance from loading/unloading of the equipment, opening of casings and closing, etc. All manpower required for the same including rigging gangs and helpers and T&P shall be provided by the subcontractor.
4.0. Loosening of inner casing parting plane bolts and removal of top half of inner casing after conducting rolling checks. For this, Induction heating machine shall be arranged by BHEL. However, the subcontractor shall provide all assistance from loading/unloading of the equipment, opening of casings and closing, etc. All manpower required for the same including rigging gangs and helpers and T&P shall be provided by the subcontractor.
5.0. Measurement of the parting plane stud lengths, UT and replacement of studs as per requirement.
6.0. Removal of rotor from the casing.
7.0. Checking of parting plane for deformation, ovality check and necessary correction.
8.0. Cleaning and visual inspection of blades, fins, inner casing (both top and bottom half) and casing cleaning by wet washing/sand blasting/alumina blasting and repair of fins ,blades to the extent possible.
9.0. Inspection of seal strips of the outer casing and casing cleaning by wet washing.

10.0. Cleaning of rotor and visual inspection of rotor, rotor blades, rotor fins etc. and repairs of fins, blades to the extent possible. Reconditioning of flow path.
11.0. Making all L-rings free and any repair/replacement as required.
12.0. Placement of rotor in Zero position in the casing after cleaning and necessary grinding of rotor fins etc. and adjustment in keys packers etc. as per requirement during checking of axial/radial clearances in blades/fins etc.
13.0. Checking of the radial clearance at the top of inner casing and necessary adjustment/grinding as per requirement.
14.0. Final box up of the inner casing after thorough cleaning.
15.0. Checking of axial /radial clearances of seal strips of sealing segments of the outer casing (both top and bottom half) and necessary adjustment/grinding as per requirement and replacement if required.
16.0. Final box up of IP outer casing and hot tightening of parting plane bolts.
17.0. Final connection of piping etc. and fixing of radial and axial keys.
18.0. Assistance for replacement of IP inner casing thermocouples.

E: OVERHAULING OF HP/IP/LPBP STOP VALVES:

1.0. Before dismantling of the stop and control valve governing characteristics of stop/control valves should be taken and any discrepancy on the valve side should be attended during overhaul.
2.0. Erect scaffolding at valves as required and remove insulation.
3.0. Removal of measuring instruments. Take reference dimensions.
4.0. Drain actuator housing. Remove oil lines and steam leak off line.
5.0. Heat and remove valve body cover bolts.
6.0. Disassemble valve completely.
7.0. Open coupling between valve and servomotor.
8.0. Detach actuator housing from valve body cover.
9.0. Dismantling of servomotor internals and cleaning of all internals. Carry out DPT as per requirement.
10.0. Disassemble actuator and valve completely.
11.0. Complete revision of the servomotor, replacement/repair of components, as required.
12.0. Determine condition of valve and decide on maintenance work to be attended. Carry out DP Test of valve internals (body, seat, disc., spindle etc.) as per requirement.
13.0. Clean and de-scale component parts.
14.0. Inspect valve stem and pilot disc. Check stem for run out. Carry out DP test of valve internals (body, seat, disc, spindle etc.) as per requirement.
15.0. Inspect sealing faces at the valve seat and disc. Lap up as necessary.
16.0. Check clearances and install the actuator and valve body.
17.0. Inspect pistons springs, discs and sealing faces.
18.0. Reseal and assemble actuator.
19.0. Attach actuator and valve body cover
20.0. Attach actuator and valve body cover to valve body and heat bolts.
21.0. Connect up stem.
22.0. Associate with BHEL/CUSTOMER during installation of measuring instruments and indicators of the valves.
23.0. Start control fluid pumps and check valves for leak and proper functioning. Attend the defects .
24.0. After completion of the job governing characteristics should be set as per standard values in association with BHEL/CUSTOMER.
25.0. Do hot tightening of valve flanges, glands and bonnets at part load and full load of machine.

F. OVERHAULING OF MS/HRH STRAINERS:

1.0. Construction of temporary platform for strainers servicing.
2.0. Cutting of drain pipe by grinder.
3.0. Dismantle the strainers.
4.0. Check for any foreign body and damage inside the valve.
5.0. Checking of welded joints by DPT carry out necessary repair/rectification.
6.0. Thorough cleaning of strainer.
7.0. Box up.
8.0. Carry out drain pipe welding. NDT of the welded joints.
9.0. NOTE :
    1.0. Before dismantling of the stop and control valve governing characteristics of stop/control valves should be taken and any discrepancy on the valve side should be attended.
    2.0. After completion of the job governing characteristics should be set as per standard values in association with BHEL /CUSTOMER.
    3.0. One set means one complete assembly of either of the MS or HRH strainer.

PART K:

OVERHAULING OF LPBP WATER INJECTION VALVES :

1.0. Associate with BHEL/CUSTOMER during removal of instruments.
2.0. Remove servomotors.
3.0. Disassemble valve, check condition of the seat and valve plug for any passing.
4.0. Lap the seat if required. Check blue impression.
5.0. Repair the damaged parts of the valve. Carry out DP test of valve internals (disc. Spindle etc.) as per requirement.
6.0. Assemble the valve.
7.0. Revision the servomotor and mount in position.
8.0. Hot tightening of flanges, glands and bonnets of the valve at full pr.
9.0. One set means one no. of complete assembly of water injection valve with servomotor.

PART L:

OVERHAULING OF CRH NRV:

1.0. Making necessary scaffolding and approach platform for CRH NRV.
2.0. Removal of existing insulation cladding sheet and insulation in the top cover area of NRV.
3.0. Removal of oil pipe line from NRV servomotor, Decoupling of servomotor from valve spindle and removal of servomotor from position.
4.0. Opening the top cover of CRH NRV by making proper lifting arrangement and removal of all internals like flap, spindle etc.
5.0. Cleaning of all internals including pressure seal area and checking for any erosion mark in gasket seating areas. Carry out DPT as per requirement.
6.0. Repair and replacement of defective component.
7.0. Build up and repair of eroded portion by grinding and matching.
8.0. Box up of NRV with new pressure seal gasket/components.
9.0. Tightening of the cover to the required torque and hot tightening of the same after charging.

10.0. Fixing the servomotor in position, Coupling the servomotor with NRV spindle and fixing of oil pipes of servomotor.
11.0. Attending to leakages if any after charging.
12.0. Removal of temporary platforms and scaffoldings.

OVERHAULING OF HP BYPSS MAIN VALVES & SPRAY VALVES BPE1,BPE2 ,BD VALVES

1.0. Decoupling and removal of actuators as may be required.
2.0. Dismantling of valves.
3.0. Cleaning / checking/ DP/ ultrasonic Testing of valve components and repair to the extent possible at site.
4.0. Lapping of seats and disc.
5.0. Assembly of valves.
6.0. Placement and coupling of actuators.
7.0. Assistance for commissioning of valves.

PART M: OVERHAULING 500 MW GENERATORS/EXCITER

1.0. Conducting Air Tightness Test of Generator Stator checking for any leakages in the Bushing area.
2.0. Removal of Exciter dome after removing all Electrical and C&I connections. Removal of Diode wheel cover.
3.0. Taking CRO of LP-Gen. & Decoupling of LP-Gen. rotors.
4.0. Note down Alignment Reading of LP-Gen as per Protocol,
5.0. Removal of Gen/Exciter Bearing no 5,6 &7. Insulation checking & correction as required.

STATOR:
1.0. Dismantle Stator End Shields and replace all Gaskets.
2.0. Check condition of Stator Core and Winding.
3.0. Check slot wedge tightness and rectify defect. (Core repair, Wedge replacement).
4.0. Checking winding support structure and all other Stator Bolts and rectify defects.
5.0. Replace all necessary Generator Flange Gaskets.
6.0. Nitrogen gas filling in the winding.
7.0. Carrying out winding Hydraulic Test as per Protocol and attending any leakage in water and nitrogen circuits.
8.0. Dismantling and cleaning H2 coolers, replacement of all gaskets and conducting Hydraulic Test of all the coolers and attending leakages if any, plugging of tubes.
9.0. Cleaning of stator, thorough inspection of stator, stator core, stator cooling gas circuit and Hydrogen cooler water pipes, stator overhang bracket bolts, core bar bolts and other fasteners inside the stator are to be inspected for tightening and proper locking of nuts and bolts.
10.0. Assistance during Conducting Wedge Tightness Test of Generator Stator. Checking of looseness of braiding in over hang portion.
11.0. Assistance during ELCID & NFT Test of stator winding and attending any defects thereof.
12.0. Removal of Generator phase and Neutral Link and replacement of Bushing sealing gaskets, 'O' rings and bushing insulator (if required).
13.0. Checking of all electrical connections of stator like bushing connection, bar to bar to connection and rectification of defects.
14.0. Assisting during Generator testing.

15.0. Conducting Air Tightness Test of Generator casing and attending leakages..
16.0. Cleaning of Primary water filters along with conical filters.
17.0. Varnishing on stator.

ROTOR:

1.0. Perform Run out checks as per protocol.
2.0. Decouple rotor, thread out rotor and check rotor visually.
3.0. Assistance during taking IR value of rotor and winding resistance and impedance of rotor.
4.0. Assistance during conduct RSO Test on Rotor.
5.0. Check rotor wedge and retaining rings.
6.0. Inspect the winding and Gas duct.
7.0. Dismantle Compressor Assembly.
8.0. Carry out DP/UT Test of compressor blades and Retaining Ring after removal of paint.
9.0. Check the IR of the compressor segments and rectify as required.
10.0. Surface matching of coupling.
11.0. Checking bearing surface and shaft seal surface and rectify any defect.
12.0. Perform Gas Tightness Test of Rotor and replace current carrying bolt and sealing washers, as necessary.
13.0. Clean all dismantled parts thoroughly before box up. Varnishing on rotor.
14.0. Rotor thread- in and Box up.
15.0. Boxing up of all dismantled parts as per procedure, seal body IR measurement and bring the IR value to the recommended value.
16.0. Replace of all Hose pipes. Cleaning of Neutral Grounding Transformer & Bus Duct
17.0. Alignment of LP-Gen including shifting/lifting of stator to be done, as required and foundation bolts stretching.
18.0. Thorough cleaning of Generator Bushing chamber and all flexible links and Teflon tube connections.
19.0. Assistance in cleaning of Neutral Grounding Transformer & Bus duct.

EXCITER:

1.0. Swing Check recording & decoupling of Gen-Exciter.
2.0. Removal of PMG stator after removing electrical connections.
3.0. Removal of all pipe lines to Bearing no.7.
4.0. Removal of bearing no.7 top cover and top half of bearing shell.
5.0. Checking of IR value of pedestal and if found less attending the same.
6.0. Removal of exciter coolers and flap gates.
7.0. Removal of top half of main exciter.
8.0. Removal of exciter rotor and placing it on stand.
9.0. Carrying out Gas Tightness Test of Exciter Rotor and attending leakage, replacement of exciter current carrying bolt and washers, as necessary.
10.0. Cleaning of all dismantled parts and windings thoroughly.
11.0. Checking of all windings for any defect and rectifying the same ..
12.0. Inspect the bandage wire for any looseness or damage & rectification .
13.0. Check and blue match the coupling flange.
14.0. Check the multi-contact band and replace the same as required.
15.0. Visually inspect the exciter rotor bearing seating portion and rectify any defect.
16.0. Cleaning of Exciter coolers and carrying out Hydraulic testing of the same as per protocol and attending leakages .
17.0. Servicing of emergency flaps of exciter.

18.0. Check ground fault detection system and rectify any fault.
19.0. Clean the filters of exciter dome.
20.0. Replacement of all gaskets and providing proper sealing of exciter dome.
21.0. Alignment of Gen.-Exciter, swing check and coupling.
22.0. Varnishing on Exciter & PMG Components.

BEARINGS:

1.0 Visual inspection of brg. 5,6 & 7 for any damage.
2.0 Carrying out DP & UT test of the bearings
3.0 Replacing JOP Hose of all three brgs,as required..
4.0 Checking of brg.,insulation and rectifying the problem..
5.0 Blue matching of bearing with seating and with shaft journal.
6.0 Replacement of bearings if necessary by a new one.
7.0 Checking of oil catcher and deflector plate and replacement of fins as required.
8.0 Complete cleaning of seating portion of bearing.

SHAFT SEALS:

1.0. Check for oil leakage in seal oil pipe lines inside generator and attending the leakage.
2.0. Checking clearances of seal rings at both ends as per protocol.
3.0. Visual inspection of seal rings for any damage.
4.0. Carrying out DP/UT test on both the seal rings and replacement of the same as required.
5.0. Thorough cleaning of seal body.
6.0. Blue matching of seal body parting plane oil catcher parting plane and seal oil Teflon bush surface.
7.0. Inspection of all Teflon bushes and replacement of the same as required.
8.0. Checking of seal oil hoses of impulse lines and replacing the same as required.
9.0. Carrying out modification of seal oil pipe lines inside the Generator as per the modification suggested, if necessary (i.e. providing supporting at suitable places).

SEAL OIL SYSTEM:

1.0 Check control and safety valves including float valve replace as required.
2.0 Check all valves for leakage and the same.
3.0 Check and clean seal oil filter.
4.0 Check seal oil flow after overhauling and adjust.
5.0 Overhauling of all DPR's as required.

PRIMARY WATER SYSTEM:

1.0. Check and clean all filters.
2.0. Check complete primary water system for leakage after Hydraulic test and attend the same. including all associated jobs.

GAS SYSTEM:

1.0. Check all valves for leakage and attend the same.
2.0. Check condition and performance of CO2 flash evaporator.
3.0. Check and attend all gas leakages of entire Hydrogen system.
4.0. Replacement H2 drier silica gel.

COOLERS: H2, Exciter, Seal Oil & PW coolers

1.0. Clean H2, Exciter, seal oil and PW coolers on waterside as required.
2.0. Perform pressure test on coolers, as required & attending leakages by plugging.
3.0. Replace all gaskets as required including all associated jobs .

DIODE WHEEL ASSEMBLY AND REPLACEMENT OF FUSES

1.0. Inspection and replacement as required of positive and negative wheel to detect any crack, overheating marks, deformation or any other defect of wheels, diodes, fuses, heat sinks, links, insulations.
2.0. Inspection and replacement as required of all fasteners and lock washers for their intactness.
3.0. Measurement and Replacement as required of fuse resistance.
4.0. Visual inspection of stroboscope and its light source where installed.

Assistance During Generator Testing :

1.0. Assistance during carrying out the Digital ELCID, RSO & NFT Test on complete generator stator core, winding & rotor. Rectification/repair of the defects identified in the ELCID Test.
2.0. Assistance during carrying out Digital RSO Test on Generator Rotor.
3.0. Hydraulic test of Generator Stator water system will be carried out at the specified pressure for the specified time period. Minor Leakages shall be attended by contractor.
4.0. Manpower assistance shall be provided by contractor during Electrical Testing of Generator Stator/ Rotor like Impedance, Winding Resistance. Shifting of the test equipment for carrying out testing is in the contractor scope.
5.0. Any extra job required to be done shall be carried out as per instruction of Engineer In-charge.
6.0. Assistance during PD (Partial Discharge) test & HV/Tan Delta Test and other Tests.

3. ASSISTANCE FOR MPI/NFT of LP Blades (optional wotk)
ASSISTANCE FOR MAGNETIC PARTICLE INSPECTION(MPI) TEST OF LPT ROTOR AND BLADES : (OPTIONAL WORK)

1.0. Removal of all free standing blades with fit root from LP Turbine Rotor.
2.0. Cleaning of blade roots and rotor grooves thoroughly.
3.0. Assistance for MPI Test for both Rotor grooves and blades.
4.0. Replacement of blades as required.
5.0. Fitment of blades on the rotor with new clamping pieces and locking strips.

ASSISTANCE FOR NATURAL FREQUENCY TEST (NFT) OF LPT ROTOR BLADES(optional work)

1.0. Removal of all free standing blades with fit root from LP Turbine rotor.
2.0. Cleaning of blade roots and rotor grooves thoroughly.
3.0. Fixing of blades with technological pieces as per requirement..
4.0. Assistance for NFT on the blades.
5.0. Replacement of blades as required. Fitment of blades on the rotor with new clamping pieces and locking strips.

4. INSPECTION OF SEALS OF GENERATOR WITHOUT ROTOR THREAD OUT.

1.0. Check for oil leakage in seal oil pipe lines inside generator and attending the leakage.
2.0. Checking clearances of seal rings at both ends as per protocol.
3.0. Visual inspection of seal rings for any damage.

4.0. Carrying out DP/UT test on both the seal rings and replacement of the same as required.
5.0. Thorough cleaning of seal body.
6.0. Blue matching of seal body parting plane oil catcher parting plane and seal oil Teflon bush surface.
7.0. Inspection of all Teflon bushes and replacement of the same as required.
8.0. Checking of seal oil hoses of impulse lines and replacing the same as required.. Carrying out modification of seal oil pipe lines inside the Generator as per the modification suggested, as necessary (i.e. providing supporting at suitable places

E- Providing expert Manpower with >20 years experience in Turbine/ Generator / Valves/ Strainers/ governing System/ commissioning/ Boiler Air Preheater & other related work of 120 MW to 500MW Rating to be provided on Man days basis

F. BOILER CHEMICAL CLEANING

1. Chemical Cleaning of Boiler for 200/210/250 MW Unit including supply of required chemicals SCOPE OF WORK

Part A: Supply Part:

1. Supply of all chemicals and consumables required for Acid Cleaning / Passivation of Boiler.
The indicative / tentative requirement of Bulk chemicals for the chemical cleaning (from Alkali Boil Out and up to 1st stage passivation) is as follows. However there may be some variation in the quantities depending on the tube analysis by BHEL-Tiruchirapalli.

Sl. No.	Description of Chemicals	Approx. Quantities	
1	Tri sodium phosphate ($Na_3PO_4.12H_2O$) BIS 573-1992	400 kg.	
2	Di Sodium Phosphate (Na_2HPO_4 12 H_2O)BIS 566 -1997	200 kg	
3	Potasium Bromate, 97% minimum	1400 kg	
4	Ammonium Carbonate, BIS:5316:1998	700 kg	
5	Hydrochloric acid, commercial grade, 31% minimum, BIS : 265 : 1993	40 tonnes	
6	Inhibitor	570 litres	
7	Ammonium bifluoride, 97 % minimum, BIS: 13119:1991	1400 kg	
8	Thiourea, 97% minimum	2800 kg	
9	Citric acid, 95% minimum, BIS: 5464:1970	1900 kg	
10	Liquor ammonia, Sp.Gr. 0.91, 25% by wt., BIS: 799:1972	4000 litres	
11	Hydrazine hydrate, 80% minimum, BIS: 12086:1987	300 litres	
12	Sodium carbonate, 90%,minimum,BIS:151:1972	1400 kg	
13	Nitrogen gas cylinders,6.3 m^3 capacity, BIS:1747:1972	300 Nos.	
14	Bleaching powder, BIS:1065:1971	2000 kg	
15	Sodium hydroxide flakes, 98% minimum, BIS :252:1991	15 tonnes	
16	Lime, 80% minimum, BIS: 1540, Part II, 1990	4 tonnes	

Note:

1. The rates quoted for supply of chemicals/consumables shall be inclusive of all taxes, duties Sales Tax, CST, VAT, transportation at site and insurance etc. and shall be treated as landed price). However Service Tax shall be paid extra for execution portion of Acid Cleaning i.e. on Part - B.
2. The quantity of chemicals projected above is for 230 m^3 of water volume, which includes the drum (full capacity), water walls, down comers, economizer, ring headers, temporary pipelines and the circulation tank (about 20 tonnes).
3. The superheater volume is taken to be 40 m^3 for which chemicals are included for filling and preservation.
4. For the chemicals from Sl. No. 1 to 10, extra quantity of 20% is included over and above the required quantity to take care of exigencies**.**
5. The chemical suppliers must be asked to provide "Test certificate" (to ensure the quality) for the above chemicals.

Part B : For Execution of Acid Cleaning

1.0 Arrangement of Equipment / Material required for the whole process such as dissolving tanks, circulating pumps, valves of various sizes, pipelines, headers, etc. as per requirement.
2.0 Deployment of adequate trained and experienced staff of various categories for the execution of work in smooth manner.
3.0 Necessary electrical equipments such as control panels, starters and cables for motors of circulating pumps.
4.0 Supply and installation of super heater plugs and orifice plates for the down comers.
5.0 High pressure gas regulating valve header assembly for connecting Nitrogen cylinder.
6.0 Execution of complete process as per the procedure and monitoring the process in the laboratory up to first and second stage passivation.
7.0 Erection of pump sets and control panels including preparation of foundations as required.
8.0 Fabrication and installation of temporary piping circuit and connecting with the main boiler.
9.0 Manual cleaning of the loose debris and other impurities from the drum are to be removed after opening the drum for inspection. If needed drum internals are to be removed and re
10.0 All instruments in the circuit will have to be removed /isolated to avoid damage by chemicals and re-installed after purging and restored back.
11.0 Laying of pipeline for taking the drains to neutralization pit .
12.0 All joints (including HP Joints) required to be done at site for temporary installation including piping to be done by I.B.R. approved welder.
13.0 The contractor will arrange transportation of all chemicals from stores to the work site.
14.0 Adequate power supply, steam, general service water and DM water will be provided free of cost by customer. However contractor has to make DG set available at site in case of failure of plant power supply.
15.0 Any other work not listed in scope of work but required for smooth execution of work will be deemed to have been covered in the scope of work and no extra claims for the same shall be entertained.
16.0 The scaffolding pipes, wooden planks, scaffolding clamps, welding electrodes, industrial gases,
17.0 Argon gas cylinder, etc. are to be arranged by the contractor.
18.0 It shall be contractor's responsibility to provide the safety equipments such as safety helmets, hand gloves, goggle; shoes etc., to the personnel engaged.
19.0 The work is of specialized nature and contractor should be fully conversant with latest practices and carry out the work in consultation with site In charge.
20.0 Removal of all temporary lines and cleaning of the area.

21.0 Removal of drums internals before acid cleaning and restoration after completion.
22.0 Inhibitor healthiness testing with test coupon before use.
23.0 Assistance from safety valve seal removal and plug fixing before acid cleaning.
24.0 Arranging required lab ware for analytical work and reagents etc. during chemical cleaning.

PREPARATORY WORK:

All the chemicals are to be arranged before start up work and stored at a convenient location to avoid any delay on this account.

CHEMICAL CLEANING OF BOILER:
The chemical cleaning of the Boiler consists the following components.
Economizer
Boiler drum
Front, Rear and side water walls, their headers, down comers and risers.
Bottom ring header.

NOTE:
1.0 The Super heater circuit should be isolated and preserved with alkaline medium with positive pressure (+5 kg) with separate pumps and temporary piping.
2.0 The chemical cleaning of the boiler should consists the following process:
3.0 Super heater preservation
4.0 De-greasing
5.0 Main acid cleaning of the Boiler
6.0 Required rinsing under Nitrogen cover
7.0 Secondary rust removal
8.0 Neutralization of the system of the Boiler
9.0 First and second stage passivation

Chemical cleaning process, which includes the following major steps, shall be carried out as per procedure given by BHEL – R& D, Tiruchirapalli based on tube analysis report. However an indicative procedure to be adopted is given below.

- ALKALI BOIL OUT
- CHEMICAL CLEANING.
- NEUTRALISATION AND PASSIVATION.

2. Chemical Cleaning of Boiler for 200/210/250 MW Unit without supply of required chemicals

SCOPE OF WORK

Execution of Acid Cleaning work

1.0 Arrangement of Equipment / Material required for the whole process such as dissolving tanks, circulating pumps, valves of various sizes, pipelines, headers, etc. as per requirement.
2.0 Deployment of adequate trained and experienced staff of various categories for the execution of work in smooth manner.
3.0 Necessary electrical equipments such as control panels, starters and cables for motors of circulating pumps.
4.0 Supply and installation of super heater plugs and orifice plates for the down comers.

5.0 High pressure gas regulating valve header assembly for connecting Nitrogen cylinder.
6.0 Execution of complete process as per the procedure and monitoring the process in the laboratory up to first and second stage passivation.
7.0 Erection of pump sets and control panels including preparation of foundations as required.
8.0 Fabrication and installation of temporary piping circuit and connecting with the main boiler.
9.0 Manual cleaning of the loose debris and other impurities from the drum are to be removed after opening the drum for inspection. If needed drum internals are to be removed and reassembled after completion of the cleaning process.
10.0 All instruments in the circuit will have to be removed /isolated to avoid damage by chemicals and re-installed after purging and restored back.
11.0 Laying of pipeline for taking the drains to neutralization pit.
12.0 All joints (including HP Joints) required to be done at site for temporary installation including piping to be done by I.B.R. approved welder.
13.0 The contractor will arrange transportation of all chemicals from stores to the work site.
14.0 Adequate power supply, steam, general service water and DM water will be provided free of cost by customer. However contractor has to make DG set available at site in case of failure of plant power supply.
15.0 Any other work not listed in scope of work but required for smooth execution of work will be deemed to have been covered in the scope of work and no extra claims for the same shall be entertained.
16.0 The scaffolding pipes, wooden planks, scaffolding clamps, welding electrodes, industrial gases, Argon gas cylinder, etc. are to be arranged by the contractor.
17.0 It shall be contractor's responsibility to provide the safety equipments such as safety helmets, hand gloves, goggle; shoes etc., to the personnel engaged.
18.0 The work is of specialized nature and contractor should be fully conversant with latest practices and carry out the work in consultation with site In charge.
19.0 Removal of all temporary lines and cleaning of the area.
20.0 Removal of drums internals before acid cleaning and restoration after completion.
21.0 Inhibitor healthiness testing with test coupon before use.
22.0 Assistance from safety valve seal removal and plug fixing before acid cleaning.
23.0 Arranging required lab ware for analytical work and reagents etc. during chemical cleaning.

CHEMICAL CLEANING OF BOILER:

The chemical cleaning of the Boiler consists the following components.
Economizer
Boiler drum
Front, Rear and side water walls, their headers, down comers and risers.
Bottom ring header.

NOTE:

1.0 The Super heater circuit should be isolated and preserved with alkaline medium with positive pressure (+5 kg) with separate pumps and temporary piping.
2.0 The chemical cleaning of the boiler should consists the following process:
3.0 Super heater preservation
4.0 De-greasing
5.0 Main acid cleaning of the Boiler
6.0 Required rinsing under Nitrogen cover
7.0 Secondary rust removal
8.0 Neutralization of the system of the Boiler
9.0 First and second stage passivation

Chemical cleaning process, which includes the following major steps, shall be carried out as per procedure given by BHEL – R& D, Tiruchirapalli based on tube analysis report. However an indicative procedure to be adopted is given below.

- ALKALI BOIL OUT
- CHEMICAL CLEANING.
- NEUTRALISATION AND PASSIVATION.

POST- OPERATIONAL CHEMICAL CLEANING

3. Chemical Cleaning of Boiler for 490/500 MW Unit including supply of required chemicals.

SCOPE OF WORK

Part A: Supply Part:

1. Supply of all chemicals and consumables required for Acid Cleaning / Passivation of Boiler.

The indicative / tentative requirement of Bulk chemicals for the chemical cleaning (from Alkali Boil Out and up to 1st stage passivation) is as follows. However there may be some variation in the quantities depending on the tube analysis by BHEL-Tiruchirapalli.

(From alkali boil out and up to 1st stage passivation)

Sl.No.	Chemical	Quantity
1	Tri sodium phosphate ($Na_3PO_4.12H_2O$) BIS 573-1992	1000 kg.
2	Di Sodium Phosphate (Na_2HPO_4 7 H_2O) BIS 566 - 1997	500 kg
3	Hydrochloric acid, commercial grade, 31% minimum, BIS : 265 : 1993	140 tonnes
4	Inhibitor	2300 litres
5	Ammonium bifluoride, 97 % minimum, BIS:13119:1991	1900 kg
6	Thiourea, 97% minimum	7600 kg
7	Citric acid, 95% minimum, BIS: 5464:1995	5000 kg
8	Liquor ammonia, Sp.Gr. 0.91, 25% by wt., BIS: 799:1985	10 tonnes
9	Hydrazine hydrate, 80% minimum, BIS: 12086:1987	1000 litres
10	Nitrogen gas cylinders, .3 m^3 capacity, BIS:1747:1972	500 Nos.
11	Bleaching powder, BIS:1065:1989	10 tonnes
12	Sodium hydroxide flakes, 98% minimum, BIS :252:1991	40 tonnes
13	Lime, 80% minimum, BIS: 1540, Part II, 1990	2 tonnes
14	Potassium Bromate, 97% minimum	4000 kg
15	Ammonium carbonate, BIS:5316:1998	1000 kg

Note:

1.0 The rates quoted for supply of chemicals/consumables shall be inclusive of all taxes, duties Sales Tax, CST, VAT, transportation at site and insurance etc. and shall be treated as landed price). However Service Tax shall be paid extra for execution portion of Acid Cleaning i.e. on Part - B.

2.0 The quantity of chemicals projected above is for 230 m^3 of water volume, which includes the drum (full capacity), water walls, down comers, economizer, ring headers, temporary pipelines and the circulation tank (about 20 tonnes).

3.0 The superheater volume is taken to be 40 m^3 for which chemicals are included for filling and preservation.

4.0 For the chemicals from Sl. No. 1 to 10, extra quantity of 20% is included over and above the required quantity to take care of exigencies**.**

5.0 The chemical suppliers must be asked to provide "Test certificate" (to ensure the quality) for the above chemicals.

Part-B: Execution of Acid Cleaning work

1.0 Arrangement of Equipment / Material required for the whole process such as dissolving tanks, circulating pumps, valves of various sizes, pipelines, headers, etc. as per requirement.

2.0 Deployment of adequate trained and experienced staff of various categories for the execution of work in smooth manner.

3.0 Necessary electrical equipments such as control panels, starters and cables for motors of circulating pumps.

4.0 Supply and installation of super heater plugs and orifice plates for the down comers.

5.0 Removal of orifice plates ring headers and restoration of same after acid cleaning.

6.0 High pressure gas regulating valve header assembly for connecting Nitrogen cylinder.

7.0 Erection of pump sets and control panels including preparation of foundations as required.

8.0 Fabrication and installation of temporary piping circuit and connecting with the main boiler.

9.0 Execution of complete process as per the procedure and monitoring the process in the laboratory up to first and second stage passivation.

10.0 Manual cleaning of the loose debris and other impurities from the drum are to be removed after opening the drum for inspection. If needed drum internals are to be removed and reassembed after completion of cleaning process.

11.0 All instruments in the circuit will have to be removed /isolated to avoid damage by chemicals and re-installed after purging and restored back.

12.0 Laying of pipeline for taking the drains to neutralization pit .

13.0 All joints (including HP Joints) required to be done at site for temporary installation including piping to be done by I.B.R. approved welder.

14.0 The contractor will arrange transportation of all chemicals from stores to the work site.

15.0 Arrangement of DG set at site in case of failure of plant power supply.

16.0 Any other work not listed in scope of work but required for smooth execution of work will be deemed to have been covered in the scope of work and no extra claims for the same shall be entertained.

17.0 The scaffolding pipes, wooden planks, scaffolding clamps, welding electrodes, industrial gases, Argon gas cylinder, etc. are to be arranged by the contractor.

18.0 It shall be contractor's responsibility to provide the safety equipments such as safety helmets, hand gloves, goggle; shoes etc., to the personnel engaged.

19.0 The work is of specialized nature and contractor should be fully conversant with latest practices and carry out the work in consultation with site In charge.

20.0 Removal of all temporary lines and cleaning of the area.

21.0 Removal of drums internals before acid cleaning and restoration after completion.

22.0 Inhibitor healthiness testing with test coupon before use.

23.0 Assistance from safety valve seal removal and plug fixing before acid cleaning.

24.0 Arranging required lab ware for analytical work and reagents etc. during chemical cleaning.

4. Chemical Cleaning of Boiler for 500 MW Unit without supply of required chemicals

SCOPE OF WORK

Execution of Acid Cleaning work

1.0 Arrangement of Equipment / Material required for the whole process such as dissolving tanks, circulating pumps, valves of various sizes, pipelines, headers, etc. as per requirement.
2.0 Deployment of adequate trained and experienced staff of various categories for the execution of work in smooth manner.
3.0 Necessary electrical equipments such as control panels, starters and cables for motors of circulating pumps.
4.0 Supply and installation of super heater plugs and orifice plates for the down comers.
5.0 Removal of orifice plates ring headers and restoration of same after acid cleaning.
6.0 High pressure gas regulating valve header assembly for connecting Nitrogen cylinder.
7.0 Erection of pump sets and control panels including preparation of foundations as required.
8.0 Fabrication and installation of temporary piping circuit and connecting with the main boiler.
9.0 Execution of complete process as per the procedure and monitoring the process in the laboratory up to first and second stage passivation.
10.0 Manual cleaning of the loose debris and other impurities from the drum are to be removed after opening the drum for inspection. If needed drum internals are to be removed and reassembed after completion of cleaning process.
11.0 All instruments in the circuit will have to be removed /isolated to avoid damage by chemicals and re-installed after purging and restored back.
12.0 Laying of pipeline for taking the drains to neutralization pit .
13.0 All joints (including HP Joints) required to be done at site for temporary installation including piping to be done by I.B.R. approved welder.
14.0 The contractor will arrange transportation of all chemicals from stores to the work site.
15.0 Arrangement of DG set at site in case of failure of plant power supply.
16.0 Any other work not listed in scope of work but required for smooth execution of work will be deemed to have been covered in the scope of work and no extra claims for the same shall be entertained.
17.0 The scaffolding pipes, wooden planks, scaffolding clamps, welding electrodes, industrial gases, Argon gas cylinder, etc. are to be arranged by the contractor.
18.0 It shall be contractor's responsibility to provide the safety equipments such as safety helmets, hand gloves, goggle; shoes etc., to the personnel engaged.
19.0 The work is of specialized nature and contractor should be fully conversant with latest practices and carry out the work in consultation with site In charge.
20.0 Removal of all temporary lines and cleaning of the area.
21.0 Removal of drums internals before acid cleaning and restoration after completion.
22.0 Inhibitor healthiness testing with test coupon before use.
23.0 Assistance from safety valve seal removal and plug fixing before acid cleaning.
24.0 Arranging required lab ware for analytical work and reagents etc. during chemical cleaning.

G. AIR PREHEATER OF BOILER

120/125/190/200/210/250/270/500 MW SETS

SCOPE OF WORK

SERVICING OF ROTARY AIR PREHEATER

1.0 Removal of Drive Assembly & Complete APH cleaning
2.0 Removal of Insulation of APH Housing & connecting ducting
3.0 Removal of all Heating Elements at CE/HE
4.0 Repairs to rotor shell plates, diaphragm plates, stay plates, gratings etc.
5.0 Erection of Cold End / Hot & Hot Intermediate heating elements.
6.0 Repair/ replacement of Bypass Angles, T-Bars etc.
7.0 Replacement of Radial Seals, Axial Seals, Bypass seals, Angles, T-Bars etc.
8.0 Servicing/ Replacement of Support Bearings
9.0 Servicing / Replacement of Guide Bearings
10.0 Setting of Radial Seals, Axial Seals, Static Seals, Bypass seals, etc.
11.0 Replacement of Hot / Cold End Sector Plates
12.0 Replacement of Main pedestal Axial Seal Plates
13.0 Replacement of Axial seal plate assemblies if required.
14.0 Setting of Pin-Rack assembly. Replacement if required.
15.0 Repair/Replacement of Soot Blowers / Water Washing system
16.0 Servicing of Lube oil system / Seal Air lines etc.
17.0 Erection of Drive Assembly, alignment and Trial run of APH.
18.0 Replacement of Expansion joints.
19.0 Repairs to gas / air ducting and connecting to APH.
20.0 Servicing of Hot Air / Cold Air dampers.
21.0 Servicing of manhole doors.
22.0 Application & cladding of APH housing and connecting ducts.
23.0 Checking of Air Pre Heater Stoppage alarm system
24.0 Checking of Air PrecHeater lighting Assembly
25.0 Trial run of Air Pre heaters.

H. ELECTRICAL/ DIGNOSTIC TESTS ON TURBINE, GENERATOR, AND NFT, MPI OF TURBINE BLADES ETC.

Following tests to be carried out :

I. GENERATOR STATOR

1. IR & PI Test with 5 KV megger.
2. DC winding resistance measurement.
3. Tan Delta/Power Factor/Capacitance test.
4. Computerised Digital ELCID test.
5. Partial Discharge probe test OR Offline PD Analysis.
6. DC leakage current/Step Voltage test.
7. Stator Slot wedge system check(wedge tightness mapping)
   i) By Wedge deflection test if ripple springs are installed)
   ii) By wedge knocking test.
8. RTD elements check.
9. IR with 1000V DC source and amp. Meter.

II GENERATOR ROTOR.

1. IR & PI
2. Digital RSO Test
3. AC Impedance measurement.
4. DC winding resistance measurement.
5. Diode wheel check.
6. Voltage balance test.

III EXCITER

1. IR & PI
2. DC winding resistance measurement.
3. Pole impedence test
4. Pole drop test.

IV . GENERATOR

1. NFT of Generator End Winding.

V. TURBINE

1. Natural frequency test on LP turbine rotor free standing blades of 120/200/210 & 250 MW sets.
2. Natural frequency test on LP turbine rotor free standing blades of 500 MW sets.
3. MPI of LP rotor blade roots, rotor grooves, rotor discs, rotor shaft etc.

I. VIBRATION ANALYSIS OF ROTOR & BALANCING ALONG WITH INSTRUMENT.

1. Vibration analysis of TG set and submission of detailed Report including observations & recommendations.
2. Dynamic trim balancing of the TG set , as required ,in addition to Vibration analysis as above.

J. THERMAL INSULATION OF TURBINE INCLUDING SUPPLY OF ALL INSULATION MATERIAL

1. Thermal Insulation (Spray & Ceramic blankets) of HP/IP/LP turbine, associated valves and Cross over pipes of200/210//250/500 MW Turbine.

a) Spray Insulation

SCOPE OF WORK:

1.0 Design, supply, fabrication and completion of thermal spray insulation on LMW TURBINE of 210 MW BHEL make, under the joint supervision of BHEL Engineers and Customer Engineers at site. The job comprises of supply, transportation of requisite materials, storage, pre-fabrication for insulation, application of insulation, aluminium sheet cladding over the insulation along with proper preservation of the materials during the tenure of work and ensure safety and security.

2.0 The insulating materials to be supplied should conform to the latest edition of the appropriate IS standard, viz. IS:677, IS:11128. The insulation thickness for different pipe sizes in different temperatures shall be selected by the bidder as per temperature mentioned in the schedule.
The tenderer should specify the type of insulation materials to be used for various applications.

3.0 The temperature difference after insulation of the outer surface of the insulation and the surrounding shall not be more than 15 to 20 ^{o}C and the insulation shall have long life at least of 10 years.

4.0 For thickness more than 50 mm the insulation should be applied in two or more layers.

5.0 All necessary hygienic and mandatory precautions pertaining to the materials in use should be taken by the successful bidder and he should advise the BHEL engineer if any hazards exist.

PORTIONS OF INSULATION

Please see Annexure-I.

1.0 All exposed parts of turbine viz. Bearing pedestals, sliding surfaces, control gear and other equipments in the vicinity which is likely to be damaged during insulation application are to be protected.

2.0 Thorough cleaning of the plant area after insulation work is over.

3.0 Turbine HP, IP & LP outer cylinders will be offered in partially insulated condition.
Removal of old insulation, cleaning of cylinder surfaces will have to be carried out by the insulating agency within the offered price. Old removed insulation will have to be removed and dumped in an identified location within the plant premises.Any other insulation work , not covered in the scope or mentioned specifically , but required for successful re commissioning of the TG set , is to be done by the bidder is deemed to be within the scope of activity of the bidder.

Design Guide Lines :

Basically the thickness of the insulation is so designed that with maximum turbine output and maximum line steam temp. the temp. on the outside of the insulation should never exceed 30 ^{o}C above room temp. No air layers are allowed to exist within the insulation. The insulation should be so designed that the heat loss shall not appreciably exceed 180 cal/m^{2}h for natural air flow. At flanges and pipe connections (also drains) the insulation must be so shaped that no soaking of the insulation can occur. Connecting heads for thermocouples and temp. detector must be outside the insulation. In case the insulation thickness is too large, a funnel shaped sheet is to be used. Temperature measurements (for continuous operation and tests) on the casings and piping are also not to be insulated. They are in any case covered.

For turbine casings, the thickness of insulation on bottom part shall be 20% thicker than insulation thickness on top part.

At each end of turbine casing, we recommend to install radiation plates of 2 mm thick aluminium plate. The shielding plate prevents oil, in case of a leakage, from being sprayed directly into the insulation and thereby soaking into the insulation and finally catching fire and burning. The radiation plates would prevent too much heating of the bearing pedestal.

After spray insulation of turbine cylinders, cementing to be done (one coat) and heat, oil resistant epoxy paint to be applied.

The durability and adherence of insulation layer is of particular importance on the bottom of the casings, therefore special attention shall be paid to this when the insulation is designed and applied. The insulation compound shall not contain any substance detrimental to health.

10. **Method of Application:**

Spray insulation for HPC, IPC, LPC and Steam Chest of ES & Gov. Valves.

To insulate flat surfaces or moulded shapes they must be first cleaned from rust, dirt, flat and paint remnants. After this a rust protection paint from high resistant aluminium bronze must be applied. Fixing of thermal insulation will be done by spray technique. Loose mineral wool mixed with liquid class of binder is sprayed by means of compressed air on the clean surface through a spray gun under compressed air, the mixture strings the turbine surface condensers and densely adhere to the surface forming monolithic seamless shape.

After each layer of approx 75 mm thickness spray insulation over HPC, IPC and middle part of LPC, drying out is to be carried out by hot air blowing at an elevated temperature of at least 55 ^{o}C or more to remove entrapped moisture in the insulation materials. Only after ensuring proper drying out of the insulation material, subsequent layer of spray insulation is to be applied.

Bidder has to ensure arrangement spray machine and its accessories.

Suitable support cage from M.S. strip of 25 mm x 3 mm and M.S. rods of 10 mm dia is to be fixed on cylinders. The case should take the weight of insulation being applied and provide a firm support. SS hexagonal wire netting should be fixed and stitched at intermittent level for providing support. The sprayed insulation around joints has a sheet metal separator so that the loosening of the screwed joints involves only limited damage to the insulation. Around corners funnel shaped metal sheets are to be provided. Around casing interfaces, aluminium protection plates (2 mm) are to be provided. Screws in the region of sprayed insulation are covered with aluminium foils .

The final layer of insulation shall be provided with the hard coat consisting of self setting cement compound. It shall be quick drying blended with suitable fillers. The material shall be used without asbestos fluff. A layer of Tissue/Fabric shall be wrapped all over the insulation in semi wet condition and finally finished with oil and heat resistant epoxy paint coating of selected grade.

Any defects identified on spraying, insulation shall have to be rectified as per the requirement of BHEL by the agency. No additional price is payable.

SPECIFIC CONDITION

1.0 As the time schedule for overhauling job completion is of outmost importance and same is greatly dependent upon timely mobilisation, commencement and completion of Turbine Thermal Insulation. The successful bidder has to ensure –

i. Timely availability of all insulation and associated materials at site.
ii. Timely mobilisation of spray insulation machine at site.
iii. Timely mobilisation of requisite manpower to work round the clock.

2.0 For purpose of transportation of insulation materials and spray insulation, successful bidder will have to make their own arrangement for road permit/ license, suitable transport etc. BHEL or their client will not provide any assistance to the party in this matter and no delay on account of arrangement of road permit etc. will be allowed.

RECOMMENDED PROCEDURES FOR INSULATTION OF PIPES

1.0 Remove outer layer of self setting cement compound and first layer of 50 mm thick un-bonded mineral wool mattress from whole length of H.P. loop pipe. Replace by new mineral wool mattress to obtain the prescribed/designed thickness along with wire netting as specified and fixing with hardcore self setting cement compound. A layer of tissue/fabric shall be wrapped all over the insulated and hard coated pipes in wet condition and same shall be finally finished with oil and heat resistant epoxy paint making thickness of 80-100 microns.

RECOMMENDED REPAIR PROCEDURES FOR INSULATED STEAM CHEST

1.0 Remove outer cemented compound insulation with least damage to inner insulation. Remove top 50 mm thick, old spray insulation and apply fresh spray insulation. Compact and secure by wire netting of specified type and grade.
2.0 Properly tighten the net and stitch at intermittent level for support as required.
3.0 Replenish the glass wool whenever such loss has occurred.
4.0 Provide with hard coat consisting of self setting cement compound.
5.0 Wrap layer of tissue/fabric all over the insulation in semi wet condition.
6.0 **Provide with oil and fire ,HEAT resistant coating (painting**) of selected grade and shade.

SPRAY INSULATION SCOPE OF WORK

	Equipment Description	**DIA in mm**	**Temp/Thickness (DegreeC/mm)**	**Remarks**
A.01. i.	Complete HPC including integral transfer pipe line and its flange joint (TOP/BOTTOM)	TOP BOTTOM	540/260 535/310	Spray type insulation
ii.	HPCV 1 & 2		535/175	-do-
iii.	HPCV 3 & 4 including steam chest		535/175	-do-
02.i.	Flange heating jacket pipe line	80(OD)	As applicable for T&B casing	Mattress type insulation
ii.	Flange heating jacket pipeline	80 (OD)		Mattress type insulation
03.i.	Gland steam pipe line	80 (OD)		Mattress type insulation
ii.	--do--	60 (OD)		Mattress type insulation
04.	HPC transfer pipe after flange	280 (OD)	535/175	Spray type

	joint			insulation
05.	Pipe line after chest of HPCV 3 & 4	280 (OD)	--do--	Spray type insulation
06.	Other integral pipelines of HPC Bottom	Upto two metre length each	As application for bottom casing	Mattress type insulation
07.	Stud heating pipe	60 (OD)		DO
08.	Minor repair work after flange joint.	As required		DO
	Equipment Description	**DIA in mm**	**Temp/Thickness (DegreeC/mm)**	**Remarks**
B.01. i.	Complete IPC including integral pipe line and its flange IPCV 1 & 2 (both top & bottom)		535/260 535/310 535/200	Spray type insulation
ii.	IPCV 3 & 4		Same as IP top	DO
iii.	Pipe line below flange joint of IPCV 3 & 4		Same as IP bottom casing	DO
02.i.	Gland steam pipe line	60 (OD)	As applicable	Mattress type insulation
ii.	--do--	60 (OD)	As applicable	DO
03.	Transfer pipe after first flange joint	435 (OD)	--do--	
04.	Other integral pipelines of IPC Bottom			D0
05.	Stud heating pipe	60 (OD)	As applicable for T&B casing	DO
06.	Minor repair work	As required		DO
	Equipment Description	**DIA in mm**	**Temp/Thickness (DegreeC/mm)**	**Remarks**
C.01. i.	Complete LPC middle parts (including both top & bottom)		190/100	Spray type insulation
02.i.	Gland steam pipe line	90 (OD)	As applicable	Mattress type insulation
ii.	--do--	60 (OD)	As applicable	Mattress type insulation
iii.	Gland steam pipe line header (LP rear side)		As applicable	Mattress type insulation

D) COMPLETE LP/IP CROSS OVER PIPE LINE 02 NOS. INCLUDING ALUMINIUM CLADDING ALONGWITH FOLLOWING :

	Equipment Description	**DIA in mm**	**Temp/Thickness (DegreeC/mm)**	**Remarks**
01.	LP side flange joint (02 nos.)		190/100	Mattress type

i.				insulation
ii.	IP side flange joint including bellow (02 nos.)		190/100	DO
02.	Minor repair work as required			DO
E.	ESV Chest (02 nos.), IV Chest (02 nos.), HP/LP bypass valve (04 nos.) and associated valves (08 NOS)as required		As applicable	DO

MATERIAL :

- ➔ UNBONDED MINERAL WOOL MATTRESSES OF 200 KG/M^3 DENSITY TO **IS : 3677** ARE TO BE USED

- ➔ INSULATION THICKNESS, WHEREVER INDICATED ARE ONLY FOR GUIDELINES, CORRECT THICKNESS TO FULFIL THE SPECIFICATION AND RELEVANT **I.S.** SHOULD BE PROVIDED.
- ➔ Way bill will not be provided to vendor for transportation of material and machine

LIST OF T&P AND CONSUMABLES TO BE PROVIDED / ARRANGED BY THE SUBCONTRACTOR :

1) SPRAY INSULATION MACHINE
2) MINERAL WOOL INSULATION
3) OTHER CONSUMABLES REQUIRED TO COMPLETE THE INSULATION WORK IN ALL RESPECT.
4) Required scapholding materials

APPLICATION PROCEDURE FOR CERAMIC PAD INSULATION:

1. Clean the surface, of the body of the component being insulated, properly with wire brushes manually.
2. Provide and fix 6mm. dia. SS Rods of length equivalent to the insulation thickness, on the supports made of MS strips of cross-section size 25 mm wide x 3 mm thick. The support shall be made of the above MS strips, welded to make a network around the component body, so as to maintain welding base for rods. No welding shall be done directly on the body of the component being insulated.
3. Provide and apply first layer of 75 mm. thick ceramic fibre blankets duly wrapped in ceramic cloth having industrial blouse hooks at the corners and join adjacent blankets with spring type holders or with criss-cross stainless steel wire to avoid/minimize the gap in between the blankets. Secure the pads by speed clip washers inserted through the SS rods already welded as mentioned under S. No. 2. The pads joints shall be tightly secured to minimize the heat loss.
4. Provide and apply subsequent layer of 50 mm. thick ceramic fibre blankets wrapped in glass cloth having industrial blouse hooks and stitch/tighten the same with criss – cross wire and secure the above with speed clip washers inserted through the SS rods already welded as mentioned above under Sl. No. 2. The pads joints shall be tightly secured to minimize the heat loss.
5. Provide and apply all remaining subsequent layers made up of 50mm thick ceramic fibre blanket pads as described in sl.no.4.
6. Position of the pad joints of the subsequent layers should be staggered with respect to that of the joints of the previous layer.
7. The flange joints shall be insulated separately to make it easy for removal and lifting during maintenance.
8. The minimum insulation thickness to be provided on the strainers and valves shall be 225mm. However additional layers shall be fixed if required to ensure skin temperature within 20 DEG. above surrounding temperature of the component.
9. The ceramic pad insulation shall include the entire body / casing of the component being insulated and shall also cover 500mm length of connected steam pipes.

The End

K. Opening of Turbine Casings by Induction Heating:

1. Mobilisation of induction heating machine along with panel and qualified and trained operators.

2. Opening of HP and IP casing bolts during dismantling by induction heating. For this, the tools and helpers required shall be provided by BHEL.

3. Heat tightening of HP and IP casings and opening again during checking of ovality of casings.

4. Heat tightening of HP and IP Casing parting plane bolts during final assembly by induction heating.