VOLUME - IA
TECHNICAL CONDITIONS OF CONTRACT (TCC)

BHARAT HEAVY ELECTRICALS LIMITED

Contents

List of Drawings

Sl. No / Annexure	Description/ Document Name	Drawing Number	Rev No	No of sheets
1	Machinery Arrangement and Foundation	1-313-01-14135	00	4
2	Layout of Generator	HY-DG-0-139-71-86721	04	1
3	Condensate Flow P&ID diagram	HY-DG-1-31701-14176	02	1
4	Turbine integral steam & drain flow diagram	HY-DG-1-31701- 14161	02	1
5	Lube oil P&ID	HY-DG-1-31701-14162	01	1
6	Integral Piping Layout	HY-DG-0-31301-14143	00	4

1.0 Project Information (1x60 MW STG for M/s Shriram Alkalies and Chemicals Ltd., Bharuch)

1	Purchaser	:	M/s Shriram Alkalies and Chemicals Ltd
2	Project Title	:	1x60 MW STG
3	Location	:	GIDC, Industrial Estate, Jhagadia, Bharuch
4	Address Detail	:	GIDC, Industrial Estate, Jhagadia, Dist.: Bharuch, Gujarat
5	Nearest Railway Station	:	Ankeleswar
6	Road Approach	:	NH-8
7	Nearest Air Port	:	Vadodara
8	Nearest Port	:	Dahej
9	Data of Seismic Design	:	Zone- III As per IS 1893
10	Average Annual Rainfall	:	1002 mm
11	Ambient Air Temperature (Average)	:	a) Maximum : 47^0 C b) Minimum : 5.6^0 C
12	Average Relative Humidity	:	77 - 82 %
13	Climatic Condition	:	Tropical Climate

Bidder is advised to visit the project site and appraise himself about the local conditions and infrastructure available in the area for fulfilling their commitments under the contract. BHEL will not admit any claims whatsoever on account of Contractor's non-familiarization of local conditions.

2.0 SCOPE OF WORK

This section list major scope of work for 1x60MW STGs at GIDC, Industrial Estate, Jhagadia, Bharuch for Shriram Alkalies Ltd. to be carried out by contractor, but not limited to following for safe, speedy erection and commissioning of this package.

- Receipt of materials from Manufacturing Units of BHEL, BHEL Sub Vendor, Customer stores, Storage yard etc. Handling at stores/storage yard, site of work, transportation to site of work. Preservation of all materials / equipment's under custody of the contractor during storage, pre-assembly and erection, commissioning etc. shall be carried out by Contractor.

- Rotating Equipments (Steam turbine, Turbo generator, auxiliary pumps) Inspection, preparation of foundation for erection, erection, leveling, centering, alignment, grouting & final alignment. Pre commissioning & commissioning.

- Piping between various equipment & customer battery limit (Steam, Utility, Oil, CW) : All piping items will be supplied as loose and Pipes in commercial lengths.

    i. Fabrication, Preassembly, erection, alignment, welding, Insulation, NDT, Fabrication of supports, fixing hangers & supports, installation of valves, instruments installation, chemical cleaning / pickling, card board blasting, oil flushing, water flushing, hydro testing, & supply of target plates for steam blowing. Pre commissioning & commissioning.
    ii. Fabrication & erection of Temporary Piping along with supports & insulation, Installation of fixtures (blinds etc.) Hydro testing, steam blowing, chemical cleaning etc.
    iii. Lifting, laying, erection, bolt tensioning, bolt torque tightening, supporting and installation, pre and post weld heat treatment, inspection, nondestructive testing including radiography and hydrostatic test, water / steam flushing, air drying, nitrogen purging and other testing of piping installations above ground.
    iv. Supply of Consumables like Welding Rods, Filler rods for welding and target plates for steam blowing.

- Vessels (Flash Tanks, Overhead Oil tank, Drain Oil Tank): Pre assembly, preparation of foundation for erection, erection, welding. Pre commissioning & commissioning

- Heat Exchangers (Generator Air Coolers, GSC, Lube Oil Coolers): Pre assembly, preparation of foundation for erection, erection, welding, insulation. Pre commissioning & commissioning.

- Static Equipment (Lube Oil Console, Jacking Oil Skid, Governing Oil Skid, Oil Centrifuge) : Inspection, preparation of foundation for erection, erection, leveling, centering, alignment, grouting & final alignment. Pre commissioning & commissioning.

- Painting: Supply and application of painting (Primer and Final Painting) for Piping, Structural and equipment touch up.

- During the erection, testing, pre-commissioning and commissioning works, some repairs, rectification and modifications etc. are likely to occur. Bidder shall note that they are part of scope of job. The bidder while quoting the rates shall take the above in consideration and no extra payment will be entertained on this account.

Examples for repairs, rectification, modifications etc.

1. Mismatching of flanges,
2. Machine base plate hole enlarging for adjustments,
3. Supports welding to equipment and rectification as per site condition,
4. Matching of filter section,
5. Additional chipping of foundation,
6. Changing of parts when they fail during the tests etc.,
7. Re-reaming of Coupling bolts holes etc.
8. Any parting plane blue matching etc.,
9. Providing of small opening on oil tanks & mounting of oil pumps. These points are only few examples, similar types of other works are also likely to come which are incidental to the nature of erection work.

- For any extra equipment & structural the approved unit rates of erection only will be applicable, and this will not be treated as extra works for payment on man hour rates basis.

- Execute all mechanical, electrical, C&I jobs identified during check list, Technical audits, pre-commissioning and commissioning, including additional supports required to restrain pipe movement avoiding interference with nearby structural / piping.

- Obtain clearances and approvals from all applicable statutory / Government agencies e.g. IBR, Electrical Inspectorate etc.

- Dewatering inside building for equipment erection facilitating is in contractor scope.

- Provision of crane for erection activities as and when required.

FOR FURTHER DETAILED SCOPE OF WORKS REFER RELEVANT TECHNICAL SPECIFICATIONS PROVIDED IN THE SUBSEQUENT CHAPTERS IN THE TCC

S. No.	Description PART I	Scope / to be taken care by		*Remarks*
		BHEL	**Bidder**	
3.1	**ESTABLISHMENT**			
3.1.1	**FOR CONSTRUCTION PURPOSE**:			
a	Open space for office (as per availability)	Yes		Location will be finalized after joint survey with owner
b	Open space for storage (as per availability)	Yes		Location will be finalized after joint survey with owner
c	Construction of bidder's office, canteen and storage building including supply of materials and other services		Yes	
d	Bidder's all office equipment, office / store / canteen consumables		Yes	
e	Canteen facilities for the bidder's staff, supervisors and engineers etc		Yes	
f	Fire fighting equipment like buckets, extinguishers etc.		Yes	
g	Fencing of storage area, office, canteen etc. of the bidder		Yes	
3.1.2	**FOR LIVING PURPOSES OF THE BIDDER**			Not applicable
a	Open space for labour colony (as per availability)			
b	Labour Colony with internal roads, sanitation, complying with statutory requirements			
3.2.0	**ELECTRICITY**			
3.2.1	**Electricity For construction purposes** of Voltage 415/440 V			FREE
a	Single point source	Yes		At a distance of approx. 1000 M from site (Distance is only estimated, it may vary up to an extent depending on site condition)
b	Further distribution including all materials, Energy Meter, Protection devices and its service		Yes	

S. No.	Description PART I	Scope / to be taken care by		*Remarks*
		BHEL	**Bidder**	
c	Duties and deposits including statutory clearances if applicable		Yes	
3.2.2	**Electricity for the office, stores, canteen etc of the bidder**			FREE
a	Single point source	Yes		At a distance of approx. 1000 M from site (Distance is only estimated, it may vary up to an extent depending on site condition)
b	Further distribution including all materials, Energy Meter, Protection devices and its service		Yes	
c	Duties and deposits including statutory clearances if applicable		Yes	
3.2.3	**Electricity for living accommodation of the bidder's staff, engineers, supervisors etc**			Not applicable
a	Single point source			
b	Further distribution including all materials, Energy Meter, Protection devices and its service			
c	Duties and deposits including statutory clearances if applicable			
3.3.0	**WATER SUPPLY**			
3.3.1	**For construction purposes**			FREE
a	Making the water available at single point	Yes		
b	Further distribution as per the requirement of work including supply of materials and execution		Yes	
3.3.2	**Water supply for bidder's office, stores, canteen etc**			FREE
a	Making the water available at single point	Yes		
b	Further distribution as per the requirement of work including supply of materials and execution		Yes	
3.3.3	**Water supply for Living Purpose**			Not applicable
a	Making the water available at single point			

S. No.	Description PART I	Scope / to be taken care by		*Remarks*
		BHEL	**Bidder**	
b	Further distribution as per the requirement of work including supply of materials and execution			
3.4.0	**LIGHTING**			
a	For construction work (supply of all the necessary materials) 1. At office/storage area 2. At the preassembly area 3. At the construction site /area		Yes	
b	For construction work (execution of the lighting work/ arrangements) 1. At office/storage area 2. At the preassembly area 3 At the construction site /area		Yes	
c	Providing the necessary consumables like bulbs, switches, etc during the course of project work		Yes	
d	Lighting for the living purposes of the bidder at the colony / quarters		Yes	
3.5.0	**COMMUNICATION FACILITIES FOR SITE OPERATIONS OF THE BIDDER**			
a	Téléphone, fax, internet, intranet, e-mail etc.		Yes	
3.6.0	**COMPRESSED AIR wherever required for the work**		Yes	
3.7.0	**Demobilization of all the above facilities**		Yes	
3.8.0	**TRANSPORTATION**			
a	For site personnel of the bidder		Yes	
b	For bidder's equipments and consumables (T&P, Consumables etc)		Yes	

Sl. No	**Description** **PART II** **3.9.0 ERECTION FACILITIES**	**Scope / to be taken care by**		*Remarks*
		BHEL	**Bidder**	
3.9.1	**Engineering works for construction:**			
a	Providing the erection drawings for all the equipments covered under this scope	Yes		
b	Drawings for construction methods	Yes		
c	As-built drawings – where ever deviations observed and executed and also based on the decisions taken at site- example – routing of small bore pipes		**YES**	In consultation with BHEL
d	Shipping lists etc for reference and planning the activities	Yes		In consultation with BHEL
e	Preparation of site erection schedules and other input requirements		Yes	In consultation with BHEL
f	Review of performance and revision of site erection schedules in order to achieve the end dates and other commitments	Yes	Yes	In consultation with BHEL
g	Weekly erection schedules based on S. No. e. hard copy to Construction manager, by email to HO.		Yes	In consultation with BHEL
h	Daily erection / work plan based on S. No. g. hard copy to Construction manager, by email to HO.		Yes	In consultation with BHEL
i	Periodic visit of senior official of the bidder to site to review the progress so that works are completed as per schedule. It is suggested this review by the senior official of the bidder should be done once in every two months.		Yes	
j	Preparation of preassembly bay		Yes	

Sl. No	Description PART II 3.9.0 ERECTION FACILITIES	Scope / to be taken care by		*Remarks*
		BHEL	**Bidder**	
k	Laying of racks for gantry crane if provided by BHEL or brought by the contractor/bidder himself		Yes	
l	Arranging the materials required for preassembly		Yes	
M	Coordination for inspection (IMIR etc) and getting clearance from Client / PMC		Yes	
N	Preparation of formats for completion of activities		Yes	

Sl	Description	Specifications	Qty.
A.	**HANDLING & LIFTING EQUIPMENT**:		
1.	Hydraulic jack.	Capacity-25 T lift = 200 mm Dia of the table, piston = 90 mm Min. height above the ground level = 260 mm, Force on the lever = 30 Kg. Length of the level = 625 mm	4 Nos.
2	Screw Jack (ratchet type)	Capacity: 5T lift 200 mm	4 Nos
3.	Jack bolts	Min. ht. 75 mm, lift- 30 mm dia of bolt - 36 mm	16 Nos.
4.	Hand ratchet Jack	Capacity -5T stroke: 370 mm Height above the ground level 90 mm Force on the Level – 50 Kg	2 Nos.
5.	Hand ratchet Jack with chain and hooks.	Capacity- 1.5 lift-- 2M Arm length -440 mm force on the lever-55 Kg. Min. distance between the top and bottom Hook: 440 mm, Hook size = 40 mm	6 Nos.
6.	Chain pulley blocks	Capacity - 3T, lift -6m	4 Nos.
7.	Steel ropes with loops as per Site requirement		
8.	Eye bolts CSNO2 as per site requirement		
B.	**MACHINERY:**		
1.	Power saw	H. P. -1.5 Blade length 600 mm throats 200 mm, strokes/min = 60	1 No.
2.	Elec. Air compressor	Capacity -5m3/minute With air receiver (Tank) pressure = 7 atp Tank capacity = 3.5 M3 3 phase electrical motor: 440 V, 50 C/s air cooled, With pressure gauge, starter for Motor, auto-start/stop, necessary Valves, tank with drain and Safety valve OR 2 of 2.6 M3/min. 6 atp tank: 1. 8 M3 all other things are same as above.	1 No
3.	Bench grinder with two wheels	H. P. =1, RPM =2900, wheel dia =200 mm Thickness = 25 mm, 440V 3 phase 50 c/s	1 No

4.	Portable electrical drilling Machine dia: 15 mm	Dia. of the drill =15 mm Power=350 watts 250V, 50 c/s	2 Nos.
5.	Flexible shaft portable elec. Grinding machine	Shaft dia, =20 mm, Length-5M Min. RPM = 2800 Input -1.3 kW With various shaped grinding wheels	1 No.
6.	Portable pneumatic drill with Morse taper No-3 dia 32 mm	Drill dia. 32 mm Air condenser 1.8 M3/min. working pressure 5/7 atp RPM -190/360	1 No.
	Portable pneumatic grinder	Wheel dia=100 mm Thickness=20 mm Working pressure 5/7 atp	1 No.
	Portable pneumatic grinder	Wheel dia=200 mm Thickness=40 mm Working pressure 5/7 atp.	1 No
	Chamfering machine Portable size 75 to 250 mm dia	Czechoslovakian make (CKD) 6.8 KW 415 V motor with a starter on a trolley with a universal shaft coupling chamfering tool. Jaws are to accommodate the sizes 75 to 250 mm. OR similar one	1 No.
	Hydraulic pipe bending	1/2" to 2" mean radius of bend 45 to 230 mm with machine, hand operated with the blocks for 1/2",3/4.', ;1",1 1/4", 1 1/2", 1 3/4" and 2"	1 set
	Gas welding & cutting set with pressure gauges for oxygen and acetylene	Cutting & welding up to 50 mm	1 set
	Welding transformer setwith regulator	350 A, AC Max = 450 Amps Min = 75 Amps About 30 KVA Secondary = 85 V, Primary = 400/440V	4 sets
	Welding D. C. Generator set with regulator	320 A, DC 90 V, Max: 320 Amps, Min: 30 A Motor KVA: 20, 2910 RPM 440V	4 sets
	Annealing Transformer and inductor	Full set suitable for annealing alloy steel pipes (Mat. 13 cr. 44 Mo), after welding annealing temp reqd. 600ºC to 720°C similar to A.C.L.C. Belgium makes)	1 set
	Argon welding equipment		2 No.
	Electrode drying oven automatic with temp control	Capable of accommodating 6 or 8 packets electrodes	1 No.

	Camera for Iridium 192 5 curies isotope and manipulator rod. Iridium\ 192 isotope		1 No.
	Plastic cassettes 10 x 48 cm		2 Nos.
	Lead screens	10 X 48 cm	2 sets
	Lead letters	12 mm	2 sets
	Lead numbers	12 mm	2 sets
	Gevaret D-4 films	10 x 48 cm	2 pkts
	Developer to make 13.5 liter		1 tin
	Fixer to make 13.5 liter		1 No.
	Tube bending machine (5 to 25 mm)		1 No.
	Portable needle grinder pneumatic / electrical		1 No.
	All common tools like straight edge, fitters vice vernier calipers, micrometers, dial gauges, lever type dial gauges, feeler gauges, surface plate, spanners, screw drivers, hammers, mallets etc. tools as required by RE at site to be brought by the Contractor.		
D.	**MISCELLANEOUS:**		
	Gas Hose Oxygen and Acetylene	Bore dia, 10 mm 25, 50 & 75M lengths each	2 sets
	Wire brushes for welders	150 x 25 mm 3 rows wire bristles 5 rows wire bristles	 6 Nos. 6 Nos.
	Gas cutting nozzles cleaning kit		2 sets
E	**TOOLS AND TACKLES:**		
	1. Set of Torque spanners (M 6 to M 64) 2. Feeler gauges (length 300; 200 mm of different widths) 3. Flexible Torch lights with mirror 4. Inside and outside micrometers (0 to 250 mm, dia in different steps) 5. Lever type and plunger type dial indicators 6. Micron dial indicators 7. Leaf feeler gauges (0.03 and 0. 05 mm) 8. Depth gauges up to 400 mm 9. Lead wire measuring gauges 10. Magnifying glasses		

F. LIST OF TOOLS AND PLANT - C&I, ELECTRICALS :

The following tools and equipment but not limited to, are required for the installation and commissioning instrumentation & electrical works. The contractor shall make them available for erection, testing and commissioning purposes, including all consumables likely to be used at his own cost at the time of mobilization and get them certified by Engineer in charge.

S.No.	Description
1.	2.
1.	Pipe bending machine (5mm to 25 mm)
2.	Pipe wrenches (6", 8", 12")
3.	Screw spanners (7", 8")
4.	Set of screw drivers
5.	Set of Allen keys (mm & inch)
6.	Set of spanners
7.	Set of needle files (Round, triangular, square, half round and knife edge)
8.	Copper tube cutters
9.	Stainless steel tube cutter and flaming tool
10.	SS Tube bender
11.	Small size hacksaw & fraksaw
12.	Cutting pliers
13.	Nose pliers
14.	Insulation stripers
15.	Dry cable jointer
16.	Crimping tool for control and power cables
17.	Die set ¼", ½", ¾", 1 ½", 2", ET, NPT, M20X1, M20X1.5
18.	Tap set of above sizes
19.	Drill bits

20. Number punches
21. Alphabet punch
22. Embossing machine with cassettes (Numbers and alphabets)
23. Portable drilling machine up to 1-1/2”
24. Soldering gun
25. Soldering Iron
26. Multimeter (a) Digital 3-1/2 digit (b) Analog with Comet AC/DC 0-10A & Voltage-1000V.
27. Avometer
28. Megger 500V, 1000V, 2500V/ 5kv Motorized
29. Calibration kit for thermocouples RTDS
30. Continuity tester
31. Calibration kit for vibration equipment
32. 0-30 MA ammeter
33. Standard gauge for pneumatic instrument calibration.
34. Manometer 0-2 M of H20
35. Vacuum pump
36. Standard pressure gauges 0-2.5 Kg/cm2, 0-100 Kg/cm2, 0-160 Kg/cm2, 0-250 Kg/cm2.
37. Pneumatic calibrating kit
38. Telephone headphones with accessories for cable testing etc.
39. Hydraulic pump capable of generating 400 kg/cm2 pressure.
40. Dead weight tester for pressure gauges calibration up to 400 kg/cm2 range
41. Universal watch makers screw driver set
42. Day welding and cutting set
43. Welding DC Generator set with regulator etc.
44. Spring balance 0-2 Kg/cm
45. Torque wrench 0-60 Kgm

46. Dual channel Oscilloscope
47. Micro ohmmeter digital 0-200m ohm/0-10 amps DC
48. Phase sequence meter
49. Tong tester (a) 0-300 amps AC (b) 0-100 amps DC
50. Three phase variac 0-10 A, 415/450 V
51. Single phase variac 0-250 V, 10A
52. HV Test kit 0-30 KV DC
53. Relay test kit with phase shifter

G. CONSUMABLES:-

1. Birkosit
2. Hylomer
3. Led plate 200
4. Loctite 221,601,621
5. Molykote 321 R
6. Industrial Grease

NOTE: -

i) All the tools should be procured in sufficient quantities by the Contractor.

ii) The list of tools & tackles mentioned above are indicative only. The contractor has to mobilize the required tools & Plant in sufficient quantity to carry out the erection, testing and commissioning. However, on instruction of Resident Construction Manager, additional tools and tackles has to be arranged by Bidder for smooth E & C activities of the project.

SN	DESCRIPTION & CAPACITY OF T&P	QUANTITY	PURPOSE
01	EOT CRANE IN TG HALL	1 No. of 35 T	FOR HANDLING AND ERECTION WITHIN TG HALL ON SHARING BASIS AS AVAILABLE AND SUBJECT TO THEIR ACCESSIBILITY AND APPROACHABILITY.

NOTE:

1. Customer may provide one number of EOT crane of 35 T capacity subject to availability, however contractor will have to provide the EOT crane operator for his operations and will carry out the day today operational maintenance, general cleanliness, attending of gear box leakages etc., applying caladium Compound on slings and holding/supporting the supply cables etc. as part of scope of work.

2. EOT cranes will be used on sharing basis by other agencies working within the TG hall under the instruction of BHEL. Contractor has to plan his activities well in advance and inform BHEL engineer in charge/ Construction Manager the date of actual use.

6.1 **TIME SCHEDULE**

6.1.1

The entire work of erection testing and commissioning of the Steam Turbine, Generator & their auxiliaries as detailed elsewhere in the Tender Specification shall be completed within Twelve (12) Months(09 months for Erection & Commissioning+3 month for PG Test, Handing Over and Site Demobilization) from the date of commencement as certified by BHEL site Engineer.

6.1.2

During the total period of contract, the contractor has to carry out the activities in a phased manner as required by BHEL and the program of milestone events.

6.1.3

The erection work shall be commenced on the mutually agreed date between the bidder and BHEL engineer and shall be deemed as completed in all respect only when the unit is in operation. The decision of BHEL in this regard shall be final and binding on the contractor. The scope of work under this contract is deemed to be completed only when so certified by the site Engineer.

6.2 COMMENCEMENT OF CONTRACT PERIOD

The date of commencement of contract period shall be the mutually agreed date between the bidder and BHEL engineer to start the work. In case of discrepancy the decision of BHEL engineer will be final.

6.3 MOBILISATION FOR ERECTION, TESTING, ASSISTANCE FOR COMMISSIOING ETC.,

6.3.1

The activities for erection, testing etc. shall be started as per directions of Construction manager of BHEL.

6.3.2

The contractor has to augment his resources in such a manner that following major milestones of erection & commission are achieved on specified schedules:

TENTATIVE SCHEDULE

Activity	**Tentative schedule**
Mobilization for Site Establishment activities	**Jan'16**
Commencement of Erection	**Mar'16**
Mechanical Erection Completion	**July'16**
TG oil flushing completion	**June'16**
Turbine on barring gear	**May'16**
Rolling & synchronization	**Aug'16**
Trial Operation Completion	**Aug'16**
PG Test, Handing Over and Site Demobilization	**Aug'16**

6.3.3
In order to meet above schedule in general, and any other intermediate targets set, to meet customer / project schedule requirements, contractor shall arrange & augment all necessary resources from time to time on the instructions of BHEL.

6.4 CONTRACT PERIOD

For the purpose of contract, the period shall be taken as Twelve (12) Months (09 months for Erection & Commissioning+3 month for PG Test, Handing Over and Site Demobilization) from the date of commencement as certified by BHEL site Engineer. Completion of the work shall be as per BHEL Bar Charts revised from time to time. In order to expedite the work, the contractor has to deploy manpower on two-shift basis during erection and during pre-commissioning and commissioning period manpower should be provided round the clock basis as per site requirement without any extra cost to BHEL.

6.5 GUARANTEE PERIOD
The guarantee period of twelve months shall commence from the date of handing over of the Unit to Customer or six months from the date of first synchronization of the set, whichever is earlier (Provided all erection, testing, and commissioning works are completed in all respects)

The progressive payment for erection, testing and commissioning on accepted price of contract value per unit of STG Package rates will be released as per the break up given hereinafter:

The following terms of payment will be operated

a. **80 % payment against running bills, subject to actual execution at site**
b. **5% on acceptance of submitted protocols by Client.**
c. **10 % upon final commissioning and material reconciliation.**
d. **Balance 5% (retention amount) as per GCC clause no. 2.22.**
e. **Security deposit will be as per clause no. 1.10 & 1.11 of GCC.**

A detailed BBU (Billing Break Up) in line with the line items of the Price Bid specification will be submitted by the contractor, which will be approved by the BHEL Construction Manager. Based on this approved BBU, monthly running bills will be released.

7.1 Mechanical Items :

The bidder shall quote "FIRM" Prices only.

7.1.1. Equipment erection shall be paid on tonnage rate, other items as per rate schedule. The payment shall be on actual net weight of equipment erected. The terms of payment shall be strictly governed as defined below. Any deviation to the terms of payment will be evaluated in terms of loading on the prices. The tonnage indicated is only approximate and likely to vary during execution. Bidder shall keep the rates constant for any variation in quantity up to a ± 15%.

7.1.2 ERECTION,TESTING, COMMISSIONING AND PAINTING APPLICATION				
S.NO	Description	Quantities		Total Wt
		No of Items	Wt	In Kgs
7.1.2.1	Inner casing assembly	1	3000	3000
7.1.2.2	Guide blade carrier-1	1	1000	1000
7.1.2.3	Guide blade carrier-2	1	1700	1700
7.1.2.4	Guide blade carrier-3	1	2600	2600
7.1.2.5	Guide blade carrier-4	1	4600	2600
7.1.2.6	Guide blade carrier-5	1	4500	4600
7.1.2.7	Rear bearing housing Assembly	1	4300	4300
7.1.2.8	Front bearing housing Assembly	1	9900	9900
7.1.2.9	Rotor Assembly	1	18700	18700
7.1.2.10	Upper part of outer casing & ex hood(bolted condition)	1	30550	30550
7.1.2.11	Lower part of outer casing & Ex hood	1	30400	30400

7.1.2.12	Gov. Oil Accumulator Assembly	1set	600	600
7.1.2.13	Oil purification unit	1	1000	1000
7.1.2.14	Acoustic Enclosure	1set	7500	7500
7.1.2.15	Control valve	17	200	3400
7.1.2.16	QCNRV's	10	310	3100
7.1.2.17	Gear Box Assembly	1	15200	15200
7.1.2.18	Generator + Rotor splitted	1	1,25,000	125000
7.1.2.19	Generator Foundation + Duct items	1 set	10,000	10000
7.1.2.20	Brusher less exciter	1	2000	2000
7.1.2.21	Pilot Exciter	1	2000	2000
7.1.2.22	Lube oil tank	1	4500	4500
7.1.2.23	Overhead Lube Oil tank	1	1700	1700
7.1.2.24	Duplex filters	1set	250	250
7.1.2.25	Main / Aux. Lube Oil Pump Assembly	2	1500	3000
7.1.2.26	Emergency Oil Pump Assembly	1	900	900
7.1.2.27	Jacking Oil Pump Assembly	1set	2000	2000
7.1.2.28	Lube Oil Accumulators	2set	600	1200
7.1.2.29	Oil Vapour Extn Fan	2	100	200
7.1.2.30	Lube Oil Centrifuge	1	1000	1000
7.1.2.31	Transfer Oil Pump	1	100	100
7.1.2.32	Drain Oil Tank	1	1150	1150
7.1.2.33	Gov. Oil Console	1	1500	1500
7.1.2.34	Valves	1 Set	11000	11000
7.1.2.35	Gland Steam Condenser	1	1400	1400
7.1.2.36	Structural	1 Set	10000	10000
7.1.2.37	Flash Tank (HP)	1	4700	4700
7.1.2.38	Warm Up vent Silencer	1	500	500
7.1.2.39	LP Steam Vent Silencer	1	1300	1300
7.1.2.40	MP Steam Vent Silencer	1	950	950
7.1.2.41	Surface condenser (splitted)	1	1,10,000	1,10,000
7.1.2.42	Steam Jet Air Ejector	1	7500	7500
7.1.2.43	Drain Cooler	1	1500	1500
7.1.2.44	LP heater #1	1	6550	6550
7.1.2.45	LP Heater# 2	1	6600	6600
7.1.2.46	HP Heater# 1	1	13300	13300
7.1.2.47	HP Heater# 2	1	12500	12500
7.1.2.48	Steam turbine Oil Cooler	2	3100	6200
7.1.2.49	STG Air Cooler	8	1000	8000

7.1.2.50	CENT Ex Fan	2	50	100
Total Weight				**498750**

7.1.3 Piping works (Fit up and welding, Radiography, erection including hangers, supports, hydraulic testing, IBR documentation & formalities and painting)

Piping works will be approximately **38.15 MT**. Detailed drawings, schedules, etc. will be provided along with LOI/progressively during the course of execution of the works.

(A) IBR Piping: 0.310 MT
(B) Non INR: 37.84 MT

Sl No	Description	Material Type	Material Wt (kgs)
7.1.3.1	GOV Oil Piping For QCNRV	SS	200
7.1.3.2	GOV OIL PPG FOR ESV	SS	140
7.1.3.3	GOV OIL PPG FOR SERVO MOTOR	SS	310
7.1.3.4	CEP SUCTION PIPING	SA106GRB	1890
7.1.3.5	CEP DIS UPTO LCV&RECIR PIPING	SA106GRB	7130
7.1.3.6	LUBE OIL PIPING	SS	6920
7.1.3.7	OIL PURIFICATION PIPING	SS	190
7.1.3.8	JACKING OIL PIPING	SS	540
7.1.3.9	GOVERNING OIL PIPING	SS	390
7.1.3.10	PIPES FOR EQPT MOUNTED INSTR	SS	110
7.1.3.11	LO COOLER & FILTER VENT PIPING	SS	250
7.1.3.12	LUB OIL SPECIAL MATERIALS	SS	190
7.1.3.13	OIL VAPOUR FAN PIPING	SA106GRB	470
7.1.3.14	GLAND STEAM PIPING	SA106GRB, SA335GRP11	4610
7.1.3.15	GL STEAM TO GSC & EXHAUST PIPING	SA106GRB, SA335GRP11	1680
7.1.3.16	EXHAUST PIPING (SRV,EJECT ETC)	SA106GRB	2760
7.1.3.17	AIR EVACUATION PIPING	SA106GRB	1340
7.1.3.16	VALVES GLANDS SEALING PIPING	SA106GRB	450
7.1.3.17	TURBINE DRAINS PIPING	SA106GRB, SA335GRP11	940
7.1.3.18	EQUIPMENTS DRAINS TO CONDENSER	SA106GRB	1130
7.1.3.19	SUSPENSIONS & SUPPORTS	SA106GRB	6200
	Total Weight		**37840**

7.1.4 THERMAL INSULATION (APPLICATION) INCLUDING CLADDING, FIXING ARRANGEMENTS ETC.

Sl.No.	Line Number	Pipe Size(in)	Insulation Thk. (mm)	Pipe Length(mt)
7.1.4.1	**GLAND STEAM PIPING(31351)**			
(i)	6"-GS-13K-006N	6"	130	21
		1.5"	100	2
		1"	80	6
		1/2"	60	6
(ii)	6"-GS-11K-009	6"	65	21
		3"	50	9
		1.5"	45	4
		1"	45	6
		1/2"	40	6
(iii)	6"-GS-13K-007N	6"	130	3
		1/2"	85	12
(iv)	8"-GS-13K-008N	8"	135	24
7.1.4.2	**GLAND STEAM PIPING-IBR (31355)**			
(i)	2"-AS-21F-003N	2"	55	4
(ii)	1.5"-AS-21F-005	1.5"	50	6
(iii)	1.5"-AS-21F-004	1.5"	50	6
		1/2"	50	12
7.1.4.3	**CHIMNEY STEAM PIPING(31352)**			
(i)	3"-GS-13K-010N	3"	115	12
		1.5	100	4
(ii)	3"-GS-13K-011N	3"	60	18
		1.5	50	4
(iii)	6"-GS-11K-012N	6"	80	27
(iv)	6"-GS-11K-014N	6"	80	15
(v)	6"-GS-11K-013N	6"	80	21
		1"	50	12
		1/2"	45	12
7.1.4.4	**TURBINE DRAIN(31372)**			
(i)	TURBINE DRAIN D1	1"	90	18
(ii)	TURBINE DRAIN D2	1"	80	18
(iii)	TURBINE DRAIN D3	1"	60	18
(iv)	TURBINE DRAIN D4	1"	50	18
(v)	TURBINE DRAIN D5	1"	50	18
(vi)	TURBINE DRAIN D6	1"	25	18
(vii)	TURBINE DRAIN D7	1"	25	18
(viii)	TURBINE DRAIN D8	1"	50	18

(ix)	TURBINE DRAIN D9	1"	90	18
(x)	DRAIN SURGE PIPE	6"	80	1.5
7.1.4.5	**GSC EXHAUST PIPING**			
(i)	6"-PIPE (GSC)	6"	30	27
(ii)	6"-PIPE(GSC)	6"	30	27
(iii)	GSC DRAIN TO ACC DRAIN POT	2"	25	24
		1"	25	2
7.1.4.6	**EXHAUST PIPING(31363)**			
(i)	VACCUM BREAKER PIPING	3"	25	12
(ii)	10"-VA-11K-273N	10"	30	12

7.1.4.7	**Insulation /cladding of Heat Exchanger Items(SJAE,GSC,DC,LPH,HPH & Flash tank)**		
(i)	HE items	75 mm thick	205 sq.mm

- **TG insulation will be taken up separately.**

7.1.5 Electrical, Control & Instrumentation Items: Erection, Calibration, Testing, Loop Checking & Commissioning

7.1.5.1 LOCAL / FIELD MOUNTED INSTRUMENTS

Sl.No.	Description	Qty (Nos)
1	Pressure Gauges	57
2	Temperature Gauges MIS	31
3	Level Gauges	5
4	Differential Pressure Indicator	2
5	Differential Pressure Switch	3
6	Differential Pressure Transmitters	3
7	Pressure Switches	19
8	Level Switches	10
9	Magnetic Pickups (WWG-Speed Probes)	2
10	Vibration, Axial Displacement, Speed & Diff. Expansion Probes	16
11	Solenoid Valve	12
12	Bearing Thermo elements	10
13	Thermo element T/C	13
14	Electronic Pressure Transmitters Smart	31
15	RTDs	12
16	Proxi meters	16
17	Thermo wells	63
18	Flow Nozzle in Main Steam Inlet line	1

19	Flow Orifice in Condensate Line	1
20	Bimetallic Thermometers	10
21	GWR Level Transmitter	1
22	Air Flow Rota meters	2

7.1.5.2 PANELS AND CUBICLES:

Sl. No	Description	Dimension (mm)	Weight (Kgs) (Approx)	Qty
1	Turbine Control Panel	1000x1500x2500	1200	1
2	Local Gauge Rack	1400x450x1700	200 each	2
3	Governing Console Board	1500x1750 (WxH)	200	1
4	DC Starter Cubicles	1500x550x1650 each	400 each	2
5	Generator Control & relay panel	1600(W)X2000(D)X2500(H) mm	2000	1
6	Automatic voltage Regulator panel	850(W)X1000(D)X2500(H) mm	1000	1
7	DCSC for EOP	---	400	1
8	DCSC for JOP	---	400	1
9	Adopter Box	----	1000	1
10	Cable Panel	---	1000	1
11	LAVT Cubicle	2400(L)x2250(W)x2100(H)	3000	1
12	NGR Cubicle	2000(L)x1250(W)x1750(H)	1000	1
13	CT,VT,BUS DUCT ,Loose item & Associate Assessories	----		1Set

7.1.5.3 PANEL MOUNTED INSTRUMENTS:

Sl.No	Description	Qty	Weight (Kgs)
1	TSI Rack 3500 Series Bentley Nevada Make	1	30
2	Electronic Governor (WWG 505)	1	100

7.1.5.4 IMPULSE TUBING AND FITTINGS.

Sl No	Description	Length in Meters
1	Tube SS 12.7 X 2.1	510
2	Pipe SS 21.3 X 3.7	210
3	Pipe (SMLS)- 21.3 X3.73 CS	885
4	PIPE(SMLS) 21.3X 3.73 AS	450
5	Pipe(SMLS)- 60.3X 3.91 CS	100

6	Channel 100X50	30.6
7	Angle EQL 50X50X6 IS2062	27.9
8	Sheet 4.0 CS Hot Rolled	28.8
9	Plate 10 IS2062	4.5

7.1.5.5 PNEUMATIC TUBING:

Sl.No.	Description	Length (mtr)
1	Pipe SS 6 X 1.0	310
2	Pipe SS 33.4 X 3.4	200
3	Pipe SS 21.3 X 2.8	150

7.1.5.6 JUNCTON BOXES:

Sl.No.	Description	Quantity
1	Electrical Junction Boxes	33 nos
2	Proximitor Housings	9 nos

7.1.5.7 ERECTION, TERMINATION & TESTING OF CABLES & CABLE TRAYS UPTO JB:

Sl.No.	Description	Length (mtr)
1	1P x 1.5 sq.mm Signal Cable	2600
2	1P Thermocouple Extension Cable KX Type	230
3	1T x 1.5 sq. mm Shielded Cable	200
4	Perforated Cable Tray,W50MM, F25MM, C=0MM, L2.5M	712
5	Perforated Cable Tray,W150MM, F50MM, C25, L2.5 M	64
6	Cover for Cable Tray, W=50 MM, L=2.55 M	712
7	Cover for Cable Tray, W=150 MM, L=2.55 M	64

7.1.5.8 GENERATOR AUXILLARIES CONTROL CABLES

Sl no	Description	Length (Mtr)
1	10Tx1.5 sq.mm	1200
2	10Cx2.5 sq.mm	1000
3	5Cx2.5 sq.mm	15000
4	3Cx4 sq.mm	2000
5	3Cx6 sq.mm	1500
6	2Cx0.75 sq.mm	200

7.2.1. MATERIAL UNLOADING, STACKING & PRESERVATION

Sl no	Description	Weight (MT)
7.2.1.1	Material Handling, Stacking & Preservation	630

BILLING SUMMARY

Clause	Description
7.1.2	Equipment Erection Including Cost Of Grouting
7.1.3	Piping erection includes(supports, fitup, welding, Radiography, Hydro & painting)
7.1.4	Thermal Insulation (Appl.) Including Cladding, Fixing Arrangements
7.1.5	Electrical , Control & Instrumentation including fixing in position & testing
7.2.1	Material Handling, Staking & Preservations with necessary rain protection covers, etc.

Notes (MECHANICAL):

1. The Turbine and Generator may either be dispatched to site in assembled or in parts conditions. Bidders to note that turbine, Gear Box, Generator erection include the placement of turbine, Gear Box and generator at site in position, with proper foundation preparation and grouting with Conbextra GP-2 Cement.

2. Contractor shall arrange required crane services with suitable capacities for placing the heavy items like Turbine, Generator which may be sent in assembled condition on their foundations. Turbine, if sent to site in parts, necessary assembly shall be carried out at site. No extra payment is allowed neither for assembled condition nor for loose part condition.

3. In case of any discrepancy in above component weights, the item weights in packing list shall be taken as final.

4. Erection rates of pipes sizes dia 48.3 and below includes fit up, welding, radiography wherever applicable and welding of instrument isolation valves, flanges for thermo wells, stubs etc. on all pipes and equipment. Alloy steel pipe weld joints rate to be quoted including Stress relieving.

5. Piping payments for each line will be considered for payment only upon completion of activities, like Fit-up, Welding, Radiography, Supports, Painting, Insulation, Testing etc (as applicable). Decision of Construction manager is binding.

6.

Notes (ELECTRICAL, CONTROL & INSTRUMENTATION):

Complete assembly, erection, calibration, testing, commissioning and putting into successful and satisfactory commercial operation of the control and Instrumentation materials as given in the project drawings & documents listed.

a) Installation of Field Instruments, Control Valves etc. along with necessary impulse pipes and mounting materials as per the installation drawings.

b) Installation of Junction boxes & proximitor housings along with supply of necessary angles/channels etc.

c) Installation and termination of cables and the supply of necessary glands, lugs, Tag plates etc.

d) Installation of Transmitters along with supply of 2" pipe and necessary bracket.

e) Field instruments such as transmitters, gauges, and switches shall be grouped and mounted on a rack. This rack along with the supply of angles and channels will have to be fabricated and painted at site by Erection agency as per the space available. The exact grouping and rack details will be mutually worked out during the execution stage and the agency will carry out the same.

f) Tag plates for field instruments, junction boxes, proximitor housing & cables shall be supplied & fixed by the erection agency.

g) The purchaser will lay 2" Instrument air header. Further distribution starting from 2" air header up to the instrument/valve shall be done by the agency with proper supporting and fixing of the tube/fittings as per the hookup diagrams.

h) Branch trays of 50 mm or 100 mm size trays wherever required for laying one or two cables between the field instrument and the nearest main tray will be erected by agency.

i) The agency will do complete loop-checking starting from primary field instrument up to the secondary instrument.

j) Laying of sample pipes from terminal point to sample handling system/Analyzers.

k) Control valve erection shall also include the erection and wiring/tubing of related I/P convertors, Solenoid valves, limit switches that may be supplied loose.

l) All site mounted/fabricated structures/impulse lines shall be painted after applying two coats of primer. The final paint shall be epoxy based and the shade shall be as approved by BHEL site Incharge.

m) Making the necessary excavations and back filling to the original level after the cables are laid wherever buried cabling is specified.

n) Taking delivery of the materials from the owner's stores and safe transportation up to the place of erection and excess material back to owner's stores.

o) Opening of packing cases and inspection of the equipment and materials at site.

p) Trial operation for seven days, rectifying defects, if any and making adjustments as necessary.

q) Handing over of installation for commercial operations.

r) Rerolling of cables on drums if so required by site engineer.

s) Arranging plate inserts wherever required.

t) Making as built drawings.

u) Cleaning of all equipment under erection and work area at regular intervals to the satisfaction of owner's engineer.

v) Carrying out of touch up painting of equipment, including the supply of paint.

2.0 Foundation and Civil works

2.1 Equipment foundations, concrete part of the cable trenches and other civil works will be carried out by the civil agency.

2.2 The erection Agency shall check those foundations before commencement of erection to ensure their suitability by the erection agency for erection purposes.

2.3 Setting and grouting of anchor bolts, nipples and fastening devices shall be carried

2.4 Any cutting of masonry/concrete work, which is necessary, shall be done by the agency at his own cost and shall be made good to match the original work. The agency shall obtain prior approval before cutting any masonry/concrete works.

2.5 The agency shall make its own arrangement for pumping out water that may accumulate in any excavation or trenches during E&C activities.

2.6 All cable entry openings shall be properly sealed to prevent water seepage from outside trenches/conduits into the building. The required materials for doing so shall be included by agency in the cable laying prices.

3.0 Instrument Calibration Procedure

Note: Erection agency shall ensure the availability of O&M manuals and manufactures test certificates for all instruments/equipment under calibration.

3.1 Erection agency shall calibrate all field instruments in workshop, before field installation.

3.2 Necessary calibration report shall be generated for each tag / instruments and shall obtain site in-charge approval before installation.

3.3 Necessary calibration report shall be generated for each tag/instruments and shall obtain site in-charge approval before installation.

3.4 Transmitters & Gauges- shall be calibrated for 5 point calibration i.e. raising 0%-

25%-50%-75%-100% and back as per calibration range. Repeating the calibration thrice shall check output repeatability. All calibration ranges for transmitters shall be as per relevant project specific document (Instrument index). It shall be calibrated by connecting air or nitrogen to transmitter process flange. Electronic calibration by connecting external signal source to transmitter's electronic is not allowed. Agencies shall arrange nitrogen cylinders/pressure regulators etc.

3.5 All gauges shall be calibrated with reference to Master test gauge. Test Header etc., shall be arranged by contractor.

3.6 Smart type transmitters- First transmitter shall be calibrated with calibrator and it shall be verified by physical calibration using air or nitrogen. Calibrated information shall be stored in calibrator, for each tag.

3.7 Field switches- shall be calibrated for its raising/lowering set point as per relevant project document. Repeatability shall be checked thrice, for its operation. Calibration report shall be generated for each tag.

3.8 Control Valve/On-Off SOV Valves – Its leakage class, stoke length, actuator & positioner operation shall be checked in workshop. It shall calibrate for 5 point calibration i.e. raising 0%-25%-50%-75%-100% and back as per calibrated range. Repeating the calibration thrice shall check output repeatability.
Valve shall be calibrated by connecting 0.2 to 1 kg/cm2 air or nitrogen signals to its positioner and valve strokes for 0%-25%-50%-75%-100% input signals should be verified. At the same time output from its position transmitter shall also be verified and correction shall be carried out, if required. All results shall be recorded.
For SOV operated valves, operation of SOV shall be checked by energizing & de-energizing SOV coil by connecting the required voltage. SOV port operation, vent & manual reset functions shall be checked and shall be recorded accordingly.

3.9 Mass/Vertex/turbine flow meters – Electronic calibration shall be carried out by connecting electrical signals to its electronics and 4-20mA output shall be verified with respect to calibration certificate provided by manufactures.

3.10 I/P or P/I Converter- shall be calibrated by connecting 4-20mA electrical signals and its pneumatic output shall be checked. Reputability shall be carried out thrice. Its air Pressure regulator shall be verified and pressure shall be set to required value.

3.11 RTD/Thermocouple- shall be calibrated by connecting the assembly in standard Bridge/signal source and output shall be verified at 5 points (0%-25%-50%-75%-100%) of measuring range with respect standard charts for that type of RTD/Thermocouple. These shall also be calibrated using Hot Bath equipment.

4.0 Equipment Installation

The Erection Agency shall carryout following:

4.1 Unpack and check the system hardware/field instruments/equipments and transport it from site stores and installation at its intended locations.

4.2 Erection of impulse lines from process connection upto field instruments.

4.3 Carryout the laying of field cables upto Junction Boxes & fabricate and install all supplies, connections and accessories necessary to provide a complete interconnection between all equipments.

4.4 Terminate all interconnecting cables between field and junction boxes.

4.5 Test the hardware, power supplies, cabling and connections.

4.6 Termination of all field cables, ferruling of cables, loop checking from field sensor to Junction box.

4.7 Panel erection and testing shall include chipping, leveling, grouting and small modifications, if any, in panel wiring, removal of instruments for calibration & refixing.

4.8 TSI proximitor and probes erection shall include proximitor housing erection, support tube erection and protective flexible conduit erection.

5.0 Equipment Commissioning

The erection Agency shall carryout the following:

5.1 Loop checking from junction box upto final control element & vice versa as required.

5.2 Performing continuity and insulation test for all cables.

5.3 Re-calibration of field instruments /loop if required.

5.4 Agency shall provide necessary assistance /co-operation to other vendors for system integration, as required.

6.0 Cabling Methods & Scope

6.1 All above ground cables from filed instruments to junction boxes & proximitor housings shall be supported by suitable size of MS angle/ perforated tray. Cable shall be fastened to tray at the interval of ½ meter.

6.2 All underground cables from filed instruments to junction boxes & proximitor housings shall be routed through buried cable conduit. Conduit shall be thoroughly cleaned before laying the cable into it.

6.3 Cross and Direct ferruling philosophy shall be followed for ferruling inside instrument/ Junction boxes & proximitor housings/cabinet as follows:

Location	Ferrules
At Instrument end	JB No+JBTB+JBTE + Inst Tag+Inst TB+Inst TE
At Junction boxes & proximitor housings, for cable from field Instrument	Inst Tag+Inst TB+Inst TE + JB No+JBTB+JBTE

6.4 Erection agency shall prepare JB terminal drawing for each JB, indicating tag nos. for instruments, JB TB &TE no, core/pair no of all incoming/outgoing cables. Such drawing shall be laminated and pasted inside the respective field

junction boxes & proximitor housings.

6.6 All cable entry openings shall be properly sealed to prevent water seepage from outside trenches/conduits into the building. The required materials for doing so shall be included by agency in the cable laying prices.

7.0 Cabling & Impulse Piping

7.1 Routes of cables & air supply lines to individual instrument from junction boxes & proximitor housings/air-header to be decided at site to suit conditions.

7.2 All cables rising from trenches shall be run in trays.

7.3 All cables from junction boxes & proximitor housings to field instrument shall be installed in uninterrupted lengths.

7.4 All junction boxes & proximitor housings/Instrument air headers shall be located to nearest pillar/ structure/ column.

7.5 Junction boxes & proximitor housings/Instrument air headers installations shall not obstruct any traffic/passage way nor interface with accessibility or removal of process equipment

7.6 All Junction boxes & proximitor housings/instrument air headers shall be easily accessible for maintenance purpose.

7.7 For cables raising from trench & terminating in JB, trays shall terminate 400mm below/up bottom/ top of junction boxes & proximitor housings.

7.8 Whenever possible, air supply lines shall be run below cable tray, using same support. All cables shall be clamped to tray.

7.9 Trays to individual instruments shall terminate as close as possible to instrument. Instrument supports may be used to secure tray.

7.10 Tray & airline routes shown on layout are for major routes and shall be followed where possible, but if a route is not practical, an alternative route can be decided at site.

7.11 All site fabricated items, all supports or brackets needed for installation shall be fabricated and painted by the agency with two coats of red chromate Zinc primer and two coats of epoxy based paint of shade 631 of IS-5.

7.12 Directly buried cables shall be laid on and covered with sand/riddle with mud protected by brick barriers at sides and pre-cast concrete slabs on top. Location of buried cables shall be indicated clearly by cable marker, made of galvanized from interval of 30 meters and at every change of direction.

7.13 The location of cable Joint if any shall be clearly indicated with cable marks with an additional inscription “Cable Joint”.

7.14 Cable termination at the equipment end shall be done by the following methods:

a) Power cables : Crimping (Hydraulic/Manual)
b) Control cables & Signal cables : Manual crimping.

7.15 Each control cable core entering Junction boxes & proximitor housings shall be neatly dressed and served with Nylon cord to keep it in position at the terminal block.

7.16 All cable entry points shall be sealed and made vermin and dust proof. Unused openings, if any shall be effectively closed.

7.17 Damaged galvanized surface shall be coated with cold galvanized paint.

7.18 All equipment after erection shall be touched up where required with coats of finishing paint.

8.0 Mounting of Junction boxes & proximitor housings, Cable Trays & Air headers

8.1 Junction boxes & proximitor housings/ Air Header normally shall be mounted to nearest column at operating height. Otherwise it shall be mounted on standpipe.

8.2 Generally, Junction boxes & proximitor housings & instrument air headers shall be supported by 50x50x6 mild steel angle frame

9.0 As built drawings:

Erection Agency shall incorporate all corrections done during erection & commissioning of the plant and furnish 6 sets of as-built drawing.

10.0 Impulse Line & pneumatic line Erection and Testing

10.1 Impulse line shall be of Alloy steel, Carbon steel, SS pipe & SS tubes as per detail engineering drawing to be forwarded to contractor around one month before actual work.

10.2 The pipe routing after first root valve, supporting, welding, any special test required as per piping welding/ erection procedure etc. & connecting to instrument shall be in C&I contractor scope.

10.3 All the testing shall be as per project piping specification & specification & all the impulse lines are subject to hydro test at pressure same as mother pipe hydro test pressure.

10.4 Welding procedure shall be as issued for piping work for this project.

10.5 All weld joint in CS, SS, AS line are subject to 100% radiography test with min two shots per joint.

10.6 The impulse line shall be supported at regular interval of 200- 300 mm with U bolts / angles etc.

10.7 Erection agency shall generate all testing reports/ documentation required for final acceptance of customer.

11.0 Painting of Impulse line & supporting structures.

11.1 The all non- Stainless steel impulse lines & fittings for instrumentation connection shall be painted. Surface preparation. Primer coating etc shall be in contractor's scope.

11.2 Painting shall also apply for impulse line structure, supports, running channels etc.

11.3 Scope of supply of painting material, execution tools/ devices etc shall be in contractor scope.

11.4 The method of painting, color, quality shall be identical to main mother pipe.

11.5 Steam jacketing, insulation etc if required to meet mother pipe requirements shall be contractor scope.

7.3 Mode of Payment and measurement of work completed

Refer General Conditions of Contract

Note:

1. BHEL at discretion may further split up the above items and effect payment to suit the site conditions, cash flow requirements, according to the progress of work.
2. Payments against the above Billing break up will be subject to the other statutory deductions, viz. retention amount, TDS towards income tax, security deposits, etc. as per the provisions contained in GCC,SCC, NIT & other contract documents.

8.0 TAXES, DUTIES, LEVIES

8.1. For All types of works
8.1.1
The contractor shall pay all (save the specific exclusions as enumerated in this contract) taxes, fees, license charges, deposits, duties, tools, royalty, commissions or other charges which may be levied on the input goods & services consumed and output goods & services delivered in course of his operations in executing the contract. In case BHEL is forced to pay any of such taxes, BHEL shall have the right to recover the same from his bills or otherwise as deemed fit.
However, provisions regarding Service Tax and Value Added Tax (VAT) on output services and goods shall be as per following clauses.

8.1.2 Service Tax & Cess on Service Tax

Contractor's price/rates shall be exclusive of Service Tax and Cess on Services. In case, it becomes mandatory for the contractor under provisions of relevant act/law to collect the Service Tax & Cess from BHEL and pay the same to the concerned tax authorities, such applicable amount will be paid by BHEL at the prevailing Service Tax Rate (presently 14.36 %) on the admitted bill value.

Contractor shall submit to BHEL documentary evidence of Service Tax registration certificate specifying name of services covered under this contract. Contractor shall submit serially numbered Service Tax and Cess Invoice, signed by him or a person authorized by him in respect of taxable service provided, and shall contain the following, namely,

1. **The name, address and the registration number of the contractor,**
2. **The name and address of the party receiving taxable service,**
3. **Description, classification and value of taxable service provided and,**
4. **The service tax payable thereon.**

All the Four conditions shall be fulfilled in the invoice before release of service tax payment.

Wherever, more than one route/option are available for discharge of service tax liability under a particular service, (e.g. "works contract Service"), contractor shall obtain prior written consent from BHEL site before billing the amount towards Service Tax.

8.1.3 VAT (Sales Tax /WCT)

As regards Value Added Tax (VAT)/CST on transfer of property in goods involved in Works Contract (previously known as Works Contract Tax) applicable as per local laws, the price quoted by the contractor shall be inclusive of the same and in no case input or output VAT/CST will be reimbursed extra.

In any case the Contractor shall register himself with the respective Sales Tax authorities of the state and submit proof of such registration to BHEL along with the first RA bill. Contractor will submit all the details of VAT/CST paid for the contract in the prescribed format of the respective state VAT laws. Also, the contractor will issue the tax Invoices to BHEL as per the Tax laws of respective state on monthly basis. Contractor shall also be required to furnish to BHEL necessary proof of VAT remittance on monthly basis.

Deduction of tax at source shall be made as per the provisions of law and is to be construed as an advance tax paid by the contractor and no reimbursement thereof will be made.

Further, if BHEL, at the instance of customer or otherwise adopts the specific route for discharging output VAT liability itself, benefit of the reduction in liability of the contractor will be passed on to BHEL.

In case, BHEL is forced to pay any VAT liability on behalf of contractor, the same will be recovered from contractor's bill or otherwise as deemed fit

8.2 New Taxes/Levies

In case the Government imposes any new levy/tax on the output service/ goods/work after award of the contract, the same shall be reimbursed by BHEL at actual.

In case any new tax/levy/duty etc. becomes applicable after the date of Bidder's offer, the Bidder/Contractor must convey its impact on his price

duly substantiated by documentary evidence in support of the same before opening of Price Bid. Claim for any such impact after opening the Price Bid will not be considered by BHEL for reimbursement of tax or reassessment of offer.

No reimbursement/recovery on account of increase/reduction in the rate of taxes, levies, duties etc. on input goods/services/work shall be made. Such impact shall be taken care of by the Price Variation/Adjustment Clause (PVC) if any. In case PVC is not applicable for the contract, Bidder has to make his own assessment of the impact of future variation if any, in rates of taxes/duties/ levies etc. in his price bid.

8.3 BUILDING & OTHER CONSTRUCTION WORKERS (REGULATION OF EMPLOYMENT AND CONDITIONS OF SERVICE) ACT, 1996 (BOCW Act) AND RULES OF 1998 READ WITH BUILDING & OTHER CONSTRUCTION WORKERS CESS Act, 1996 & CESS RULES, 1998 and INTER-STATE MIGRANT WORKMEN ACT, 1979 (IN CASE BIDDER ENGAGE MANPOWER FROM OTHER STATE)

In case any portion of work involves execution through building or construction workers and/or inter-state migrant workmen, then compliance to the above titled Acts as applicable shall be ensured by the contractor and contractor shall obtain license and deposit the cess under the Act. In the circumstances it may be ensured as under:-

i. It shall be the sole responsibility of the contractor in the capacity of employer to forthwith (within a period of 15 days from the award of work) apply for a license to the Competent Authority under the BOCW Act and/or ISMW Act as applicable and obtain proper certificate thereof by specifying the scope of its work. It shall also be responsibility of the contractor to furnish a copy of such certificate of license / permission to BHEL within a period of one month from the date of award of contract.

ii. It shall be the sole responsibility of the contractor as employer to ensure compliance of all the statutory obligations under these acts and rules including that of payment / deposit of cess as per the applicability under above referred Acts within a period of one month from the receipt of payment.

iii. It shall be the responsibility of the sub-contractor to furnish the receipts / challans towards deposit of the cess together with the number, name and other details of beneficiaries (building/Inter-

state Migrant workmen) engaged by the sub-contractor during the preceding month.

iv. It shall be the absolute responsibility of the sub-contractor to make payment of all statutory payments & compensations to its workers including that is provided under the Workmen's Compensation Act, 1923.

1.1
The work covered under this specification is of highly sophisticated nature, requiring the best quality of workmanship for fabrication, engineering and construction management. The Bidder should ensure timely completion of work. The Bidder must have adequate quantity of tools, construction aids, equipment's etc., in his possession. He must also have on his rolls adequate, trained, qualified and experienced supervisory staff and skilled personnel.

1.2
The work shall be executed under the usual conditions affecting major power plant construction and in conjunction with numerous other operations at site. The Bidder and his personnel shall co-operate with the personnel of other agencies, co-ordinate his work with others and proceed in a manner that shall not delay or hinder the progress of work as a whole.

1.3
All the work shall be carried out as per the instructions of BHEL engineer. BHEL engineer's decision regarding the correctness of the work and method of working shall be final and binding on the Bidder.

1.4
The Bidder shall at his cost perform any services, tests etc, although not specified but nevertheless required for the completion of work.

1.5
Contractor shall erect all the equipment as per sequence prescribed by BHEL at site. The sequence of erection, methodology will be decided by the BHEL engineers depending upon the availability of material, work fronts etc. No claims for extra payment from the Contractor will be entertained on the grounds of deviation from the methods and sequence of erection adopted in erection of similar TG sets or for any reasons whatsoever.

1.6
All the necessary certificates and licenses required to carry out this work are to be arranged by the Contractor expeditiously at his cost.

1.7
The work to be carried out under the scope of these specifications covers the complete work of collection from stores/storage yard, handling, transporting, unloading at erection site, pre-assembly, erection, alignment, hot alignment, bolting, fastening, welding, radiography, leveling, cold pulling, adjusting, Non-destructive testing, Post weld heat treatment, hydraulic test, chemical cleaning, passivation, steam blowing, oil flushing, water flushing, air flushing, pre-commissioning tests, trial running of auxiliaries covered under these specifications, commissioning and all other activities till handing over of the unit. The work shall conform to dimensions and tolerances specified in the various drawings, documents etc. That will be provided during the course of installation. If any portion of the work is found to be defective in workmanship or not conforming to drawings or other specifications, the Contractor shall dismantle and re-do the work duly replacing the defective materials at his cost failing which the work will be got done by BHEL at the cost and risk of the contractor.

1.8
The terminal points as decided by BHEL shall be final and binding on the Contractor.

1.9
During the course of execution of this work, certain rework/ modification/ rectification/ repairs/ fabrication etc. will be necessary on account of feedback from various thermal power stations on units already commissioned and/or units under erection and commissioning and also on account of design discrepancies and manufacturing defects and site operation/maintenance requirements. Contractor shall carryout such rework/ modification/rectification/fabrication/repairs etc., promptly and expeditiously. Claims of contractor, if any, for such works will be dealt as per relevant clauses of General Conditions of Contract.

1.10
Daily log sheets indicating the details of work carried out, man-hours, consumables used etc, shall be maintained by the Contractor and got signed by BHEL engineer every day.

1.11
All tools and tackles, fixtures, equipments, materials, manpower, supervisors/ engineers, consumables etc. required for this scope of work shall be provided by the Contractor. All expenditure including taxes and incidentals in this connection will have to be borne by him unless otherwise specified in the relevant clause.

1.12
The contractor shall make adequate security arrangements including employment of security personnel and ensure protection from theft, fire, pilferage, damage and loss of materials/equipments issued to him for the work. Special care will have to be taken to guard against pilferage / theft of copper tubing, brass fittings, brass valves and other costly materials.

1.13
All equipments shall be handled very carefully to prevent any damage or loss. No bare wire ropes, slings etc, shall be used for handling of the equipments without the specific permission of the engineer.

1.14
Contractor shall ensure proper housekeeping and remove all scrap materials periodically from various work area covered in the scope and deposit the same at the place earmarked for this purpose. In case of contractor's failure to do the same, BHEL reserves the right to remove scrap at contractor's cost and risk.

1.15
Access to site for inspection by BHEL and customer engineers shall be made available by the contractor at all times.

1.16

Contractor shall mobilize sufficient quantity of sleepers for stacking of materials in his custody.

1.17.1
Utility Points : Number of utility points (Service / plant air, service / plant water, service / washing steam, inert gas (N_2) etc., shall be indicated in the P & I diagram. Contractor to locate the utility points as advised by site engineer and shall route the piping to these points as per site conditions, and shall submit as built layout with Bill of Material (BOM) to BHEL for approval.

1.17.2
The utility points shall be located at convenient point to handle and to be terminated with brass / bronze valve with suitable connection for hose pipe.

1.18
As Built Drawings : Contractor shall be supplied with two extra copies of the layout & isometrics drawings. Contractor to incorporate in one of the copy with Red ink all the changes / deviations / alterations etc carried out at site due to various reasons, with site engineer‘s endorsement. Marked up drawings shall be submitted to BHEL for approval.

1.18
Site Inspection : The owner / employer or his authorized agents may inspect various stages of work during the currency of the contract awarded to him. The contractor shall make necessary arrangements for such inspection and carry out the rectification pointed out by the owner / employer without any extra cost to the owner / employer. No cost whatsoever such duplication of inspection of work be entertained.

1.19
Field Quality Assurance Formats: It is the responsibility of the contractor to collect and fill up the relevant FQA Log sheets / Welding logs & Heat treatment charts and present the same to BHEL after carrying out the necessary checks as per the log sheets and obtaining the signature of BHEL / Customer in token of their
acceptance. Monthly Running Bill Payment to the contractor will be linked with the submission of these Log sheets.

1.20
For other agencies, such as cabling, instrumentation etc., to commence their work from / on the equipments coming under this scope, Contractor has to clear the front, expeditiously and promptly as instructed by BHEL Engineer. Some time it may be required to re-schedule the activities to enable other agencies to commence / continue the work so as to keep the overall project schedule.

1.21
For the purpose of planning, contractor shall furnish the estimated requirement of power (month wise) for execution of work in terms of maximum KW demand.

1.22

Contractor should obtain the formal statutory clearance from Chief Inspector of Boilers to carry out erection & Welding of piping / tanks under IBR purview. All IBR piping layout drawings received from BHEL for pipeline erection to be submitted to Boiler Inspector for approval. Arrangement for the visit of Boiler inspector for field inspection, hydraulic test etc., is in the scope of contractor, and necessary drawing / details only will be given by BHEL. Inspection fee, if any shall be paid by BHEL. After approval of the drawings, Erection of pipe lines / tanks to be started.

2.0 COLLECTION AND RETURN OF EQUIPMENTS, MATERIALS & CONSUMABLES

2.1
Contractor shall take delivery of the components, equipments, lubricants, chemicals, special consumables, steel etc from the storage yard/stores/sheds of BHEL/ client. The Contractor should note that the transport of equipments to erection site, assembly yards etc should be done by the prescribed route, without disturbing the other works and contractors and in the most professional manner. Special equipments such as laboratory equipments, measuring and controls equipments, special electrodes, valves, shims, packing materials for joints and seals, lubricants, actuators etc, shall be stored, when taken over by the Contractor, in appropriate manner as per BHEL's instructions.

2.2
The contractor shall return all parts, materials, consumables etc. remaining extra over the normal requirement with proper identification tags to BHEL stores. In case of any misuse or use over actual requirement, BHEL reserves the right to recover the cost of parts/materials used in excess or misused, with departmental charges.

2.3
Transportation of lube oil, Chemicals, Gas cylinders etc. from stores, is included in the scope of this contract. The contractor shall have to return all the empty and excess drums to the customer/BHEL stores. Similarly, transport of chemicals for various pre-commissioning activities/ processes mentioned in clauses herein from BHEL/customer's stores and charging of chemicals into the system for carrying out various pre-commissioning activities and processes mentioned herein and returning of remaining and/or the empty containers of the chemicals to customer/BHEL stores is the responsibility of contractor. After completion of oil flushing operation, the used oil shall be filled in empty drums and which in turn shall be returned to BHEL/customer's stores.

TEST TAPPING POINTS

Installation and welding of Tapping Points for taking performance test measurements shall be carried out by the contractor as part of this work for the equipments covered under this tender specification under the guidance of BHEL engineer. The scope will be limited to all the tapping points for which materials are available and their locations identified within the regular contract period and extensions thereof.

2.4
All packing and forwarding material shall be returned as soon as the material is unpacked. The location for storage of such materials shall be as indicated by BHEL Engineer.

2.5
All Measuring and Monitoring Devices (MMD) used for the work in scope of these tender specifications shall be calibrated by the accredited agencies that are approved by BHEL or calibration tractability is established up to National Physical Laboratory.

2.6
Contractor shall furnish the consumption details of chemicals, lubricants, TIG welding filler wire, welding electrodes and other consumables on monthly basis.

3.01 SCOPE OF CONTRACT:

The intent of specifications is to provide erection services according to most modern and proven techniques and codes. The omission of specific reference to any method, equipment or material necessary for the proper and efficient erection of the plant shall not relieve the Contractor of the responsibility of providing such facilities to complete the erection.

3.02 Should any error or ambiguity be discovered in the specification or information furnished to him the Contractor shall forthwith bring the same to the notice of Engineer of BHEL before commencement of work. The Engineer's interpretation in such cases shall be final and binding on the Contractor.

3.03 Any part of work for which there is no specification laid down in the contract shall be carried out as per the instructions and requirements of the site Engineer.

3.04 FOUNDATION AND CIVIL WORKS:

3.05 Buildings and other necessary civil works for equipment etc. will be provided by the client of BHEL. However, all adjustment of the foundation level, dressing and chipping of foundation surfaces, foundation bolt pockets and grouting of equipment, auxiliaries after alignments etc. as may be required for the erection of equipment/plants will have to be carried out by the Contractor at his own cost. Supports for pipes, valves, flanges etc. are to be grouted wherever necessary, by the contractor with cement concrete at his own cost, as per instructions of the BHEL Engineer. All materials like cement, steel, sand, gravel etc. for the purpose of grouting shall be arranged by the contractor at his own cost including special grout mixes.

3.06 Any civil work damaged by the Contractor in the execution of the work shall have to be made good by contractor at his own cost to the satisfaction of BHEL/its client

3.07 PRE-ASSEMBLY:

The Contractor shall transport the equipment and materials requiring pre-assembly from the storage yard to the pre-assembly areas. The contractor shall take delivery of the components and equipment from the storage yard after getting the approval of the Engineer on standard indent forms to be specified by the BHEL Engineer. After completion of erection work, complete

and detailed account of the equipment so erected shall be submitted to BHEL duly certified by BHEL Engineer, by the Contractor.

3.08 Any fabrication including supply of Engineering materials required for pre-assembly or erection of pre-assembled blocks/pieces other than those made available by BHEL or their clients at site shall be Contractor's responsibility at his cost.

3.09 METHOD OF ERECTION: -

The components of equipment are sent in partly assembled and partly disassembled condition for convenience of transport. They are to be dismantled, cleaned, assembled stage by stage, erected, matched (including minor modification), aligned and adjustments carried out.
Valves, fittings and pumps are to be thoroughly cleaned where necessary by dismantling the same before erecting and aligning. Valves requiring hydraulic testing, checking of operation and setting are to be done by the contractor. Any test rig required for these operations will be fabricated by Contractor with his material. All the above activities are to be carried out by the Contractor within his stipulated rates. Careful handling of equipment while lifting and transporting is required. Highest care should be taken, especially while lifting heavy equipment like compressor barrels and casings, turbine casing, rotors, condensers and other heat exchangers etc.

3.10 ERECTION:

3.11 The scope of erection shall include transporting to work spot the materials from storage yard/pre-assembly area, erection work, alignment pre-heating, welding, post heating, heat treatment, stress relieving and X-raying, leveling adjusting, cabling, calibration, instrumentation, tubing etc. till the turbo-set and other equipment are finally tested and approved for acceptance and are taken over by BHEL/their clients for putting into commercial operation.

3.12 The Contractor shall provide at his own cost in sufficient quantity all consumables

a) Sealing material, shellac compound, hemp fiber- klingerite, permanite, temporary CAF gaskets, general purpose gland packing, adhesive and other tapes etc.

c) Cleaning material like washing soda, soap, dungy cloth, cotton waste, carbon tetrachloride etc.

d) Adhesive papers, tapes, grinding and lapping stones, emery cloth, emery paper etc.

e) Soldering and welding material including thermo chalks, fluxes, all electrodes, oxygen, acetylene, argon (for carbon, steel, alloy steel & stainless steel) etc.

f) Hardware items including nuts, bolts, etc.

g) Electrical items such as cables, bulbs, switch etc. for construction works.

h) Packing plates and shims for minor adjustments.

i) Scaffolding etc.

j) Miscellaneous items of consumables nature not specifically mentioned but required for erection purposes incidental to such works. The materials so supplied and used shall be of the best quality and subject to prior approval of BHEL.

k) All grout mixes.

l) Necessary tools and accessories like crimping material, identification tag ferrules, clamps, bolts & nuts etc. required for laying pneumatic tubing, impulse tubing & piping, are not in BHEL scope of supply. The same has to be supplied by the contractor

m) Erection of instruments shall include fabrication of instrument stands and hardware like nut & bolt for mounting instruments on to stands. For instrument stands fabrication consumable like gas, welding rods, nuts, bolts and anchor fasteners etc. are also in contractor's scope.

3.13 PROTECTION:

The Contractor shall take all reasonable care to protect the work under erection till such time the erected equipment are taken over by BHEL/their client. Wherever necessary, suitable fencing and lighting shall have to be provided by the Contractor as a safety

measure against accidents and damage of property of BHEL/their clients. Caution notices shall be displayed by the Contractor to give warning to the persons working at site of access to any part which may be deemed to be unsafe and hazardous.

3.14 PAINTING:

All the items erected-main equipment, auxiliaries, piping, etc. will have to be painted by band or spray as directed by the Engineer with paint procured by

Contractor. For items received painted, two coats of finish paint over one/two coats of primer are essential. For items received and erected without any paint, two coats of finish paints over two coats of primer are essential. The quality, specification, colors and brand of paint are subject to approval by the Engineer. The scope of work includes scraping off old paint where required, color bands, lettering, arrows, etc., as directed. Provision of scaffolding, consumables etc. incidental to the work are to be arranged by the contractor at his own cost. The work is subject to inspection/approval by BHEL's clients. Paint weight is not considered for tonnage purposes. Painting of all equipment and piping is to be carried out by the contractor. All shop painted equipment is to be painted with two coats of finish paint using ""APCODUR" of Asian Paints or equivalent. All the piping to be painted with primer and two coats of finish paint of approved color and brand with Synthetic enamel paint. The contractor shall arrange for the painting deploying his own tools, tackles, manpower, etc.

3.15 In case of damage or loss to any equipment or components or any property thereof of BHEL or their clients caused by the Contractor's men while handling and erecting the same due to negligence and carelessness on the part of the Contractor's workmen, the responsibility of repairing or replacing shall rest with the contractor. In case the Contractor fails to make good loss or damage within a reasonable time, the actual cost of damage or loss together with overheads will be recovered from Contractor's bill. Decision of BHEL regarding the cause as well as extent of the cost of damage shall be final and binding on the Contractor. Delay in progress or works due to this will be attributable to contractor.

3.16 Until the plants or equipment are deemed to have been taken over, the Contractor shall be liable for and shall be deemed to have agreed to indemnify BHEL or their clients occasioned by negligence or fault of the Contractor or his personnel.

3.17 The erection devices, alignment fixtures, including supply of materials for same, tools and tackles, lifting device and all other materials necessary to carry out the entire work shall be arranged by the Contractor. Before putting into use all such fixtures, devices, etc. shall have to be approved by BHEL.

3.18 The contractor shall execute the work in the most substantial and workman like manner. Accuracy of work in stipulated time is an essential part of this contract. The Contractor shall be responsible to ensure the assembly and workmanship to confirm to the dimensions and tolerances given in the drawing, specifications, quality or suitability or measurements, or as per the instructions of Engineer. If any portion of work is found to be defective, in

specification or measurements, the Contractor shall dismantle and redo the work at his cost to the satisfaction of BHEL. Time lost on this account will be attributable to the Contractor.

3.19 Fabrication of pipes 2" & below for which isometric drawings are not given, like governing oil lines, and seal oil lines, has to be done at site as per the site conditions, for which pipes are supplied in commercial lengths. Fabrication of bends, tees elbows, reducers etc. for pipes of dia. up to 2" and below will also be done at site by the contractor at no extra cost from the above pipes supplied in commercial lengths. However, bends, tees, elbows, reducers etc. above 2" will be supplied readymade.

3.20 Permanent supports for an II the pipes of all diameters wherever required are to be fabricated at site by the Contractor within his quoted rates. However special supports like spring suspensions, clamps, and hanger rods will be supplied by BHEL. Material for fabrication such as plates, angles, channels, rods, I - sections, pipes etc. will be supplied in running lengths. Fabrication as above will include adjustments by cutting and welding as required. Temporary supports will have to be provided wherever required at contractor's cost.

3.21 The pressure parts shall be erected in conformity with the provision of Indian Boiler Regulations and will be subject to inspection by the chief inspector of Boilers, or anyone appointed by him in his sole jurisdiction.

3.22 Non-destructive tests like hydrostatic pressure test, air tightness test etc. as instructed by the engineer from time to time, shall be carried out by the contractor to the satisfaction of BHEL/it's client.

3.23 Scope of erection also includes any installation work on pressure parts, connected with instruments and controls.

3.24 For alignment and level adjustments of the equipment like Pumps, motors etc. necessary shim plates and pickings suitably fabricated, wherever required, shall be arranged by the Contractor at his own cost.

3.25 <u>WELDING:</u>

3.26 All necessary preheating, of welds and stress relieving operation of welds are part of the erection work and shall be performed by the Contractor in accordance with the relevant regulations and standards of BHEL practice and to the satisfaction of BHEL Engineer and in accordance with the drawings and specifications.

3.27 Erection of equipment involves good quality welding dye penetration test heat treatment radiography work. Wherever required 100% dye penetration test, have to be carried out as per instructions of BHEL Engineers. Contractor's personnel Technicians along with laborers engaged should have adequate knowledge on the above works.

3.28 The pressure parts shall be erected in conformity with the provision of Indian Boiler Regulations and may be directed as per any other standard/specification in practice in BHEL. The method of welding (Viz.) Arc, Gas, TIG or other method may be indicated in the detailed drawings. BHEL Engineer will have the option of changing the method of welding as per site requirements.

3.29 Welding of high pressure parts shall be done by certified High pressure Welders who possess valid certificate or CIB of the state in which the equipment is erected as per provision of IBR. The high pressure Welders who possess necessary certificate shall appear well in advance before the expiry of the validity of this certificate for requalification test as per relevant provision of IBR and keep the certificate valid till the completion of work. The services of such welders, the validity of whose certificates have expired shall have to be terminated forthwith.

3.30 All Welders deployed on this work shall be tested and approved by BHEL Engineer before they are actually engaged on work though they may possess the IBR Certificate BHEL reserves the right to reject any welder without assigning any reason

3.31 BHEL Engineer is entitled to stop any welder from the work if his work is unsatisfactory for any technical reasons or there is a high percentage of rejection of joints welded by him, which, in the opinion of the BHEL Engineer, will adversely affect the quality or the welding though the welder has earlier passed the tests prescribed by BHEL Engineer. The welders having passed qualification tests does not relieve the Contractor of a Contractual obligation to check on the Welder's performance.

3.32 All charges towards testing of Welders for approval of Welders for engaging in the erection work shall be borne by the Contractor.

3.33 Sufficient quantity of test plates and pipe pieces as considered adequate for testing contractor's welders will have to be arranged by Contractor at his cost. All the other expenses in conducting the test including radiography and heat treatment shall also be borne by the Contractor.

3.34 All welded joints shall be subjected to acceptance by BHEL Engineer.

3.35 WELDING AND THEIR PRESERVATION:

3.36 The electrodes/wires and related supplies as required for site welding are to be procured by the Contractor at his cost.

3.37 All the welding electrodes/wires shall be stored by the Contractor carefully to prevent deterioration of their properties. Proper care should be taken to preserve low hydrogen electrodes, alloy steel & stainless steel electrodes which have to be stored in an air- conditioned room at constant relative humidity by the contractor.

3.38 All these electrodes shall be dried in the electric drying oven to temperature and period specified by the Engineer, before they are used for erection work.

3.39 HEAT TREATMENT:

3.40 Preheating, post weld heating and stress relieving after welding, is part of erector's work and shall be performed by the Contractor in accordance with IBR regulations and BHEL Engineer's requirement. Contractor shall arrange to supply heating equipment with automatic recording devices. Also the contractor shall have to arrange for labor, all heating elements, thermocouples, etc., insulating material like mineral wool, asbestos, cloth, ceramic beads, asbestos ropes, etc., required for heat treatment and stress relieving works. During preheat and stress relief operations, the temperature shall be measured at least at two different points for pipes above 200 mm dia. by thermocouple, and recorded on a continuous printing type recorder. All the recorded graphs for heat treatment works shall be the property of BHEL. The contractor has to provide thermo chalks temperature recorders, thermocouple attachment units, graph sheets, etc. for checking.

3.41 The contractor shall maintain a record in the form as prescribed by BHEL of all operations carried out on each weld and maintain a record indicating the number of welds, the names of Welders who welded the same, date and time of start and completion, preheat temperature radiographic results, rejection, if any percentage of rejections, etc., and submit copies of the same to the BHEL Engineer as required. Interpretation of the BHEL Engineer regarding acceptability or otherwise of the welds shall be final. All site welding joints shall be subject to acceptance by BHEL Engineers.

3.42 The Contractor shall carry out the edge preparation of weld joints at site in accordance with details acceptable to BHEL Engineer. Wherever possible, machining or automatic flame cutting will be allowed only for edge preparation. Some extra lengths in various fabricated pipes given as erection allowance shall have to be cut and edges prepared to suit the site conditions at no extra cost.

3.43 Heat treatment may be required to be carried out at anytime (day and night) to ensure the continuity of the progress. The contractor shall make all arrangements including labor required for the work as per directions of B H EL.

3.44 All the data such as heating temperature, heating rate, soaking time, maximum temperature reached during heat treatment shall be properly recorded and documented which will be the property of BHEL.

3.45 Oxy.-acetylene flame heating or exothermic chemical heating for stress relieving is not permitted. Heating shall be by means of Electric Induction Coil or Electric Resistance coil. Potentiometric type recorders shall only be used for temperature recording purposes.

3.46 <u>RADIOGRAPHY:</u>

3.47 Radiography work of welds connected with this contract shall be arranged by the Contractor including provision of services of Technicians and necessary equipment and consumables like Isotope camera, X-ray films, and chemicals. Also contractor has to provide necessary labor required such as Riggers, Helpers, etc. to assist the technician for carrying out the above radiography work and making other arrangements such IS providing scaffolding approaches, plat-form, lighting arrangements at his cost as per the

instructions of BHEL. It may be noted that invariably the radiography will be carried out after the normal working hours only.

3.48 Radiography inspection of welds shall be performed in accordance with requirements and recommendations of BHEL Engineer and also as per the directions of BHEL's customer. The minimum extent of radiographic inspection shall be as per provision of IBR Reg. (151) h. They may, however be increased depending upon the performance of the individual Welder at the discretion of BHEL Engineer/Boiler Inspection Authority.

3.49 Quantum of radiography shall be enforced as per the specifications and as per the drawings. BHEL Engineer reserves the right to alter the quantum of

radiography of joints. The decision of the BHEL Engineer in this regard is fixed and final and binding on the contractor. Any rectifications required shall have to be done by the Contractor at his cost. All X-ray films of joints radio graphed at site in connection with work shall be properly preserved in air-conditioned rooms and shall become the property of BHEL.

3.50 All field welded joints shall be subjected to dye-Penetrant examination as specified in the respective drawings and shall have to be accepted by BHEL Engineer. Any rectifications required shall have to be done by the contractor at his cost.

3.51 For carrying out ultrasonic testing of welded joints large size tubes and pipes, it will be necessary to prepare the surface by grinding to a smooth finish and contour as desired by BHEL Engineer. The Contractor's scope of work includes such preparation and no extra charges are payable for this.

3.52 It may also become necessary to adopt inter layer Radiography/MPT/UT depending upon the site/technical requirement necessitating interruptions in continuity of the work and making necessary arrangements for carrying out the above work. The contractor shall take all this into account and quote the price inclusive of all such work and radiography.

3.53 The welded surface irrespective of place of welding shall be cleaned of slag and painted at the center with primer paint to prevent corrosion at no extra cost towards this.

3.54 All the welded joints of steam admission pipelines to HPT, IPT and LPT shall have to be subject to non-destructive tests, viz. magnetic particle test, dye-penetration test and hardness test in addition to radiography. All the weld seams shall be properly ground and subjected to 100% radiographic examination.

3.55 The contractor shall have to do root run or gas welding for pipe joints by TIG process wherever required as per the instructions of BHEL Engineer.

3.56 Welding of hangers' supports, stubs, and impulse piping is to be carried out by the contractor according to drawing, specifications and as per BHEL Engineer's instructions. Preheating, post-heating, stress relieving, etc., have to be carried out by the contractor according to drawing and specifications and as per BHEL Engineer's instructions.

3.57 CLEANING OF EQUIPMENTS

3.58 The Contractor shall take necessary measures to ensure that will all the machined surfaces are greased and covered, for proper protection.

3.59 The contractor shall clean the internal surfaces of all piping before erection mechanically and by air blowing as per the instructions of the site Engineer. The inside of all the equipment shall be thoroughly cleaned before they are installed.

3.60 All pressure parts and such other lines as may be directed by the Engineer shall be acid pickled, flushed with alkali water, oil, steam, or air as directed. Cleaning sequence and arrangements of temporary piping will be directed by the Engineer and contractor shall execute the work under the direction of the Engineer. Temporary pipe material and other connecting material including and/ alkali will be supplied by BHEL.

3.61 After flushing with water, steam blowing or after chemical cleaning as indicated by the Engineer all parts of equipment (viz. valves etc.) shall be dismantled, checked for accumulation of dust wear or damage, cleaned Rectified/replaced if necessary and reassembled by the Contractor without any claim for extra cost., However, the parts to be replaced in such cases will be supplied by BHEL.

3.62 All the bearings, gear boxes etc. of the equipment and electrical motors to be erected are provided with protective grease only. Contractor shall arrange as and when required by the Engineer, for cleaning these bearings gear boxes etc. with kerosene or some other agent, if necessary by dismantling some of the parts of the equipment already installed and shall arrange for re-greasing/lubricating them with recommended lubricants and for assembling back the dismantled parts. Lubricants will however be supplied free of cost.

3.63 The Contractor shall provide all labor for execution of work including installation and dismantling of temporary piping, strainers, valves and instruments required for conducting the cleaning work.

3.64 The Contractor shall effectively protect the finished work from action of weather and from damage or defacement and shall cover the finished parts when and where required for their protection

3.65 **HYDROSTATIC TESTING: -**

3.66 All pressure parts and some of the low pressure parts shall be subjected to the hydrostatic pressure test as required by the Indian Boiler Regulations & API. ASME, STDS, TEMA, ASAB, 31.3 IBR, ASME APC (ASAB 31.3) Contractor shall supply all necessary labor and equipment required for conducting the test.

3.67 The test shall be performed by the Contractor to the complete satisfaction of the Boiler Inspector and the Engineer. All leaky joints shall be cut out repaired or re-welded as directed and test repeated until satisfactory results are obtained.

3.68 INSULATION:

The Contractor should carryout thermal insulation (Supply end application) for equipment and piping. He should also carry out cold insulation and insulation for personal protection where required.

The quality of insulation material is subject to approval by BHEL and the work should be got executed by the contractor through agencies reputed in the field like M/s. Lloyds Insulation etc. to standard specifications. The cost of the supply and application of insulation should be included within the overall cost of the contract. The weight of insulation done will not de reckoned for purposes of tonnage erected. For detailed technical specifications etc. please refer to the following documents enclosed to this tender schedule (a) TC 51751 (b) 3-30826-00001.

3.69 OIL FILLING:

Oil for flushing purposes should be drawn from the stores of BHEL or its client as directed and filled into the lube oil tank. Thorough cleaning of the L.O. tanks and S.O. tanks including painting of the inside surface where required with Apcodur or equivalent paint to be supplied by BHEL is necessary. On completion of flushing, oil is to be drained and fresh charge for trial run and commissioning filled. Oil for second filling also has to be drawn from stores as mentioned above. The work being incidental to the main erection work under contract, no extra payment is envisaged and weight of oil filled will not be considered for tonnage purposes.

3.70 INSPECTION AND TEST RUN:

The Contractor shall provide personnel for the test run of all equipment erected by him to work under the direction of the Engineer, in case any defect is detected during test run such as loose components, undue noises or vibration, strain on connected equipment etc., the Contractor shall immediately attend to these defects and take necessary corrective measures.

3.71 Contractor shall provide personnel for the testing of all equipment erected by him to work under the direction of the engineer, after the solo run of the turbine, the contractor shall provide personnel for the bearings inspection.

3.72 <u>COMMISSIONING:</u>

3.73 The Contractor shall carry out all tests such as hydrostatic pressure test, function test OT pumps & motors, sole run of Turbine, leak test of compressors etc. as per standards followed by BHEL. Necessary skilled and unskilled personnel and supervisory staff as may be required shall be supplied by the Contractor during start up, testing and commissioning of the equipment.

3.74 Contractor shall install temporary piping if required in connection with testing and commissioning of these units at various points, as required by the Engineer and shall remove them in a neat and workman like manner after tests are over all at no extra cost.

3.75 The erection, testing and commissioning of the (Turbo-Generator/Turbo compressor) units should be carried out in accordance with drawings and specifications which shall be supplied to the Contractor by the Engineer from time to time under the supervision/ guidance of and to the entire satisfaction of the Engineer of BHEL. This shall, however in no way relieve the Contractor of his responsibility of providing adequate and competent supervisory staff. Drawings and specifications will be supplied only after ensuring that the contractor has employed qualified, trained Engineers/Supervisors for supervising the job. Drawings and specifications will not be handed over to the unqualified men of Contractor.

3.76 <u>FACILITIES PROVIDED BY BHEL/THEIR CLIENTS AT SITE</u>:

3.77 **LAND:-**

BHEL/client will allot sufficiently leveled area, storage sheds for storage of Turbo- compressors & components and pre-assembly area at a suitable location. For contractor's Office shed sufficient area will be allotted on rent as charged by BHEL's client. The remittance of rent shall be as directed by BHEL/their clients. Upon completion of the work, the contractor shall dismantle and clear all debris as directed by BHEL.

3.78 **ELECTRICITY:**

a) Electricity for construction purpose will be made available at 3 Ph. 415 V 4 wire systems “At a single point in the project site. The bidders are advised to visit site and ascertain full details of the same before submitting their offers.". Further distribution of power to various erection equipment and power tools shall be arranged by Contractor by providing his own cable, main switch board, distribution switch board, service connections etc. and shall meet all the local statutory requirements.

b) The Contractor shall not be entitled to any compensation on account of interruptions /shut downs or temporary power failures.

3.79 **WATER SUPPLY**

Water (including drinking water) required for construction purposes will be supplied at one point for each purpose. The Contractor shall make necessary arrangements at his cost for further distribution and storage of water.

3.80 BHEL reserves the right to draw water and electricity without charges, from the distribution line laid by the Contractor.

3.81 Customer's workshop facilities and cranes end other heavy equipment required for construction may be made available to the Contractor at the rates as may be fixed by Customers, subject to their availability and provided they do not affect the Customer’s work.

3.82 All electrodes are to be arranged by the contractor.

3.83 Oil for first filling for the Turbo-generators will be supplied by BHEL's Client. Wastage of oil during erection, Oil flushing etc. shall be made up by the Contractor at his own cost.

3.84 Instruments used by Contractor for work purposes shall be made available to BHEL Engineers whenever required without any extra charge.

3.85 BHEL shall provide instruments required by their Engineers for commissioning of turbo- compressors. However, the Contractor shall arrange for instruments as included in the list of tools and plants at his own cost.

3.86 BHEL will arrange for Engineers required for commissioning. However, the Contractor shall arrange workers and supervisory staff round the clock where necessary during commissioning and till handing over of the set.

3.87 BHEL shall supply material required for temporary piping and other connected materials for flushing or blowing of the pipelines.

3.88 PROJECT SITE RULES:

In addition to what has been mentioned in the general and special conditions, the site rules mentioned hereinafter shall be strictly observed by the Contractor and his employees. Contractor's work shall be also subject to inspection by Customer's Engineers and the Contractor shall provide all necessary assistance for such inspections.

3.89 **PRE-COMMISSIONING TEST AND TRIAL OPERATIONS:**

On completion of mechanical erection by the Contractor each item of the equipment and plant shall be thoroughly inspected by BHEL for correctness and for completion of thermal insulation etc. The Contractor shall also carryout within his quoted rates the installation of metering and connected wiring and piping works, laying out connected cables, cable jointing and generally carry out all works connected with their testing and commissioning and thereafter the Contractor shall put forth the equipment and plants for pre-commissioning tests at site. The procedure for pre- commissioning tests to be performed at site shall be as per agreement between BHEL and Customer.

3.90 **TESTING AND INITIAL OPERATION:**

The Contractor shall at his own cost perform the following work to be completed before trial operation as defined. The works to be carried out for this purpose shall include the following but details of the same shall be strictly in accordance with the drawings, specifications and technical information furnished by the BHEL and duly approved by Customer.

1. Alignment of generator/compressor and turbine tandem unit

2. Adjustment of eccentricity for cylindrical part and/or rotary part under cold condition and hot condition.

3. Tightness test and/or pneumatic test of intercoolers, after collars, surface condenser and other heat exchangers.

4. Pressure test and/or pneumatic test of all pipeline system

5. Cleaning of generator/compressor and turbine inner parts by oil and other cleaning agents where needed
6. Flushing of process gas line system by air/mechanical cleaning and/or pickling.

7. Flushing of steam line system by steam.

8. Flushing of condensate line system by water.
9. Acid and chemical cleaning of oil line system.
10. Flushing of miscellaneous small line system by Air.
11. Alignment of all pipe line connection to the unit.
12. Adjustment of pipe hanger supports including spring supports
13. Initial and preliminary checking of all wiring, tubing and cabling before energizing.
14. Function test of control valves and other valves.
15. Function test of all electrical items and pumps.
16. Trial operation of oil console unit.
17. Oil circulation of oil system for flushing purpose
18. Painting of all equipment, pipes where needed
19. Trial operation of Hot well pumps.
20. Function test of steam ejector.
21. Vacuum test of surface condenser unit.
22. Trial operation of all auxiliary units
23. Initial charge of lubricant, seal and control oils
24. Supply and application of thermal insulation work for turbine and other equipment and piping.
25. Turbine spin test.
26. Adjustment of turbine trip device.
27. Adjustment of steam inlet governor and extraction governor.
28. Piping test of safety valve on steam extraction line

29. Generator/Compressor and turbine tandem trial run

30. Adjustment of servo motor and steam inlet control valves

31. All electrical switches connected to the trip / inter lock circuit shall be checked / tested for their functioning by simulating the service condition.
32. On advice of BHEL Commissioning Engineer, contractor shall put all instruments in line with the process. The Contractor shall modify the settings or ranges in case suggested by the BHEL Commissioning Engineer. During Commissioning of main equipment and other related equipment / auxiliaries, the contractor shall fine tune instruments in auto control mode to suit system requirements.

33. Before charging pneumatic supply air header, the lines shall be blown for a period specified by BHEL Engineer at full parameter and all signal tubes shall be blown at least once.

The above tests shall be carried out under the supervision of BHEL's supervisory personnel on satisfactory completion of all pre-commissioning tests; the trial operation of the units shall start. The trial operation shall be considered successful if it is proved that the unit can operate continuously during the period of trial operation. Tests at site including the trial operation will be carried out in compliance with Customers' instructions. During trial operation, no repair or adjustment other than running adjustment will be permitted.

3.91 **GUARANTEE TESTS AT SITE:**

The guarantee tests of the plant shall be carried out after achieving 100% output of the equipment which may take around six months from the date of commissioning immediately after the conclusion of the operation. Detailed tests for conducting the guarantee tests shall be given later. Guarantee tests shall be carried out jointly by the representatives of BHEL and the Customer. The worker and supervisory personnel required during guarantee tests shall be provided by the Contractor without any extra charge.

OIL PIPING

1) All dimensions /elevations refer to C.L. of pipe lines unless otherwise specified.
2) a) Pipe routing shall be done strictly as per drawing. Wherever dimensions are not specified same may be routed as per site convenience.
   b) Pipe nominal size 2" and below shall be routed as per site convenience unless otherwise specified in the drawing.

3) a) Fusion faces shall be as per plant standard No. HY0620599.
   b) Weld edges shall be debarred before welding.
4) Follow the following WPS Nos. for weld joints:
   Carbon steel (SA 106-B or Eq): WE 003/A2 Stainless steel (A312TP 321 or Eq):WE-313/A2 or A1.

5) 100% of fillet welds shall be tested with liquid penetrant for IBR Piping (Group A), 10% all fillet weld at random for remaining piping shall be tested with Liquid penetrant.

6) Drain lines / return headers shall be erected with a slope of 1 Deg in the direction of flow.
7) All hangers are of rigid type unless otherwise specified. Small bore pipes shall be Fixed clips to the nearest structure suitably.

8) Orifice shall be erected after oil flushing.

9) Pipes shall be thoroughly cleaned during erection and should be acid pickled as per drawing No.4-170552 after the lines are completely erected and hydraulically tested.

10) Hydraulic test shall be conducted on complete pipe lines (except drain lines) at 1.5 times max. working pressure before acid pickling.

11) After cleaning, all pipes shall be painted as per plant standard No.HY 0674162, unless otherwise specified.

CLEANING AND PAINTING OF LUBE OIL
(CARBON STEEL AND STAINLESS STEEL)

Scope: This standard covers the pickling and painting requirement of Carbon Steel Piping and pickling requirement s of Stainless Steel Piping.

1.0 Mechanical cleaning for Carbon Steel and Stainless Steel Piping.

2.1 Mechanical cleaning consists of removing scales, welding spatters, rust, earth residues, previous painting or any other deposits adhering to the metal surface by means of wire brushes, wheels or pneumatic chisel or other similar methods while taking care not to damages the piping metal surface.

2.0 **Flushing:** Initially flush the C.S. and S.S pipe lines with water at 70o C for about one hour.

3.0 Degreasing of C.S. and S.S. Pipe lines.

3.1 **Purpose:** For removal of any oil, grease etc., which may be adhering to the metal surfaces of line.

3.2 **For degreasing:** A solution containing 15% caustic soda and 15% sodium Phosphate in water at 80oC shall be used. The solution shall be kept agitated during degreasing.

4.0 **Flushing:** The C.S. and S.S. Pipe lines shall be flushed with hot water at 80o C for 1 hour.

5.0 Pickling of Carbon Steel Pipe Lines.

6.1 Use a mixture of sulphuric Acid and Hydrochloric Acid. The strength of the pickling solution depending on the surface condition of the part to be treated. The concentration may be up to 20% and temperature can be 20 to 65o C. Duration of pickling shall be 24 hours or use 5% sulphuric acid or use 20% Hydrochloric Acid.

6.2 Washing: The pipelines shall be flushed with water.

6.3 Neutralization : In alkaline solution consisting of caustic soda 5% Benzoate 2 to 3% and sodium Nitrate 10% . The PH values of the solution shall be PH 8-10. T. No-time lapse should be allowed between articles 6.2 and 6.3 above. Or 2% phosphoric acid can also be used for Neutralization.

6.4 Drying: Immediately after neutralization pipe lines shall be dried with compressed air which is free from oils and humidity.

6.5 Protection : If the pipe lines are not put into service within few days of above treatment, they shall be protected by Anti-oxidizers and fill with Nitrogen.

7.0 Pickling of stainless steel pipe lines.

7.1 A solution of 7% by vol. of Industrial Nitric Acid and 3% by vol. of industrial sulphuric acid in water at 50o C shall be used for pickling for half an hour.

or

A solution containing citric acid 8% by Wt. and Rodine 92 A or 130 (Powder) 1-5% by wt. in water at 65oC to 70o C shall also be used for Pickling for 12 hours. However citric acid is preferable.

7.2 Same as Art. 6.2 above (Washing)

7.3 Same as Art.6.3 above. (Neutralization)

7.4 Same as Art 6.4 above(Drying)

7.5 Same as Art.6.5 (Protection).

8.0 Painting of CS. Pipe lines.

8.1 Pipe lines shall be cleaned by wire brushing also see Art.2.1 for details.

8.2 Anti-corrosive painting.

Apply 4 coats of anticorrosive paint DURALIT SR 1.423. 2201 of MAX MAYER or its equivalent APCODUR CP 684 yellow with its suitable thinner No.121. The total thickness of dry film shall be around 0.2mm.

8.3 Finish paint.
Apply one coat of DURALIT ISC series 431 (1.431-8176) of MAX MAYER) or its equivalent
APCODOUR CF 692 ADUIRALTY GREY by adding suitable thinner No.181, The thickness of dry film shall be around 0.04mm.

9.0 Stainless steel surfaces do not re quire painting.

GENERAL INSTRUCTIONS FOR ACID CLEANING (PICKLING) OF PIPE LINES OF OIL SYSTEM
(TURBO COMPRESSOR AND TURBO GENERATOR SETS)

1.0 GENERAL:

The purpose of acid cleaning (pickling) is to remove the rust resulted due to long Exposure to the atmospheric conditions and for dislodging g the burs, welding slag and the mil scales adhering to the internal surface of the pipe lines. The oil pipe lines include lubricating oil pipe lines, governing oil pipe lines, seal oil system pipe lines and all the drains.

After completing the fabrication of piping for the oil circuit, the pipes shall invariably be pickled. (Note: sand blasting method shall not be resorted to). It is always desirable that this operation is carried out by a reputed agency which is specialized in pickling pipe work. If this is not possible due to any reasons, the following procedures are recommended. The activities involved for this process are given below with detailed procedures in sequential manner.

2.0 Methods of pickling pipe lines material wise.

2.1 Carbon steel and alloy steels.

2.2 Stainless steel; and steels with high chromium content.

3.0 Preparation at site.

3.1 Mechanical cleaning of oil pipe lines.

3.2 Hydraulic testing of oil pipe lines.

3.3 Steam blowing of oil pipe lines.

3.4 Assembly of oil pipe lines for acid cleaning.

3.5 Pressure testing of contours (loops).

4.0 Flushing of the contour with hot water.

5.0 Quantity of acid solution and acid cleaning process.

5.1 Circulation process.

5.2 Soaking /filling process.

6.0 Flushing with hot water after pickling g and neutralization.

7.0 Die-assembly of contours and dray compressed air blowing.

8.0 Oil spraying of the pipe sections.

9.0 Safety precautions.

10.0 Approximate material requirement.

2.0 METHODS OF PICKLING PIPE LINES MATERIAL WISE.

2.1 Material: carbon steels & alloy steels.

a)Hot water flushing	D.M.water	Item under hot water flushing
b)Degreasing with an Alkaline solution	Alkaline solution consisting of 50 gms. Of tri-sodium phosphate, 50 gms.of sodium carbonate,20 gms of caustic soda per 1 ltr of water at 80 deg. C circulation /filling for 2hrs. at 70 to 80 deg.C	Item under circulation process
c)Hot water flushing after degreasing.	Hot water circulation for one hour at 70 to 80 deg.C	Item under hot water flushing.
d) Acid cleaning with	Acid solution consisting of HCL at 10% concentration inhibitor of 1% by volumeOther inhibitors like 1% Forma-line or 3% pyridine can also be used. (say roudine 213) and the rest with water at temp 70	Refer item under circulation method

Note: Other acid solutions which are less frequently used are:
i) Sulphuric acid 10 to 15% concentration; soaking period 1 hour.

ii) Phosphoric acid of 30 to 40% concentration; soaking period 10 hours

It is not advising to use NITRIC ACID SOLUTIONS for this Process.
e) Hot water flushing After acid cleaning. Hot water flushing at 70 to 80 C for one hour.
f) Neutralisation: After acid cleaning to neutralize the acid a solution of 5 to 10% of caustic soda of 50 gms of Trisodium Phosphate mixed in one liter of water maintained at 40 to 50 Deg. C can be used. Circulation may be for one hour. Soaking period may be 10 to 20 minutes.
However, it is to be continued till the PH value of the solution reaches to the required value of
about 8 to 10.
g) Hot water flushing: Hot water circulation at 80 Deg C for one hour.

h) Dry with	Air blowing with compressed Air free from oil, moisture etc	Ref. item under air blowing
i) Protecting the interior with	1) Filling the loops with oil and spraying the oil inside the pipes which are not included in the loops 2) Cleaning the pipe ends with cloth	

2.2 Material : Stainless steel and steels with high chromium content.

ACTIVITY	**ACTIVITY COMPOSITION AND OTHER DETAILS**	**FOR DETAILED PROCEDURES REFER ITEMS**
a) Hot water washing	D.M.water circulation at about 80Deg C for one hour	
b) Degreasing with	i) Solution consisting of 15% caustic soda Alkaline solution. plus 15% sodium phosphate per litre of circulation item. Water at 80 Deg C.or	Refer pickling

	ii) Solution consisting of 50 gms trisodium phosphate 50 gms. Of sodium carbonate and 20 gms. Caustic soda per one litre of water at 70 Deg. To 80 Deg.C. CIRCULATION :2 hrs.	
c) Hot water flushing after degreasing	Circulation at 80Deg. C for one hour	Refer circulation
d) PICKLING	i) Cleaning with a solution of 7% (by volume) industrial Nitric acid and 3% (by volume) filling industrial sulphuric acid and 90% (by volume water at 50 Deg.C for 30 minutes). ii) Preferably pickling of stainless steel piping may be done with solution containing Citric Acid 6% (by weight),Redine 92 A or 130 (Power) 1.5% (by weight) at a temperature of 65 Deg to 70 Deg.C 12 hours circulation method.	
e) Hot water flushing	Circulation at 80 Deg.C for one hour	
f) Neutralisation	Solution of 10% Caustic soda and 90% Circulation for one hour	
g) Hot water flushing	Circulation at 80 Deg.C for one hour	
h) Dry with	Air blowing with compressed air free from oil, moisture etc.	
i) Protecting the interior with	i) Filling the loops with oil and spraying the oil inside the pipes which are not included	

	in the loops. ii)Closing the pipe ends with cloth	

3.0 PREPARATION AT SITE:

3.1 MECHANICAL CLEANING OF OIL PIPE LINES;

All the pipe sections are thoroughly cleaned with the help of round wire brushed of proper sizes and chains. The tee branches, reducers, bends are cleaned with greater care. Wherever possible, the excess of welding metal protruding over the internal surface of the pipe sections are to be removed by grinding or with the help of hand files. After cleaning is done the pipe sections are blown with compressed air to remove the dirt of dust.

The cleaning is continued till all the rust, loose materials, welding burrs, slogs are dislodged and removed. All the joining flanges of the pipe lines are to be scraped and colour matches with the surface plate.

3.2 HYDRAULIC TESTING OF OIL PIPE LINES:

After the successful mechanical cleaning, the pipe lines are to be hydraulic tested at the recommended pressure and the test results are to be recorded. Maximum possible pipe line sections which form the complete con tour are assembled temporarily on a levelled ground for the purpose of hydraulic testing. The selection of sections has to be done from the point of convenience. Pipe sections which cannot be included in the contours have to be tested individually. This test is inevitably required for all the high pressure pipe line sections included in the seal oil system.

3.3 STEAM BLOWING OF OIL PIPE LINES:

All the pipe sections which cannot be mechanically cleaned are to be steam blown in two stages. The steam required for blowing is obtained from the existing units of a package boiler where no Unit exists. The parameters of the steam used for blowing are 7 to 8 Kg./cm2, temperature of 180 To 200 deg. cent. Minimum flow to be maintained during process is 4 to 5 t/hr. Duration of each Blow shall be 15 to 20 minutes. The second blowing is given after cooling the pipe sections to the ambient temperature. The blowing further ensures the removal of all the loose, materials, welding slag adhering to the internal surface of the internal surface of the pipe sections.

3.4 ASSEMBLY OF OIL PIPE LINES FOR ACID CLEANING;

Note : Pipe sections of diameter 80mm below are not to be included in the contour. They are acid cleaned by soaking process. Soaking filling method can be done wherever the circulation process is not possible due to air locks and also depending on the loops prepared.

The pipe sections are assembled in different contours on a levelled ground and supported over wooden sleepers at number of places near the joints. The selection of sections has to be done from the point of convenience. Where parallel flow paths as unavoidable, orifices shall be provided restrict to flow in the path offering the least resistance for the flow. The contours shall have to be provided with drain points for draining the solution and air vent for removal of air.

while charging with the solution. The cleaning of the front pedestal inner oil pipe lines is not done by acid. They are only mechanically cleaned and steam blown. The contours are to be provided with sampling points both a suction and return lines for facilitating the collection samples for analysis.

The contours are also to be provided with valves in suction and return ends for the regulating flow. A drain line to the neutralizing pit with a valve is to be provided before the valve on the return line. A by pass line is also provided for the contour with a valve for facilitating the starting of the acid pumps. All the pipe sections joints are to be provided with acid resistance rubber gaskets only, wherever temporary pipe lines or blanks are required; they are to be provided by the contractor.

3.5 PRESSURE TESTING OF CONTOURS:

Contours assembled are hydraulic tested with one discharge to the dissolving tank to check for the tightness of all the joints.

4.0 FLUSHING OF THE COUNTOUR WITH HOT WATER.

Hot water flushing of the contours are carried out with filter water prior to acid circulation process in order to remove the dust, dirt or moll scales.. This also helps to check the tightness of all the flanged joints under hot conditions. The filter water is first taken into the dissolving tank and head to a temperature of 60 deg. C by passing steam. The parameter of the steam admitted shall be 8kg.cm2 and temperature of 180 to 200 deg.C. The acid circulation pump is then started on re-circulation and further the temp. of the water in the dissolved tank is raised to 70 deg.C by passing more quantity of steam. The air valve provided in the contour is opened and the suction valve of the contour is opened slowly for charging the contour. When all the air is expelled out of the contour, the water starts coming out in the form of a jet from the air vent. After ensuring the complete removal of the air, the air valve is closed and the

discharge valve of the contour to the neutralizing pit is opened slowly and the storage tank maintained at a constant level i.e.3/4th gauge throughout the process. The rate of discharge of water to be maintained at 50 t/hr. This quantity may vary from set to set. The approximate time required for the completion of the process is three hours.

5.0 QUANTITY OF ACID SOLUTION AND ACID CLEANING PROCESS:

5.1 SAMPLE CALCULATIONS:

The quantity of acid to be used for cleaning a contour depends upon the volume of contour /piping loop. A sample calculation to arrive at the required quantity of acid for a contour of 6 m^3 volume is given below. However, the total quantity of acid required will depend upon the total volume of pipe lines to be cleaned which varies from set to set. .
Volume of contour = 6 m^3 The dissolving tank volume is of say =2 m^3.

The working volume of the tank is taken as 10 m^3 as the level is to be maintained at ½ of the level gauge glass.

Total volume =6+10 = 16m3

If acid concentration is chosen as 15% of phosphoric acid (H3 P04).

For 80% concentration of H3 P 04:

Commercially available quantity of acid required is =2.4/0.8=3 m3. Specific gravity of acid required is 1.75. Weight of H3 P04 required for 6 m^3 contour cleaning is = 1.75x3= 5.25 MT.

5.2 PREPARATION OF SOLUTION AND PROCESS OF CIRCULATION METHOD:

Demineralised water is filled in to the dissolving tank up to the lower gauge glass full. One of the acid circulation pumps is started on recirculation through the contour/pipe loop. The temperature of the tank water is raised to 50 deg. Cent. by passing of steam in to the dissolving tank. Just after the temperature of 50 deg.cent. is attained, the addition of the calculated quantity of acid, a sample from suction of the contour is sent to laboratory for checking required concentration . The temperature of 60 to 80 deg.cent. is maintained throughout the process by controlling required steam quantity. The parameter of the steam is 7 to 8 Kg/cm^2 and temperature 180 to 200 deg.cent.(care is to be taken to see that the tank level does not increase more than 1 ¾ level gauge glass. The closed circulation of the acid solution is continued for 6 hours after the complete addition of the acid.

During the circulation hourly samples are taken from the suction and return lines and analised for the following:

1) PH 2) acidity 3) Iron content.

NOTE: The concentration of the acid and type of acid chosen may vary depending upon the material and cleanliness of the pipe lines. Refer item for method of pickling noted.

After the successful completion of the 6 hours circulation the pumps are stopped. The contour is allowed to soak with the solution for one hour. This is called the "Locking of the process". The circulation is resumed once again for about 15 to 20 minutes and the process is locked for 5 minutes. This operation is repeated for 3 to 4 times to dislodge the extraneous matter that might have been stuck up at the sharp bends of the contour. Even during this locking process, Samples are taken from the suction return lines and analysed as earlier.

Then the complete solution is discharged in to the neutralizing pit first through the pump and then by gravity after stopping the pump. The contour is also drained. While discharging the acid solution, it is neutralized by adding NaOH in to the neutralizing pit.

5.3 SOAKING PROCESS/FILLING PROCESS:

The pipe sections of diameter 80mm and below which are included in the contour are acid cleaned (pickled) by "soaking process". This method comprises of blanking one end of the pipe sections completely and filling up of the acid solution prepared with the required concentration .
After the pipe section is filled with the acid solution, the other end is also blanked loose to allow the gases to escape.

In some cases, all the small bore pipe sections and other small branches are completely immersed in the tank for digressing, pickling and neutralization and it is ensured that all the pipes are filled inside fully with the solution. In both the methods, it is to be left for 24 hours and after which the solution is drained out from the pipe sections. These were finally blown by steam and air.

6.0 FLUSHING OF THE CONTOUR WITH D.M.WATER:

After the system is completely drained the dissolving tank is filled with the D.M.. Water and the water in the tank is put on recirculation through the acid pump. The contour is slowly charged end the water is put on recirculation through the contour

and the bypass valve of the contour is closed. The temperature of the D.M. water of the dissolving tank is raised to 70 to 80 deg. Cent. by passing steam of 7to 8 Kg/cm^2 and temperature of 180 to 200 deg. Cent. The discharging valve of the contour to the neutralizing pit is slowly opened and the hot flushing of the contour is started. The recirculation valve to the tank is closed. The rate of discharge to the neutralizing pit is maintained at 50t/hr. This quantity may vary from set to set. The dissolving tank is mad up continuously with D.M. water and the constant level of 1 ¾ gauge glass is maintained. The hourly samples from the discharge line is collected and analysed for the following:

1) PH 2) CONDUCTIVITY 3) ACIDITY 4) IRON CONTENT.

The temperature of the water at the dissolving tank is maintained at 70 to 80 deg. Cent. throughout the process. The rinsing of the contour is deemed to be over when the acidity and iron content becomes nearly equal over a set of consecutive readings of zero. The pipe sections which are soaked are also booked in to contours and rinsed with D.M.water as above or the pipe sections are steam washed till such results as above are obtained. The approximate time required for the above process is 8 hours.

7.0 DESSEMBLY OF CONTOUR AND DRY COMPRESSED AIR BLOWING:

Soon after completing the D.M.water rinsing the pipe sections of the contour are dissembled and taken over a platform where the arrangement for dry compressed air is made compressed air is made available for blowing. The temperature of the compressed air used shall be 50 deg. Cent. and the pressure 3 50 4Kg/cm^2. The clean dried surface has a dark steel gray colour, which indicates that the acid cleaning is of required standard.

8.0 OIL SPRAYING OF THE PIPE SECTIONS:-

The dry pipe sections are then sprayed with DTE medium oil for protecting them from further rusting till they are erected back. For this purpose oil is thrown in to the pipe section using a small container and blown with compressed air. The end of the pipe sections are covered with wooden blanks to prevent the entry of the dust. The method of preservation is adopted when the cleaned pipe lines are required to be stored for 1 to 2 months. This is called the “passivation”.

9.0 SAFETY PRECAUTIONS TO BE TAKEN DURING AND AFTER ACID CLEANING:

1) The acid cleaning area shall be maintained free from foreign materials which may obstruct the movement of the personnel.

2) Ensure that the persons working in the acid cleaning process use the following:

a) Rubber gloves

b) Goggles

c) Aprons

d) Gum boots

e) Masks

3) Ensure the availability of first aid box, eye drops neutralizing bottle and cotton rolls.

4) The pipe sections after acid cleaning are to be stored properly so that no moisture or dust enters in to them till erected.

5) Smoking is strictly prohibited in the area where acid cleaning is done, no fire should be lit around the area.

6) Drilling, cutting, Welding of the pipe sections are strictly prohibited after the acid cleaning. All the stubs for instrument tapings are hence to be provided before acid cleaning and properly Plugged during and after acid cleaning till erected.

7) The damaged bolts and nuts during acid cleaning shall be replaced by new ones.

8) Due precautions to be taken while tightening the joints of the loop so that they do not leak.

10.0 MATERIAL REQUIREMENT (VARIES FROM-SET TO SET):

1)	Quantity of filter water	:	1250 MT
2)	Quantity of D.M.Water	:	1900 MT
3)	Quantity of acid	:	16.5 MT
4)	Quantity of steam for heating	:	150 MT

	the solution etc:.		
5)	Quantity of Na OH	:	3 MT
6)	Capacity of dissolving tank	:	20 m3
7)	Acid pumps	:	100m3/hr
			10Kg/cm^2
			4Nos.
8)	Hot air blower	:	1No.
9)	Thermometer (dial type)	:	0 to 100 Deg.C.
			1No.

OIL FLUSHING FOR TG SETS

1. GENERAL

After completion of fabrication, acid pickling and installation the entire oil system should be thoroughly flushed, in order to eliminate all the contaminants, which might have been introduced into the oil system during the erection operations.

Acid pickling (write up Ref.No.4-17-0552) would have already removed all the Residual impurities from the oil system. However, oil flushing is to be carried out to make sure that no foreign material will be carried by the oil to the bearings and governing elements, which is dangerous to the turbo set.

During oil flushing, high velocity of flow in the oil lines can be achieved by temporarily removing the throttling points in governing line and opening the bearing inlet orifices such that drain oil pipe is 2/3 full. These high velocities will help in detaching loose particles adhering to the pipe walls, so that they will be carried away by the oil flow.

2. FLUSHING OIL:

Oil system can be flushed with the same type of oil that is employed for normal turbine operation.

Oil quantity required for flushing is approximately 60% to 70% of the quantity of oil required for normal operation of the turbine. However it has to be ensured that the oil pump does not starve for oil at its suction, during flushing.

After completion of flushing, the oil has to be centrifuged by centrifuging equipment and then tested. From the test results it can be decided whether the oil, after being used for flushing, is still usable as turbine lubricant.

NOTE: Other types of cleaning agents, especially chemical detergents, must never be used for flushing operations.

3. PREPARATION FOR START UP:

OIL TANK: Before filling with oil, the oil tank and strainer are to be thoroughly cleaned. Only cloth but never cotton waste should be used for cleaning.

The cleaning materials used, should not leave any residue, and then the tank is to be loaded up with oil.

LUBRICATING OIL CIRCUIT:

a) All the adjustable orifices are to be opened such that drain oil pipes are 2/3 full.

b) All filter cartridges in lube oil filter are to be removed.

c) Upper halves of the radial bearings are to be taken out. Journal portion is to be covered with cloth leaving the hole space for oil inlet. The cloth is to be pressed in between the bearing covers such that it will not become loose and pass on along with oil.

d) Thrust bearing is to be removed.

e) Proper tightening of all the flanges is to be ensured.

f) Flushing of delivery pipe lines of the other oil pumps which are not used for flushing operations can be done by connecting their delivery pipe lines to the oil tank before the strainers.

g) The delivery lines of jacking oil pump need not be flushed. These are to be cleaned after flushing.

h) Gear boxes are not to be flushed; temporary pipe of 11/2" may be connected from inlet to drain through inspection window.

GOVERNING OIL CIRCUITS;

a) All the orifices in trip oil, secondary oil and primary oil circuits are to be removed.

b) Damaging devices in secondary oil circuits and primary oil circuits are to be removed.

c) Control slide is to be taken out from the governing valve servomotors.

d) Solenoid valve is to be kept in operating position.

e) Tripping device is to be turned in to operating position locked.

f) Starting device is to be turned into operating position and locked.

g) About 20 to 30 mm dia temporary orifice is to be provided in the power oil inlet line to servomotors.

h) Low lube oil protection is to be ensured for operating position by assembling 13mm thick stopper below the position.

i) Vacuum protection is to be kept in operating position with the help of lever.

j) Position is to be removed from emergency stop valve or the

4. FLUSHING OPERATION:

Oil pump is to be switched ON. In case of centrifugal pump delivery line is to be closed before switching on the pump and to be gradually opened later. Pump input amperage is to be watched and if it rises too high, pump delivery is to be throttled for reducing it. In case of positive displacement Pumps, all the valves in the delivery are to be kept fully open before switching on the pump. Any leakages found in the oil system are to be curbed.

Flushing is to be started with lube oil header to drain by blocking oil entry to bearings and providing a temporary line between the two headers.

Subsequently the flushing can be extended to individual bearing oil lines, governing system, to all oil pumps, standby coolers, standby filters and over head oil tanks etc.

The best cleaning effect can be obtained by using alternatively hot and cold oil for flushing. Oil should therefore be heater up to 70C to 80 C. Oil temperature should not go up beyond 85 C because higher temperatures may be harmful for the oil.

After flushing for a period of about four hours, at a temperature of 70 deg. to 80deg. Cent., oil is to be allowed to cool down to about 30 to 35 deg. cent. When the pipes are also cooled to that temperature, oil is to be again heated to 70 to 80 deg. Cent. All the pipes must be hot during oil flushing. If any pipes are found to be cold, the reason why oil is not flowing through those lines is to be investigated and the fault to be rectified. Tapping on the pipes at intervals, further improves the removal of foreign materials from the pipe walls.

5. FLUSHING PERIOD:

Coarse impurities will be retained by the strainer in the oil tank. For filtering out the smaller foreign particles, filter cartridges should be kept in position during the last third of the flushing time. Differential pressure across the filter should be watched and paper filter cartridges are to be replaced whenever the differential pressure rises above 1.5 Kg/mm.

Oil centrifuging equipment (if available) is to be kept in service during oil flushing as an additional means of purification. Other oil filtering facilities can be provided by inserting fine filter meshes (approximately 25 microns) at the flange connections of bearing housings. These meshes will enable to check the impurities still present after flushing.

Flushing operation has to be continued until no substantial amounts of contaminants are found in the filters any more or no substantial rise in differential pressure across filters with in a period of 12 hours.

POST FLUSHING OPERATIONS:

a) Oil tank and strainers are to be cleaned. The oil tank is to be filled up with operating oil to the required level.

b) Oil filter is to be cleaned. In case of paper cartridges, used cartridges are to be replaced by new cartridges.

c) If stop valve is included in the flushing, oil portion is to be cleaned and piston is to be assembled back.

d) Lower half cells of bearing halves are to be cleaned. Thrust bearing pads and top halves of radial bearings are to be assembled in operating position.

e) Removed orifices and damping devices are to be assembled back in trip, secondary and primary oil lines.

f) Primary and secondary oil pipes are to be separately cleaned.

g) Orifice at the power oil inlet to servomotor is to be removed.

h) Stopper piece in low lube oil protection is to be removed and cleaned.

i) Overhauling and assembly of control slide in servomotor is to be carried out.

j) Temporary lines provided for flushing operation are to be removed.