0This job specification shall be completely filled-in, duly signed by supplier and enclosed along with offer.

OFFER FOR 2x660 MW FGD OXIDATION BLOWER

PROJECT: 2 X 660 MW MAHAGENCO KORADI

TYPE: _____

REF: _____

Technical Offer

MANUFACTURER: _____
_____
_____
_____
_____

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1.0 PROJECT INFORMATION:

The proposed power project. i.e. 2x660 MW Supercritical Thermal Power Project (Unit-11 & 12), at Koradi in Nagpur, Maharashtra.

The Koradi Thermal Power Station project is located near Koradi Village, which is situated at about 11 km from Nagpur city in Maharashtra. National Highway NH-19, which is referred to Delhi–Kolkata highway is about 25 Km from the Site. The nearest National Highway NH- 20 is about 8 Km from the site.

a.	Owner	MAHAGENCO.
b.	Buyer	BHEL, Hyderabad
c.	Process/Application	Flue Gas Desulphurization

A) SITE CONDITIONS

Guarantee points

1.	**Ambient Temperature and Relative Humidity**		
	Ambient Temperature	:	48°C (High) & 3.9°C (Low)
	Relative Humidity	:	61 % (in Dry Season) and 85% in Monsoon season

Design point.

1.	**Ambient Temperature and Relative Humidity**		
	Ambient Temperature (Design)	:	45° C
	Relative Humidity	:	60 %

Note:

1.Guarantee point site condition shall be applicable for the Guarantee Values as well as for the Guarantee/performance test at shop/ site.

S. No	Constituents	Unit	Average Parameters	CW BLOWDOWN QUALITY
1.	pH value	--	7.8	85
2.	Conductivity	µS/cm²	1000	5000
3.	Total dissolved Solids (TDS)	mg/l	600	3000
4.	Total suspended Solids (TSS)	mg/l	--	
5.	Turbidity	NTU	20	100
6.	Free Residual chlorine	mg/l	-	
7.	Total hardness	mg/l as CaCo3	260	1300
8.	Calcium	mg/l as CaCo3	160	800
9.	Magnesium	mg/l as CaCo3	100	500
10.	Total Alkalinity	mg/l as CaCo3	230	230
11.	Chlorides	mg/l as Cl	100	500
12.	Ortho-Phosphate	mg/l	2.50	12.5
13.	Total Phosphate	mg/l	6.00	30
14.	Silicate as SiO2	mg/l	30.00	150
15.	Sulphates	mg/l	45.00	225
16.	Iron	mg/l	0.20	1
17.	Zinc	mg/l	0.10	0.5
18.	KMnO4	-	-	
19.	BOD	mg/l	20	20
20.	COD	mg/l	100	100

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2.Equipment and material must be suitable for the range of ambient conditions.

B) WATER ANALYSIS

The following water to be used for quenching the oxidation air if discharge temperature is more than 70 deg C.

2.0 INTENT OF SPECIFICATION

This specification covers the minimum requirements for the complete design, material, manufacturing, shop inspection, testing at the manufacturer's works, supervision of erection & commissioning and performance Guarantee testing of Oxidation blower along with accessories which is to be furnished in the Flue Gas Desulphurization plant of 2X660MW MAHAGENCO Koradi Project. The following points may be noted.

a. There are two units of 660 MW and each unit is envisaged with one FGD system. Each FGD system will be provided with 2 numbers of Oxidation Blower (1 working + 1 standby) which are located inside the Recirculation Pump & Oxidation Blower shed.

b. Vendor shall assume full unit responsibility for the entire equipment assembly and make all possible efforts to comply strictly with the requirements of this specification and other specifications/ attachments to inquiry/order.

c. In the event of any conflict between the requirements of two clauses of this specification, documents or requirements of different codes and standards specified, the more stringent requirement as per the interpretation of the owner shall apply.

d. The Vendor shall offer only proven design which meets the Provenness criteria indicated in Annexure-I. Necessary document evidences as per Attachment-3K for qualification shall be submitted along with the bid. If the Vendor doesn't meet the specified Provenness criteria in Annexure-I, then the Vendor will not be allowed to participate in the Tender.

e. In case, deviations are considered essential by the Vendor (after exhausting all possible efforts), the same shall be separately listed in the Vendor's proposal under separate section, titled as "List of Deviations/Exceptions to the Enquiry as listed in **Annexure-II.** Deviations/Exceptions mentioned anywhere else in documents submitted by bidder are not acceptable.

f. Any deviation, not listed under the above section, even if reflected in any other portion of the proposal, shall not be considered.

g. No deviation or exception shall be permitted without the prior written approval of the purchaser.

h. Compliance to this specification shall not relieve the Vendor of the responsibility of furnishing equipment and accessories/auxiliaries of proper design, materials and workmanship to meet the specified start up and operating conditions.

i. In case, the Vendor considers requirement of additional instrumentation, controls, safety devices and any other accessories/auxiliaries essential for safe and satisfactory operation of the equipment, the same shall be recommended along with reasons in a separate section and include the same in scope of supply.

j. All accessories, items of work, though not indicated but required to make the system complete for its safe, efficient, reliable and trouble-free operation and maintenance shall also be in supplier's scope unless specifically excluded.

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k. Vendor are requested to carefully examine and understand the specification and seek clarification, if required, to ensure that they have understood the specification. The Vendors offer should not carry any sections like clarifications, interpretations and/or assumptions.

3.0 APPLICABLE CODES/STANDARDS/REGULATIONS/SPECIFICATIONS:

The design and materials shall conform to the requirements of applicable codes and regulations of the latest edition. The design, manufacture, installation and testing of the Oxidation Blower shall follow the latest applicable Indian/International (AISI / ASME/EN) Standards.
Standard specification of FGD Blowers for MAHAGENCO Koradi Projects)/ BS:1571-1/ BS:1571-2/API 619

If any other country standard used shall also be accepted subjected to approval by MAHAGENCO Koradi, in such case Vendor shall furnish adequate information to justify that these standards are equivalent or superior to the international standard mentioned above. A copy of such standard duly translated (complete word to word translation) in English shall be furnished by Vendor.

4.0 PROVENNESS CRITERIA:

The Vendors are required to meet the Qualification Requirement (QR) for Oxidation Blower as per **Annexure-I & submit necessary documents evidence requirement as per attachment-3K along with necessary supporting documents. Vendor's offer will be rejected if the Vendor fails to meet the Qualification criteria**.

5.0 TECHNICAL INFORMATION: SELECTION PARAMETERS FOR OXIDATION BLOWERS

Sl. No	Description	Requirement			
1.	Quantity	1 No. Working + 1 No standby for each absorber. Total =4 Nos. (2 Absorbers)			
2.	**Parameters**				
	Operating Points	(1) Blower Design Point	(2) FGD Design point BMCR WC	(3) Guarantee Point	(4) Guarantee Point Aux. power
	Blower capacity Nm^3/hr-wet	14250	8850	6500	5600
	Discharge pressure(min) mmWc	9350	8400	6700	6000
	Efficiency (min)				75%
	Power consumption (at Motor terminal point) in KW				160 KW
	Relative humidity	60%	60%	60%	60%
	Suction temperature	45.0° C	45.0° C	27.0° C	27°C
	Atmospheric pressure	968 hPa			
	Discharge temperature	<70° C			
	Type of Blower	2x100% Motor driven positive displacement type oxidation blowers complete with VFD drive, lube oil system, instrumentation and accessories. The blower will be used for supplying a variable volume of air to the absorber reaction tank. **Note: VFD & Transformer is in BHEL Scope**			
	Duty	Continuous			

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Sl. No	Description	Requirement			
3.	**Cooling water**				
	Inlet temperature	BHEL to provide			
	Increase in temperature	Max 10 ° C			
	Pressure loss	<0.05 MPa (Max)			
	Supply pressure	PEM to provide			
	Flow (m^3/hr)	Vendor to provide			
4.	**Air Composition (Wet)**	(1) Blower Design Point	(2) FGD Design point	(3) Guarantee Point power	(4) Guarantee Point Aux. power
	H_2O (vol%)	5.86	5.88	2.18	2.18
	O_2 (vol%)	19.76	19.76	20.56	20.54
	N_2 (vol%)	Balance	Balance	Balance	Balance
5.	**Material of construction**				
	Casing	Vendor to provide			
	Shaft	Vendor to provide			
	Impeller	Vendor to provide			
6.	Voltage level for Motors	a) Up to 0.2KW – Single phase 240V AC/ 3phase 415V AC b) Above 0.2 KW and up to 200 KW- 3 phase 415V AC c) Above 200 KW and up to 1500 KW- 3 phase 3.3kV AC d) Above 1500KW-11 kV			
7.	Air filter filtering efficiency	Vendor to provide along with name of Vendor supplying the Air Filter			
8.	Blower Driver	Motor [with VFD and Direct on-line (DOL)]			
9.	Cooling system for reducing the temperature of air at the blower outlet to <70 deg Celsius	Quenching/Cooling arrangement with water injection arrangement to be provided. Heat exchanger should not be provided. Water analysis is given in Table 1.0 (B). Quenching Nozzle back pressure- <1.0 bar(g)			
10.	Instrumentation execution	a) All field transmitter like pressure, temperature, flow, level, DP etc. shall be HART type. b) **Control Valve Actuators:** For close loop control system, conventional i.e. 4-20 mA / (HART) based actuators along with 4-20 mA (HART) based electronic transmitters (which are directly used in control of final control element), shall be provided. For balance measurements for even these areas/ applications Profibus based PT/DPT/TT shall be provided. c) The following requirements for Transmitter shall overrule relevant requirement specified in standard specifications.			

Range	Accuracy	Turndown (For Span)	Stability (% of Calibrated range)
<=400 mmWc	0.10%	20:1	+/-0.2% for 1 Year
>400 mmWc	0.06%	50:1	+/-0.25% for 10 Year
>250 Kg/Cm^2	0.065%	10:1	+/-0.15% for 5 Year

Detail technical specification for Control & Instrumentation, **please refer Annexure-III.**

d) Rotor Vibration Sensors: 02 nos on DE side and 02 nos on NDE side.
e) Bearing Temperature Sensors: 02 nos on DE side and 02 nos on NDE side.

11.	**POWER SUPPLY**				

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Sl. No	Description	Requirement
	The following voltage levels shall apply:	
	3.3 kV ±6%,50 Hz	Voltage for motors equal to/bigger than 200 KW and for power distribution within the plant.
	415 V ±10%, 50Hz	Standard voltage for power supplies to small electric power consumers and motors below 200 KW.
	Vendor shall design and supply the equipment suitable for satisfactory operation under above mentioned power supply condition.	

6.0 SCOPE OF SUPPLY

Scope for the Vendors shall include Design, Engineering, Manufacturing, Inspection/testing as per approved quality plans, packing, Supply, and Supervision of Erection & Commissioning, Performance Guarantee Test.

Design: Includes basic engineering, detail engineering, preparation and submission of engineering drawings/calculations/datasheets/quality assurance documents/field quality plans, storage instructions commissioning procedures, operation & maintenance manuals, performance guarantee test procedures and assisting BHEL in obtaining time bound approval from MAHAGENCO.

Supply: Includes manufacturing/fabrication, stage inspections, final inspections, shop floor testing, painting & packing.

Test: The scope of the Vendor includes all shop tests, type tests, site tests, routine tests etc., fulfilment of complete quality assurance & inspection requirement and related activities for all the equipment & systems covered under the scope of the Vendor.

Performance Guarantee Test: The Performance guarantee tests shall be carried out for all Oxidation Blower as per BHEL/MAHAGENCO approved test procedure, all the special equipment, tools and tackles, instruments, measuring devices required for successful conductance of test shall be provided by Vendor free of cost.

Painting: The Vendor scope of work includes supply of paints and painting of all equipment's as per approved painting schedule from MAHAGENCO.

Supervision of Erection & commissioning: Includes supervision of erection & commissioning, supervision of trial operation, training of customer's O&M Personnel.

Supplier's scope shall cover complete air blower unit including sub-systems, start-up spares and special tools (typically) as given below. The scope of supply for air blower shall include but not limited to the following:

Sl. No	Scope	
6.01	Blower complete with	
	i.	Casing
	ii.	Rotor and Shaft assembly
	iii.	Common base frame and shock absorber if applicable
	iv.	**VFD drive panels and transformers for positive displacement type compressor is in BHEL SCOPE.**
	v.	Suction filter, throttle / IGV
	vi.	Suction & Discharge silencers
	vii.	Blow-off valve & silencer (if required)
	viii.	Lubrication system
	ix.	Accessory piping within the skid

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Sl. No	Scope
	x. Safety Valves, Gate valve, butterfly valve, check valves as per specification and P&ID enclosed in **Annexure – VII**
	xi. Acoustic Enclosure (with complete accessories) to meet specified Noise Level
	xii. Gear Box if required
	xiii. Coupling with coupling guards (all couplings between driver & driven equipment)
	xiv. Expansion joints at Discharge
	xv. Companion flanges with gaskets and fasteners
	xvi. Bearing cooling
	xvii. Quenching arrangement to reduce the discharge air temperature to <70 deg C
	xviii. Foundation bolts for supplied items
	xix. Instruments: Differential pressure indicator in the suction filter, 4 Nos RTD for each blower (2 no's at each Drive end and Non-Drive End), Pressure Indicator at discharge as per P&ID. Any other instruments, not indicated in the P&ID, but required as per blower manufacturer's standard practice or required for the completeness of the system shall also, be provided. **For detail instrument specification, refer Annexure-III**
	xx. Mechanical Running and Performance test at shop with job motor/Shop motor of similar rating. The same will be finalized by MAHAGENCO Koradi during QP approval.
	xxi. Painting and Rust Prevention during shipment, erection and storage
	xxii. Supervision of Erection & commissioning at site
	xxiii. Proper Packing
	xxiv. Special tools & tackles as applicable for operation and maintenance
	xxv. Mandatory spares
	xxvi. Erection and start-up spare as applicable
	xxvii. Installation, operation and maintenance manuals
	xxviii. Training of O & M staffs at site
	xxix. All other items, instruments shall be as per reference P&ID given in **Annexure- VII**
	xxx. Any other items required for completeness of the equipment except the items covered in the exclusions.
	Vendor shall refer to the reference P&ID enclosed in **Annexure – VII** for detailed clarity on the scope.
6.02	**CONSTRUCTION FEATURES**
a.	Each blower shall be a complete unit with casing, rotor, shaft and drive unit etc.
b.	The Blowers shall be Centrifugal type/ positive displacement type with lube oil system, instrumentation and accessories. It shall be compact and simple in design requiring minimum number of spares.
c.	The oxidation blowers should be complete with drive arrangement consisting of coupling, coupling guard, base frame shock absorbers, mounting bolts, air filter, Acoustic enclosures, silencers, safety valves and check valves etc.
d.	The Oxidation Blowers shall be designed for continuous operation along with suitable quenching arrangement with temperature measurement and control to meet the exit temperature < 70 deg C. The Vendor shall specify the cooling water requirement for reducing the temperature of discharge air.
e.	The rotor shall be ground all over and accurately machined. The Rotor along with other rotating parts shall be statically balanced and then dynamically balanced as per ISO 1940 to ensure efficiency, vibration, performance and long bearing life.

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Sl. No	Scope
f.	The air intake filter cum silencer, preferably dry type, to prevent dust and other atmospheric impurities from entering the blower shall be provided for each blower. Air filter shall have better filtering efficiency.
6.03	**COOLING ARRANGEMENT**
a.	The discharge air temperature <70 °C may be obtained by Quenching arrangement with water injection at the common discharge with temperature measurement and control.
b.	In case of Casing cooling, the Vendor shall consider the water quality available and accordingly select the casing material to withstand the corrosion, if any. The inside of the casing also to be coated with corrosion resistant materials of adequate thickness to enhance corrosion resistance of the Blower.
c.	The Vendor to provide the following accessories along with cooling arrangement (with auto drain) ▪ Required pipe fittings within the scope of terminal points ▪ Required number of spray nozzles ▪ Water quantity required ▪ Required flow control devices like valves, pressure gauges and other instruments. ▪ Scheme & arrangement drawing shall be mentioned in offer.
6.04	**CASING**
a)	Casing shall be of robust construction. It shall be made from Casting or fabricated from heavy gauges steel sheets or plates or Vendor's proven design standard.
b)	In case of castings, the casing will be of Gray Cast Iron confirming to IS: 210 grade 25 or equivalent, designed for the duty conditions or proven design standard. Castings shall be free from all defects and blowholes and shall be machined to close tolerance. In case of fabricated casings, it shall be rigidly reinforced and supported by structural members. Weld seams shall be continuous to have air–tight enclosure.
c)	Casings shall also have smooth interior to avoid accumulation of dense particles. Inlet shall be spun to have a smooth contour.
d)	If necessary, provision for ready access to the interiors of casings and other possible trouble points shall be made by means of readily removable, bolted on plates or by hinged and latched doors.
e)	Any connections shall be flanged. Flange diameter and drilling shall conform to ANSI B16.5 Class 150
6.05	**ROTORS & IMPELLERS**
a)	Rotor assemblies shall be statically balanced and then dynamically balanced as per ISO 1940.
b)	In case of centrifugal blowers, the Impeller material should be as per their standard for air application.
6.06	**SHAFT, SHAFT SEALS AND BEARINGS:**
a)	The shaft shall be made of alloy steel or Vendor's proven design standard.
b)	Shafts shall be conservatively designed to transmit maximum power required and to assure rigidity. Shafts shall be machined and ground to close tolerances and shall be tapered to permit easy removal of the seals and bearings.
c)	Shaft shall run in high precision heavy duty bearings. Lubrication system provided shall be such that visual checking of lubricant level is possible.

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Sl. No	Scope
d)	The shaft shall be finished to close tolerance at the rotor, coupling, pulley and bearing diameters. The size of shaft shall be calculated on the basis of maximum combined shear stress. This shear stress shall not exceed 30 percent of the elastic limit in tension or 18 percent of ultimate tensile strength.
e)	The design of shaft shall also take into consideration the critical speed of the shaft, which shall be at least 20% above the operating speed or 60 to 75% of the operating speed to minimize vibrations. Shafts shall be tapered to permit easy removal of the seals and bearings.
f)	Shaft seals shall be provided to seal rotating shafts. Shaft seals shall be of the labyrinth type, of non-sparking material and shall be horizontally split to facilitate maintenance. The housing shall be of cast iron or fabricated steel construction and shall be horizontally split to provide access to all bearings and shafts.
g)	The bearings may be ball, roller or sleeve bearing. If sleeve bearings are used these shall be machined for close running fit. The bearings shall be designed to take the necessary radial load as well as the net axial thrust. Bearings shall be lubricated properly and sized for an operating life minimum of 50,000 hours on the basis of maximum load.
h)	Blower induced vibration due to flow pulsations shall be avoided through suitable design.
i)	Bearing temperature sensor shall be provided for remote monitoring of the bearing metal temperature of blowers. 2 Nos of RTD shall be provided to measure bearing temperature at DE and NDE ends.
6.07	**COUPLING**
a)	The HT drive motor is excluded from the scope of supply. However, the Vendor shall supply coupling for secondary transmission.
b)	Coupling shall be of flexible type. The Vendor shall furnish both halves of the coupling. Both the Coupling halves shall be bored and keyed to fit shafts of the blower and the motor by Vendor.
c)	All rotating parts such as coupling shall be covered with suitable protective guards. Guards shall be easily removable type.
6.08	**BASE PLATE**
a.	A common base plate shall be provided for Blower assembly, Motor & Gear box (if applicable). It shall be rigidly constructed, adequately braced and provided with finish pads for mounting blower.
b.	Suitable holes shall be provided for grouting and these shall be so located that the base plate can be grouted in place without disturbing the blower and motor.
c.	Common base plate for Blower, Motor & Gear box (if applicable) shall be in the scope of the Vendor and the details of the Motor details (If it is in BHEL) will be furnished to the Vendor to provide Motor mounting bolts.
6.09	**MOTORS**
	• Above 0.2 kW and up to 200 kW: 3 phase 415 V AC-**VENDOR SCOPE** • Above 200 kW and up to 1500 kW: 3.3 KV- **BHEL SCOPE** • Above 1500 kW: 11 KV-**BHEL SCOPE.**
6.10	**ACCESSORIES:**
6.10.01.	**Lube Oil Unit: (If applicable)**
a)	Each blower shall be furnished with an integral lubricating oil package. Each package shall be complete with single water to oil heat exchanger, full flow oil filter and oil pump. The oil pump shall be direct driven from the blower shaft. The complete package shall

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Sl. No	Scope
	be factory wired, assembled and mounted on the base plate. Air cooled LO System shall be applied. If cooling water is required, Vendor shall provide the supply requirements (flow, pressure) and the return conditions (temperature, pressure drop)
b)	Emergency power supply is not available. The Lubricating oil system shall be designed that will satisfy the required lubrication for bearing at the time of electric power failure also.
c)	Oil Bath System for Lubrication can also be provided instead of Lube oil system for machine to coast down
6.10.02.	**Coupling Guards-** All rotating parts outside casing such shall be covered by the guard.
6.10.03.	**Timing Gears**
a)	Timing gears shall be of the wide faced spur or helical type, hardened & ground to DIN Class V or better accuracy.
b)	Bearings shall be of anti-friction type only. The Vendor shall provide the countermeasure for the fretting corrosion on the fitting surface of the thrust disc and separated outer race of anti-friction bearings.
c)	Lubrication is required for Timing gear pair and bearings.
6.10.04.	**Intake Air Filter Silencers:**
a)	Each blower shall be provided with an inlet filter silencer of dry type and a conical shaped screen ahead of the filter. Filters shall be capable of removing minimum 82 Percent of all particles 10 microns and larger. Suitable filter area shall be provided for air suction. The suction area shall be minimum of twice the inlet pipe area. Differential pressure gauges shall be provided in filters to monitor any clogging in filters. Silencers shall be provided in discharge also.
6.10.05.	**Expansion Joints:**
a)	Expansion Joints shall be provided at the suction and discharge of each blower
6.10.06.	**Safety Valves:**
a)	Each blower shall be provided with a safety relief valve on its discharge.
b)	The valve, valve operator and controller shall be remotely mounted to prevent vibration damage. The valve shall be mounted in an easily accessible location to allow for maintenance and testing.
c)	The safety valve discharge piping shall be routed to a location such that personnel exposure to the discharge is prevented.
6.10.07.	**Piping and Valves:**
a)	All interconnecting piping whichever is necessary for operation of each unit shall be provided complete with shut off valves, check valves, strainers and fittings. Details of Oxidation blower piping: Material: A53-B or equivalent suitable for specified application. **For Detail Pining specification, valve materials & Actuator refer Annexure-IV**
b)	Details of valves are given below: **i) MOTORISED GATE VALVE** Rating: CL 150, Body: A105, Trim:13CR, Lining: Seat STL, Connection: RF, Operation: Electrically operated with hand wheel integral starter type. SIL 2, Non-intrusive type.

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Sl. No	Scope
	ii) CHECK VALVE: Rating: CL 150, Body: A395, Trim: 13CR, connection: RF, Type: BC, SWING. **iii) GATE VALVE/Control Valve:** Rating: CL 150, Body: A105, Trim:13CR, Lining: Seat STL, Connection: SW, Operation: Hand wheel, Bonnet: BB, OS&Y **For Detail Pining specification, valve materials & Actuator refer Annexure-IV**
6.10.08.	**Blower control:**
a)	Blower should be provided with suitable control equipment for smooth running to avoid surge, choke etc.
b)	Each blower shall be furnished with required instrumentation and electrical accessory devices mounted and connected in a control cabinet.
c)	Provisions shall be made for the interface between the local cabinet and the DCS such that the operation of the forced oxidation system can be controlled from the control console in the FGD Control room
6.10.09.	**Blower Shut Down:**
a)	Following is a typical list of abnormal conditions which might require blower shut down/Alarm. The contractor shall propose the exact conditions which require shutdown/alarm Blower shutdown signals: a) Discharge air temperature high b) Discharge pressure low or high. Temperature transmitter for initiating Shutdown of blower during when "Discharge air temperature high" shall be supplied by Vendor. Pressure Switch for initiating Shutdown of blower during when "Discharge pressure low or high" shall be supplied by Vendor.
b)	In addition to the Instrumentation & Control devices, sensing conditions which require shut down an emergency stop push button shall be provided. The push button shall be wired to the terminal blocks in the control cabinet for external connection to the blower controller.
c)	Provision shall be made to shut off the blower automatically should the level of lubricating oil falls below the design value. Suitable provision shall be made to take the signal to PLC / DCS system. In case of water cooling, the blower shall be shut off automatically whenever the pressure of the cooling water supply line falls below preset value.
6.10.010.	**PROVISSION FOR VIBRATION MONITERING:**
a)	Shaft vibration sensors shall be provided. These shall be provided for X axis & Y axis vibration measurement in bearing housing. The vibration sensor transducer output shall be 4-20mA for connection to DCS/PLC.
6.10.011.	**INSTRUMENTS AND ACTUATORS:**
a)	All instruments and actuators shall be interfaced with DDCMIS via the HART communication protocol, i.e., smart HART, in compliance with IEC 61158. All electric actuators shall be provided with integral starters and shall be non-intrusive, with SIL 2 certification or higher.
b)	**FIELD MOUNTED LOCAL JUNCTION BOXES/LOCAL CABINETS & CONDUITS**: i) Each equipment shall be furnished with required instrumentation and electrical accessory devices mounted and connected in a local cabinet or Junction box. Provisions shall be made for the interface between the local cabinet or junction box

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	and the DCS such that the operation of the equipment's can be controlled from the BHEL supplied DCS in the FGD Control room. JUNCTION BOX shall be Powder coated Junction box with CRCA sheet for IP class IP65 and the following requirements to be met: No. of ways ------ 12/24/36/48/64/72/96/128 with 20% spares terminals. Material and Thickness------ 4mm thick Fiberglass Reinforced Polyester (FRP). Type--- Screwed at all four corners for door. Door gasket shall be of synthetic rubber. Mounting clamps and accessories----- Suitable for mounting on walls, columns, structures etc. The brackets, bolts, nuts, screws, glands required for erection shall be of SS, included in Vendors scope of supply Type of terminal blocks--------- Rail mounted cage-clamp type suitable for conductor size upto 2.5 mm2. A M6 earthing stud shall be provided. Grounding------- To be provided. Color ------- RAL 7035. ii) **CONDUITS** Conduits shall be generally used for interconnecting cables from field instruments to Local JB's. All rigid conduits, couplings and elbows shall be hot dipped galvanized rigid mild steel in accordance with IS: 9537 Part-I (1980) and Part-II (1981). The conduit interior and exterior surfaces shall have continuous zinc coating with an overcoat of transparent enamel lacker or zinc chromate. Flexible conduits shall be water leak, fire and rust proof flexible GI conduits shall be provided. The temperature rating of flexible conduit shall be suitable for actual application. All rigid conduit fittings shall conform to the requirements of IS: 2667, 1976. Galvanized steel fitting shall be used with steel conduit. All flexible conduit fittings shall be liquid tight, galvanized steel. The end fittings shall be compatible with the flexible conduit supplied. Conduit sealing, explosion proof, dust proof and other types of special fittings shall be provided as required by these specifications and shall be consistent with the area and equipment with which they are installed. Fittings installed outdoors and in damp locations shall be sealed and gasketed. Hazardous area fittings and conduits sealing shall conform with NEC requirements for the area classification. Contractor shall provide double locknuts on all conduit terminations not provided with threaded hubs and couplings. Water tight conduit unions and rain tight conduit hubs shall be utilized for all the application which shall be exposed to weather. Moisture pockets shall be eliminated from conduits. Conduits shall be securely fastened to all boxes and cabinets.
c)	**INSTRUMENTS** Vendor shall refer to the Blower P&ID, refer **Annexure-VII** for the details on the instruments to be supplied. The instruments indicated are minimum requirements. Any additional instruments required for function of the system shall be provided by the vendor. The Following Shall be Provided as Minimum Meeting Specification Requirements.

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	• All the primary Instruments shall be provided on as required basis meeting functional redundancy, availability and reliability requirements of the specification subject to minimum quantities as indicated in P&ID. **If BHEL/MAHAGENCO comments on the P&ID for additional requirement of instrumentation, Vendor shall incorporate the same with any cost implication.** • All Instruments which are Integral to equipment like pumps, motors etc. / skid mounted instruments and are not indicated in enclosed drawings (as applicable) or in BOQ etc. included in relevant sub-sections, but are required for control, monitoring and operation of the equipment/plant/ Systems are to be provided by the Contractor to meet actual system requirements. Specification / type of instruments shall be as per standard and proven practice of equipment supplier. • In case of multiple measurements of temperature for any application, resulting in trip / protection, dual input TTs is recommended by the equipment manufacturers, the same shall also be acceptable. The exact applications for which this type of transmitter to be provided shall be finalized during detail engineering. Remaining temperature transmitters in to be Single Input field mounted type. • **Redundancy requirements:** For Binary and analog inputs required for protection of major the whose non-availability may result in loss of generation triple-sensing devices shall be provided. Binary and analog inputs, which are, required for protection of more than one equipment as well as protection signals for important auxiliaries and HT Drives etc., triple sensing devices shall be provided. In addition to above other binary and analog inputs required for closed loop control system (CLCS), dual-sensing devices shall be provided. • Vendor has to follow the below mentioned philosophy for designing individual equipment P&ID's along with **Annexure-VII**. • In this package fieldbus based controls(profibus) and conventional controls (hardwired 4-20mA/DI/DO) are envisaged. The usage of these two types of controls and devices is indicated below. The distribution of equipment/ devices for both conventional and Profibus based controls shall be in various FGs of Control System, complying with Functional Grouping guidelines. • **Close Loop controls**: For close loop control of following applications of main plant SG/TG/FGD/BOP (Auxiliaries of SG and TG), conventional i.e. 4-20 mA / (HART) based actuators along with 4-20 mA (HART) based electronic transmitters (which are directly used in control of final control element), shall be provided. For balance measurements for even these areas/ applications fieldbus(profibus) based PT/DPT/TT shall be provided. • **Open Loop controls**: For open loop control of complete main plant and offsite areas HART base control system, HART based actuators, HART DP based IMC in

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	LV SWGR/MCC and fieldbus based PT/DPT/TT shall be provided excluding applications given in Note-A. Vendor to note that Solenoid operated pneumatic open close actuators, HT/LV SWGR/MCC where IMC is not envisaged and instruments other than PT/DPT/TT envisaged under this package are conventional, i.e. not based on fieldbus system. Hence, in most of the FGs of DDCMIS mix of conventional and fieldbus-based control system is envisaged. • For fieldbus-based instruments, actuators, Profibus DP based IMCs following guidelines shall be followed: i) Actuators which are in main and standby line shall be wired to separate host/ master of FF/Profibus respectively. ii) Dual/ Triple redundant PT/DPT/TT shall be wired to separate segments. iii) IMCs for redundant (main and standby) equipment's shall be wired to separate Profibus DP master. • Loop Reaction Time (time between field acquisition to field output in control system): i) For Fast Closed loop controls of conventional system (Refer above table), loop reaction time shall be 250ms or better as per process requirement. ii) For other Closed loop controls, conventional/ fieldbus based/ mixed, loop reaction time shall be 500 ms or better as per process requirement. iii) For Fast Open loop controls of conventional system (synchronization related breakers and Tie/ trip selection), loop reaction time shall be 100ms or better. iv) For other Open loop controls, conventional/ fieldbus based/ mixed, loop reaction time shall be 1 Second or better as per process requirement. v) For applications indicated at Note A above, loop reaction time shall be as per process requirement. The above shall be suitably demonstrated by the contractor. • Temperature elements, electronic transmitters etc., are to be provided for all the cases. **Use of process actuated switches is acceptable only in case indicated in tender drawings**. • All local sensors and gauges for pressure/temperature shall be provided as per process requirements. All instruments shall be as per specification enclosed **in Annexure-III**
d)	**Actuators** All Pneumatic and Electrical Actuators shall be in compliance with **Annexure-IV.**
6.10.012.	**FIRST FILL OF CONSUMABLES:**
a)	Vendor's scope shall also include supply and filling of all chemicals, reagents, resins, lubricants, grease, filters and consumable items for operation up to COD including top up requirements at the time of issuance of PAC/declaration of COD. All lubricants proposed for the plant operation shall be suitable for all operating and environmental conditions that will be met on site consistent with good maintenance procedures as instructed in the maintenance manuals.

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b)	Detailed specifications for the lubricating oil, grease, gases, servo fluids, control fluids, chemicals including items qualities and quantities required per month of the plant operation for the MAHAGENCO/BHEL's approval herein shall be furnished eighteen (18) months prior scheduled COD of the 1st unit. On completion of erection complete list of bearings/equipment giving their location and identification marks shall be furnished to MAHAGENCO along with lubrication requirements. All types of chemicals, consumables, lubricants and grease shall be readily obtainable locally and the number of different types shall be kept to a minimum. For each type and grade of lubricant recommended, Vendor shall list at least three equivalent lubricants manufactured by alternative companies.
6.10.013.	**TRAINING**
	Successful Vendor shall provide comprehensive training for MAHAGENCO Engineers, O&M, Erection & Commissioning staffs at site covering all aspects of the Oxidation blower- Operation & Maintenance, Troubleshooting etc. Cost of training is to be included in base price.
6.10.014.	**SPARES, TOOLS & TACKLES**
a.	**START UP & COMMISSIONING SPARES**
	Start-up & Commissioning Spares shall be part of the main supply of Oxidation blowers. Start-up & commissioning spares are those spares which may be required during the start- up and commissioning of the equipment/system. All spares required for successful operation till commissioning of Oxidation blowers shall come under this category. Vendor shall provide an adequate stock of such start up and commissioning spares to be brought by him to the site for the equipment erection and commissioning. The spares must be available at site before the equipment's are energized. This start-up & commissioning spare part list shall not be included in "Initial (mandatory spares) Spare Parts List".
b	**INITIAL SPARE PARTS (MANDATORY SPARES):**
	Vendor to quote for below mentioned mandatory spares with break up price: i. Casing- 2 Nos ii. Impeller/Vane/Lobes Assembly – 2 Sets (1 Set consist of 1No DE & 1No NDE assembly) iii. Shaft bearings driving end – 2 Sets iv. Shaft bearings Non-driving end – 2 Sets v. Blower instrumentation spare – 1 set (As per Annexure-X) Vendor shall quote for the "Initial Spares Part List", and it will be considered for L1 evaluation. Initial spare parts items shall be handed over separately and shall not be mixed with the supply of the main equipment parts. Spares shall be sent in pre-decided lots in containers/secure boxes. All boxes/containers are to be distinctly marked in red color with boldly written "S" mark on each face of the containers. Spares shall not be dispatched before dispatch of corresponding main equipment's. Each item shall be labelled in English and be packed against damage and sealed to prevent deterioration from corrosion. All spares supplied under this contract shall be strictly inter-changeable with the parts for which they are intended for replacements. All the Initial spares shall be manufactures along with the main equipment components as a continuous operation as per same specification and quality plan.
c	**RECOMMENDED SPARES**

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	Vendors shall also furnish the Final Spares Part List (i.e. recommended spares list) along with the offer required for 3 years of normal operation of the plant and should be independent of the list of the mandatory spares. Prices of recommended spares will not be used for evaluation of the bids. The price of these spares will remain valid up to 6 months after placement of Notification of Award for the main equipment.
d	**SPECIAL TOOLS & TACKLES:**
	Any special tools & tackles required for the entire equipment to disassemble, assemble or maintain the units (One set for each unit), they shall be included in the quotation and furnished as part of the initial supply of the machine. List of special tools & tackles shall be decided by Vendor as per his proven practice. When special tools are provided, they shall be packaged in separate, boxes with lugs and marked as "Special Tools for (tag / item number)." Each tool shall be stamped or tagged to indicate its intended usage. Levers and eye bolts for the removal of parts to be serviced shall be submitted with special tools.
6.10.015.	**EXCLUSION**
	The following work associated with the air blower will be by others: a. Supply of main drive HT motor (Refer 6.09) b. Civil foundation (However, Vendor to provide foundation drawing & materials like Foundation sleeves, Insert plates, Foundation bolts, anchor bolts, nuts and any other structural material for completion of foundation items. And foundation grouting procedure). c. Walkways, platforms and ladders d. Element handling hoists
6.10.016.	**MATERIAL CODES**

	Var. No	Description	Material Code
	01	2x100% Motor driven positive displacement type oxidation blowers including lube oil system, instrumentation and accessories (like Acoustic Enclosure etc.).	TC9762943007
	02	Blower Casing	TC9762943015
	03	Impeller/Vane/Lobes Assembly	TC9762943023
	04	Shaft bearings driving end (Required 1No. each for complete replacement of all bearings in one Blower for DE side)	TC9762943031
	05	Shaft bearings Non-driving end (Required 1No. each for complete replacement of all bearings in one Blower for NDE side)	TC9762943040
	06	Blower instrumentation spare- (Spare list as per **Annexure-X** Philosophy)	TC9762943058

7.0 GENERAL TECHNICAL REQUIREMENT.

1.	Metric unit shall be used in the drawings and in the any displays on the equipment's. Special attention should be taken that the unit of pressure shall be in dual scales of kPa and kg/cm^{2}G. For instance, the pressure gauges should have dual units indication.

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2.	Descriptions in the drawings, in the documents, and in the displays shall be in English
3.	All rotating parts such as coupling shall be covered with suitable protective guards. Guards shall be easily removable type.
4.	The equipment shall be designed to withstand the corrosive and moist environment in which these are proposed to operate.
5.	Suitable drain connections shall be provided.
6.	The equipment shall be suitable for stable operation continuously.
7.	Limit of connection: The buyer (BHEL) has an intention to minimize interface for utilities as much as possible. The Vendor shall consider this requirement in the planning stage of layout for the equipment. The Vendor shall provide the header piping for utilities and branch piping to each nozzle. Terminal points for all utilities shall be located at skid edge. The Vendor shall specify all terminal points with tie-in number in the P&ID and submit it in the proposal to confirm the scope of supply.
8.	Service life: Entire equipment except wearing parts shall be designed and fabricated for a minimum service life of 30 years of operation or 200,000 full load operating hours whichever is longer.
9.	Corrosion allowance: Corrosion allowance for entire equipment shall be in accordance with latest applicable international standard.
10.	Unless otherwise specified, flanges shall be in accordance with ANSI B16.5 Class 150
11.	Rotation arrows shall be cast in or attached with stainless steel plate on each item of rotation equipment at a readily visible location.
12.	Unless otherwise specified, all equipment items where the weight exceeds 15 kg shall be provided with suitable lifting lugs, ears or ring bolts or tapped holes for lifting rings. Minimum shock factor for lifting lugs shall be minimum 2.0. The position of lifting lugs and reference dimension shall be shown on GA and/or outline drawings. NDT shall be conducted for lifting lugs. When any spreader bars are required for lifting and laydown, the Vendor shall provide spreader bar with equipment.
13.	Skid Mount/Transportation: Equipment shall be fabricated as skid mount design as much as practical to minimize erection at the site.
14.	Two pieces of stainless-steel earth lugs shall be provided with equipment diagonally. The position of earth lugs shall be shown on each GA and/or outline drawing.
15.	Provide double nuts for anchor bolts. There should be leveling bolts fixed in base frame for levelling and grouting the base frame.
16.	Vendor shall provide allowable vibration level on foundation in foundation drawings and/or general arrangement drawings.
17.	If the driver/driven equipment train is in the resonance condition or any vibration problems occur, the Vendor shall solve the problems in a timely manner.

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18.	The Vendor shall have full responsibility for vibration control of the equipment train at the site and the unit's satisfactory performance, even if the foundation and drivers are provided by the BHEL.
19.	Vendor shall provide the mating flanges with the necessary gaskets.
20.	All the surfaces of the carbon steel should be rust prevented before shipment for the period of at least 12 months for storage and construction.
21.	Vendor to specify capacity of crane or hoist required for material handling and the details of heaviest component to be handled.
22.	The list of all Bought out items with makes and country of origin to be mentioned along with offer to be submitted.
23.	Quality Plan to be submitted along with the offer.
24.	During entire period of the equipment / project erection, commissioning & operation, the Vendors shall strictly follow and adhere to the guidelines for effective Health & Safety Management. Supply of safety gears/PPE for Vendor's/Vendor's sub vendor personnel deputed at site for Supervision of E&C, PG tests etc. shall be in Vendor's scope.
25.	Cost towards the participation in discussions/meetings, technical discussions/meetings with customer for approval of drawing/documents etc. shall be included in Vendor scope. TA/DA, boarding and lodging to attend these meetings shall be borne by the Vendor.
26.	Material of construction for all equipment/components shall be subject to BHEL/MAHAGENCO/TPI approval during detail engineering. Accordingly, Vendor shall consider MOC for all equipment/component as per best engineering practice, global standard and global references.
27.	Vendor to provide sub vendor list and Vendor shall strictly adhere to MAHAGENCO approved vendor list (**MAHAGENCO Vendor Indicative List enclosed in Annexure-XII**). In case Vendor proposes an additional vendor for an item or vendor approval is required for any new item, acceptance shall be subject to approval by MAHAGENCO/ BHEL before placing order and Vendor shall submit relevant documents as per sub-supplier questionnaire attached in enclosed **Annexure-XI** (Sub-Questionnaire).
28.	It shall be the complete responsibility of the successful Vendors to obtain "Sub Vendor Approval" from BHEL / MAHAGENCO for all equipment's & components. Any delay in sub vendor's approval should not affect the project schedule. If any of the sub vendors does not have the approval of MAHAGENCO/ BHEL, the same may be replaced with another MAHAGENCO/BHEL approved sub-vendor only, without any price implications to BHEL.
29.	The modalities of inspection (Stage, Final, In-process) shall be finalized during detail engineering after submission of quality assurance plan (QAP). It shall be reviewed by the MAHAGENCO and BHEL. Vendor shall follow the procedures of inspection as per the approved QAP. Vendor has to submit the following documents along with inspection call and if any other documents required as per approved QAP. - Raw material inspection certificate - Internal test reports

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	- Statutory certificates as required. - All inspection & testing shall be carried out based on the following documents: a. Relevant Standards b. Specifications c. Approved drawings d. Data Sheets e. Calibration certificate for all the measuring instruments f. Vendor should also coordinate in getting the MDCC's (Material Dispatch clearance certificate) and all types of IC's (Inspection Certificates) from the customer/customer's consultant along with BHEL. g. Field Quality Plan and check list shall be submitted by vendor for erection and commissioning of oxidation air blower system.
30.	Minor Chipping i.e. up to 50 mm thk, micro leveling and providing shim plates for erection of equipment / item at site shall be in the scope of Vendor.
31.	During detail engineering, Vendor to strictly adhere to BHEL/ MAHAGENCO drawing formats, document numbering, quality plan & FQP formats.
32.	The identification and numbering of equipment, systems, items, etc. of supply, as well as of all documents and drawings shall be in accordance with the VGB guideline RDS-PP (Reference Designation System for Power Plants - KKS system).
33.	Complete detail engineering drawings, calculations, selection of components etc. shall be reviewed & subject to approval of BHEL/MAHAGENCO during detail engineering
34.	Vendor shall furnish necessary inputs & drawings of all equipment in editable Auto CAD/ MS-Word /Excel format.
35.	During detail engineering, successful Vendor shall ensure flow of drawings/documents as per schedule. Any comments from BHEL/MAHAGENCO should be addressed timely by the Vendor.
36.	Vendor to note that list above is not exhaustive and any work /items required for completing the smooth operation and ensuring satisfactory running of the machines till final hand over to the end user shall also be in the scope of the Vendor.
37.	Vendor shall submit the signed and stamped copy of all the pages which constitutes this technical enquiry specification signed by authorized signatory and clearly mentioning each clause under following two categories to avoid any ambiguity in scope understanding & the scope division along with technical offer. a) Accepted without deviation and considered in scope of work. b) Not considered in scope of work.

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8.0 SUPERVISION OF ERECTION, TESTING AND COMMISSIONING

1.	The erection of Oxidation Blower will be done by owner as per Erection Manual and check List. However, the Vendor shall make two visits per Blower for the supervision of erection, pre- commissioning & post- commissioning check-up, start-up, testing and trial runs of all the items covered under the scope of supply.
2.	There will be two visits per blower. The Vendor will be informed well in advance for the visit. Vendor shall include 7 working days per visit in the offer with minimum 8 visit for all four-oxidation blower. Minimum 56 working days must be included in the quoted price.
3.	TA/DA, boarding and lodging shall be borne by the Vendor and shall be inclusive in supply portion.
4.	Price comparison for evaluating the lowest bid will be considered all main supply, supervision of E&C charges and mandatory spares price all together.
5.	BHEL shall conduct performance test of FGD package at site. Vendor shall provide supervision services for site performance test on per diem basis for each unit. The per diem charges rate shall be quoted separately and this will not be used for bid evaluation. The price validity is up to 4 years from date of awards of contract.

9.0 INSPECTION AND TESTING

(As per approved quality plan. However, minimum requirements are as below)

	The General inspection requirements to be considered are as below. **Sample quality plan for Blower, refer Annexure- VI**
1.	Vendor shall furnish written copies of shop production, fabrication and quality test procedures and drawings to be used on the Blowers for review by BHEL/MAHAGENCO prior to manufacture.
2.	The Vendor shall furnish MRT & Performance test procedure along with standard. The test procedure will be reviewed and approved by the BHEL/MAHAGENCO.
3.	Performance test for all 4 Nos Oxidation Blower will be witnessed by BHEL/ MAHAGENCO/ TPI before dispatch of machine at the Vendor's works. A notice of minimum three (3) weeks shall be given for witnessing the test
4.	A dynamic balancing certificate stating that the rotating assembly has been balanced dynamically shall be sent to BHEL/MAHAGENCO/TPI within one (1) week of the successful completion of balancing
5.	**During performance test of blower as per the details mentioned in Clause 5.0, vendor to note the below points**: a) There shall be no negative tolerance on blower capacity and head, no deviation is acceptable for this. In case vendor is unable to demonstrate capacity and head, then vendor to make necessary modifications in blower to meet the requirement. b) There shall be no positive tolerance on blower power. If, during testing, the power consumed by each blower (at the motor input terminal) exceeds the Guaranteed Power Consumption (GPC) quoted by the vendor in kW by more than 4%, the blower package shall be rejected. For excess actual power consumption (APC) up to a maximum of 4%, the penalty shall be as per Clause 13.0
6.	Vibration levels shall be measured during shop running/performance tests.

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7.	Contract shaft seals shall be used during shop tests, unless the seal design is unsuitable for the shop-test condition.
8.	Blower shall not be released for shipment, until shop tests data and performance tests curves have been approved by Owner.
9.	Vendor should furnish performance guarantee as per applicable standard guarantee for the design, manufacture, material and safe operation of the equipment's
10.	Vendor shall arrange all calibrated gauges, Instruments during testing
11.	BHEL/MAHAGENCO/TPI shall witness the performance test at Vendor's works for the first blower and a notice of minimum three (3) weeks shall be given for attending the witness.
12.	Mechanical running and the performance test shall be carried out. Vendor shall arrange Motor of similar rating for the shop test and inspection. If MAHAGENCO will insist to conduct Mechanical run and performance test by Job Motor, Vendor shall conform the MAHAGENCO requirement. The BHEL will arrange Job motor at Vendors works (if motor in BHEL scope).
13.	The performance test may be carried out using air at shop and shall be converted to the design condition.
14.	Inspection and testing will be done as per MAHAGENCO approved Quality Plan. In case of order placed on foreign Vendor, Vendor shall engage and appoint at their cost of any reputed Third-Party Inspection Agencies having international presence for carrying out inspection of equipment's and material at Vendor's & sub Vendors works. Sample QP (indicative) is attached in **annexure-VI** for reference, however any change during final approval shall be acceptable to Vendor.

Quality Plan Requirement: As per approved Quality Plan however, minimum requirements are as below.

1	Quality Plan Requirement:
	(i) MQP (Manufacturing Quality Plan) shall be submitted in attached format for BHEL & MAHAGENCO review & approval. Sample Quality Plan is attached for indicative purposes and guidance only. Any additional test or inspection requirement specified by BHEL / MAHAGENCO during QP approval shall also be applicable & complied by vendor.
	(ii) MQP shall invariably cover w.r.t Inward inspection including on Raw material Procurement. In- process and Final inspection in elaborated way/details.
	iii) Vendor shall also to give specific confirmation that on need basis, their competent officials shall visit to BHEL & MAHAGENCO for finalization of Quality plan including test procedure/methodology during pre-award/Post-award approval/detailed engineering in the event of an order
	(iv) No deviation on BHEL & MAHAGENCO approved MQP is acceptable
	(v) Vendor shall agree to submit all cross-referred documents other than codes/Standards to BHEL/Customer/Consultant.

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Important Notes shall be included in MQP:

a. QP approval doesn't absolve vendor of its responsibility in meeting the specification, approved drawing and data sheet and inspector in checking & ensuring the requirements as per these engineering documents.

b. Latest revision of standards & specification shall apply. Only International Standard are applicable. Indian & Chinese Standards are not applicable.

c. Materials shall be procured in compliance to Functional Technical Specification.

d. Inspection shall be in compliance to functional Technical Specification.

e. NDT shall be carried out by Qualified Personnel with compliance to Approved NDT Procedures and Acceptance Norms, as per ASME Section V.

f. Only level II & above qualified person in respective NDE to verify or witness the NDT test report/results.

g. Gauge and measuring Instruments, with valid calibration only shall be used.

h. Clearing and Painting of products shall be carried out as per Approved Painting Schedule.

i. Finished Products shall be packed to comply with Approved Packing Schedule.

j. Welding shall be carried out by Qualified Personnel with compliance to approved NDT Procedures and Acceptance Norms, as per ASME Section V.

k. Pre-despatch inspection photographs of the equipment/item shall be included in quality documentation.

l. Latest version of standards/drawings /tolerances etc to be mentioned in quality plan/drawing. This QP should be read along with BHEL specification, BHEL drawings / approved drawings, data sheet, BOM and PO.

m. Drawing / data sheet/ specification shall prevail over quality plan in case of any contradiction.

n. BHEL reserves the right for conducting repeat test, if required.

o. BHEL/MAHAGENCO approved inspection engineers to be deployed for inspection.

p. Inspection to be offered only after ensuring that all documents (quality plan, drawings, data sheet, purchase specifications, etc) are available as per purchase order.

q. Vendor to offer original test certificates issued by third party laboratories or suppliers.

r. Vendor to ensure with TPIA that a note 'compared with original test certificate. Reviewed, verified and found in order' shall contain with every inspection report.

s. Only valid and calibrated measuring instruments and equipment shall be used – TPIA to verify.

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	t. Vendor to ensure with TPIA that material test certificate & traceability records are available for use of correct material. u. Qualification of equipment, process & personnel for special processes like welding, brazing, painting & metal coating etc. (as applicable as per PO) shall be ensured. v. Vendor to ensure that all certificates are endorsed by TPIA with comments (witnessed or verified) as per quality plan. w. Vendor shall offer log sheets containing actual measured values instead of saying ok/not ok to TPIA. x. Vendor shall submit complete inspection and test documentation whichever is identified with (√) under column 'd' of approved quality plan shall be enclosed with the inspection report. y. Vendor shall submit original copies of all inspection and test documents authenticated by TPIA.
2	**Domestic/Inland Inspection** will be carried out by BHEL/BHEL appointed Third Party Inspection Agency (TPIA)/Customer/Customer Appointed Inspection Agency/Consultant. This is applicable for all Stage inspection and Final Inspection identified as "W" - Witness or "CHP"- Customer Hold point as per customer PFD/SLD (Process instrumentation Diagram/Process Flow Diagram/Single Line Diagram) etc. (As Applicable).
3	Inspection Agency for Foreign Vendors and also for Indian Vendor but importing from Foreign Sources: (1) Any one of the following Third-Party Inspection Agency (TPIA) shall be appointed by the Vendor and same shall be furnished by the Vendor in techno commercial bid itself. (2) The details so TPIA with contact details like Name of the official. Phone no. Email ID shall also to be submitted during pre/post award. However, cost for such inspection agency shall be borne by the Vendor only. Inspection charges for such inspection agency shall be indicated separately so that if BHEL/Customer is undertaking the inspection by on their own, then these charges non-claimable by the Vendor. List of TPIA 1. M/s Bureau Verits. 2. M/s TUV_Nord 3. M/s TUV-SUD 4. TUV Rheinland 5. M/s Lioyd Register M/s DNV
4	**Stage Inspection during manufacturing Process:** Stage inspection during manufacturing shall be carried out as per approved quality plan and all necessary documents shall be provided for review, verification and clearance for further processing. This inspection call shall be given well in advance (at least 2 weeks before) to TPI/Vendor's own inspection agency to avoid delay in the manufacturing processes.

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5	**Inspection before despatch for domestic supplier:** Inspection before despatch at supplier's works shall be carried out by BHEL/BHEL appointed inspection agency. Inspection shall be done as per approved Quality Plan/Technical specification/Approved drawing/Approved Data Sheet.
6	**Inspection at foreign Source/Supplier:** (a) As in Sl no. 3. shall be ensured without fail. (b) No material/items shall be despatched without getting the written communication from BHEL/Customer inspection carried out by BHEL/BHEL appointed Third Party Inspection Agency (TPIA)/Customer/Customer Appointed Inspection Agency/Consultant. This is applicable of all stage inspection and Final Inspection Identified as "W"- Witness or "CHP"- Customer Hold Point as per customer approved Quality Plan/Technical specification /Approved Drawing/Approved Data Sheet/Scheme/pride/PFD/SLD (Process instrumentation Diagram/Process Flow Diagram/Single Line Diagram) etc. (As applicable). Inspection before despatch for Foreign supplier: Inspection before despatch at supplier's works shall be carried out by Vendor appointed inspection agencies having international presence at vendors and or vendor's sub vendor works. Inspection shall be done as per approved Quality Plan/Technical specification/Approved Drawing/Approved Data Sheet by TPIA mentioned in Sl No 03 at supplier's cost.
7	Painting shall be done strictly as per BHEL/Customer approved painting Schedule/ Scheme only. Paint Thickness/Paint shade shall be ensured as per BHEL/Customer approved painting Schedule/specification/data sheet etc. No deviation is acceptable unless otherwise accepted by BHEL/Customer in writing. Any conflict if any among BHEL/Customer approved painting schedule/specification/data sheet etc. shall be brought to the notice to BHEL well in advance before proceeding including the BOI being procured for assy/skid like motors etc.
8	Specific conformation for document package in the event of an order (2 Hard copies & Soft copy in PDF file) is to be given containing the following with proper linkages. (I) Index Sheet (II) MQP/RQP Endorsement sheet (As applicable) (III) TCs Identified by BHEL/Customer for record for "CHP"/"W" and verification portion ("V") as given in the approved QP. (IV) Final inspection report +TC including Chemical+Mechanical+HT+NDT etc. (V) Third Party Inspection Report +TC (VI) Customer CHP/MDCC (VII) Type Test/Performance Test report conducted (VIII) Type Test/Performance Test Approval/Clearance obtained from BHEL/Customer (IX) BOM with As build Drawing with Actual make/rating used with BHEL/Customer approved drawings.
9	Packing/Sea worthy Packing shall be as per BHEL Packing schedule/Approved drawing/Sketch. This shall be ensured to take care transit/handling/ transhipment in Road /Sea/Air/ Photographs are to be submitted for BHEL review before despatching the material as per contract conditions.

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10	Outsourcing of test facilities: Vendor shall ensure all the testing facilities in house. However, if any of the test facilities are not available with successful Vendor, then Vendor shall ensure the same at NABL accredited their party lab/Govt. Lab for major testing such as NDT, Electrical & Mechanical Testing.
11	Important Note: No deviation on the above requirement 01 to 10 is acceptable w.r.t. Quality Requirement and those offers not meeting these specific customer requirements is liable for rejection and hence the Vendor shall submit all the required documentary evidences in the offer itself.
12	## Necessarily to be filled up by the Vendor at the time of offer itself otherwise the offer may not be considered w.r.t. Quality Requirement being customer specific requirement.

10.0 PAINTING

10.1.	Painting shall be done strictly as per BHEL/Customer approved painting schedule / scheme only. Paint Thickness / Paint shade shall be ensured as per BHEL / Customer approved painting schedule / specification / data sheet etc. No deviation is acceptable unless otherwise accepted by BHEL/Customer in writing. Any conflict if any among BHEL / Customer approved painting schedule / Spec / data sheet etc. shall be brought to the notice to BHEL well in advance before proceeding including the BOI being procured for assy/ VFD & transformer etc.
10.2.	Surface Preparation: Blast cleaned conforming to sa2-1/2 swiss standard
10.3.	**PRIMER COAT**: Epoxy resin-based Zinc Phosphate Primer with minimum DFT of 100 µm. **INTERMEDIATE COAT**: Epoxy resin-based paint pigmented with titanium dioxide with minimum DFT 150 µm. **FINISH COAT**: One coat of epoxy paint pigmented of DFT of 75 microns. Additionally, Finish coat of polyurethane of minimum DFT of 25 microns. Final shade as per approved quality plan. The above painting is just a tentative schedule. Painting details will be informed during contract stage. a) Base: To be informed during contract stage b) Lettering: To be informed during contract stage preventive paint after inspection at shop floor before dispatch shall be in Vendor's scope. For Detail specification of **Surface Preparation & Painting** refer **Annexure-V**

11.0 PERFORMANCE AND SCHEDULE GUARANTEE

	PERFORMANCE GUARANTEE All performance tests for blowers shall be carried out in accordance with any latest international codes/standards.
11.1.	Vendor shall furnish Performance guarantee for the design, manufacture, material, safe and trouble-free operation of the Oxidation Blower and its accessories.
11.2.	Capacity and head of the blower to be guaranteed as per clause 5.0 of this specification.
11.3.	At guarantee point, for the given capacity and head, vendor shall demonstrate guarantee power mandatorily during shop performance test. In addition to guarantee point, vendor

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	shall demonstrate performance at any one of the operating point (as informed by BHEL/MAHAGENCO) of clause 5.0 of this specification during testing. These points shall be catered in test procedure document and obtain the approval from BHEL/MAHAGENCO.
11.4.	The Vendor shall guarantee 98% availability of equipment for a continues period of 120 days.
11.5.	The vendor shall guarantee that the equipment offered shall meet the ratings and performance requirements stipulated for oxidation blower system equipment covered in this specification.
11.6.	The guaranteed performance parameters indicated/furnished by the Vendor in his offer, shall be without any tolerance values whatsoever and all margins required for instrument inaccuracies and other uncertainties shall be deemed to have been included in the guaranteed figures.
11.7.	Noise level-≤85 dB (A) at 1m horizontal distance from equipment/enclosures and 1.5m above operating floor is to be guaranteed.
11.8.	The overall vibration levels measured on the non-rotating parts of either centrifugal compressor or positive displacement compressor shall be as per ISO 10816-1 Class A/B<=2.3mm/s, however for Integrally geared type centrifugal compressor the shaft vibration shall also be measured and it shall be as per ISO7919-3. The overall shaft vibration for zone A/B shall be as per following equation In SI units: A = 4800/SQRT(N) Where, A = amplitude of unfiltered vibration, in µm true peak to peak, N = maximum continuous speed, in rpm.
11.9.	Acceptance tests to be carried out as per the procedure defined by the Vendor which shall be submitted for MAHAGENCO's approval.
11.10.	In the event that the performance test is unsuccessful in meeting performance guarantees, Vendor shall take necessary remedial action at his cost and the performance test shall be repeated.
	SCHEDULE GUARANTEE
11.11.	All performance tests shall be carried out in accordance with the relevant latest international codes/standards. In case during performance guarantee tests, it is found that the equipment/system has failed to meet the guarantees, the vendor shall carry out all necessary modifications and/or replacements to make the equipment/system comply with the guaranteed requirements at no extra cost to the BHEL/MAHAGENCO and re-conduct the performance guarantee test(s) with BHEL/MAHAGENCO's consent. However, if the specified performance guarantee(s) are still not met even after the above modifications/replacements within ninety (90) days or a reasonable period allowed by the BHEL/MAHAGENCO, after the tests have been completed BHEL/MAHAGENCO will have the right to the following: **i) For Category-I Guarantees:** Accept the equipment/system/plant after levying Liquidated Damages as specified hereunder. The liquidated damages, for shortfall in performance indicated in operating point 3 of clause 5.0 for this specification is on per blower basis. The liquidated damages shall be prorated for the fractional parts of the deficiencies. The performance guarantees coming under this category shall be called 'Category - I' Guarantees.

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AMOUNT OF LIQUIDATED DAMAGES APPLICABLE FOR CATEGORY-I GUARANTEES.

FOR POWER CONSUMPTION: Please refer clause 13.0 of this specification.

i) For Category-II Guarantees:

In case the noise level is not met by the Vendor during demonstration test, the Vendor shall carry out all necessary modifications and/or replacements to comply with the guaranteed requirements at no extra cost to the BHEL/MAHAGENCO and re-conduct the Noise level test with BHEL/MAHAGENCO's consent. If, however, the demonstrated noise level is not met even after the above modifications / replacements within ninety (90) days or reasonable period allowed by the BHEL/MAHAGENCO, after tests have been completed. the BHEL/MAHAGENCO will have the right to either of the following:
Reject the equipment /System / plant and recover from the contractor the payment already made.

OR

Accept the equipment /system/plant after assessing the deficiency in the noise level, and recover from the contract prices an amount equivalent to the damages as determined by BHEL/MAHAGENCO. Such damages shall, however be limited to the cost of replacement of equipment, replacement of which shall remove deficiency so as to achieve the guaranteed noise level.

AMOUNT OF LIQUIDATED DAMAGES APPLICABLE FOR CATEGORY-II GUARANTEES.

FOR NOISE LEVEL:

Description	Data
Noise level measurement shall be carried out using applicable and internationally acceptable standards. The measurement shall be carried out with a calibrated integrating sound level meter meeting the requirement of IEC 61672-1 & 2 (latest edition). Sound pressure shall be measured all around the equipment at a distance of 1.0 m horizontally from the nearest surface of any equipment/ machine and at a height of 1.5 m above the floor level in elevation.	≤ 85 dB(A)

12.0 BID EVALUATION CRITERIA FOR POWER CONSUMPTION:

12.1.	**POWER GUARANTEE** Vendor shall indicate guaranteed power (at motor input terminal) of blower at the Guarantee point (Operating point-4 of clause 5.0 of this specification) with zero positive tolerance in their offer. This power value shall be used for loading and penalty criteria. At guarantee point, for the given capacity and head, vendor shall demonstrate guarantee power mandatorily during shop performance test.
12.2.	**BID EVALUATION CRITERIA FOR POWER CONSUMPTION**: Guaranteed power (at motor input terminal) of blower at the Guarantee point shall be 160 KW (Base Value at operating point 4 of clause 5.0 of this specification). For Bids guaranteeing/offering a guaranteed power consumption greater than 160 KW, the following condition shall be applicable. For Guarantee power above 160 KW, for each KW increase in power, loading shall be as per the formula given below. **Loading for excess power consumption = (GPC-BV) X PL X No of Working Blowers** • **GPC**- Guaranteed Power Consumption quoted by Vendor in KW

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- **BV**- Base Value i.e. 160 KW
- **PL**- Power Loading per KW (i.e. INR 450000/KW)
- **No of Working Blowers** - 2

a) The maximum loading for bid evaluation shall not exceed Fifteen percent (15%) of the vendor quoted "Total price for evaluation" as per price schedule.
b) Exchange rate as applicable on bid opening date will be considered.

Furthermore, bids offering lower or better guarantee power consumption below the Base Value, shall not be given any credit during evaluation.

13.0 LIQUIDATED DAMAGES FOR POWER CONSUMPTION

13.1. **AMOUNT OF LIQUIDATED DAMAGES (LD) APPLICABLE FOR CATEGORY-I GUARANTEES.**

If actual Power Consumption during PG Test at shop exceeds the value guaranteed by the Vendor, liquidated damages for shortfall in performance shall be deducted from contract price as per the formula given below:
Liquidated damage deductible = (APC-GPC) X P X No of working Blowers

- GPC- Guaranteed Power Consumption quoted by Vendor in KW
- APC- Actual Power Consumption in KW
- P- Penalty per KW @ **INR 450000**/KW.
- No of working Blowers - 2

a) In case APC is more than 104% of GPC, machine will be rejected.
b) All these liquidated damages for short fall in performance shall be deducted from the contract price.
c) Contractor's aggregate liability to pay liquidated damages for failure to attain the functional guarantee shall not exceed Fifteen percent (15%) of the Contract Price.
d) Exchange rate as applicable on bid opening date will be considered.
e) Performance penalty specified above shall be independent and this penalty shall be levied concurrently as applicable

Since performance test is witnessed for the first blower however, LD charges are applicable for 2 Nos of oxidation air blower based on performance result of first blower.

14.0 WARRANTY

14.1 The Vendor shall warrant that the equipment/ items shall be free from defects in the design, engineering, materials and workmanship of the Plant and Equipment supplied and of the work executed. The Warranty period shall be 36 months from the date of supply or 24 months from the date of commissioning, whichever first occurs. If during the Defect Liability Period, any defect should be found in the design, engineering, materials and workmanship of the Plant and Equipment supplied or of the work executed by the Vendor, the Vendor shall promptly, in consultation and agreement with BHEL regarding appropriate remedying of the defects, and at its cost, repair, replace or otherwise make good (as the Vendor shall, at its discretion, determine) such defect as well as any damage to the Facilities caused by such defect.

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14.2	In case of failure of the equipment to meet the guarantee, MAHAGENCO/BHEL reserves the right to reject the equipment. However, MAHAGENCO/BHEL reserves the right to use the equipment until new equipment supplied by vendor meets the guaranteed requirement.

15.0 CONFLICT

15.1	Vendor's equipment shall be designed for and shall meet the service, performance and minimum level of quality requirements specified. Vendor shall be solely responsible for advising BHEL in writing of any conflicts between the specifications and vendor's design, including performance and levels of quality. Vendor agrees that its obligations, liabilities and warranties shall not be diminished or extinguished due to its meeting the requirements of the Specification.
15.2	If any conflict arises between the Vendor and BHEL/MAHAGENCO regarding the interpretation of a clause in this specification, the interpretation provided by BHEL/MAHAGENCO shall be deemed final.

16.0 DOCUMENTATION

16.1	The Successful vendor shall submit necessary data, documents (Including Lateral analysis report) and drawings for review, approval with requirements as specified in this specification. Drawings that are reviewed by the MAHAGENCO/BHEL will be returned to vendor with a transmittal letter with any comments and / or questions marked on the drawings or noted in the letter. All comments and questions must be resolved before resubmission of drawings / documents. If the design has not developed enough to resolve some of the comments or questions, vendor shall place a "hold" on those items or areas of design. MAHAGENCO / BHEL reserves the right to return drawings unprocessed to vendor if there exists any evidence that vendor has not acknowledged all comments and questions. All necessary GA drawings, sections, sub-assembly drawings, specifications of main and sub components and necessary set of operation & maintenance manual as asked by MAHAGENCO must be furnished by vendor in soft and hard copy forms. For all document's softcopy format shall be searchable pdf, however in addition all drawings, diagrams like P&IDS shall be supplied in AUTOCAD or other editable format and all lists in Excel format. Further break up of technical documents will be discussed during finalization of the purchase contract. Unless agreed otherwise, ten (10) hard copies and one (01) set of electronic copies of all documents are to be submitted in the English language. Electronic Copies shall be submitted in primary original data format (e.g. DOC, XLS, DWG) as well as in a printable non-proprietary document format (e.g. PDF). Especially P&IDs shall be submitted as DWG files and PDF files. Vendor to ensure submission of hard copies as per MAHAGENCO's requirement for all engineering drg./doc and for all subsequent revisions along with a

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	soft copy through email to concerned project team. However, all the engineering related information shall be furnished in soft form to BHEL.

A. TECHNICAL DOCUMENTS TO BE SUBMITTED ALONG WITH THE OFFER:

	Description	Purpose
16.2	**Attachment-3K (annexure of Qualification Requirement refers Annexure-1)**	Qualification Requirement (QR)
16.3	**Reference plant details of similar or higher capacity of Oxidation Blower size supplied.**	QR
16.4	Sign & Seal of vendor on all pages on specification	Technical evaluation of Bid (TEB)
16.5	Deviation list (if any to be submitted by vendor)	TEB
16.6	General Arrangement (GA) & Cross section drawing of Oxidation Air Blower system with bill of materials, Material of Construction (MOC), major assemblies Weights and dimensions (also weight & dimensions of heaviest item in every assembly) for E&C.	TEB
16.7	a. Oxidation Air Blower System foundation plan and loading. details.	TEB
16.8	Fill data sheet of Oxidation air blower, (Data Sheet format Annexure-IX) and other accessories.	TEB
16.9	P & ID diagram of Oxidation Air Blower (Including Lube oil system, if applicable) system.	TEB
16.10	Schedule of Guarantee (**As per Clause 5.0**)	TEB
16.11	Operation philosophy and logic of oxidation Air Blower system.	TEB
16.12	Oxidation Air Blower Performance curves. i. Flow v/s Total pressure ii. Flow v/s efficiency iii. Flow v/s power consumption iv. Torque vs. speed curve for Motor selection.	TEB
16.13	Blower and Motor Sizing Calculation	TEB
16.14	Proforma Packing List	
16.15	Instrumentation list	TEB
16.16	Required Electric Load list & other Utility List	TEB
16.17	Schedule of Guaranteed power consumption along with breakup.	TEB
16.18	Make of all bought out items & sub vendor list.	TEB
16.19	Quality Plans.	TEB
16.20	List of Start-up & Commissioning to be provided (Vendor scope).	TEB
16.21	Spare List (Mandatory & Recommended)	
16.22	List of Special Tools to be provided (Vendor scope).	TEB
16.23	General Assembly Drawing & Cross-sectional Drawing	TEB
16.24	Sub-Vendor List	TEB
16.25	Delivery Schedule	TEB
16.26	Test Arrangement & Test procedure	TEB

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16.27	Hoist/Crane requirement	TEB
16.28	Overall space & headroom requirement for Ball Mill System	TEB
16.29	Terminal point details	TEB
16.30	Catalogue	TEB

B. DOCUMENTS TO BE SUBMITTED AFTER CONTRACT:

Sl. No.	Description	Document submission (Rev 00 submission) Time	No of copies, After award of contract	Remarks
1	HT Motor Sizing calculation	2 weeks after contract.	1	
2	GA drawing of HT Motor	3 Weeks from Receiving input from Vendor	soft copy to vendor	By BHEL to Vendor
3	Utility Consumption	4 weeks after contract	1	
4	Sub vendors List and approval process.	2 weeks after contract	1	If it is not available in CAV
5	Scope of Supply	4 weeks after contract	2	
6	I/O List	2 months after contract	1	
7	Instrument list (including range Model)	2 months after contract	1	
8	Drive list	2 months after contract	1	
9	BBU of Mandatory spares as per BHEL Format	2 months after contract	1	
10	BBU of Main supply equipment	2 months after contract	1	End customer Approval
11	Start-up & Commissioning Spares	2 months after contract	2	
12	Operation and Maintenance Manual (All Equipment)	2 months after contract	10 hard copies and 5 softy copies in English	
13	Manufacturing Schedule	3 weeks after contract	1	
14	Progress report	Every month	1	
15	Proforma Packing List	1 months prior to shipping	1	
Oxidation Blower				
16	Blower Data Sheet, GAD, Foundation details, weight of each component, MOC, P&ID and Other Details	2 weeks after Motor Input	1	End customer Approval
17	Performance curve	2 weeks after Motor Input	2	End customer Approval
	i. Flow v/s Total pressure			
	ii. Flow v/s efficiency			
	iii. Flow v/s power consumption			
	iv. Torque vs. speed curve for Motor selection			

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18	Cross section detail drawing	2 months after contract	1	End customer Approval
19	Painting Schedule	2 months after contract		End customer Approval
20	Assembly drawings of each equipment	2 months after contract	1	BHEL
21	Inspection and Test Procedure	2 months after contract	1	End customer Approval
22	Quenching system Detail Drawings	2 months after contract	1	BHEL
23	Lubricating oil list	2 months after contract	1	
24	Special tools list	2 months after contract	1	
25	Installation and assembly procedure	4 months after contract	1	
26	Inspection & Test record	2 weeks after test	1	
27	Inspection Certificate	2 weeks after test	1	
30	Pre-Commissioning Check List	2 months after contract	2	
32	Quality Plan (For Oxidation Blower)	1 month after contract	4	End customer Approval

17.0 PRICE SCHEDULE

Sl. No	Description	Material Code	Quantity	Unit Price	Total Price
01	2x100% Motor driven positive displacement type oxidation blowers including lube oil system, instrumentation and accessories (like Acoustic Enclosure etc.). As per sub-clause 8.2 of clause 8.0 of this specification 56-man days shall be included for E&C supervision for oxidation blower system (including Sl. No. 02 & 03 of the price schedule)	TC9762943007	4 Nos		
02	Blower Casing	TC9762943015	2 Nos		
03	Impeller/Vane/Lobes Assembly	TC9762943023	2 Sets		
04	Shaft bearings driving end (Required 1No. each for complete replacement of all bearings in one Blower for DE side)	TC9762943031	2 Sets		
05	Shaft bearings Non-driving end (Required 1No. each for complete replacement of all bearings in one Blower for NDE side)	TC9762943040	2 Sets		

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06	Blower instrumentation spare- (Spare list as per Annexure X Philosophy) **Note: Price to be quoted against each item as per Annexure-X**	TC9762943058	1 Set		
	Total price for evaluation				
01	Supervision charges for performance test at site*.		Per Diem		

Remarks: * The price validity for supervision charges is up to 4 years from the date of the contract award. Please note that if the erection and commissioning man-days as mentioned in Sub-clause 8.2 of clause 8.0 are exceeded, then the above per diem rate will be applicable for the additional man-days.

18.0 PACKING AND FORWARDING INSTRUCTIONS

18.1.	Proper packing to be ensured. **Indigenous Supply**: Oxidation Blower & sub system assembly shall be wrapped in polythene bags & packed in a strong rigid wooden crate. Rain water should not enter into the Oxidation Blower internals during storage in the outer yard of power plant.
18.2.	Imported Supply: All imported supply (supplies from outside India) should be packed as per Sea worthy Packing specification no. PE-TS-888-100-A001 in **Annexure-VIII**. Liberal packing materials and struts shall be provided to arrest rolling and to protect from transit damages.
18.3.	Equipment and process materials shall be packed and semi-knocked down, to the extent possible, to facilitate handling and storage and to protect bearings and other machine surfaces from oxidation. Each container, box, crate or bundle shall be reinforced with steel strapping in such a manner that breaking of one strap will not cause complete failure of packaging. The packing shall be of best standard to withstand rough handling and to provide suitable protection from tropical weather while in transit and while awaiting erection at the site. All the major equipment shall be supplied in steel crates. The package shall be supplied in containers and it should be suitable for storage in the outside yard of the plant for a minimum period of 12 months.
18.4.	Equipment and materials in wooden cases or crates shall be properly cushioned to withstand the abuse of handling, transportation and storage. Packing shall include preservatives suitable to tropical conditions. All machine surfaces and bearings shall be coated with oxidation preventive compounds. All parts subject to damage when in contact with water shall be coated with suitable grease and wrapped in heavy asphalt or tar impregnated paper.
18.5.	Crates and packing material used for shipping will become the property of owner. (MAHAGENCO).
18.6.	Packaging or shipping units shall be designed within the limitations of the unloading facilities of the receiving ports and the ship will be used. It shall be the Vendor's responsibility to investigate these limitations and to provide suitable packaging and shipping to permit transportation to site.
18.7.	Packing (tare) shall be part of the equipment cost and shall not be subject to return. The packing should ensure integrity and cohesiveness of each delivery batch of equipment during transportation. In case of equipment assemblies and unit's delivery in the packing of glass, plastics or paper the specification of packing with the material and weight characteristics are to be indicated.
18.8.	Each package should have the following inscriptions and signs stenciled with an indelible ink legibly and clearly: a. Destination

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	b. Package Number c. Gross and Net Weight d. Dimensions e. Lifting places f. Handling marks and the following delivery marking
18.9.	Separate packing has to be done for each unit. Each package or shipping units shall be clearly marked or stenciled on at least two sides as per the Dispatch Address given in the indent/enquiry. In addition, each package or shipping unit shall have the symbol painted in red on at least two sides of the package, covering one fourth of the area of the side
18.10.	Each part of the equipment which is to be shipped as a separate piece or smaller parts packed within the same case shall be legibly marked to show the unit of which it is part, and match marked to show its relative position in the unit, to facilitate assembly in the field. Unit marks and match marks shall be made with steel stamps and with paint
18.11.	Each case shall contain a packing list showing the detailed contents of the package. When any technical documents are supplied together with the shipment of materials no single package shall contain more than one set of such documents. Shipping papers shall clearly indicate in which packages the technical documents are contained.
18.12.	The case number shall be written in the form of a fraction, the numerator of which is the serial number of the case and the denominator the total number of cases in which a complete unit of equipment is packed.
18.13.	Wherever necessary besides usual inscriptions the cases shall bear special indication such as “Top”, “Do not turn over”, “Care”, “Keep Dry” etc. as well as indication of the center of gravity (with red vertical lines) and places for attaching slings (with chain marks)
18.14.	Marking for Safe handling: To ensure safe handling, packing case shall be marked to show the following: a. Upright position. b. Sling position and center of Gravity position. c. Storage category. d. Fragile components (to be marked properly with a clear warning for safe handling)
18.15.	Each crate or package is to contain a packing list in a waterproof envelope. All items are to be clearly marked for easy identification against the packing List. All cases, packages etc. are to be clearly marked on the outside to indicate the total weight where the weight is bearing and the correct position of the slings are to bear an identification mark relating them to the appropriate shipping documents. All stencil marks on the outside of cases are either to be made in waterproof material or protected by shellac or varnish to prevent obliteration in transit.
18.16.	The packing slip shall contain the following information: - Customer name, Name of the equipment, Purchase Order number with Date, Address of the delivery site, Name and Address of the Sender, Serial Number of Blower & accessories, BHEL item Code, Gross Weight and Net weight of Supplied items.
18.17.	Prior to transport from manufacturer’s work to destination, components of the unit shall be completely cleaned to remove any foreign particles. Flange faces and other machined surfaces shall be protected by an easily removable rust preventive coating followed by suitable wrapping.
18.18.	All necessary painting, corrosion protection & preservation measures shall be taken as specified in painting schedule. Supplier shall consider the coastal environment zone which is defined as “very severe” during final finishing/shipping.
18.19.	Successful Vendor shall furnish the detail packing /shipment box details with information like packing box size, type of packing, weight of each consignment, sequence no. of dispatch, no. of consignment for each deliverable item against each billing break up units/ billable blocks. Without

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	these details the BBU shall not be approved during detail engineering. Also, complete billing break-up with above mentioned details shall be submitted within 10 days of LOI.
18.20.	All items/equipment shall be dispatched in properly packed condition (i.e. no item shall be dispatched in loose condition such that it becomes difficult to store/identify its location at site at a later stage).
18.21.	Cases which cannot be marked as above shall have metal tags with the necessary markings on them. The metal tags shall be securely attached to the packages with strong steel binding wire. Each piece, Skid, Case or package shipped separately shall be labelled or tagged properly.
18.22.	Each package or shipping units shall be clearly marked or stenciled on at least two sides as follows. **MAHAGENCO KORADI THERMAL POWER PROJECT** **2x660 MW, STAGE – 11 &12, Nagpur District** **Maharashtra- 441111** **BTG PACKAGE CONTRACTOR: "BHARAT HEAVY ELECTRICALS LIMITED, INDIA**

Annexure No.	Annexure Description
I	QUALIFICATION REQUIREMENT.
II	LIST OF DEVIATIONS/EXCEPTIONS
III	SPECIFICATION FOR MEASURING INSTRUMENTS
IV	SPECIFICATION FOR LOW PRESSURE PIPING, VALVE MATERIALS & ACTUATOR
V	SPECIFICATION OF SURFACE PREPARATION & PAINTING
VI	MANUFACTURING QUALITY PLAN FOR BLOWER
VII	BLOWER P&ID
VIII	SEAWORTHY PACKING SPECIFICATION
IX	DATA SHEET FORMAT
X	BLOWER INSTRUMENTATION MANDATORY SPARES
XI	SUB-VENDOR QUESTIONNAIRE
XII	MAHAGENCO'S VENDOR INDICATIVE LIST

	Date	Revision details	Revised	Approved
00	03.03.2026	New standard prepared	ABUL	DILEEP

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~~The DJU shall be submitted by the Bidder or Bidder's sub-vendor , QFGDM, Subsidiary Company/Joint Venture Company, Collaborator, TLA provider (As applicable)~~

~~2.7.5~~ ~~All above Qualifying Requirements should be read in totality and not in isolation.~~

~~2.7.6~~ ~~Not-withstanding anything stated above, the Owner reserves the right to assess Bidder or Bidder's sub-vendor's capability and capacity to perform, should the circumstances warrant such assessment in the overall interest of the Owner.~~

2.7.7 Provenness criteria for critical equipment, auxiliaries, systems and bought out items for Flue Gas Desulphurisation System:

A. The Bidder / Bidder's sub-vendor(s) is required to meet the provenness criteria and/or qualification requirement for critical equipment, auxiliaries, system and bought out items as per criteria stipulated below:

~~Booster Fans~~, ~~Slurry Recirculation Pumps~~, Oxidation Blowers, ~~Wet Limestone Grinding Mills, Slurry Pumps, Agitators & Vacuum Belt Filters~~ for the Wet Limestone based Flue Gas Desulphurisation (FGD) System offered by the Bidder shall be only from such manufacturer(s) who has previously designed (either by itself or under collaboration / licensing agreement), manufactured / got manufactured the respective equipment(s) of the type, application and minimum equipment rating as stipulated below such that the respective equipment(s) should have been in successful operation in at least one (1) plant for a period not less than one(1) year reckoned as on the date of consideration for approval but not later than six months to award date of contract to the Main bidder:

Type and Rating for Qualification

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S. N.	Name of Equipment	Type of Equipment	Application	Equipment Rating	MSPGCL
(a)	Slurry Recirculation Pumps	Centrifugal type	Wet Limestone based FGD application in Coal fired power plant	Flow 10200 m3/hr (min.) with Head 16 Meters of Liquid Column (min.)	80% of the flow & 100% of the head of the offered Slurry Recirculation Pump
(b)	Oxidation Blowers	Centrifugal/ positive displacement type blower	Wet Limestone based FGD application in Coal fired power plant or in any other process application	Flow 7300 Nm^3/hr DIY Basis (mim) with Head 8500 mmwc (min.) for spray tower process Or Head 3500 mmwc (min.) for bubbling type process Oxidation Blower	80% of the flow & 100% of the head of the offered Oxidation Blower
(c)	Wet limestone Grinding mills	Horizontal Wet Ball mill	Wet Limestone based FGD application in Coal fired power plant or any other process application.	20 T/hr (minimum) with pulverizing fineness not less than 90% thru 325 mesh.	80% of the offered Ball mill capacity with pulverizing fineness not less than 90% thru 325 mesh
(d)	Slurry Pumps	Centrifugal type	Wet Limestone based FGD application or ash slurry application in Coal fired power plant	Flow 50 m3/hr (min.) with head 30 Meters of Liquid Column (min.)	80% of the flow & 100% of the head of the offered Slurry Pump(s)
(e)	Agitators	Vertical/ Horizontal	Wet Limestone based FGD application in Coal fired power plant or in any other process application	Agitator rating not less than that supplied for 500 MW or higher size unit for similar application	Agitator rating not less than that supplied for 500 MW or higher size unit for similar application

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S. N.	Name of Equipment	Type of Equipment	Application	Equipment Rating	MSPGCL
(f)	Vacuum Belt filters	Belt type	Wet Limestone based FGD application in Coal fired power plant or in any other process application	35 T/hr (minimum)	80% of the offered Vacuum Belt filter capacity
(g)	Booster Fans	Axial type with variable pitch control	Coal fired power plant	--	80% of the flow & 100% of the head of the offered Booster Fan with Fan Speed 900 rpm (maximum)

Bidder shall offer and supply only the type of the above equipment(s) for which he himself or the manufacturer proposed by the bidder for the above equipment(s) is qualified.

The provenness criteria for equipment (Booster Fans) stipulated at Sl. No. 2.7.7A (g) above shall also be considered acceptable provided the rating parameters (i.e., flow, head and rated rpm) is covered within the operating regime of the respective fan performance curve of the reference plant equipment.

The provenness criteria for equipment (Slurry Recirculation Pumps) stipulated at Sl. No. 2.7.7A (a) above shall also be considered acceptable provided the rating parameters (i.e., flow and head) is covered within the operating regime of the respective Slurry Recirculation Pump performance curve of the reference plant equipment.

B. A JV / Subsidiary Company formed for manufacturing and supply of equipment(s) as listed at clause no. 2.7.7 A above in India shall be considered qualified for such equipments, provided that it has a valid collaboration or licensing agreement for design, engineering, manufacturing of such equipment(s) in India with a qualified equipment manufacturer who meets the requirements stipulated at

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clause 2.7.7A above (or the technology provider of the qualified equipment manufacturer) for the respective equipment(s). Before taking up the manufacturing of such equipment(s), the bidder/ his sub-vendor(s) must create /have created manufacturing facilities at his works as per collaborator's/licenser's design, manufacturing and quality control system for such equipment(s).

Further, in such a case, such qualified equipment manufacturers should have, directly or indirectly through its holding company/ subsidiary company, at least 26% equity participation in the Indian Joint Venture Company/ Subsidiary Company, which shall be maintained for a lock-in period of seven (7) years from the date of incorporation of such Joint Venture/ Subsidiary or upto the end of defect liability period of the contract, whichever is later.

C. In case the Bidder or the proposed sub-vendor is not manufacturer of proven Oxidation Blowers as per clause 2.7.7 A (b) above but is a manufacturer of Blowers/compressors for minimum 50 NM^3/min capacity, the Bidder or the proposed sub-vendor can also manufacture Oxidation Blowers, provided it has collaboration or valid licensing agreement for design, engineering, manufacturing, supply of such Oxidation Blowers in India with such manufacturer who meet the requirements stipulated at clause 2.7.7 A (b) above for the Oxidation Blowers. Before taking up the manufacturing of such equipment, the bidder/ his sub-vendor must create /have created manufacturing facilities at his works as per collaborator's /licenser's design, manufacturing and quality control system for such equipments.

~~D. (i) In case the Bidder or the proposed sub-vendor is not manufacturer of proven Wet limestone Grinding mills as per clause 2.7.7 A (c) above but is a manufacturer of dry Grinding mills for power or cement industry of minimum 20 T/h capacity, the Bidder or the proposed sub-vendor can also manufacture Wet limestone Grinding mills, provided it has collaboration or valid licensing agreement for design, engineering, manufacturing, supply of such Wet limestone Grinding mills in India with such~~

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manufacturer who meet the requirements stipulated at clause 2.7.7 A (c) above for the Wet limestone Grinding mills. Before taking up the manufacturing of such equipment, the bidder/ his sub-vendor must create /have created manufacturing facilities at his works as per collaborator's /licenser's design, manufacturing and quality control system for such equipments. In addition, the Bidder shall be required to furnish a letter of support from Collaborator(s) / Licensor / Technology provider for successful performance of the equipment valid up to the end of defect liability period of the contract as per the format enclosed in the bidding document, at the time of placement of order on the approved sub-vendor.

OR

(ii) In case, the bidder or proposed sub vendor is not a manufacturer of proven Wet Limestone Grinding Mills as per clause 2.7.7 A (c) above, but have designed, manufactured & supplied dry Grinding Ball Tube mills for at least 500 MW pulverized coal fired power plant, the Bidder or the proposed sub- vendor can also manufacture Wet limestone Grinding Mills provided it has a licensing agreement with a Wet limestone Grinding mills manufacturer who meet the requirements stipulated at clause 2.7.7 A (c) above for the Wet limestone Grinding mills and provides extended warranty of three (3) years for the Wet Limestone Grinding Mills. In addition, the Bidder shall be required to furnish a letter of support from Collaborator(s) / Licensor / Technology provider for successful performance of the equipment valid up to the end of defect liability period of the contract as per the format enclosed in the bidding document, at the time of placement of order on the approved sub- vendor.

E. In case the Bidder or the proposed sub-vendor is not manufacturer of proven Agitators as per clause 2.7.7A(e) above but is a manufacturer of Agitators for similar process/duty application in petrochemical or metals and mining industry, the Bidder or the proposed sub-vendor can also manufacture Agitators, provided it

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~~has collaboration or valid licensing agreement for design, engineering, manufacturing, supply of such Agitators in India with such manufacturer who meet the requirements stipulated at clause 2.7.7A(e) above for the Agitators. Before taking up the manufacturing of such equipment, the bidder/ his sub-vendor must create /have created manufacturing facilities at his works as per collaborator's /licenser's design, manufacturing and quality control system for such equipments.~~

~~F. In case the Bidder or the proposed sub-vendor is a manufacturer of Slurry Pumps who meets the requirements stipulated at clause 2.7.7 A (d) above, the Bidder or the proposed sub-vendor can also manufacture Slurry Recirculation Pumps, provided it has collaboration or valid licensing agreement for design, engineering, manufacturing, supply of such equipment in India with such manufacturer who meet the requirements stipulated at clause 2.7.7 A (a) above for the Slurry Recirculation Pumps. Before taking up the manufacturing of such equipment, the bidder/ his sub-vendor must create /have created manufacturing facilities at his works as per collaborator's /licenser's design, manufacturing and quality control system for such equipment.~~

G. Before taking up the manufacturing of such equipment(s) as per clause 2.7.7 B, ~~2.7.7 C, 2.7.7 D(i), 2.7.7 E& 2.7.7 F~~ above, the Bidder / its sub vendor(s) must create (or should have created) manufacturing and testing facilities at its works as per Collaborator / licenser's design, manufacturing and quality control system for such equipments duly certified by the Collaborator / licensor. Further, the Collaborator / Licenser shall provide (or should have provided) all design, design calculation, manufacturing drawings and must provide (or should have provided) technical and quality surveillance assistance and supervision during manufacturing, erection, testing, commissioning of equipments.

H. Bidder shall offer and supply only the type of the above equipment(s) for which it, itself or the manufacturer / Collaborator(s) / Licenser(s) proposed by the Bidder for the above equipment(s) is qualified.

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I. The Employer reserves the right to fully satisfy himself regarding capability and capacity of Bidder / its sub vendor(s) and the proposed arrangement and may prescribe additional requirement before allowing manufacture of the equipment listed above for this contract.

J. ~~In case the Bidder or the proposed sub-vendor is not manufacturer of proven Booster Fans as per clause 2.7.7A(g) above but is a manufacturer of such equipment for units of at least 200 MW rating, the Bidder or the proposed sub vendor can manufacture such equipment for 490/500 MW units also, provided it has collaboration or valid licensing agreement for design, engineering, manufacturing, supply of such equipment in India with such manufacturer who requirements stipulated at clause 2.7.7A (g) above for the Booster Fans~~

~~Note to clause 2.7.7A~~

~~Whenever the term 'coal fired' is appearing above, "Coal" shall be deemed to also include bituminous coal/brown coal/Anthracite Coal/lignite~~

2.7.8 ~~Agency for Wet Stack Flow Model Study~~

~~Wet Stack Flow Model Study shall be carried out by an agency which has successfully performed at least two (2) flow model studies, in separate coal fired power plants, of wet stack installed after wet limestone based FGD Absorber (without reheating of cleaned flue gas), and based on the studies developed at least two (2) wet stack liquid collection systems which are in successful operation for a period of at least two (2) years reckoned as on the date of consideration for approval but not later than six months after award date of contract to the Main bidder.~~

2.8 Selective Catalytic Reduction System

The Bidder/Bidder's sub-vendor should meet the qualifying requirements stipulated in any one of the qualifying routes i.e. Route-1 (clause 2.8.1) or Route-2 (clause 2.8.2) or Route-3 (clause 2.8.3) including requirements stipulated in sub clauses of respective Route.

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CRITICAL EQUIPMENT, AUXILIARIES, SYSTEMS & BOUGHT OUT ITEMS FOR FLUE GAS DESULPHURISATION (FGD) SYSTEM

Summary of Critical Equipment indicated under clause 2.7.7

Equipment Name	Sub-Vendor Name	Collaborator's Name, if applicable	Seeking Qualification as per clause..... Volume-I, Section-III
Oxidation Blowers			*2.7.7A /*2.7.7B /*2.7.7C

1. If qualification sought as per clause 2.7.7 A then the details of the sub vendor (manufacturer) shall be filled by the bidder in the format above
2. If the qualification sought as per the clause 2.7.7B, then the details of JV/Subsidiary Company formed for manufacturing of such equipment in India shall be furnished individually for each equipment by the bidder such as,

   i. Copy of document of incorporation of JV/Subsidiary company in India

   ii. Copy of collaboration or valid licensing agreement for design, engineering, manufacturing, supply of such equipment in India with the collaborator or technology licenser who meets the requirement.

   iii. Copy of document of at least 26% equity participation of qualified equipment manufacturer in the Indian JV company/subsidiary company directly or indirectly through its holding company /Subsidiary company, which shall be maintained for a lock -in period of seven (7) years from the date of incorporation of such JV/subsidiary or up to the end of defect liability period of the contract which ever is later. Further, the details of collaborator or technology licenser or technology provider of the qualified equipment manufacturer who meets the requirement stipulated at 2.7.7B, shall be filled by the Bidder in the format will be provided at ordering stage. In addition to that, the sub vendor along with the Indian JV company/subsidiary company, qualified equipment manufacturer and its holding company/subsidiary company as applicable shall furnish the DJU.

*** strike out whichever is not applicable.**

1.00.0 Applicable for Bidder/his sub vendors seeking qualification as per clause no. 2.7.7, Sub-section-III, Volume-I. Bidder shall furnish the required data only for those equipment /auxiliaries which are proposed to be sourced under this route.

We, hereby furnish the data on proneness criteria for critical equipment, auxiliaries, systems and Bought Out Items Oxidation Blowers, which have been designed (either by self manufacturer or under Collaboration/Licencing Agreement), *manufactured/ *got manufactured and supplied by us /Manufacturer (or manufactured/ got manufactured & supplied by our proposed sub-vendors) and these are in successful operation in at least one (1) plant for a period not less than one year reckoned as on the date of consideration for approval but not later than six months to award date of contract to the Main bidder i.e. BHEL. The details of type and minimum equipment rating of such are given below:

Signature of authorized signatory.....

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ATTACHMENT - 3K

Oxidation Blowers: We declare that, we/our Sub-Vendor, have manufactured and supplied at least one (1) number of Oxidation Blower of minimum 7300 Nm3/hr (dry basis) flow with Head 8500 mmwc (min.) for spray tower process Or Head 3500 mmwc (min.) for bubbling type process, Centrifugal/positive displacement type working in FGD application in Coal fired power plant and which has been in successful operation for minimum one (1) year reckoned as on the date of consideration for approval but not later than six months to award date of contract to the Main bidder i.e. BHEL. as per the details furnished below:

Sl No.	Description	Reference Work
1	Name of the reference plant & location:	
2	Client name and his address:	
3	No. of units and capacity in MW of unit:	*Yes/*No
4	Whether power plant is coal fired	
5	Whether operating in a Wet Limestone based FGD application in Coal fired power plant	*Yes/*No
6	Name of equipment manufacturer & address:	
7	Date of commission of the equipment:	
8	Model no. of the equipment:	
9	Brief Technical particulars of the equipment	
10	Flow (In Nm^3/Hr.)	
11	Head (mmWc)	
12	Whether the equipment(s) are in successful operation in at least one (01) plant for a period not less than one (01) year reckoned as on the techno-commercial bid	*Yes/*No
13	Flue gas Desulphurization system details:	*Technical extract/letter/ *email/ *Drawing from user or contract document or scheme or *any document in public domain enclosed at annexure.. to Attachment-3K
14	Scope of Work:	*Letter of Award or *Contract or *P.O. enclosed at Annexure.....to Attachment-3K
15	Performance details:	*Certificate/*Letter/*Email from End user enclosed at Annexure.....to Attachment-3K

*** strike out whichever is not applicable.**

Signature of authorized signatory.....

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ANNEXURE –II

Project Name: ……. ENQ/ NIT No: _____(Vendor to fill & submit along with offer)

LIST OF DEVIATIONS/EXCEPTIONS TO THE ENQUIRY DOCUMENT

Sl No	Clause No	Page No	Description of Deviation

Note- 1. Supplier shall submit this form indicating technical deviation if any, indicating each clause no. If there is no technical deviation, Supplier shall submit this form indicating "NO DEVIATION"

2. Deviation Listed elsewhere other than the above format shall not be considered for offer evaluation.

SIGNATURE OF BIDDER ----------

NAME ----------

DESIGNATION ----------

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7.00.00 MEASURING INSTRUMENTS (PRIMARY AND SECONDARY)

7.01.00 GENERAL REQUIREMENTS

7.01.01 Measuring instruments/equipment and subsystems offered by the Bidder shall be from reputed experienced manufacturers of specified type and range of equipment, whose guaranteed and trouble free operation has been proven. Further all instruments shall be of proven reliability, accuracy, and repeatability requiring a minimum of maintenance. They shall comply with the acceptable international standards and shall be subject to Owner's approval. All instrumentation equipment and accessories under this specification shall be furnished as per technical specifications, ranges, makes/ numbers as approved by the Owner during detailed engineering.

7.01.02 Every panel-mounted instrument requiring power supply shall be provided with a pair of easily replaceable glass cartridge fuses of suitable rating. Every instrument shall be provided with a grounding terminal and shall be suitably connected to the panel grounding bus.

7.01.03 All transmitters, sensors, switches and gauges for parameters like pressure, temperature, level, flow etc. as required for the safe and efficient operation and maintenance as well as for operator and management information (including all computation) of equipment in the system under the scope of specification shall be provided on as required basis with in quoted lump sum price. The Contractor shall furnish all Instrumentation / Control equipment & accessories
under this specification as per technical specification, ranges, makes & model as approved by the Employer during detailed engineering.

7.01.04 The necessary root valves, impulse piping, drain cocks, gauge-zeroing cocks, valve manifolds and all the other accessories required for mounting/ erection of these local instruments shall be furnished, even if not specifically asked for, on as required basis. The contacts of equipment mounted instruments, sensors, switches etc. for external connection including spare contacts shall be wired out in flexible/rigid conduits, independently to suitably located common junction boxes. The proposal shall include the necessary cables, flexible conduits, junction boxes and accessories for the above purpose. Double root valves shall be provided for all pressure tapping where the pressure exceeds 40 Kg./cm2.

7.01.05 The instruments which are proposed to be used for PG test as indicated in the tender P&IDs shall meet the minimum requirements specified in ASME PTC or subsequent clauses in this chapter whichever is better.

7.01.06 Transmitters for pressure shall transmit signal, which is linear with respect to the measured pressure.

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7.01.07 Flow meter transmitter shall meet the specified accuracy criteria when operating between 25 and 100 percent of full-scale flow value. The accuracy guarantee shall include the effect of errors in the differential head measuring device, square root converter and signal generator, but not the primary device.

7.01.08 Transmitters for level shall transmit signal, which is linear with respect to the measured level based on a specific gravity of 1.00.

7.01.09 Generally, bidder shall have considered transmitters instead of process switches. Process actuated switches may be accepted only in very few cases if the same is as per standard and proven practice of equipment supplier.

7.01.10 A suitable number of permanent thermocouples for use in observing tube metal temperature during start-up shall be installed by the manufacturer. The number of thermocouples shall be adequate to facilitate measurement of the superheater element being operated. These thermocouples shall be wired by the manufacturer to a point outside the furnace casing & terminating in a suitable junction box.

7.01.11 A thermocouple type retractable temperature probe shall be provided at the superheater inlet to enable controlling the firing rate at start up so that the flue gas temperature can be contained within a limit when there is no steam flow through the reheater tubes. The probe shall be interlocked to be retracted when the temperature of the flue gas exceeds the safe limit of operation of the probe.

7.01.12 Temperature compensation shall produce corrections, over a flow range from 10 percent to 100 percent of maximum flow, subject to a plus or minus tolerance of one-half of one percent of the maximum flow.

7.01.13 All Instrument Scale Displays shall be in engineering units. Instrument scales displayed on screen will have graduations with scale divisions based on multiples of 10. The smallest division shall preferably be a whole number approximately 1% of the scale range if not otherwise impracticable. Pressure instrument shall have the unit suffixed with ‘a’ or ‘g’ to indicate absolute or gauge pressure, respectively. Scales and charts of all instruments shall have linear graduations

7.01.14 Instrument range shall be selected to have the normal reading, preferably between 50% and 70% of full scale for linear parameters and 70% to 90% for flow measurements. Deviation indicators shall have the null position at mid-scale. The normal operating parameter shall be identified with a clear green mark.

7.01.15 Required local instruments, panels, gauge boards etc. shall be provided for safe and efficient operation of the plant.

7.01.16 Local and remote performance mentoring of heat exchangers and coolers shall be provided with upstream and downstream temperature measurement.

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Heat exchangers and strainer chocking condition shall be monitored at local and remote.

7.01.17 Wherever the measurement is influenced by process pressure & temperature, for example measurement of steam flow, feed water flow, boiler separator, air flow etc. required correction against pressure and temperature shall be introduced for such measurement.

7.01.18 In Bunker, silos and first field of ESP radar type level transmitter (minimum two numbers at each measurement location) shall be provided. Level switches shall be provided at each hoper.

7.01.19 For measurement of level of tanks/vessels/sumps containing oil, chemicals or water, Ultrasonic type level transmitters shall be provided. Bidder can also provide Radar type transmitter in place of ultrasonic transmitter as per process requirement subject to approval by Owner during detailed Engineering. However, other type of level transmitters, if any, shall be acceptable only if there are constraints on account of process/ equipment/ device for having an effective measurement using the above. The acceptability of the same shall be subject to Owner's approval.

7.01.20 Bidder shall provide all measuring instruments, field instrument, primary & secondary instruments, remote and local monitoring instruments, skid mounted instruments, flow elements, final control elements as per process and specification requirement of BTG package. Bidder shall also provide instrument and flow elements on process lines, tanks, equipment etc even when process lines/ tanks/equipment not in bidder scope if process demand for the same.

7.02.00 METERING BASES AND CHART UNITS

1.	Pressure	:	Kg/cm^2
2.	Differential Pressure	:	mm of H_2O column / Kg/cm^2
3.	Draught	:	mm of H_2O column
4.	Vacuum	:	Kg/cm^2 (abs)/mm of Hg column
5.	Temperature	:	Degree Celsius (^OC)
6.	Flow (Steam, Water)	:	Tonnes / hr.
7.	Flow (Oil)	:	Tonnes / hr.
8.	Flow Air	:	Tonnes / hr / M^3 / Hr.
9.	Density	:	gms / c.c.
10.	Level	:	mm
11.	Conductivity	:	Micro-mho / cm
12.	Gas Analyser	:	Percentage by weight or as specified in respective case.
13.	Dissolved Oxygen / Silica / Sodium & Hydrogen	:	ppm /ppb or %

7.03.00 ELECTRONIC TRANSMITTER

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7.03.01 **For Pressure, Diff Press And DP Based Flow / Level Measurements**

1.	Working Principle	:	Smart
2.	Type	:	Microprocessor based 2 wire type (loop powered), Hart protocol compatible.
3.	Output Signal	:	Simultaneous transmission of digital and 4-20 mA DC signal. HART protocol
4.	Signal Processing		Silicon solid state electronic circuitry
5.	Measuring Element		Capsule / Diaphragm
6.	Element material		AISI-316 (Stainless Steel) or better
7.	Accuracy		± 0.075% of span or better
8.	Repeatability		±0.05% of Span or better
9.	Over Pressure		150% of max. Operating pressure
10.	Turn-down ratio (minimum)		100:1
11.	Zero and span drift		+/- 0.015% per deg.C at max span
12.	stability		± 0.1% of calibrated span for six months for Ranges up to and including70 Kg/cm² ± 0.25% of calibrated span for six months for Ranges more than 70 Kg/cm²
13.	Span and Zero		Continuous, tamper proof, Remote as well as manual adjustability from instrument with zero suppression and elevation facility.
14.	Housing		Weather proof as per IP-65, metallic housing with durable corrosion resistant coating
15.	Connection (Electrical)		Plug and socket type
16.	Process connection		1/2 inch NPT (F)
17.	Accessories		-Diaphragm seal, pulsation dampeners, syphon etc. as required by service and operating condition. -2 valve manifold for absolute & Gauge pressure

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			transmitters, 3-valve and 5 valve manifold for DP/Level/Flow applications. The valve manifold shall be non integral type (except Fuel Oil area). For hazardous area, explosions proof enclosure as described in NEC article 500 Mounting: 2 inch pipe mounting.
18.	Diagnostics & display		Self-Indicating feature and digital display on transmitter
19.	Power supply		24V DC ± 10%.
20.	Adjustment/calibration/maintenance		From hand held HART calibrator/ centralized PC based system (as applicable).

Notes
- For primary air/ secondary air/flue gas applications, DP type transmitters shall be provided for pressure measurement.
- LVDT type is not acceptable.
- Where the process fluids are corrosive, viscous, solid bearing or slurry type, diaphragm seals shall be provided. Parts below the diaphragm shall be removable for cleaning. The entire volume above the diaphragm shall be completely filled with an inert liquid suitable for the application.

7.04.00 HART HAND HELD CALIBRATOR

Hand held calibrator shall be provided for adjustment/calibration/maintenance of the HART compatible transmitters. The hand held calibrator shall be suitable for all types of transmitters supplied in the package. If one type of hand held type calibrator is not suitable for communicating with all types of transmitters, then separate hand held calibrator will be provided.

7.05.00 TEMPERATURE ELEMENTS AND ACCESSORIES

7.05.01 Thermocouple

Sl. No.	Features	Essential / Minimum Requirements
1	Type	(a) Type-J (Iron Constantan) / Type-K (Chromel Alumel) / Type-R (Pt.- Rhodium Pt.). [As per application]
		(b) Duplex.
		(c) Ungrounded.

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Sl. No.	Features	Essential / Minimum Requirements
2	Wire gauge	16 AWG for Type-K, 24 AWG for Type-R.
3	Standard	ANSI-MC 96.1.
4	Protecting Tube	
a.	O.D	8 mm.
b.	Material	316-SS Seamless.
c.	Filling	Magnesium Oxide (Purity above 99.4%).
5	Response time	a) < 20 seconds for measurement.
		b) < 10 seconds for control.
6	Accuracy	± 1.1^0 C up to 300 ^{0}C & 0.4% of measured temperature range above 300 ^{0}C.
7	Head	
	Type	IP-65 universal screwed type.
	Material	Die cast aluminium or better.
	Terminal blocks	Nickel plated Brass - screw type/ silver plated.
	Instrument connection to well	½" NPT F.
	Cable connection	½" NPT gland and grommet.
	Others	Terminal head cover with SS chain and suitable gasket. All thermowells in the high velocity steam service shall be checked for Strouhal's frequency limit to arrive at a safe size and design of thermowells.
8	Accessories	(a) Adjustable nipple-union-nipple (½", Sch 80 x ½" NPT M) with thermowell connection.
		Compression fittings/unions.
		(b) Flanges etc. (for flanged connections only).

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Sl. No.	Features	Essential / Minimum Requirements
		(c) Forged barstock thermowell as per ASME PTC code. Process connection M 33 x 2 (M) in general or 1½" Flanged for Flue gas / Furnace / Air etc. application. Material of construction of Thermowell: SS 316 : In general Inconel: For flue gas application Tungsten carbide : For coal mill application.
9.	Name plate	Tag number, service engraved in stainless steel tag plate.

7.05.02 **Resistance Temperature Detector (RTD)**

Sl. No.	Features	Essential / Minimum Requirements
1	Type	Platinum (Duplex), Ungrounded.
2	Resistance	100 ohm at 0 ^{O}C.
3	Base	Wound on ceramic (anti-inductive).
4	Wiring	3 / 4 Wire.
5	Protecting Tube	
	a. O.D.	8 mm.
	b. Material	SS-316, Seamless.
	c. Filling	Magnesium oxide (Purity above 99.4%).
8	Response time	< 20 seconds for measurement.
		< 10 seconds for control.
9	Calibration	DIN 43760.
10	Accuracy	± 0.5%.
11	Head:	
	Type	IP-65 universal screwed type.

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Sl. No.	Features	Essential / Minimum Requirements
	Material	Die cast aluminium or better.
	Terminal blocks	
	Cable connection	½" NPT gland and grommet.
	Others	Terminal head cover with SS chain and suitable gasket. All thermowells in the high velocity steam service shall be checked for Strouhal's frequency limit to arrive at a safe size and design of thermowells.
	Accessories	(a) Adjustable nipple-union-nipple (½" Sch 80 x ½" NPT M) with Thermowe (b) Compression fittings / unions. (c) Flanges etc. (for flanged connections only) (d) Forged / barstock Thermowell as per ASME PTC code. Process connec Material of construction of Thermowell: SS 316: In general. Inconel: For flue gas application. Tungsten carbide: For coal mill application.
	Name plate	Compression fittings / unions.

7.05.03 **Metal Temperature Thermocouples**

Sl. No.	Features	Essential / Minimum Requirements
1.	Measuring Medium	Metal Temperature
2.	Material of Thermocouple.	Chromel Alumel Type K
3.	Type of Thermocouple	Duplex with ungrounded separate hot junctions

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Sl. No.	Features	Essential / Minimum Requirements
4.	Insulation	Mineral Insulation (Magnesium Oxide).
5.	Thermocouple wire gauge	16 AWG
6.	Protective sheath	SS 321
7	Protective sheath dia	4 mm OD (minimum)
8	Calibration & accuracy	As per IEC-584/ ANSI-MC-96.1 (special limits of error) for T/C
9	Mounting accessories	1/2" BSP SS sliding end connector, weld pad, clamps of heat resistant steel SS310. Adjustable gland fitting for connection at the junction box end as per manufacturer's standard.
10	Cold end sealing	SS pot seal with colour coded PTFE Insulated flexible tails. Sealing compound- Epoxy resin. Length of PTFE insulated flying leads shall be minimum 750 mm.
11	Minimum bending radius	30 mm
12	Length of T/C	On as required basis considering location of measurement point and the JB/TTJB location.

Note:

1) The specification for thermocouples of bearings metal temp measurements can be as per their manufacturer standards. The manufacturer shall submit the adequate supporting documents for establishing their standard practice. However, type of thermocouples shall be K-type.
2) For boiler metal temperature applications, considering the location of installations and response time, manufacturer's standard and proven specification for metal temperature measurement can also be accepted subject to employer's approval. The manufacturer shall submit adequate supporting documents for establishing their standard and proven practice.
3)

7.05.04 **Thermowells**

a) Shall be one-piece solid bored type of 316 SS of step-less tapered design. (As per ASME PTC 19.3, 1974)
(b) For Mill classifier outlet long life solid sintered tungsten carbide material of high abrasion resistance shall be provided.
(c) For Air & Flue gas 316 SS protecting tube with welded cap. (However contractor shall provide better material for Flue gas service if required based on the specified boiler design parameters).
(d) For furnace zone, impervious ceramic protecting tube of suitable material along with Incoloy supporting tubes and adjustable flanges.

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7.05.05 TEMPERATURE TRANSMITTER

Following types of 2-wire temperature transmitter (directly powered from 4-20mA input cards of DCS) shall be provided. The temperature transmitter shall be fully compatible with thermocouples and RTDs being provided by the contractor. Temperature compensation of the thermocouples shall be performed in the temperature transmitter itself.

a. Single Input Head mounted Temperature Transmitter
These shall be suitable for mounting in the head of temperature element itself. The protection class of head of thermo well along with its plug-in connector shall be min. IP65.

b. Single Input DIN-rail mounted Temperature Transmitter
These shall be especially designed for DIN-rail mounting in JBs. JB shall be as per tender specification and IP 65 Protection class. This temperature transmitter shall be the ones which are specially designed for DIN-rail mounting with IP 20 protection class. These shall have terminals for input/output provided on front side when mounted on DIN-rail. Head mounted temperature transmitter with clamps to make it suitable for DIN-rail mounting shall not be acceptable under this category.

c. Dual-input Temperature Transmitter with Indicator:
The dual-input TTs shall be suitable for mounting in enclosures/racks and shall be provided with clamps. Indicator shall be provided with these transmitters. These transmitters shall have bump less change over facility to second sensor in case first sensor fails. This change-over is to be alarmed. Protection class shall be IP65 minimum.

d. Common requirements for each of the above type of temperature transmitters

i. Output : 2-wire (power supply from input card of Control System) with 4- 20mA output with Super-imposed HART protocol signal
ii. Input : Same transmitter shall be capable to handle Pt-100 RTD, Thermocouples K&R types (input type to be selectable at site through HART terminal)
iii. Isolation : min. 500 V AC
iv. EMC compatibility : as per EN 61326
v. Operating ambient : 0 to 85 deg C (without indicator)temperature0 to 70 deg C (with indicator)
vi. Power supply : compatible with input module of ControlSystem
vii. Accessories : Mounting arrangements including clampsetc.
viii. Composite Accuracy: a. For head mounted and DIN-rail mounted types RTD =<0.4% of 0-250 deg C span T/C-K type
=<0.4% of 0-600 deg C Span T/C-R type
=<0.4% of 0-1000 deg C span CJC accuracy (for thermocouples) shall be =< 1 deg C

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ix. For dual-input type:

RTD =<0.25% of 0-250 deg C Span T/C-K type =<0.2% of 0-600 deg C span
CJC accuracy (for thermocouples) shall be =< 1 deg C

7.06.00 PR. GAUGE, D.P. GAUGE, TEMP. GAUGE AND LEVEL GAUGE

7.06.01 Pressure Gauge and Differential Pressure Gauge

1	Type	:	Bourdon/Bellows/Diaphragm
2	MOC Sensing &Socket	:	AISI-316 SS
3	Movement Material	:	AISI-304 SS
4	Case Material	:	Stainless steel. Enclosure IP-65.
5	Dial Size	:	Generally 150 mm (100 mm for SWAS gauges)
6	Scale	:	Black lettering on white background in 270 Deg. arc.
7	Window	:	Shatterproof glass
8	Range Selection	:	Normal process pressure – 50 ~ 70% of range (approximately).
9	Over-range Protection	:	125% of maximum range by internal stop. External stop at zero.
10	Adjustment	:	Micrometer screw for zero adjustment.
11	Element Connection	:	Argon welding
12	Process Connection	:	1/2" NPT (M) Bottom connection for local mounting, backconnection for panel mounting.
13	Performance	:	Accuracy of +/- 1.0% of span or better.
14	Safety Feature	:	Blow out disc /diaphragm at the back
15	Accessories	:	a) Snubbers and Glycerin filled for pulsating
			b) siphons for steam and hot water services
			c) Stainless steel Diaphragm seals for corrosive, viscous andsolid-bearing or slurry type process fluids.
			d) Gauge saver wherever required
			e) 3-Way stainless steel Gauge valve for pressure gauges.Process connection ½" NPT.
			f) 5-valve SS316 manifold constructed from bar stock fordifferential pressure gauge. Process

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			connection ½" NPT.
			g) Union, nut & tail piece and other Installation accessoriesas required.
16	Applicable standard	:	IS-3624 / 1996
17	Electrical Contactrating	:	Not applicable
18	Nameplate	:	Tag number, service engraved in stainless steel tag plate

7.06.02 Temperature Gauge

1	Type	:	Inert gas filled capillary type / Bimetallic rigidstem type
2	Sensi Elementng Material	:	Bourdon-AISI 316 SS / Bimetal strip helix
3	Capillary	:	AISI 316
4	Bulb / Stem Material	:	AISI 316
5	Thermometer connection to well	:	½" NPT / SS 304
6	Case Material	:	Stainless Steel
7	Dial Size	:	150 mm in general
8	Scale	:	Black lettering on white background.
9	Capillary	:	Armoured Stainless steel. Length of capillary shall be on 'As required' basis.
10	Mounting	:	Surface with adjustable angle / Panel.
11	Overrange Protection	:	125% of range or more.
12	Range	:	Normal temperature – 50 ~ 70% of range approximately.
13	Zero adjuster	:	Micrometer screw adjustable from front.
14	Window	:	Shatterproof glass.
15	Accuracy	:	1 %
16	Enclosure Class	:	IP-65
17	Accessories	:	a). Forged/bar stock thermowell screwed as per ASME PTC code. Process connection M 33X2 (M).
			Material of construction of Thermowell:

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			- SS 316: In general
			- Inconel: For flue gas application
			b) Installation accessories as required.
			c)Tungsten carbide for coal mill operation
18	Nameplate	:	Tag number, service engraved in stainless steel tagplate

7.06.03 Gauge Glass

1	Type	:	Reflex or transparent. Resistant to mechanical shocks bysteel armour.
2	Glass	:	Toughened borosilicate
3	Body material	:	forged Carbon steel / stainless steel as per processrequirements/ flanged connection
4	End connection	:	As per ASME PTC and drain /vent valve 15NB
5	Accuracy	:	± 2%
6	Pressure rating	:	Twice the maximum working pressure
7	Scale	:	Linear vertical
8	Range selection	:	Covers 125% of max. of scale
9	Test Pressure	:	1.5 times to the max. design pressure at 38°C
10	Housing	:	CS /304SS
11	Accessories	:	SS Ball check valves, gaskets, companion flange, SS drainand vent valve, nuts & bolts etc.

7.06.04 Sight Glass

1	Type	:	Flap-type
2	End connection	:	Screwed / Flanged
3	Material :		
a)	Body	:	SS-304
b)	Cover Plate	:	SS-304
c)	Indicator	:	SS-316
4	Sight Glass	:	Toughened Borosilicate
5	Gasket	:	Neoprene
6	Bolts & Nuts	:	High tensile steel
7	Hydraulic Test Pressure	:	1.5 times maximum working pressure

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8	Accessories	:	As required

7.07.00 PROCESS SWITCHES

7.07.01 Pressure Switch and Differential Pressure Switch

1	Type	:	a) Piston for high pressure application
			b) Bellow / Diaphragm for low pressure application
2	Sensing element material		AISI SS-316. All other wetted part SS316.
3	Case Material		Epoxy coated Die-cast aluminum alloy with neoprene gasket.
4	Setter Scale	:	Required.
5	Accuracy		± 1.5%.
6	Over range	:	150% of maximum pressure
7	Adjustments	:	Internal Set Point adjustable over span
8	Process Connection	:	1/2" NPT (M) bottom connected
9	Switch configuration	:	One DPDT (Two SPDT)
10	Switch Rating	:	240V, 5A AC/220V, 0.5A DC
11	Switch Type	:	Snap acting, shock & vibration proof
12	Terminal Block	:	Suitable for full ring lugs for cable connection.
13	Cable connection	:	½" NPT conduit connection or compression gland.
14	Enclosure Class	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area).
15	Performance	:	Repeat accuracy □1.0%
16	Nameplate	:	Tag number, service engraved in stainless steel tag plate
17	Accessories	:	a) Remote diaphragm seal with SS-316 capillary for viscous &corrosive application. MOC of seal material shall be as per process fluid requirement.
			b) Retentionring and screws for surface mounting.
			c) 1/2" NPT 2 Valve SS-316 manifold constructedfrom bar stock for pressure switch
			d) 1/2" NPT 5-Valve SS-316 manifold constructed from bar stock for DP switch
			e) ½" NPT Brass cable gland
			f) Siphons for steam and hot water services

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7.07.02 Temperature Switch

1	Type	:	Bimetallic / gas filled-in
2	Stem /Bulb Material	:	AISI SS-316
3	Capillary	:	SS Capillary & Flexible armour
4	Case material	:	Epoxy coated die-cast aluminum alloy with neoprene gasket conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
5	Over Protection range	:	120%
6	Instrumentconnection	:	Bottom
7	Setter Scale	:	Black graduation on white linear scale. Graduation 0-100% with red pointer for set points.
8	Switch configuration	:	One DPDT (Two SPDT)
9	Switch rating	:	240V, 5A AC/220V, 0.5A DC
10	Switch type	:	Snap acting, shock and vibration-proof.
11	Adjustability	:	Internal Set point adjustable over span
12	Cable connection	:	½" NPT conduit connection or compression gland.
13	Compensation	:	a) Capillary compensation with in invar wire throughout the capillary length
			b). Case compensation
14	Performance :		
	a) Scale Accuracy		±1.0 % of full scale.
	b)Repeatability		±0.5 % of full range.
	c)Response time		Less than 40 seconds with thermowell.
15	Capillary length	:	3 meters (minimum)
16	Nameplate	:	Tag number, service engraved in stainless steel tagplate
17	Accessories	:	a). Forged thermowell, Mounting accessories,
			b). ½" NPT cable gland.
			c). Material of construction of Thermowell:
			SS 316 : In general
			Standard : ASME PTC 19.3

7.07.03 Level Switch

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Type-1			
a)	Type	:	External cage float operated, magnetically coupled
b)	Float material	:	AISI 316 stainless steel
c)	External cage &		
	other wetted part	:	AISI 316 stainless steel
d)	External cage mounting	:	Side , on standpipe
e)	External cage connection:		1” Flanged
f)	Switch housing	:	Epoxy coated die cast aluminum alloy with neoprenegasket conforming to IP-65.
g)	Enclosure class	:	IP 65
h)	Type of switch	:	Snap acting magnetically operated
i)	Switch configuration	:	1 DPDT / 2 SPDT
j)	Contact rating	:	5A, 240VAC / 0.25A, 220V DC
k)	Accessories	:	Counter flange, nuts & bolts, suitable gasket etc.
			Globe type Drain Valve.
			½”NPT Brass cable gland
l)	Application	:	Clean & non acidic fluid application in over groundtanks

Type-2			
a)	Type	:	Float operated, magnetically coupled
b)	Float material	:	Polypropylene
c)	Housing	:	Polypropylene
d)	Mounting	:	Side mounted.
e)	Process	:	1/2” NPT (F) / Flanged
	connection		
f)	Switch type	:	1 DPDT / 2 SPDT
g)	Enclosure class	:	IP 65
h)	Contact rating	:	5A, 240VAC/ 0.25A, 220V DC
i)	Cable	:	Integral FRLS PVC stranded copper (5 meters(minimum)
j)	Application	:	Acid application in over ground tank

Type-3			
1	Type	:	Capacitance type
		:	a). Rod or suspended electrode

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2	Probe		b) Rope type probes may be used only where requiredprobe length is greater than 1.5 meters.
			c) Reference rod for non grounded tank.
3	Probe Mounting	:	1-1/2” Flanged
4	Material of construction	:	316 SS and to suit fluid type
5	Insulation	:	PTFE / PP / Kynar Part / Full as required
6	Enclosure	:	Powder coated Die cast aluminium with neoprene gasketconforming to IP-65.
			(Explosion proof for NEC Class-1, Division 1 area).
7	Mounting	:	Probe on tap, switch unit separate on surface
8	Supply voltage	:	240V AC ±10%, 50Hz / 24V DC±10%,
9	Relay output	:	1 DPDT / 2 SPDT
10	Contact rating	:	5A min. at 240V AC on resistive load
11	Response time	:	100 msec or better
12	Cable connection	:	½” NPT with brass cable gland
13	Accessories	:	Counter flange, cable gland, prefab cable and stainlesssteel name plate engraved with alpha-numeric.
			Diagnostic & status LED on front of enclosure.

Type-4			
a)	Type	:	Non-contact Ultrasonic type
b)	Signal processing	:	Microprocessor Controlled
c)	Display	:	Large alpha-numeric back lit LCD / LED
d)	Calibration & Configuration		Accessible from front panel
e)	Diagnostic	:	On-line
f)	Status	:	For power, Hi / Lo / V. Hi / V. Lo-level indication,fault etc.

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g)	Construction	:	Plug-on board
h)	Power supply	:	240 V AC 50 Hz / 24V DC (UPS supply)
i)	Hysteresis	:	Fully adjustable
j)	Output contacts	:	Potential free changeover contacts @ 5A 230V AC.
k)	Repeatability	:	0.25% of span or better
l)	Operating temp.	:	Transmitter-55° C and Sensor- 80° C
m)	MOC Sensor	:	SS 316 in general PTFE , PP for corrosive application.
n)	Humidity	:	95% non-condensing.
o)	Enclosure	:	IP-65 powder coated die cast aluminum
p)	Cable connection	:	½" NPT with cable gland
q)	Mounting	:	2" flanged
r)	Accessories	:	Cable gland, mounting accessories.
s)	Application	:	Sludge pits and overhead tanks containing slurry, viscous and dirty fluid like slaked lime, lime preparation tank etc.

7.07.04 RF Type Level Switch

S.No	Feature		Essential / Minimum Requirement
A.	Application	:	Silo / Bunker level measurement & All ESP hopper
B.	Electronic Controller	:	240 V AC, 50 Hz
	Input Supply	:	24VDC/220VAC @50/60 hz
	Body material	:	Di-Cast Aluminium Housing
	Relay Output	:	2 Nos. Relay Changeover Potential Free Contacts (2SPDT)
	Contact Rating	:	5A or 6 A at 240 V AC / 24 V DC
	Class of Protection	:	IP-67
	Ambient Temperature	:	55 Deg. C (Max)
	Local Indication	:	Local indication Bar with numerical display
	Cable Connection	:	3/4" ET (2 Nos.) for Supply and Output 5/8" ET(1 No.) for Probe Connection
	Repeatability	:	100%
C.	Sensing Probe	:	

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	Type of Probe	:	Rigid
	Material	:	Stainless steel SS 316
	Probe Head Housing	:	Cast Aluminum
	Insulation (B/W Active& Shield And Shield& Ground)	:	PTFE
	Probe Head Protection	:	IP-76 for ESP application
	Mounting	:	Side Mounted
	Cable Connection	:	5/8" ET(1No.)
	Process Connection	:	40 NB BSP THREADED
D	Signal Cable	:	Coaxial cable for Connection Between Sensing probe and electronic Controller (@ 10 Mtrs. Per Level Probe)

7.08.00 FLOW ELEMENTS

7.08.01 ORIFICE PLATE

Features	Essential/Minimum Requirements
Type	Concentric as per ASME PTC-19.5 (Part-II), ISARP-, or BS-1042
Material	316 SS
Thickness	3 mm for main pipe diameter up to 250 mm,6 mm for main pipe diameter above 250 mm and 10 mm for main pipe diameter of 500mm and above.
Material of branch pipeRoot valve type Root valve material Root valve size	Same as main pipeGlobe 316 SS 1 inch
Impulse pipe of same material up to root valve	Required
Tapings	Flanged weld neck. 3 pairs. Of tapping. Beta Ratio 0.34 to 0.7
Beta Ratio calculation to be submitted	Yes
Assembly drg. And flow Vs DP Curves	Yes
Accessories	Root valves, flanges, Vent/drain hole (As required), jack screw, Meter run pipe

7.08.02 FLOW NOZZLE

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Features	Essential / Minimum Requirements
Type	Long radius, welded type as per ASME PTC-19.5 (Part-III) or BS-1042
Material	316 SS
Thickness	Suitable for intended application
Material of branch pipe Root valve type Root valve materialRoot valve size	Same as main pipeGlobe 316 SS 1 inch
Impulse pipe of same materialup to root valve	Required
Tapings	D and D/2 (3 Nos.of tappings)
Beta Ratio	Around 0.7
Beta Ratio calculation to besubmitted	Yes
Assembly drg. And flow Vs DPCurves	Yes
Accessories	Root valves, flanges, Vent/drain hole (As required), nipples, meter run pipe.

Contractor shall submit certified flow calculation and differential pressure vs. Flow curves for each element for Owner's approval. Sizing calculation, precise flow calculation for all the flow elements, fabrication and assembly drawings and installation drawings shall be submitted for Owner's approval. One Flow element of each type shall be calibrated in the test laboratory for validation of computed flow calculations.

7.08.03 VENTURI (For Liquid applications)

Features	Essential/Minimum Requirements
Type	Rough Welded (for Pipe dia between 200mm to 1200mm) or Machined (for Pipe dia 50mm to 250mm) as per ISO 5167- 4:2003
Material	Same as Main Pipe
Thickness	Same as Main Pipe
Root valve type	Globe Type
Root valve material	Same as Pipe material
Root valve size	1 inch
Impulse pipe of same material up to root valve	Required
Tapping	3 pairs of tappings for each Venturi as per ISO 5167-4:2003, However for some areas like CPU, DM & PT plant- 2 Pairs of Tappings shall

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	be provided as minimum
Beta Ratio	0.4 to 0.7
Beta Ratio calculation to be Submitted	Yes
Assembly drg. and flow Vs DP Curves	Yes
Accessories	Root valves, vent and drain hole.

Contractor shall submit certified flow calculation and differential pressure vs. Flow curves for each element for employer's approval. Sizing calculation, precise flow calculation for all the flow elements, fabrication and assembly drawings and installation drawings shall be submitted for employer's approval.

4.03.01 ROTAMETERS

Sr. No.	Features	Essential / minimum requirements
1.	Type	Variable Area Metal Tube
2.	Fluid media	Water/oil
3.	Tube body	SS316
4.	Material of float	316 SS
5.	Indicator	Linear scale
6.	Accessories	Flange, orifice in case of bypass Rota meter (for line size above 100 mm)
7.	Housing protection class	IP-65
8.	Accuracy	± 2% of measured value.
9	Scale	Graduated- Engraved black on white background.
10	Material tube	Borosilicate glass.
11	Process connection	Flanged.
12	Accessories	Slip-on orifice plate of 316-SS and taps of Stainless Steel as per application requirements. Applicable SS Isolation valves and SS Range Orifice - for bypass type rotameters.

7.08.04 ULTRASONIC FLOW METER

a. Ultrasonic Flow meter shall be dual path transit time clamp-on type.

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b. The flow meters shall be of proven reliability, accuracy and repeatability requiring a minimum of maintenance. They shall comply with relevant international standards and shall be subject to approval.

c. All accessories required for mounting/erection of these instruments shall be furnished, erected and installed as necessary for completeness of the system though not specifically asked for. Also the equipment shall include necessary cables, flexible conduits, junction boxes required for the purpose.

d. Flow meters shall be provided with suitable environment protection devices / structures such that they shall be suitable for continuous operation in the operating environment of a coal fired utility station without any loss of function or departure from the specification requirements.

e. Technical Requirements

i.	Type	:	Transit time Clamp On Ultrasonic meter
ii.	Mounting Style	:	Dual path with two sets of transducers on the same pipe
iii.	Flow measurement	:	Instantaneous Flow rate as well as totalized flow
iv.	Power supply	:	240V AC, 50Hz with built –in battery back up.
v.	Analog Outputs	:	Isolated 4-20mA linear outputs for each path
vi.	Binary Output	:	Contact relay outputs, 2 NO + 2 NC for alarm
vii.	Communication ports	:	RS 232 C digitalHand held terminal port
viii.	Display/Indication	:	Flow meter with LCD screen backlight based local display and keypad. If required, transmitter shall be suitably located away from the sensor for better access and visibility.
ix.	Recording / Totalizing / Logging Facilities	:	Yes. Should be able to compute cumulative flow over intervals selectable by Owner i.e., daily, weekly, monthly etc. The data shall be stored in the memory of flow computer for access in future.
x.	Software features	:	Compensation for any cross path errors Programming, configuration, shall be possible from front panel.
xi.	Diagnostics	:	False signal tolerance , power supply failure etc.
xii.	Protection Class	:	IP-65 or better, Weather protection against direct sunlight, rain etc for Flow meter and suitable for Cooling water for Transducer.
xiii.	Accuracy	:	± 1%
xiv.	Electrical connection	:	Plug and socket
xv.	Accessories	:	All mounting hardware required like

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clamping fixtures, mechanism to remove the transducers online, interconnecting cables etc.
All weather canopy for protection from direct sunlight and direct rain. Material of all fittings shall be SS 316.

7.08.05 MASS FLOW METER

A.	**Sensor**	
01	Measuring Principle	Coriolis Mass flow
02	Primary Element	Flow Tube of 316SS or better
03	Heating Arrangement	Integral with Flow Element
04	Temperature Control for Heating	To be provided.
05	Process Connection	ANSI RF Flanged and rating as per process requirement.
06	Drain	Self-draining facility
07	Accessories	Counter flanges, Mounting nuts, bolts, gaskets etc. Handheld configurator. Mounting U-bolts, nuts, bolts, prefab cable etc. ½"NPT cable gland.
B.	**Transmitter**	
08	Measured quantities	Mass Flow rate, Total Mass Flow, Density, Temperature as minimum.
09	Input Signal Processing	Digital Processing
10	Display	Digital Display (LCD)
11	Output	2 Nos. isolated output of 4-20mA DCselectable from four measured quantities
12	Load	< 750 ohms
13	Power supply	240V AC, 50 Hz.
14	Turn Down	100:1
15	Accuracy	± 0.2% of measured value
16	Repeatability	+ 0.05%
17	Housing	IP 65 (Explosion proof for NEC Class-1, Division 1 area)
18	Hazardous duty Version	FM Standards
19	Nameplate	Tag number, service engraved in stainless steel tag plate

7.09.00 LEVEL MONITORING INSTRUMENTS

7.09.01 DISPLACER TYPE LEVEL TRANSMITTERS

Sl. No.	Features	Essential / Minimum Requirements

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3.00.00 LOW PRESSURE PIPING

3.01.00 General

3.01.01 This section covers all the low-pressure piping up to 450mm NB size, associated valves and specialties that include but is not limited to the following systems.

3.01.02 Service Air System - shall consist of distributions terminated at hose valves for general housekeeping on the different floors of Power House, boiler galleries and other auxiliary buildings of Main Plant. Distribution scheme shall also include some continuous and intermittent requirement of boiler and Turbine-generator islands. Fundamentally for this project both Instrument air and Service air are considered as instrument quality air.

3.01.03 Instrument Air System - shall comprise of distribution of instrument quality air to pneumatically operated instruments/ valves/dampers of the Main Power House, boiler and other auxiliary buildings.

3.01.04 Service water system (clarified/filtered quality) - including supply to overhead SW tank in Power house from Plant Water System Terminal Point and from there to different distribution points of the Main Power house and other auxiliary buildings included in this package.

3.01.05 Drinking Water System - (potable water) including supply to overhead tank of Power House, from Plant Water System Terminal Point and from there to different distribution points of the Main Power House and other auxiliary buildings.

3.01.06 Demineralised Water Supply system including supply of DM water from Plant Water System to condensate storage tank and from there to different required points under Main Plant Package.

3.01.07 Demineralised Water Closed Cycle Cooling: shall include supply of DMW make up from Condensate Storage tank to DMCW make up tank via DM Service pumps and also closed DM cooling system of the boiler and turbine area coolers.

3.01.08 Air Preheater wash water system including supply of Filter/Clarified water from PWS terminal point to APH wash water storage in bidder's scope.

3.01.09 Any other low pressure piping as found necessary during detail engineering shall also be included.

3.01.10 Piping under this sub-section shall include all piping, valves and specialities as indicated herein and not limited to the following:

i) All low pressure piping including bends, elbows, tees, branches, laterals, crosses, reducing union, couplings, caps, saddles, shoes, flanges, blank flanges, Y-pieces etc. as required for the piping system under the scope of this section.

ii) Matching pipes, matching pieces like reducers/enlargers etc., counter flanges with bolts, nuts, washers, temporary and permanent gaskets, threaded union etc. for all terminals of other packages as required.

iii) Machining work of flanges, pipe spools and matching pipes to connect flow measuring orifices/nozzles with the main pipe work.

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iv) All isolating and regulating valves, non-return valves, steam/air traps, relief/safety valves (wherever applicable), strainers, pressure reducing orifices etc. complete with the counter flanges and matching connecting pieces as required within the terminal points of entire low pressure piping system.

v) Anchors, hangers and supports, etc. as required. Any platform necessary for maintenance and operation of valve and equipment located 1.5 m above any permanent floor or platform including access ladders, supporting structures etc.

vi) All secondary structural steel members required for pipe supports from building steel structures and from embedded steel wherever provided including pipe supports in trenches. However, trench piping should be avoided to the extent possible.

vii) Funnels, tundishes for drips and drains including all miscellaneous drain piping and drain piping from tundish outlet up to drain points. All drain and vent lines shall be conveniently terminated to floor drain points/permanent drain trenches of the Power Station.

viii) Flanges, counter flanges, blank flanges, bolts, nuts, washers, temporary and permanent gaskets, fasteners caps etc. as required for interconnecting piping, valves & fittings as well as for terminal points.

ix) Cleaning and Painting of all piping, valves & specialties at manufacturer's shop.

x) Following general requirements shall however be provided:

a) Instrument Connections including instruments, root valves, sensing lines etc.

b) Pipe stubs and blanking plates etc. required for chemical cleaning and hydro-testing.

c) For conducting acceptance test, the required pressure, temperature, flow measurement points shall be provided.

d) All miscellaneous instruments

3.02.00 **Codes and Standards**

3.02.01 In addition to the requirements spelt out elsewhere, the design, manufacture, inspection and testing of the piping, fittings, valves and specialties covered under this specification shall conform, in general, to the standards and codes (latest edition) mentioned below:

IS-1239 [Part-I & II]	Mild steel tubes, tubulers and other wrought steel fittings.
IS-3589	Electrically welded steel pipes for water, gas and sewage (150 to 2000 mm nominal diameter)
IS-554	Dimensions for pipe threads where pressure tight joints are required on the threads
IS-1363 [Part-I & II]	Hexagonal head bolts, screws and nuts (size range M5 M36)
IS-1364	Precision and Semi-precision hexagon bolts, screws, nuts and lock nuts (diameter range 6 to 39 mm)

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IS-3138	Hexagon bolts & nuts (M42 to M150)
IS-5312	Swing check type reflux (non-return) valves
IS-2379	Colour code for the identification of pipelines
IS-2016	Plain washers
IS-2712	Compressed asbestos fibre jointing
ANSI B-16.5	Steel pipe flanges and flanged fittings
ANSI B-16.9	Wrought steel Butt welding flanged
ANSI B-16.11	Forged steel fittings, Socket welding and Threaded
API-600	Steel gate valves
BS-2633	Class I Arc welding of ferritic steel pipe work for carrying fluids
BS-534	Specification for steel pipes and specials for water and sewage
BS-5351	Specification for Ball valves
AWWA-C-504	Specification for Butterfly valves
AWWA-C-208	Dimension for fabricated steel water pipe fittings

Equivalent codes and standards internationally accepted may also be offered by bidder. However same may be subject to acceptance by the Purchaser.

3.03.00 **Design Criteria & Requirements**

3.03.01 The piping systems included in this section shall be designed to operate continuously without replacement during the plant service life of 30 years.

3.03.02 The piping system shall be complete in every detail and in accordance with the highest standard of workmanship. Any item of the section on which the contractor is in doubt shall be referred to the Owner for clarification.

3.03.03 All design and fabrication shall be in accordance with codes/standards specified.

3.03.04 No pipe work shall be run in trenches carrying electrical cables.

3.03.05 Pipe size above 50 NB shall be shop fabricated and of size 50 NB and below shall be field run.

3.03.06 All piping shall be identified by means of colour strips and by adequate lettering, conveniently spaced and located. Identification colours and lettering shall be as approved.

3.03.07 Air release and drain branches shall be provided wherever necessary depending upon the layout and arrangement so that the drains and air release valves are located for easy operation.

3.03.08 Unless otherwise specified, all pipework shall be suitable for a minimum pressure of 10.0 kg/sq. cm(g) at 80 deg. C or as required by the design of the different piping system, if higher.

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3.03.09 DRAIN PIPE WORK

i) Low pressure drains shall have an isolating valve at the point of take-off from the pipe or vessel to be drained, or as near as possible for conventional operation.

ii) Unless otherwise stated, all drain piping shall be of 25 mm NB minimum and all vent piping shall be of 15 mm NB size minimum.

iii) Unless otherwise stated, wherever a main or branch of any pipeline is terminated with a valve, such terminal valve shall be provided with a blank flange/blanking cap at the free end.

3.03.10 Specification of pipes used in different services included in the L.P piping section has been detailed in Annexure-I of this sub-section below.

3.03.11 MATERIAL SPECIFICATION

i) Materials for pipes and fittings shall be as stipulated in Annexure-I. In case bidder wants to offer alternative piping material, same may be accepted by the Purchaser depending on the merits of alternative material.

ii) Pipe attachments for supports, anchors and restraints, which are coming in direct contact with pipes shall have similar materials as the piping concerned. All other materials of supports, anchors and restraints shall be of tested quality and as per manufacturer's standards.

3.03.12 FABRICATION

i) Except where otherwise specified all piping shall have butt welded connections with a minimum of flanged joints necessary for maintenance. Where flanges are adjacent to welded fittings, weld neck flanges shall be used.

ii) Branches shall, in general, be formed by welding. Standard fittings may be used in positions and for sizes where approval has been given in detail drawings. Pipe bends and tees shall be truly cylindrical and of uniform section. all welded branches shall be reinforced where needed as per the applicable codes/regulations.

iii) Piping shall be fabricated in the shop in the largest transportable sections to minimise the number of field weld joints. The choice of field weld joints locations shall be based on the traverse of the pipe through walls, floors, sleeves or other restrictive areas. Support attachments for major piping shall be done at shop.

iv) All pipes bends shall be made true to angle with no negative tolerance and shall have a smooth surface free of flat spots, crease and corrugations. A cross section through any bent portion of the pipe shall be true in diameter, within plus or minus 3% of the pipe diameter. Pipe bends shall be made from straight pipe pieces of sufficiently higher thickness so that after thinning, the minimum thickness of bends shall not be less than the minimum thickness required for the straight pipe. Thinning allowance shall be considered as per the relevant code.

v) For bends in pipes straight piece of pipes shall be bent by the contractor to required bend radius. However, forged bends (Bend radius = 1.5 x pipe diameter) wherever required shall be provided at no extra cost.

vi) The ends of Pipe and welded fittings shall be bevelled according to details shown in the relevant piping code. All welding shall be made in such a manner

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that complete fusion and penetration are obtained without an excessive amount of filler metal beyond root area. The reinforcement shall be applied in such a manner that it shall have a smooth contour merging gradually with the surface of adjacent pipe and welded fittings. Backing rings shall not be used on any pipe welds, unless otherwise approved by the Engineer.

vii) *Cutting and Bevelling*

a) Carbon steel piping - End preparation for butt welding shall be done by machining/flame cutting.

b) Socket welding - Socket weld and preparation shall be done by saw or machine cutting.

~~3.03.13 HANGERS, SUPPORTS, ANCHORS~~

~~i) Normally pipe supports and anchors shall be selected at those points in the buildings where provision has been made for the loads imposed. The cutting of floor/roof beams or the reinforcement in slabs will not be permitted. Piping attached to a plant item shall be supported in such a way that the weight of the piping is not taken by the plant item.~~

~~ii) Support spacing shall be as per good engineering practice. However in no case it shall be less than support spacing stipulated in ANSI B31.1.~~

~~iii) Accurate weight balance calculations shall be made to determine the required supporting force at each hanger location and the pipe weight load at each equipment connection.~~

~~iv) All large pipes and all long pipes shall have at least two supports each arranged so that any length of pipe or valve may be removed without any additional supports being required.~~

~~v) Support steel shall be of structural quality. Perforated strap, wire or chain shall not be used. Support components shall be connected to support steel by welding, by bolting or by beam clamps. Bolt holes shall be drilled and not burned. Support components may be bolted to concrete using approved concrete anchors.~~

3.03.14 VALVES AND ACCESSORIES

i) All valves shall be of approved make and type and shall have cast/forged bodies with covers and glands of approved construction and materials as specified in Annexure-II & III of this sub-section. The valves shall be provided with electric motors/solenoids and actuators as required.

ii) Valves and specialties to be supplied under this specification will be used for various air and water services and will be located indoor/outdoor and on horizontal/vertical runs of the pipe lines. However, mounting of valves in vertical pipe runs should be avoided as far as possible.

iii) All valves shall, unless otherwise stated, have the internal diameter same/as the internal diameter of the pipes to be joined.

iv) All valves shall receive tests at manufacturer's or bidder's works in accordance with the specific requirements of the approved Codes of Practice.

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v) Valves shall be rising stem or otherwise as approved by the Purchaser.

vi) Gate valve and Ball valve have been specified with the intention of achieving isolation and tight shut-off. In full open condition, these valves should offer minimum of resistance to fluid flow.

vii) Globe valves have been specified with the intention of achieving good control of fluid passing. The plug and seat will have therefore suitable profiles for obtaining such controlling action.

viii) Check valves have been specified in order to prevent reverse flow through them.

ix) All valves shall function smoothly without sticking, rubbing or vibration on opening or closing and shall be suitable for most stringent service conditions i.e. flow, temperature and pressure under which they may be required to operate.

x) Material, design, manufacture, testing etc. for all valves and specialties along with the accessories shall conform to the latest editions of codes.

xi) By pass valves shall be provided for larger size valves as per standards followed and as felt necessary for smooth and easy operation, even though not specifically mentioned in the specification.

xii) All flanged valves and specialties to be supplied under this section shall be provided with two (2) counter flanges, bolts, nuts, washers, gaskets etc.

xiii) All valves shall be of approved design and manufacture. Where valves are of similar size and type they shall be interchangeable with one another. Valves shall have welded or flanged connections subject to the Purchaser's approval.

xiv) All valves shall have outside screwed spindles and screwed thread of spindle shall not pass through or into the stuffing box. Where valves are exposed to the weather, protective covers shall be provided for the spindles which shall be subject to approval.

xv) Gate, Globe and Ball valves shall be provided with the following accessories in addition to other standard items:

a) Hand wheel with embossed open and shut directions.

b) Local position indicator.

xvi) Gate valves, in addition shall be provided with following extra features:

a) Bypass valve for larger valves

b) Draining arrangement

c) Enclosed Gear operators for valves 300 mm size and above for ease in operation.

xvii) All gate and globe valves shall be rising stem type.

xviii) All valves shall be provided with hand-wheels, chain, operator, extended spindle and floor stand wherever required so that they can be operated manually by a single operator from the nearest operating floor either at a lower or higher elevation as the case may be. If such a valve is provided with integral bypass then similar arrangement shall be done for the bypass valve also.

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xix) All valves and specialties shall be provided with brass Tag Discs indicating Tag numbers and nomenclature of the valve including duty or service intended and the function of the valves specialties.

xx) Stems shall preferably be arranged vertically with gland at the top, however, in no circumstances must the stem be inclined downward from horizontal or gland be at the bottom. Globe valves shall be installed with the pressure under the disc. Valves shall not be fitted in inverted position.

xxi) Where necessary, for accessibility, grease nipples shall be fitted at the end of extension piping and where possible these shall be grouped together and mounted on a common panel situated at a convenient position. A separate nipple shall be provided to lubricate each point. The Bidder shall supply the first fill of oil or grease for these parts. The Bidder shall supply a suitable manually operated grease gun for the standard type of nipple provided.

xxii) The spindles for all valves for use outside the building shall have weatherproof protection covers of approved construction.

xxiii) All valves shall be fitted with indicators so that it may be readily seen whether the valves are open or shut. In the case of those valves fitted with extended spindles, indicators shall be fitted both to the extended spindles and to the valve spindles.

xxiv) Plastic or bakelite valve hand wheels will not be accepted.

xxv) All valves shall be closed by rotating the hand wheel in a clockwise direction when looking at the faces of the hand wheel. The face of each hand wheel shall be clearly marked with the words 'Open' and 'Shut' with arrows adjacent to indicate the direction of rotation to which each refers.

xxvi) Wherever practicable heavy valves of total weight including actuator, drive motor, integral by-pass etc., equal to or greater than 500 kg shall be provided with suitable lugs to permit direct suspension by hanger rod or direct resting on bottom support, as applicable.

xxvii) Special attention shall be given to the operating mechanism for large size valves in order that quick and easy operation is obtained and maintenance is kept to a minimum.

xxviii) Eyebolts shall be provided where necessary to facilitate handling heavy valves or parts of valves.

xxix) The Bidder shall supply with his bid and in addition during the course of the Contract, comprehensive drawings showing the design of valves, test pressure and working pressure/temperatures. They should include a parts list referring to the various materials used in the valve construction.

xxx) All sampling and root valves shall be of integral body bonnet type.

xxxi) For Design Requirements for different valves refer Annexure-II & III below.

xxxii) *Safety/Relief Valves*

a) Safety/Relief valves shall be of direct spring loaded type and shall have a tight, positive and precision closing.

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b) All safety valves shall be provided with manual lifting lever.

c) Valves used for air and any other compressive fluid shall be of pop type.

d) Safety/Relief valves shall be constructed and adjusted to permit the fluid to escape without increasing the pressure beyond 10% above the set blow off pressure. Valve shall reset at a pressure not less than 2.5% and more than 5% of the set pressure.

e) Releasing capacity of the safety/relief valves shall be as per the applicable codes and standards and shall be subject to the approval of the Engineer.

f) The seat and disk of safety valves shall be of suitable material to resist erosion. The seat of valve shall be fastened to the body of the valve in such a way that there is no possibility of the seat lifting.

3.03.15 HOSE PIPE AND ACCESSORIES

i) Hose valves for service water system shall be Gate valves and service air system shall be Globe valves.

ii) Hose pipes with fittings for Service Water System:

a) The water hose shall be as per IS-444 (Type-3).

b) Length of each hose shall be 15 metres.

c) For each hose, one end shall be fitted with M.S. female coupling with swiveling nuts and soft seating ring suitable for connection to male end of hose valve and other end shall be made threaded for joining with the swiveling nut of a second hose whereby two hose lengths may be joined.

iii) Hose pipes with fittings for Compressed air System

a) The compressed air hose shall be as per IS-911 (Type 2).

3.04.00 **Erection and Installation of LP Piping**

3.04.01 All fittings like "T" pieces, flanges, reducers etc. shall be suitably matched with pipes for welding. The valves will have to be checked, cleaned or overhauled in full or in part before erection, after chemical cleaning and during commissioning.

3.04.02 Adjustments like removal of ovalties in pipes and opening or closing the fabricated bends of high pressure piping to suit the layout shall be considered part of work and the Erection contractor is required to carry out such work as per instruction of Bidder/Owner, which shall include specified heat-treatment procedures, etc. also wherever required.

3.04.03 Certain adjustments in length may be necessary while erecting high pressure pipelines and the Erection contractor should remove the extra lengths to suit the final layout after preparing edges afresh and adopting specified heat treatment procedures.

3.04.04 Suspension for piping, pressure parts, etc., will be supplied in running lengths which shall be cut to suitable sizes and adjusted as required.

3.04.05 All the valves, lifting equipments, actuators, power cylinders, etc., shall be serviced and lubricated to the satisfaction of Engineer before erecting the same and also during pre- commissioning. Even after commissioning the equipments,

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if there are problems in the operation, they have to be attended to by the Bidder during the tenure of the contract. Welding or jointing of extension spindle for valves to suit the site conditions and operational facility shall be part of erection work.

3.04.06 All tubes and pipes shall be cleaned and blown with compressed air and shown to the engineer before lifting. Bigger size pipes should be cleaned with flexible wire brush, wherever necessary. After cleaning is over the end caps shall be put back in tube openings till such time they are welded to other tubes.

3.04.07 Fine fittings, drain piping, oil systems & other small bore piping have to be routed according to site conditions and hence shall be done only in position. As such, layout of small bore piping shall be done as per site requirement. There is a possibility of slight change in routing the above pipelines even after completion of erection which shall be carried out by the Bidder without any extra cost to the Purchaser. Work shall also include fabrication of small bends at site from straight lengths to suit the site conditions.

3.04.08 No temporary supports shall be welded on the pressure parts. Welding of temporary supports, cleats, etc., on the building columns shall also be avoided. In case of absolute necessity, Erection contractor shall take prior approval from Bidder/Engineer. Further, any cutting or alteration of member of the structure or platform or other equipments shall not be done without specific prior approval of Engineer.

3.04.09 Wherever piping erected by the Erection Contractor is connected to piping or equipment erected by some other agencies the joint at the connecting point shall be considered under this specification.

3.04.10 All piping shall be grouped wherever practicable and shall be routed to present a neat appearance.

3.04.11 The piping shall be arranged to provide clearance for the removal of equipment for maintenance and for easy access to valves, instruments and other piping accessories required for operational maintenance.

3.04.12 Piping shall be generally routed above ground but where specifically indicated approved by the Engineer, the piping may be arranged in trenches, or buried and properly protected as per AWWA Standards.

3.04.13 Overhead piping shall have a minimum overhead clearance of 2.3 meters above walkways and working areas and 6 meters above roadways unless otherwise approved by the Engineer.

3.04.14 Drains shall be provided at all low points and vents at high points as per actual layout regardless of whether some have been shown in respective drawings or not. The pipelines shall be sloped towards the drain points.

3.04.15 All drips and drains for piping and equipment whether shown in the drawings or not shall terminate on the ground floor up to station drain unless otherwise noted. Leading such drains up to station drainage is also the responsibility of the Contractor.

3.05.00 **Drawings, Data, Information & Manuals**

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3.05.01 Drawings, data, Information to be furnished by the Bidder besides those already mentioned in volume: II with the offer.

3.05.02 After Award of Contract

i) Detail drawings including fabrication drawings of all shop fabricated piping system indicating design parameters and complete bill of material (Relevant Standards and grades to be indicated) and information/data pertaining to the hydrostatic and non-- destructive test requirements to be submitted progressively.

ii) Detail dimensioned drawing of each valve, specialties, indicating tag no., pressure rating, manufacturing standard, the bill of materials and hydrostatic test pressures. The drawing shall include the end preparation details and shall indicate the position of the hand wheel/operator. Technical particulars of motor operators wherever applicable shall also be indicated.

iii) General arrangement drawing for each hanger/support/anchor etc. indicating identification number, auxiliary supporting structural details, other details & information as required in the specification.

iv) Wiring diagram for all limit switches of motor operated valves.

v) The loading data required for design of structures shall be furnished well in advance to suit Purchaser's time schedule.

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ANNEXURE – I

Specification for Low Pressure Piping

	A		B		C	D
Services	**Filter/Clarified Water piping, DMCW piping**		**Drinking Water Supply, piping (filtered water, chlorinated)**		**Demineralised Water, Service and Instrument Air Piping less than and equal to 50 mm NB**	**Demineralised Water, Service and Instrument air piping for sizes equal to greater than 65 mm NB**
Material of Pipe	Carbon Steel IS-1239 Heavy Grade upto 150 mm NB and IS-3589 for sizes above 150 mm with minimum pipe thickness of 6 mm.		Carbon Steel as per IS-1239 Heavy Grade for sizes upto 150 mm NB and IS-3589 for sizes above 150 mm NB with minimum pipe thickness of 6 mm. The pipes shall be galvanized as per IS-4736		Stainless Steel as per ASTM A-312 Gr. 304. Size- as per schedule 40 ANSI B36.10	Stainless steel as per ASTM A-312 Gr. 304. Size-upto 150 mm NB as per schedule 10S, ANSI B-36.10.
Construction	ERW / Seamless		ERW / Seamless		ERW	ERW
Joints	Slipon Flange and butt weld for size 65 mm NB and above and Socket weld joint for size 50 mm NB and below.		Screwed flange for sizes 65 mm NB and above and screwed socket for size 50 mm NB and below.		Socket welded for size 50 NB and below	Slipon flange and butt weld joint.
Fittings	Pipe Sizes > = 65 mm NB	Pipe Sizes < = 50 mm NB	Pipe Sizes > = 65 mm NB	Pipe Sizes < = 50 mm NB		

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	A		B		C	D
Services	**Filter/Clarified Water piping, DMCW piping**		**Drinking Water Supply, piping (filtered water, chlorinated)**		**Demineralised Water, Service and Instrument Air Piping less than and equal to 50 mm NB**	**Demineralised Water, Service and Instrument air piping for sizes equal to greater than 65 mm NB**
Materials	ASTM-A-234 Gr. WPB	ASTM-A-105	ASTM-A-234 Gr. WPB galvanized as per IS-4736	ASTM-A-105 galvanised as per IS-4736	ASTM-A-182 F304	ASTM-A-351-CF8
Construction	Welded/ Seamless	Forged	Welded/ Seamless	Forged	Forged	Welded/Seamless
Standard	ANSI-B-16.9 for fabricated fitting AWWA-C-208	ANSI-B-16.11	ANSI-B-16.9	ANSI-B-16.11	ANSI-B-16.11	MSS-SP-43
End details	Pipe size >=65mm NB Butt welded as per ANSI-B-16.25	Pipe size <=50 mm NB Socket welded as per ANSI-B-16.11	Pipe size >=65 mm NB Screwed Flanged	Sizes <=50 mm Screwed socketed as per ANSI-B-	Socket welded	Slip - on flanges

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	A	B	C	D
Services	**Filter/Clarified Water piping, DMCW piping**	**Drinking Water Supply, piping (filtered water, chlorinated)**	**Demineralised Water, Service and Instrument Air Piping less than and equal to 50 mm NB**	**Demineralised Water, Service and Instrument air piping for sizes equal to greater than 65 mm NB**
		16.11All fittings shall be galvanized.		
Flanges	150 lb class as per ANSI-B-16.5 complete with nuts, bolts and gaskets	As per ANSI-B-16.5 pressure class 150lbs - galvanised- complete with nuts, bolts and gaskets.	As per ANSI-B-16.5 pressure class 150lb complete with nuts, bolts and gaskets. Material as per class 4.01.00.	150lb class, flat face, as per ANSI-B-16.5 complete with nuts, bolts and gaskets.
Pipes which fall under IS: 1239 shall be hydrostatically tested according to the said code.				

ANNEXURE II

SERVICES OF VARIOUS CATEGORIES OF VALVE SHALL BE AS FOLLOWS:

Valve Classification		**Service**		
A.	Cast iron body Gate/Globe/Check Valve	i) ii) iii) iv)	Service Water (Clarified/Filtered) Filtered Water Drinking Water Inhibited Demineralised Water	For sizes 65mm NB and above.
B.	Stainless steel body/ Gate/Globe /Check/Ball Valve	i) ii) iii)	For Demineralised water Drinking Water Service and Instrument Air	For all sizes For sizes less than and equal to 50 mm NB For all sizes. Ball valves to be used in air line.
C.	Steel Body valves	i) ii)	Clarified/Filtered Water Inhibited Demineralised Water for DMCW system	For sizes less than and equal to 50 mm NB
D.	Cast Iron body butterfly valve	i) ii) iii) iv)	For Demineralised Water Clarified Water Filtered Water Inhibited Demineralised Water for DMCW system	As required for safe and trouble free operation. For butterfly valve specifications refer HP piping specification also. For DM water line rubber lining/EPDM/equivalent protection to be provided

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ANNEXURE III

SPECIFICATION OF VALVES

	Cast Iron Body Gate / Globe / Check Valve	**Stainless steel Body Gate / Globe / Check / Ball Valve**	**Steel Body Gate / Globe / Check Valve / Ball Valve**
1.00.00	CIGC	SSGC	STGC
2.00.00	a) i) IS 780 for 50 mm - 300 mm NB ii) IS2906 for 350 mm NB and above or as per MSS-SP-70	a, b, c) ANSI-B-16.34	i) API 600 for 50mm NB and above /ANSI-B-16.34 ii) API 602 for size below 50mm NB/ANSI-B-16.34

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	Cast Iron Body Gate / Globe / Check Valve	Stainless steel Body Gate / Globe / Check / Ball Valve	Steel Body Gate / Globe / Check Valve / Ball Valve
	b) MSS - SP - 85 c) IS-5312/MSS - SP -71	d) BS-5351	b) BS-1873/ANSI-B-16.34 c) BS-1868/ANSI B16.34
3.00.00	To be suitably chosen considering the pressure requirement.		

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	Cast Iron Body Gate / Globe / Check Valve	Stainless steel Body Gate / Globe / Check / Ball Valve	Steel Body Gate / Globe / Check Valve / Ball Valve
4.00.00	Cast body and bonnet / cover	Forged body upto 50mm NB and Cast body above that	Same as Group-B
5.00.00			
5.01.00	IS 210 Gr. FG 260	ASTM-A-182 F304 for Ball Valves: A351 CF8 for cast body, A 182 F304 for forged body.	ASTM-A-216 Gr. WCB for cast body & ASTM-A-105 for forged body
5.02.00	IS-210 Gr. FG 260	ASTM-A-182 F304 for Gate, Globe, Check valves and 351CF 8M for Ball valves.	13% Cr Steel as per ASTM-A-182 Gr. F6 heat treated and hardened(min 250 NB) for cast body and ASTM-A-105 Hard faced

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	Cast Iron Body Gate / Globe / Check Valve	**Stainless steel Body Gate / Globe / Check / Ball Valve**	**Steel Body Gate / Globe / Check Valve / Ball Valve**
		For DKW system : ASTM-A-182 F6A (min. 250 HB)	with Stellite (min 350 HB) for forged body
5.03.00	13% Cr steel as per IS 1570	For Ball valves PTFE seats and seals.	13% Cr. Steel as per ASTM-A-182 Gr. F6
6.00.00	Socket welded for size equal to and below 50mm NB and flanged with counter flanges for 65mm NB and above.		

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		A. Cast Iron Body Gate/ Globe/Check Valve	B. Stainless steel Body Gate/Globe/Check/Ball Valve	C. Steel BodyGate/ Globe/Check Valve/ Ball Valve
7.00.00	**Testing**			
	a) Gate	**i) As per IS - 780 for 50 mm - 300 mm NB**		API-598
		ii) IS-2906 for sizes equal to and above 350 mm NB	As per ANSI B-16.34	
	b) Globe	Hydrostatic Test as per MSS-SP-85		BS-1873

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		A. Cast Iron Body Gate/ Globe/Check Valve	**B. Stainless steel Body Gate/Globe/Check/Ball Valve**	**C. Steel BodyGate/ Globe/Check Valve/ Ball Valve**
	c) Check	IS-5312/MSS-SP-71		BS--1868

4.00.00 LARGE DIAMETER LOW PRESSURE PIPING & FABRICATED TANKS

4.01.00 General

4.01.01 This specification is intended to cover the design, supply of steel plates, structural steel and all accessories as required, associated civil works, paints and protective paintings as specified and as required, fabrication, erection, painting, testing of the following items with accessories as specified.

4.01.02 The Large Diameter Piping to be fabricated and installed shall include the pipe lines having sizes 450 mm NB and above. This will also include steel lined concrete ducts.

4.01.03 The Circulating Water Piping will be used for supplying water (Filtered/Clarified Cooling Water quality as mentioned elsewhere in the specification) for condenser cooling from the CW pump house sump by C.W. Pumps to the condenser and also for taking out the hot water from the outlet of condenser to the top of cooling towers. The scheme of C.W. piping has been shown in relevant tender drawing.

4.01.04 Auxiliary cooling water (same cooling water quality as mentioned above) piping will be used for supplying auxiliary cooling water by Auxiliary C.W. pumps to the Plate Heat Exchangers and for cooling the closed cycle cooling DM water. ACW piping shall also be used for taking out the hot water from these coolers to the cooling towers / hot water header. The scheme of Auxiliary C.W. piping has been shown in relevant tender drawing.

4.01.05 All piping system as mentioned above, and shown in relevant drawings complete with all interconnections including connections with pump flanges and condenser/ equipment flanges wherever required, bends, reducers, tees, distant pieces etc. of all sizes and shapes as required for complete installation of the piping system. The nominal size of various pipes in different sections to be fabricated from steel plates is pipes above 450 mm N.B.

4.01.06 Erection of all vents, drains, instrument tapping points with stubs up to root valves and thermometer well etc.

4.01.07 Drains, vents, thermometer wells and instrument stubs up to root valves etc. Connected with the above pipelines may be erected from straight length of piping.

4.01.08 All bends, reducers, distant pieces, tees, etc. of all shapes and sizes shall, however, have to be fabricated as necessary. All materials required for the same shall be supplied by the Contractor at his own cost.

4.01.09 Valves, Flanged butterfly valves, strainers, flanges, root-valves other accessories shall be provided. Butterfly valves at C.W. pump discharge, condenser inlet and outlet, Auxiliary C.W. pump discharge shall be provided with Power actuators. Over and above, those specified above, the Bidder shall provide additional valves/strainers etc. if required for safe and trouble free operation of the systems. All the slip-on type counter flanges, blank flanges, caps, etc. necessary for the piping, shall be fabricated and installed by the Contractor to make the installation complete in all respect. All materials for the same shall be supplied by the Contractor at his own cost. All necessary bolts, nuts & gaskets required for

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installation of the system shall also be supplied by the Contractor. For details of Motor/Hydraulic Actuators, refer relevant specifications.

4.01.10 All flanged manhole and manhole covers, flanged tees with blank flanges appearing on above piping are included in the scope of work. Also all flanged tees and blank flanges for tapping water supply from these pipelines to meet the necessity of Purchaser's other equipment are included. All materials required for the same shall be supplied by the Contractor.

4.01.11 Steel hanger, supports, saddles, clamps etc. required for all the pipes at locations as indicated in the attached drawings and as required will be designed, fabricated and erected by the Contractor after approval of the relevant drawings. Supports, clamps etc. for pipeline in pipe trenches, if any and other places are also to be designed by the Contractor and fabricated and erected by Contractor after approval of his relevant fabrication drawings. All materials required for the same and also the trenches shall be made by the Contractor at his own cost.

4.01.12 All angle rings and annular rings that are to be welded in the piping for grouting in the wall openings are included. All necessary seating plates for all pipe supports with anchoring arrangement including steel straps, wearing plates to be welded to the piping system etc. are included. The concrete pedestal, thrust blocks etc. where required, shall have to be provided by the Contractor. The seating plate shall also be grouted by the Contractor. Necessary anchor bolts, nuts, sleeves etc. shall be supplied by the Contractor.

4.01.13 The details of Miscellaneous steel tanks for storage of water at atmospheric pressure to be fabricated and erected under this section of specification are given as follows :

i) One (1) Condensate storage tank for each unit (i.e. total 2 nos.) will store D.M. water at atmospheric pressure. Condensate storage tank will be located outdoor.

ii) One (1) Drinking Water Tank for each unit will be installed on the Power House Building roof. One drinking water tank and one service water tank shall also be provided on the roof of canteen.

iii) The Demineralised water (DMW) make-up tanks One for each unit will store demineralised water for supplying make-up quantity to the demineralised closed cooling circuit of the Plant. These tanks will be located at an elevated level, in the Power House.

iv) One service water tank for each unit shall be located on the Power House Building roof.

v) Fuel oil tanks

4.01.14 RUBBER EXPANSION JOINTS

i) Rubber Expansion Joints (under group-A) will be installed at the C.W. Pumps discharge and ACW pumps discharge as required. These expansion joints shall be used to take care of axial and lateral movement of the equipment and pipes. The expansion joints shall also be designed to absorb equipment vibration.

ii) The expansion joints (under Group-B) will be used on C.W Pipes at inlet and outlet of condenser to absorb relative movement between C.W Pipes and condenser.

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iii) The expansion joints under Group-`B' shall be designed for the maximum pressure that may appear in the C.W and ACW system considering shut-off, water hammer, back wash and other operating conditions. The condenser will be designed to withstand the maximum axial thrust from the inlet and outlet nozzles and if necessary pressure compensation type bellow may be provided.

iv) Expansion joints with retaining rings and requisite nos. of fixing bolts, nuts, washers gaskets connection, bellow with the companion/equipment flange.

v) Various accessories like companion flanges, control rod/unit assembly including stretcher plates, limit rods, washers, nuts, bolts etc.

vi) Spring supports if required shall be provided for supporting M.S fabricated C.W pipes at inlet to and outlet from the condenser.

vii) Required number of spring supports as detailed shall be supplied.

4.01.15 MISCELLANEOUS STEEL TANKS

i) The connections, accessories and fittings to be supplied with each tank shall be as indicated in the approved drawings, specification and as required. The piping material required inside or outside up to the flanged terminal shall be supplied by the Contractor.

ii) Tank connections shall be provided with suitable counter flanges with necessary bolts, nuts & gaskets by the Contractor, wherever required.

iii) The tank, where applicable, shall be complete with supporting structure, legs or pedestals, base plate, anchor bolts, nuts & sleeves etc. as required.

iv) The special fittings, e.g. conservation vent valves, level indicators etc. shall be supplied by the Contractor.

v) Preparation of detailed design, fabrication drawings, bill of materials, tag and piece numbers, welding procedure, etc.

vi) General layout showing pipe routing, location of expansion joints, butterfly valves, etc. as shown in enclosed drawings including their subsequent revisions will be furnished to the Contractor.

vii) Stiffeners where not specified and other structural framing for supporting tank shell shall be designed by the Contractor including supply of materials for the same.

viii) This specification covers supply of steel plates, structural steel, pipes etc. as required.

ix) The scope of work under this specification shall include excavation and backfilling work required for installation of pipes running underground.

x) Minor concrete works like pipe supports, thrust blocks, etc. as required will be supplied and erected by the Contractor at his own cost. Necessary steel work at supports shall also be supplied, fabricated and erected by the Contractor.

4.01.16 The final fixing grout over the concrete support or through the opening left in the concrete work shall be done by the Contractor.

4.02.00 **Codes and Standards**

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4.02.01 In addition to the requirements spelt out elsewhere, the design, manufacture, inspection and testing of the piping, fittings, valves and specialties including tanks, covered under this specification shall conform, in general, to the standards and codes (latest edition) mentioned below:

4.02.02 LARGE DIAMETER PIPING

IS-2062	Code for Structural Steel – For Material of pipe
IS-817	Code of practice for Training and testing of metal arc welders
IS-1367	Technical supply conditions for threaded steel fasteners
AWWA-C-504	Butterfly valve

4.02.03 STEEL STORAGE TANKS

IS-803	Code of practice for design, fabrication, and erection of vertical mild steel cylindrical welded oil storage tank.
IS-804	Rectangular pressed steel tank
IS-805	Code of practice for use of steel in gravity water tank
IS-816	Code of practice for use of metal arc welding for general construction in mild steel
IS-823	Code of procedure for manual metal arc welding of mild steel
IS-2825	Code for unfired pressure vessels
API-12D	Large welded production tanks
API-12F	Small welded production tanks
API-620	Recommended rules for design and construction of large welded, low pressure storage tanks
API-650	Welded steel tank for oil storage
BS-1564	Pressed steel tank
BS-2594	Carbon steel welded horizontal cylindrical tank

4.02.04 RUBBER EXPANSION JOINTS

EJMA	Expansion joint manufacturer's association
Fluid Sealing Association	Technical Handbook - Rubber Expansion Joints and Flexible pipe connectors

4.02.05 SPRING SUPPORTS FOR PIPES

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EJMA	Expansion joint manufacturer's association
IS-1570	Schedule for wrought steel
IS-2062	Weldable Structural Steel

4.03.00 **Design Criteria & Requirements**

4.03.01 This shall be read in conjunction with the requirement mentioned elsewhere in the specification.

4.03.02 LARGE DIAMETER PIPING

i) The pipe sizes chosen shall be the next higher size to that calculated by taking velocity of water as 2 m/s.

ii) All piping to be fabricated under this section shall be made of tested quality mild steel plates having thickness as mentioned elsewhere; however the plate thickness shall not be less than that stated below:

S. No	Pipe Dia. (O.D)	Plate Thickness
1	450 to 800 NB	10 mm
2	Above 800 to 900 NB	12 mm
3	950 NB-1200 NB	14mm
4	1200 NB-1800 NB	16mm
5	1800 NB-2500 NB	18mm
6	>2500 NB	20mm

iii) All plates used will be of mild steel quality conforming to IS-2062 (latest revision) or equivalent.

iv) Flanges should be machined on both faces. Fabrication of flanges from segment plates should be avoided. However, if under special circumstances flanges from segment plates are to be provided, on specific instructions of the Purchaser/Engineer, such flanges should be completely stress relieved after welding and all welds shall be subject to dye penetration test. These flanges should also be machined.

v) All welds are to be continuous single V butt with finished head of size equal to thickness of plate. All welding shall be as per IS- 817 (latest revision).

vi) The pipe circumferential weld shall be done in such a way that the longitudinal welds become staggered in any two consecutive sections.

vii) Pipe sections in straight lengths delivered at erection site shall be of suitable length to minimise field joints as far as possible. End preparations shall be done at the fabrication yard to facilitate site welding.

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viii) The piping shall be prepared cold rolled to true cylindrical shapes in a number of passes in a plate bending machine so that no undue stresses are developed.

ix) The pipe running underground below rail/road crossings shall be stiffened by longitudinal ribs and annular rings. The above stiffening has been provided to make the piping adequately strong so that the same will retain its true circular shape under the external loading.

x) Manholes shall be provided wherever required and the sizes shall conform to the requirement. All manholes shall be provided with flanged covers with handle, gasket, bolts, nuts etc. Manhole pits shall be provided for buried piping at regular intervals of 100 m. Valve pit, if required shall be provided for buried piping system for accessibility and maintenance of the valves. The design of the valve pit shall be approved at the detail Engineering Stage.

xi) Gaskets shall be minimum 3 mm thick full face rubber.

xii) Bolts and nuts shall be hexagonal head conforming to IS-1367 (latest revision).

xiii) The pipe sections shall be carefully placed on the sand bed prepared as specified before and then welded. The method of holding the pipe sections in position for welding during erection shall be approved by the engineer. All joints before welding shall be thoroughly cleaned and requisite welding gap maintained.

xiv) Welding shall be carried out as per provisions laid down in IS-816 (latest revision). Welding shall be done by experienced and good operators who have been qualified by tests as specified in IS-817 (latest revision).

xv) Welding sequence shall be done in such a way so as to minimise the distortion due to welding shrinkage. Any distortion will be duly rectified by the Contractor.

xvi) Welding shall not be carried out when the surface of the parts to be welded are wet for any cause and during periods of rain and strong winds unless the welder and work are properly shielded.

xvii) The unpainted ends of pipe surface shall be painted after completion of jointing. Precaution shall be taken to prevent any crack or damage in the external coating during installation. Pipes shall be laid in trenches excavated along the route and the over ground portion shall be installed as per final layout drawings furnished to the Contractor.

xviii) On completion of all welding in the pipe lines, the same shall be tested hydrostatically and after successful testing, shall be covered by sand wrapping and backfilling with earth as specified elsewhere in this specification.

xix) Installed pipe shall be closed up at both ends at the end of each day by water tight plug or other means approved by the Owner to prevent debris/animals/ human beings from entering the pipe.

4.03.03 STEEL STORAGE TANKS

i) Tanks shall be suitably constructed for safe, proper and continuous storage of liquid described. the design code, material standard, minimum plate thickness, size and other details shall be as per the specified Codes and Standards as applicable.

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ii) For cylindrical tanks, the plates shall be cold rolled through plate bending machine by several number of passes to true curvature. For rectangular pressed steel tank, the plates shall be heated uniformly in a furnace and formed in a press, each of which is capable of taking the whole part at a time. Alternatively, the plates may be pressed cold, the flanges made by V-die and the corners welded provided no cracks are developed.

iii) Vessel seams shall be so positioned that they do not pass through vessel connections. For cylindrical vessels consisting of more than two sections, longitudinal seams shall be offset.

iv) Where possible, the inside seam weld shall be ground smooth, suitable for application of corrosion resistant primer.

v) For vessels with dished ends, Bidder shall submit in his drawings details of the proposed dished ends. The details shall comprise of the following:

a) The method of manufacture.

b) Knuckle and crown radii and length on straight.

c) Whether dished ends are fabricated in one piece or segmented.

d) A sketch showing number of segments and seam arrangement, if segmented ends are proposed.

vi) Proper means shall be provided against the chance of over-turning effect of wind on an empty vertical cylindrical tank.

vii) Due consideration for wind load and/or earthquake effect shall be given by the Contractor in the design of tanks. Data for wind load and earthquake shall be taken as indicated in relevant sections. Maximum allowable stresses for design loadings combined with wind or earthquake shall not exceed 133% of stress permitted for the design loading condition but in no case shall exceed 80% of specified minimum yield strength of the material.

viii) Except where otherwise indicated in the Purchaser's drawings/ specifications, if the stiffening of the shell and/or roof is necessary the same shall be stiffened from outside.

ix) Reinforcement pads in tank connections shall be provided as per applicable code & the reinforced connection shall be completely preassembled into a shell plate. The completed assembly including the connection shall be thermally stress relieved as per API Standard 620 if specified.

x) All welding shall be done as per IS-803, IS-817, IS-823 and IS-816, latest revision as applicable. All welds are to be continuous welds. Bidder shall clearly state in his offer the make and type of welding rods proposed by him for fabrication. Inspection of welding shall be carried out in accordance to IS-822, IS-823. Welding sequence shall be adopted in such a way so as to minimise the distortion due to welding shrinkage, Contractor shall indicate in his drawing the sequence of welding proposed by him which should meet prior approval of the Engineer.

xi) *Tank Connections*

a) Bidder shall furnish all piping material required for the tank connections.

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b) Unless otherwise specified, for all flanged connections Bidder shall furnish suitable counter flanges and the necessary nuts, bolts, gasket.

c) Flange faces of all nozzles shall be machined and square with the vessel centrelines.

d) Unless otherwise stated bolts and nuts shall be of hexagonal head conforming to IS: 1367, latest revision.

e) The material and thickness of gaskets shall be suitable for the specified service. On completion of hydraulic test, contractor shall replace the gaskets used during testing at his own cost.

f) All tanks shall be provided with connections for drains, vent and overflow. Condensate storage tank shall be provided with pump recirculation connections. Spare inlet and outlet- 2 (two) each shall be provided for condensate storage tank and one (1) each for others. Each of the above spare connections shall be provided with isolating valves.

xii) *Accessories*

a) The tanks shall be provided with accessories as indicated in the Specification. All the accessories shall conform to relevant Indian Standard. The following broad guidelines are given for some of the accessories.

b) Conservation Vent Valve/Breather - Where continuous venting to atmosphere directly is not permitted for the stored liquid, a conservation vent valve or a breather of approved make & design shall be provided on each of the vent/overflow connection of the condensate storage tank. The conservation vent valves where provided, shall be designed to relieve the pressure or vacuum corresponding to plus or minus 55mm water gauge in the space above liquid in the tank. Detail cross-sectional drawing indicating materials of construction shall be submitted alongwith the proposal.

c) Level Indicator - Float operated or tubular gauge glass type indicator of high grade workmanship shall be provided on each tank. Tank of height not exceeding 3m shall have tubular gauge glass and others float operated level Indicator. For tubular gauge glass, isolating valves and protective guards against mechanical shock shall be provided.

d) Level Transmitter & switches - Where specified level transmitter & switches of approved make & type shall be furnished along with instrument root valves. Repeat accuracy of operation shall be ± 1% of the full range. At least four level switch one for High level actuation and other for Low Level actuation shall be provided for each tank to motor operated gate valves at inlet lines of specified tank. In addition low level and high level alarms should be provided for manual intervention.

e) Dip Hatch - Each large dia cylindrical tank shall be fitted with one dip hatch. Dip hatch shall have screwed end and shall be fitted with brass cap and chain.

f) All tanks shall be provided with vertical rung ladder. In addition to this, internal vertical ladder is to be provided in all tanks where the tank height exceeds 3M, vertical ladder is to be provided with cage.

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g) Top Manhole shall be provided in all tanks. Besides manhole at the side of tank shall be provided in case of condensate storage. Manhole size shall not be less than 600mm NB (min.).

xiii) When installation of tank is specified the recommendation regarding installation in IS: 803 shall be followed in general. In addition to those recommendations, the following shall also be taken care of.

xiv) The finished tank grade for cylindrical tank shall be crowned from the outer periphery to the centre with a slope. The sloping factor shall be taken as 1:36 unless otherwise specified.

xv) Sufficient number of plugged holes shall be provided in the bottom plate of the vertical tanks for bottom testing as specified in IS-803.

xvi) Welding shall be done in accordance with IS-803, IS-817 & IS-823.

xvii) Welding sequence shall be adopted in such a way so as to minimise the distortion due to welding shrinkage. Contractor shall indicate in his drawing the sequence of welding proposed by him which should meet prior approval of the Engineer.

4.03.04 RUBBER EXPANSION JOINTS

i) Design of the Expansion Joint shall take care of the axial, angular or rotational movement of the bellow and/or the equipment vibration. Axial compression or elongation of RE joint under design pressure from free condition shall be 10 mm (max.). Lateral deflection of RE joint under design pressure from free condition shall be 10 mm. Lateral deflections with simultaneous axial elongation and compression shall be 10 mm. These figures shall be confirmed based on the final details of condenser and C.W. pumps & piping.

ii) The general design and constructional features of various components of the Expansion Joints shall be as follows:

iii) *Body*

a) Expansion bellow shall be manufactured from abrasion resistant natural or synthetic rubber.

b) The Expansion Joints shall have integral flanges at both ends complete with split retaining rings. The flanges shall be made of tough non compressible duck to resist stresses set up when the flange bolts are tightened. The flange compound shall be designed to resist flow under bolting pressure. The bolt holes drilled on the flanges shall be thoroughly coated with self- vulcanizing rubber so that edges of the plies are not exposed.

c) 2 sets of split retaining rings shall be installed on each Expansion Joint to increase resistance to pressure. The rings shall be made of rolled steel IS-2062, split, bevelled and galvanized. They are to be placed directly against the flange of the Expansion Joint and bolted through it to the metal flange of the pipe. Steel washers shall be used at the points where the rings are split.

iv) *Carcass*

a) Fabrics of high strength synthetic fibres (High quantity canvas duck and polyester chord, reinforced) shall be used in suitable number of plies to hold the

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shape of the bellow at the working condition. All fabric plies shall be impregnated with rubber or synthetic components to permit flexibility between them.

b) Copper coated steel wire or solid endless rings embedded in the carcass shall be used for reinforcement of the expansion bellow.

v) Cover

a) The exterior and interior surfaces of the bellow shall be of Neoprene 3 mm thick shore hardness 65± 5 deg. durometer. Protective hypalon coatings shall be applied at the exterior.

~~vi) *Control rod assembly*~~

~~a) Expansion Joint shall be supplied with control rod assembly to prevent excessive elongation or contraction of the bellow. Control rod assembly shall consist of long bolt, nuts & lock nuts, washers/spherical washers, connecting plates (gusset plate) for fixing the assembly with companion flanges.~~

~~b) Control rod assembly shall allow transverse and rotational movements under limiting axial conditions of the expansion joints.~~

~~c) Design of the control rod assembly shall take care of the maximum axial thrust across the bellow calculated on the basis of maximum fluid internal pressure and the internal diameter of the arch.~~

~~vii) Joints shall be provided with companion flanges. Companion flanges shall be flat faced, slip-on and shall be fabricated from steel plates or forged.~~

~~4.03.05 SPRING SUPPORTS~~

~~i) The spring rate for the springs to be adopted shall be around 40 Kg/mm. The no. of springs and their initial compression for each type of support shall be selected accordingly. The above details shall be furnished along with the offer.~~

~~ii) Each spring selected shall not be loaded more than 60% of its maximum rated load while carrying the load.~~

~~iii) The spring supports shall be taken from the ground floor and the method of attachment shall be detailed by the Bidder.~~

~~iv) The material of construction of component parts shall be equal to or superior than the following:~~

~~Sl. No.~~	~~Item~~	~~Description~~
~~1.~~	~~Spring~~	~~Spring steel conforming to IS-1570 Gr.50 Cr.1 V-23 or equal~~
~~2.~~	~~Spring housing~~	~~Carbon Steel to IS-2062~~
~~3.~~	~~Base plate, anchor~~	~~Carbon Steel Hot dip galvanised bolts, nuts, etc.~~
~~4.~~	~~Saddle~~	~~Carbon Steel to IS-2062~~
~~5.~~	~~Support Table~~	~~Carbon Steel to IS-2062~~

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v) All other materials used shall be compatible with the service requirement and shall be of tested quality. In case a resilient seating is found necessary, details of same with hardness, material etc. shall be indicated in the tender.

vi) All the mounting plates, base plates, along with foundation bolts, nuts, washers etc. as required shall be supplied by the Bidder. All items required for completing the installation of the spring assemblies shall be supplied under this section.

vii) The support saddles shall be welded to the respective pipe at site by the Bidder. Bidder shall ensure that the supports can be placed in their respective position with the pipes already installed.

viii) The spring assemblies shall be set at shop for loads when filled up with water. The design shall however permit that at site load adjustment to an extent of ± 10% of specified loads shall be possible and even after this adjustment; the system will allow free movement of pipes under loaded and empty conditions. The offer shall clearly indicate method of adjustment proposed.

ix) The locking device to be provided for the spring assemblies should be such that it is possible to easily unlock the springs even when there is certain amount of unbalance between the load applied on the springs and the spring reactions. This is very important as there might always be certain difference between the theoretically calculated load for which the springs will be pre- compressed at shop and the actual load that will be applied on the springs during operating conditions.

x) After installation of the spring supports at site with pre- compressed springs in locked condition, the pipes will be filled up with water and then the springs will be released by unloading the springs. If water in pipe is required to be drained out for any repairs/maintenance works, the springs will be locked first and then the water from the pipes will be drained out so as to avoid undue uplift of the pipe because of loss of weight due to draining of water from the pipe. The system will be restored after repair/maintenance works by filling up the pipes with water and then releasing the locks of the springs.

xi) The above operation of the spring supports shall have to be demonstrated by the Bidder at site to the entire satisfaction of the purchaser.

xii) It shall be possible to take out the whole spring assembly for maintenance. Arrangement for lubrication of springs and other frictional parts shall also be provided to reduce frictional resistance.

xiii) The spring box housing shall have drain plugs to allow draining of accumulated water/other liquid etc.

4.03.06 BUTTERFLY VALVE

i) Butterfly valve and its operator shall be of heavy duty construction and shall be designed to withstand all working conditions i.e. shall be able to open/close or hold from/at any intermediate disc position, as required, without any difficulty under different combinations of flow and pressure.

ii) The design of the valve shall take into consideration the Water Hammer effect for accidental closure of the valve disc.

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iii) Shaft of butterfly valves may be of single piece extending completely through the valve disc or in two pieces, stubbed into the disc. hubs. The shaft diameter shall take into consideration the maximum differential pressure across the valve disc when the valve is closed and the shock load due to accidental closure of the valve disc.

iv) Disc. of butterfly valve shall have no external ribs transverse to the direction of flow. The disc shall be of a design that permits removal and replacement at site and shall be securely clamped on the body or disc of the valve.

v) Each butterfly valve shall be fitted with two (2) sleeve type shaft bearings, contained in the hubs of the valve body. Bearings shall be of self lubricated type and shall not have any harmful effect due to handling fluid.

vi) Shaft seals for butterfly valves shall be provided both at drive and non drive end of the shaft to prevent fluid flow to valve bearings.

vii) Design of the gear reducers for butterfly valves shall conform to AWWA standard.

viii) Butterfly valves to be used for flow regulation/control shall be designed to accommodate extra velocity through the valve passage to ensure normal service life. The design shall take care of the pressure drop across the valve disc due to control of fluid flow and shall take care of the erosion and cavitation effect on the body and the disc due to such operation.

ix) For detail specification refer Annexure-II

~~4.04.00 **Excavation and Backfilling**~~

~~4.04.01 This specification covers excavation in pipe trenches in all types of soil (including rock) including shoring, dewatering, back filling under pipes, transportation of earth within station premises, backfilling the excavated trenches with selected spoils, concrete encasement of pipe, compaction of fills and approaches, protective fencing, lighting and other safety measures as may be applicable, removal of surplus spoils to selected areas etc. and other works for underground pipe installations. The scope of work also covers protection of adjacent structures and protection, maintenance or removal of other pipes and conduits.~~

~~4.04.02 This shall be read in conjunction with the requirements specified in the Civil section/volume.~~

4.04.03 MATERIAL TO BE USED

i) Earth to be used for filling under pipes shall be clean, graded and free from harmful and deleterious material. Borrow material, if required, for backfilling the excavated trenches, shall be excavated from approved locations and levels, and shall consist of granular material free from roots, vegetations, decayed organic matter, harmful salts and chemicals, free from lumps and clods.

ii) Materials for shoring shall be of best commercial variety and approved by the Engineer and the same shall be arranged by the Contractor at their own cost.

iii) Shoring materials required for the work under this clause shall be arranged by the Contractor at his own cost.

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4.04.04 Soil investigation report shared with the Bidder shall be taken as a guidance only and variation therefrom shall not affect the terms and price of the Contract. The Bidder must satisfy himself regarding the characteristic and volume of all work including sub-soil & sub-soil water level conditions under these items and expected surface to be encountered. He must also satisfy himself about the general conditions of site and ascertain the existing and future construction likely to come up during the execution of the Contract so that he may evolve a realistic programme of execution and arrive at his quoted firm prices. No claim whatsoever in this regard would be entertained at later date.

~~4.05.00 **Execution**~~

~~4.05.01 SETTING OUT LEVELS~~

~~i) On receiving the approval from the Engineer on working drawings the Contractor shall set out the work from the control points furnished by the Engineer and fix permanent points and markers for ease of future checking. These permanent points and markers will be checked by the Engineer and certified by him after which the Contractor will proceed with the work. The Contractor will help the Engineer with men, materials, tools & instruments for checking purpose. It should be noted that this checking by the Engineer prior to start of the work will in no way absolve the Contractor of his responsibility of carrying out the work to true lines and levels and grades as per drawings and subsequent corrections, if necessary, free of cost to the Owner in case any errors are noticed in the Contractor's work at any stage.~~

~~ii) The clearance for starting excavation work in different areas within the work may be given separately by the Engineer in co- ordination with other Project work. As such prior approval of the Engineer shall be obtained by the Contractor in each individual case.~~

~~4.05.02 CLEANING AND GRUBBING ETC.~~

~~i) The area to be excavated shall be cleared out of fence, trees, logs, stumps, bush, vegetation, rubbish, slush etc. and levelled up. Trees up to 300 mm girth shall be up-rooted.~~

~~4.05.03 EXCAVATION IN TRENCHES~~

~~i) All excavation shall be done to the minimum dimensions as required for safety and working facility, wherever necessary and/or as directed by the Engineer, shoring - `close' or `open' type - shall be provided depending upon the nature of soil, the depth of trench and location of adjacent structures already constructed. It shall be the responsibility of the Contractor to take all necessary steps to prevent the sides of trenches and pits from collapsing.~~

~~ii) The rough excavation may be carried up to a maximum depth of 150 mm above the final level. The balance shall be excavated with special care. If the excavation is done to a depth greater than that shown on the drawing due to the Contractor's fault, the excess depth shall be filled up to the required level at the latter's cost with cement concrete not leaner than 1:4:8 ordinary concrete or richer as directed by the Engineer.~~

~~iii) The excavation must be carried out in the most expeditious and efficient manner.~~

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4.05.04 DEWATERING

i) All excavations shall be kept free of water.

ii) Grading in the vicinity of excavations shall be controlled to prevent surface water running into excavated areas.

iii) The Contractor shall remove by pumping or other means approved by the Engineer any water inclusive of rain water and subsoil water accumulated in excavation and keep the trench dewatered until the installation and backfilling work are complete.

iv) All pumps, cables, DG sets/pump and other materials required for dewatering shall be arranged by the Contractor at his own cost.

4.05.05 BACKFILLING IN TRENCHES WITH EARTH

i) Earth used for filling shall be free from salts, organic or other foreign matter. All clods of earth shall be broken to small pieces or removed. Filling shall be done on the sides and on top of pipes in layers not exceeding 150 mm, watered (if required depending upon moisture content of the fill material), rammed and consolidated, taking care that no damage is caused to the pipe.

ii) Here also, the fill should rise the same on each side and coincidentally be tamped in layers. As the backfilling is progressed, temporary bracings and struts supporting the shoring planks may be dismantled progressively. The ultimate removal of shoring planks shall only be done after the backfilling work on both sides of the pipe is complete.

iii) *Earth for backfilling may be obtained from:*

a) The excavated spoils being stacked at a suitable nearby place as directed by the Engineer.

b) Some borrow pits at distance as specified by the Engineer.

c) Stacks of excavated spoils left by other agencies.

d) Otherwise bidder shall make his own arrangements for backfilling material, with the approval of engineer.

iv) The final surface shall be trimmed and levelled to proper profile as desired by the Engineer.

v) *Testing and Acceptance Criteria for Backfilling Work*

a) The degree of compaction required will be as per the stipulation laid down in IS:4701. The density of soil in field shall be determined in accordance with IS:2720 (Part-XXVIII) or IS:2720 (Part-XXIX). The work of backfilling will be accepted after the Engineer is satisfied with the degree of field compaction achieved. The Engineer at his discretion, may ask the Contractor for performing the Standard compaction tests at some specified locations for determining the degree of compaction. The Contractor shall do the testing at some approved laboratory at his own cost and forward test results, in triplicate, to the Owner.

vi) *Disposal of Surplus Soil*

a) Surplus material from excavation which is not required for backfilling will be disposed of in designated disposal areas.

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b) The spoils shall be dumped in a systematic manner and spread in layers not exceeding 150 mm thick and consolidated with the help of compacting equipment.

c) This disposal shall be as approved by the engineer.

d) Bidder shall make his own arrangement to dispose surplus material, if cannot be utilised.

4.05.06 CIVIL WORKS

i) All Civil works shall confirm to the requirements of the civil section/volume of the specification.

4.06.00 **Testing and Inspection**

4.06.01 LARGE DIAMETER PIPING

i) After complete pipe lines have been laid and joined, the same shall be tested hydrostatically as specified elsewhere in the specification.

ii) All the longitudinal and circumferential welded seams shall be subjected to chalk and kerosene test prior to hydraulic testing of the complete pipe line. This shall be done at the presence of the Purchaser/Consultants.

iii) In addition to this, test coupons shall have to be provided for each longitudinal seams for mechanical tests (tensile and bend), if considered necessary by the Purchaser. The test coupons are to be broken in presence of the Purchaser. Contractor shall satisfy the purchaser that work is being carried out in accordance with the specification drawings and other conditions. Purchaser shall have full access to the Contractor's working area.

4.06.02 TESTS FOR STEEL STORAGE TANKS

i) Vertical Cylindrical Storage Tanks shall be tested generally as per IS:803 including the following :

a) Spot radiography if joint efficiency factor of 0.85 is specified.

b) Bottom plate testing by air or vacuum box.

c) Shell testing by filling with water.

d) Fixed roof testing by air.

ii) Horizontal cylindrical tanks manufactured in accordance with BS:2594 shall be tested hydraulically at 0.7 bar at the top of tank, unless otherwise specified.

iii) Pressed steel tanks shall be hydraulically tested by filling with water upto the top of tank as per IS-804.

iv) Radiography & hydrostatic tests shall be guided by IS-2825 for pressure vessels.

v) Hydraulic & other performance tests shall be conducted on all accessories of the tank as per applicable standard.

vi) All tanks shall be leak tested twice, after completion of fabrication and after application of anti-corrosion painting/ lining. The tanks shall be filled up with water in stages as directed by the Engineer. The duration of leakage test shall not be less than eight (8) hours.

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4.06.03 SHOP INSPECTION AND TESTING FOR EXPANSION JOINTS

i) The manufacturer shall conduct all tests requirement to ensure that all the component parts of the Expansion Joints offered conform to the requirements of applicable codes and standards.

ii) Each Expansion Joint shall be inspected for dimensional accuracy acceptance limits of which shall be mutually agreed upon.

iii) *Hydrostatic pressure test & leakage test*

a) All Expansion bellows shall be subjected to internal hydrostatic pressure test at a value of one and a half (1.5) times the design pressure for a period of 10 min. under each of the following conditions :

1) Free position of the bellow

2) With permitted (design) elongation & lateral deflections and

3) With design contraction and lateral deflection.

b) Inspection for leakage from the bellow shall be carried out during pressure test.

c) After the hydro test is over, the bellow shall be dimensionally inspected to check deformation, if any.

d) During the test, the control assembly shall be suitably adjusted to obtain the test conditions of the bellow.

iv) *Vacuum Test*

a) All Expansion Joints shall be subjected to vacuum test at a pressure of 700 mm of Hg for a period of 10 min. under each of the three conditions mentioned above for hydrostatic test.

v) Chemical Analysis

a) Test for chemical composition of the bellow material, split retaining ring, control rod assembly shall be carried out, if asked for in data sheets.

4.07.00 **Painting**

4.07.01 This shall be read in conjunction with the Painting Requirements of the specification.

4.07.02 LARGE DIAMETER PIPING

i) Before application of the paint, the internal and external surfaces shall be thoroughly cleaned with wire brush or blasting as required for removal of loose dirt, mill scales etc. Manufacturer's recommendation shall strictly be followed in the application of paint.

ii) Inner surface of each section of the pipe shall be given adequate number of coats of epoxy resin based red oxide primer paint or approved equal so as to achieve a dry thickness of minimum 0.8 mm. Inner surface painting shall be applied at the fabrication yard before laying the pipes in position, leaving about 200 mm at both ends for welding of joints. This portion shall be painted after completion of laying and jointing.

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iii) Outside surface of pipes and fittings including hangers and supports that will be overground or in a pit shall be given one (1) coat of red lead primer before despatch from fabrication yard. After installation, the part of the pipe line from where priming coat has been rubbed off shall be retouched with primer. Then two coats of Synthetic Enamel paint of approved quality and colour shall be applied.

iv) Outside surface of all valves and accessories supplied by the Purchaser but erected on the piping system by the Contractor shall also be given one (1) coat of synthetic enamel paint of approved quality and colour.

v) Outside surface of buried pipes and fittings shall be provided with corrosion protection as follows:

vi) One coat of coal tar primer of approved quality followed by a final coating of epoxy resin & coal tar blend and then an outer wrap shall be applied to the external surface of the coating. FRG reinforced plastic or coal tar wrap shall be used conforming to AWWA-C-203/IS10221 or approved relevant codes/ standards. Contractor shall submit detailed protection procedure for approval.

vii) The pipes that will be buried underground shall be spark tested after completion of wrapping of each sections/field jointing to check the quality of insulation that has been provided on the pipe.

4.07.03 STEEL STORAGE TANKS

i) Surface preparation: Internal Sand blasting and external wire brushing.

Pipe Dia. (O.D)	Plate Thickness
Primer	a) Internal - epoxy based Zn rich primer b) External - Synthetic Red lead.
Finish Coat	c) Internal – Coal tar epoxy d) External - Synthetic enamel

ii) Outside of bottom surface shall have 3 coats of Bitumastic paints.

4.08.00 **Drawings, Curves & Information Required**

4.08.01 The Bidder shall submit the following besides the different information required elsewhere under this section of specification.

4.08.02 Outline and fabrication drawings of the tanks indicating plate thickness, details of structural support, stiffeners and details of connections provided.

4.08.03 Illustrative literature and drawings and the equipments supplied for the accessories supplied with tanks.

4.08.04 General Arrangement and Sectional drawings with data on weight and material of construction for each category of Expansion Joints with control rod assemblies.

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4.08.05 A comprehensive write-up or brochure on the manufacturing and testing facilities in the shop of the manufacturer for rubber expansion joints.

4.08.06 Complete technical details of each type of spring support. The Bidder shall also submit outline drawings showing the support arrangements indicating principal dimensions and weight of the supports. Whenever necessary, cross-sectional details shall be furnished showing the details of assembly of components and their material of construction.

4.08.07 The Bidder shall clearly indicate for each type of support the number of spring used, rated load of springs, actual load to be carried, initial compression requirement, etc. The Bidder shall also indicate maximum and minimum spring compressions within which his design will permit spring movement for loaded and empty working conditions.

4.08.08 Various drawings, data and instruction manual shall be submitted for review/approval of Purchaser and afterwards for final distribution in quantities following the procedure as set up in the applicable clauses in General Conditions of Contract.

4.08.09 Detailed fabrication drawing showing the sizes, materials and weld edge preparation etc. The fabrication drawings shall give all necessary information for fabrication, erection and painting of steel work in accordance with provisions of this specification. Welding symbols used shall be in accordance with the requirements of IS:813 - latest revision and shall be consistent throughout. Weld lengths called on the drawings shall be net effective lengths.

4.08.10 Bidder shall submit working drawing for excavation and backfilling purpose as mentioned earlier.

4.08.11 The Contractor shall also submit detailed calculations in support of the final pipe thickness adopted.

4.08.12 Instruction Manuals covering maintenance repair and replacement of equipment fabricated and supplied by them.

4.08.13 Details of welding procedure and weld roots to be used.

4.08.14 Design calculations for plate thickness etc., considering all applicable loads, seismic effect, wind load etc.

4.08.15 Test procedures for tanks and test certificates.

4.08.16 General Arrangement drawing of each size and type of Rubber Expansion Joint with control rod assembly giving principal dimensions and weights.

4.08.17 Cross-sectional assembly drawing of each size and type of Rubber Expansion Joint complete with data on materials of construction, control rod assembly etc.

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ANNEXURE - I

SPECIFICATION OF MISCELLANEOUS STEEL TANKS

Sl. No.	**Description**	**Shape**	**Nominal Capacity (m^3) Min.**	**Nos. Reqd.**
1.	Condensate Storage Tank	Vertical cylindrical with conical roof	500	2
2.	Drinking Water Tank on Power house roof	- Do-	25	2
3.	DM Water make up Tank in DM CW system.	Horizontal Cylindrical with flat ends	5	2
4.	Service Water Tank	Horizontal Cylindrical with conical roof	35	2

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ANNEXURE- II

CAST IRON BODY BUTTERFLY VALVE

1.	Valve classification Code	:	CIBF
2.	Basic Design Code	:	AWWA-C-504
3.	Pressure	:	To be suitably chosen by the Bidder according to requirement, but not less than class 75A as per AWWA-C-504.
4.	Construction	:	Cast Body and Disc
5.	Material		
	a) Body	:	2% Ni Cast Iron as per IS-210 Gr. FG260 with 2% Ni.
	b) Valve Disc	:	-Do-
	c) Valve Shaft	:	Stainless Steel ASTM-A-479 type 304
	d) Seat ring	:	Clamping ring Stainless Steel ASTM-A-479 type 304
	e) Shaft Bearing	:	Ferrobestos LA-33
	f) Gland Packing	:	Impregnated Teflon

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	g) Seal	:	Nitrile Rubber
6.	End preparation	:	Flanged, Drilled as per ANSI B16.1. Necessary counter flange nuts, bolts, gaskets are to be provided with each valve.
7.	Testing	:	As per AWWA-C-504. However valve disc strength for both forward reverse flow is to be carried out as per BS5155. Certificate for proof of design test for similar type of valve is to be furnished.

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ELECTRIC ACTUATORS

GENERAL:

Actuators shall be designed for valve operation to ensure proper function in accordance with specifications given below and complying to EN15714-2 or equivalent. All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions.

This sub-section of specification is applicable for following types of electric actuators:

Modulating duty electric actuators:

These shall be provided as per standard practice of OEM of equipment, meeting other requirements of specifications. For specifications of Blade pitch actuators of this chapter.

Electric actuators for valves/ dampers/ gates (other than covered above):

These actuators shall be Non-Intrusive type electric actuators. The interface of these actuators with DDCMIS shall be of two types viz. with Hardwired interface and with Fieldbus interface. The common requirements of both these type of actuators are specified below, specific requirements of Non-Intrusive hardwired actuators are specified at below and specific requirements of Non-Intrusive fieldbus actuators are specified below.

1. COMMON REQUIREMENTS FOR NON INTRUSIVE ELECTRIC ACTUATORS

TYPE:
The actuators shall have integral starters with built in SPP (Single Phasing Preventer). 415 V, 3 phase 3 wire power supply shall be given to the actuator from switch board as applicable through a switch fuse unit. Control voltage of the motor starter shall be 110 V AC / 24 V DC, derived suitably from 415V power supply.

The actuators shall be Non- Intrusive electric actuator. All actuator settings including torque, limit shall be possible without opening the actuator cover and LCD indication shall be available integral to actuator body.

RATING:
(a) Supply Voltage & frequency: 415V +/- 10%, 3 Phase, 3 Wire & 50HZ +/-5%.
(b) Sizing: Open/Close at rated speed against designed differential pressure at 90% of rated voltage.
For ON/OFF type: Three successive open-close operations or 15 minutes, whichever is higher.
For inching type: 150 starts per hour or required cycles, whichever is higher.

CONSTRUCTION:
(a) Enclosure: Totally enclosed weatherproof, minimum IP-68 degree of protection.
(b) Manual Wheel: Shall disengage automatically during motor operation.

MOTOR:
(a) Type : Squirrel cage induction motor suitable for Direct On Line (DOL)starting.

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(b) Enclosure: Totally enclosed, self-ventilated.
(c) Insulation Class F. Temperature rise 70 Deg C. over 50 Deg C ambient.
(d) Bearings: Double shielded, grease lubricated antifriction.
(e) Earth Terminals: Two
(f) Protection: Single Phasing Protection, Over heating protection through Thermostat (as applicable) and wrong phase sequence protection shall be provided over and above other protection features standard to bidder's design. Suitable means shall be provided to diagnose the type of fault locally.

POSITION/TORQUE TRANSMITTER:
The Position/ Limit measurement shall be done using absolute encoders which will give information of position/ limit in both the directions. Electronic measurement of torque shall be provided.

LOCAL OPERATION:
It shall be possible to operate the actuator locally also. Lockable local/remote selection shall be provided on the actuator.

LCD DISPLAY:

A local LCD display shall be provided to give information regarding actuator alarms, status and valve position indications as a minimum in local.

WIRING:
Suitable voltage grade copper wire.

TERMINAL BLOCK:
For power cables, the grade of TBs shall be minimum 650V.

ACCESSORIES:
All required accessories (if applicable) for calibration / settings/ configuration of various parameters of actuator shall be provided.

2. SPECIFIC REQUREMENTS FOR NON INTRUSIVE HARDWIRED ACTUATORS

INTERFACES:
For ON-OFF and INCHING type actuators interface with the control system shall be through hardwired signal only.

(a) Open/Close command, open/ close status and disturbance monitoring signal (common contact for Overload, Thermostat, control supply failure, L/R selector switch at local & other protections operated) shall be provided hardwired.
(b) The actuator shall be able to accept open/close command at 24V DC with max. 2.5VA load from control system. Accordingly suitable isolated interface in the actuator shall be provided.
(c) Open/close command termination logic shall be suitably built inside actuator.

TERMINAL BOX:
Suitable terminals/ connectors, integral to actuator, for terminating instrumentation & power cables shall be provided. Necessary glands for power cables and instrumentation cables shall be provided.

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3. SPECIFIC REQUIREMENTS FOR NON INTRUSIVE FIELDBUS ACTUATORS

INTERFACES:
For ON-OFF and INCHING type actuators interface with the control system shall be through fieldbus network.

(a) Open/ close commands, open/ close feedback status, disturbance signal etc. shall be available to the Control System through the fieldbus network along with diagnostics. The detailed diagnostics including the actuator operating data shall be available to the DDCMIS through the fieldbus network.
(b) All actuators shall be Foundation Fieldbus/ Profibus compatible. However the exact protocol shall be based on finalized protocol of DDCMIS. If Profibus DP protocol is envisaged then actuator shall have two (redundant) Profibus DP ports for connecting the redundant Profibus DP cables. That is if one profibus cable is cut or not working/ not available, then complete actuator functionality shall be available through the second redundant cable without any manual intervention.
(c) Open/close command termination logic shall be suitably built inside actuator.

4. TERMINAL BOX:

Suitable terminals/ connectors, integral to actuator, for terminating fieldbus cables and power cables shall be provided. Necessary glands for power cables and armored fieldbus cables shall be provided.

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ANNEXURE - 8

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PAINTING REQUIREMENTS

PREPARED BY

(An ISO 9001:2015 certified Company)

STEAG Energy Services India Pvt. Ltd.

(A wholly owned subsidiary of STEAG Energy Services GmbH, Germany)

A-29, Sector-16, NOIDA-201301, India

FEBRUARY, 2024

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1.00.00 GENERAL

1.01.00 This section covers minimum requirements of PAINTING REQUIREMENTS for 2 x 660 MW pulverized fuel based thermal power plant; to meet well established engineering practices and other relevant codes and standards. PAINTING REQUIREMENTS will cover the following:

1.01.01 All un-insulated carbon steel and alloy steel equipment, structures, vessels, drums, tanks, etc.

1.01.02 All un-insulated carbon steel and alloy steel piping, fitting, valves, ducting, etc.

1.01.03 All structural steel work, pipe structural steel supports, walkways, handrails, ladders, platforms, etc.

2.00.00 SURFACE PEPARATION AND PAINTING

2.01.00 Surface preparation methods and painting shall be as specified herein.

2.02.00 If the bidder desires to use any method/materials (paint/primer) other than that specified, specific written approval shall be obtained from the owner/engineer, for using the substitute method/material.

2.03.00 Unless specified otherwise, paint shall Not be applied to following surfaces –

2.03.01 Surface of insulation

2.03.02 Surface of non-ferrous materials like, stainless steel / nickel / copper / brass / monel / aluminium / haste alloy / lead / galvanised steel

2.03.03 Surface of plastic and / or plastic coated materials

2.03.04 Valve stem

2.03.05 Pump rods, shafts

2.03.06 Bearings

2.03.07 Gauges

2.03.08 Lined surfaces

2.03.09 Clad surfaces

2.03.10 Nameplates

2.03.11 Code stampings

2.03.12 Push buttons

2.04.00 All pipelines shall be colour coded for identification, as per approved colour coding scheme, finalised during detailed engineering.

2.05.00 Where band colour is specified, same shall be provided at min. 30 meter intervals on long uninterrupted lines and also adjacent to valves and junctions.

2.06.00 **The scope includes-**

2.06.01 Supply of all necessary materials, equipment, weather and adjacent surface protection, scaffolding; to ensure the work is carried out in accordance with the specification and mutually agreed programme.

2.06.02 Surface preparation, application and quality control of painting and surface protection of all equipment, steel structures and piping of the project/plant.

2.06.03 Maintenance of the paint work until completion of the contract, this shall include repair of any damaged areas. Protection against any external damage, till handover of the project is the responsibility of the bidder.

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2.06.04 Disposal of painting waste resulting from painting, shall comply with applicable laws, regulations, ordinances etc., of the local authority, state or the nation pertains to the work and coating materials.

2.06.05 All necessary precautions to meet the requirements of the specification, taking into consideration safety (of personnel and equipment) and environment protection.

3.00.00 CODES AND STANDARDS

3.01.00 All materials, testing, and application shall be as per the stipulation of applicable approved International standards so far as they are equal to or more stringent than this specification. In addition to the codes and standard mentioned elsewhere in the specification, the latest edition of following standards and their amendments of any or their approved equivalent shall be followed:

Colours for ready mixed paints and enamels	IS: 5
Methods of Sampling and Test for Paints, Varnishes and Related Products	IS: 101 (All relevant Parts & Sections)
Specification for Ready Mixed Paint, Brushing, Zinc Chrome, Priming	IS: 104
Specification for ready mixed paint brushing, petrol resisting, Air drying for Interior paints of tanks and containers, Red oxide	IS: 144
Ready Mixed Paint, Brushing, Bituminous, Black, Lead-free, Acid, Alkali And Heat Resisting	IS: 158
Glossary of terms relating to paints	IS: 1303
Code of Practice for Painting of Ferrous Metals in Buildings	IS: 1477
Ready Mixed Paint, Air Drying, Red Oxide-Zinc Chrome, Priming	IS: 2074
Aluminium paints for general purposes	IS: 2339
Colour code for identification of pipe lines	IS: 2379
Code of practice for painting of concrete, masonry and plaster surfaces: Part 2 schedules.	IS 2932
Code of practice for painting of nonferrous metals in buildings	IS; 2524
Recommended Practice for Hot-Dip Galvanizing of Iron and Steel	IS: 2629
Enamel, Synthetic, Exterior : (a) Undercoating (b) Finishing	IS; 2932
Code of Practice for Whitewashing and Colour-washing	IS: 6278
Identification of pipeline used in thermal power plants	IS: 9404
Pictorial surface preparation standards for painting of steel surfaces	IS: 9954
Ready Mixed Paint, Air Drying, Red Oxide - Zinc Phosphate, Priming	IS; 12744

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Aluminium Paint, Heat Resistant	IS: 13183
Determination of dry film thickness	ISO 2808
Preparation of steel substrates before application of paint & related Products. Part-1: Rust grades & preparation grades of uncoated steel substrates & steel substrates after overall removal of previous coatings	ISO 8501-1
Assessment of dust on steel surface prepared for painting (Pressure sensitive tape method)	ISO 8502-3
Corrosion protection of steel structures by Protective paint systems	ISO 12944 (Part 1 to 8)
Paints & Varnishes (Performance requirements)	ISO 20340
Code of practice for protection of iron & steel structure against corrosion	BS EN ISO 14713
Swedish standard for surface preparation	SIS 55900
Society for Protective Coatings	SSPC
Surface preparation by Pickling	SSPC-SP-08
American Standard Test Method for paints and coatings	ASTM
Surface preparation & Protective coating	NORSOK M-501
Discontinuity (Holiday) testing of new protective coatings on conductive substrates	NACE SP0188

4.00.00 GENERAL REQUIREMENTS

4.01.00 The plant shall be designed to meet the complete requirements for a 2 x660 MW pulverized fuel based thermal power plant taking into consideration the plant location, environmental conditions, meteorological conditions, available input quality considerations to meet continuous, safe, efficient, economic and reliable working of the complete system for a period not less than 30 years.

4.02.00 All the equipments shall be protected against external corrosion by providing suitable painting.

4.03.00 Surface preparation and coatings should be durable enough, so that no repainting should be required for at least 10 years.

4.04.00 The painting should ensure optimal protection of the installation.

4.05.00 Painting should be environment friendly and easy to apply.

4.06.00 The surfaces to be provided with painting shall be properly & thoroughly properly prepared before painting.

4.07.00 Minimum requirements are specified herein.

4.08.00 Painting system for the plant shall be selected for medium corrosivity category, i.e. C3 and medium durability category, i.e. 7-15 yrs, as per ISO 12944. However, a minimum requirement of the specification has to be met.

4.09.00 System specific requirement of painting may be mentioned in other part/section of the specification. If there is any contradiction between this section and the other, the better painting scheme should be implemented.

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4.10.00 This specification covers the surface preparation, method of application and material to be used for all coating of equipment, steel structures and piping. Steel material subjected to surface preparation on shop/site shall have minimum requirements in accordance with Rust Grade B (SSPC/SSPM Volume-2).

4.11.00 Coating materials according to SSPC, EN ISO, ASTM, BIS or DIN standards, shall be used.

4.12.00 The paint manufacturers shall provide coating system data sheet for each coating system to be used containing the following information:

4.12.01 Surface preparation

4.12.02 Film thickness (min. & max.)

4.12.03 Min. & max. Recoating intervals at relevant temperatures

4.12.04 Mixing ratio, thinner details and coating repair systems

4.13.00 Owner/Engineer may take random sample of paint/materials, for testing, to ensure the quality of materials being used.

4.14.00 Shop fabricated equipment will be delivered to the site coated with a shop applied system or the manufacturer's standard finish, in accordance with the requirements of this specification.

4.15.00 For equipment that has received shop prime coat, touch-up prime coat and additional coats, as required, shall be applied in accordance with the coating schedule. It is responsibility of the vendor to ensure compatibility between shop and field applied paint systems.

4.16.00 During surface preparation and painting, necessary precautions should be taken to protect other (non target) surface from abrasive blasting, coating over spray and splatter. Any damage to other surfaces should be suitably repaired by the bidder, to the satisfaction of the owner/engineer.

4.17.00 Following should be covered in the painting schemes / schedules and quality plans-

4.17.01 Recommended paint scheme for the project.

4.17.02 Procedure for surface preparation & application.

4.17.03 Latest published product & instructions for application data.

4.17.04 Pre-qualification for equipment and blasting materials, product, procedure and personnel qualifications for the paint and painting systems.

4.17.05 Paint repair procedures.

4.18.00 Painting records shall contain:

4.18.01 Equipment/component/location, which is painted

4.18.02 Date of painting

4.18.03 Paint details such as specification no., colour, date of manufacturer, expiry date, shelf life & pot life.

4.18.04 Application method and equipment

4.18.05 Ambient conditions at the time of painting.

4.18.06 Surface temperature.

4.18.07 Drying time between coating, DFT and number of coatings.

4.19.00 **Surface Preparation**

4.19.01 All surfaces to be painted shall be thoroughly cleaned of oil, grease and other native & foreign materials.

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4.19.02 Surfaces shall be free from moisture and contamination from chemicals and solvents.

4.19.03 Rust, mill scale, weld spatter, flux, shall be removed by the methods indicated in the Painting Scheme/Schedule.

4.19.04 Removal of grease and oil contamination shall be in accordance with SSPC-SP1 prior to cleaning process described below.

4.19.05 Mechanical cleaning by power tool and scrapping with steel wire brushes shall be adopted to clear the surfaces. However, in certain locations where power tool cleaning cannot be carried out, hand scrapping may be permitted with steel wire brushes and/or abrasive paper.

4.19.06 Cleaning with solvents shall be resorted to only in such areas where, it is required, to achieve the desired results. Cleaning with solvents shall be adopted only after written approval of the Engineer.

4.19.07 Machined surfaces shall be protected during the cleaning operations.

4.19.08 The blast cleaned surface shall be checked for signs of salt contamination as per ISO 8502-6 &9. The maximum allowable level of contamination shall be 20 mg/m^2. Surfaces that do not meet these criteria should be reprocessed.

4.19.09 The following surface preparation schemes are majorly envisaged. Depending upon the requirement, any one or combination of these schemes, or equivalent, may be employed to achieve the necessary surface preparation before application of primer.

SP1	Solvent cleaning
SP2	Application of rust converter (Ruskil or equivalent grade)
SP3	Power tool cleaning
SP4	Shot blasting (shot blasting shall be used as surface preparation method for hot worked pipes, prior to application of primer)
SP4*	Shot blast cleaning/ abrasive blast cleaning to SA21/2 (near white metal) 35-50 microns
SP5	Shot blasting/ abrasive blasting
SP6	Emery sheet cleaning/Manual wire brush cleaning

4.19.10 MANUAL CLEANING

i) Manual/power tool cleaning shall be done as per grade St-2 or St-3, of ISO 8504-3. This method to be used for repair painting or on already painted surface and in case of usage on new construction painting, prior approval may be obtained from owner/engineer.

	Condition of surface	ISO 8504-3	SIS 55900	SSPC
Hand tool cleaning	Rusted	C St2	C St2	SP2
	Rusted & pitted	D St2	D St2	SP2
Power tool cleaning	Rusted	C St3	C St3	SP3
	Rusted & pitted	D St3	D St3	SP3

a) Grade St-2: Thorough scraping and wire brushing, machine brushing, grinding etc. This grade of preparation shall remove loose mill scale, rust and foreign matter. Finally the surface is to be cleaned with a vacuum

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cleaner or with clean compressed air or with clean brush. After preparation, the surface should have a faint metallic sheen. The appearance shall correspond to the prints designated St-2

b) Grade St-3: Very thorough scraping and wire brushing, machine brushing, grinding etc. After preparing the surface, it should have a pronounced metallic sheen and correspond to the prints designated St-3

4.19.11 BLAST CLEANING

i) *Compressors*: Compressed air supply for blast cleaning shall be free of water and oil. Air compressors shall not be allowed to deliver air at 110 ºC. The blasting activity shall be performed at ambient temperatures above 5ºC and relative humidity less than 85%. Steel temperature shall be 3ºC above dew point. Necessary safety precautions for equipment and operator shall be adhered to.

ii) *Abrasives*: Abrasives used for blast cleaning carbon steel and alloy steel shall be as per ISO 8504-2 and SSPC painting manual. Suggested abrasives may be chilled iron grit or shot steel and malleable iron grit and shots non metallic abrasive (aluminium oxide, copper slag, garnet etc.).

iii) Removal of mill scale and rust using abrasives such as grit or shot under high pressure. The grade of blasting performed in line with the approved painting scheme.

iv) The quality and grain size of abrasives and the parameter of their use are to be chosen to obtain the surface profile depth and cleanliness. Abrasives shall comply with applicable laws, regulations, ordinances etc., of the local authority, state or the nation pertaining to the work.

v) Profile measurements for abrasive blast cleaned surface shall be made with a Profile comparator and permanent record shall be maintained with Testex Press-O-Film.

vi) Surfaces prepared for coating shall be coated the same day and before any visible rusting occurs (the time elapsed between blast cleaning and commencement of painting shall under no circumstances exceed 6 hours, and in any case, must commence before signs of degradation occur).

vii) After blasting cleaning, depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 25 mm may be used.

4.20.00 **Application of Primer & Paint**

4.20.01 The paint/primer manufacturer's instructions regarding thinning, mixing, method of application, handling and drying time shall be strictly followed and considered as part of this specification. The Dry film thickness (DFT) of primer/paint shall be as specified herein.

4.20.02 Surfaces prepared as per the agreed/approved surface preparation scheme shall be applied with primer paint within 6 hours after preparation of surfaces.

4.20.03 Paint application shall be by brush, roller or spray gun. Local regulations regarding spray and roller coating shall be observed. A smooth uniform film shall be applied to the surfaces to be coated.

4.20.04 Where primer coat has been applied in the shop, the primer coat shall be carefully examined, cleaned and spot primed with one coat of the primer before applying intermediate and finish coats.

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4.20.05 When the primer coat has not been applied in the shop, primer coat shall be applied by brushing, rolling or spraying on the same day as the surface is prepared. Primer coat shall be applied prior to intermediate and finish coats.

4.20.06 Steel surfaces that will be concealed by building walls shall be primed and finish painted before the floor is erected. Tops of structural steel members that will be covered by grating shall be primed and finish painted before the grating is permanently secured.

4.20.07 Painting shall be performed when the temperature of the surface is greater than 3ºC above the dew point of the surrounding air and relative humidity of the air is less than 85%, unless local conditions dictate otherwise, and the Owner is in agreement. Guidance on the estimation of the probability of condensation can be found in ISO 8502-4. The measurement of these conditions is the responsibility of the bidder.

4.20.08 In addition, paints shall not be applied under the following conditions:

i) When the surface temperature is greater than 60 ºC, unless a higher temperature is agreed by the paint manufacturer.

ii) When the air temperature is less than approximately 5ºC, depending on local conditions.

iii) When there is the likelihood of an unfavourable change in weather conditions within two hours after painting.

iv) When there is a deposition of moisture in the form of rain, condensation, frost, etc., on the surface.

v) When the available light is less than 500 lux.

4.20.09 Paints shall not be applied within 50 mm of edges which will later have to be welded. Such weld edge preparation areas shall be applied with one coat of weldable primer for distance of 50 mm either side of the weld line.

4.20.10 For internal protection of pipes/tubes, VCI pellets shall be used at both ends after sponge testing and ends capped. VCI pellets shall not be used for SS components and composite assemblies.

4.20.11 On the internal surface of 1000 NB & above pipes (non-sea water application), a primer coat followed by hot coal tar enamel or coal tar epoxy painting (cold) shall be applied.

4.20.12 When zinc rich primers are used, care shall be taken to mask to avoid any possibility of over spraying onto duplex, austenitic stainless steels; nickel alloys or 9% nickel steel components.

4.20.13 Two pack coatings like Air drying epoxy, Polyurethane coatings etc shall be mixed in the ratio recommended by manufacturer to ensure proper and complete curing of the coatings. The base and hardener are to be separately mixed first to obtain a homogenous mixture. The hardener is to be added to the base slowly, with continuous mixing / agitation and not the reverse. Power agitation is preferred over hand mixing.

4.20.14 Any addition of thinner to achieve the application viscosity should be made only after the components are thoroughly mixed. Excess thinner is not recommended, as increase in volume, leads to lower DFT, sagging, longer curing time, etc.

4.20.15 Coating containing heavy or metallic pigments that have a tendency to settle shall be kept in suspension by continuous use of a mechanical agitator whilst

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being applied, to ensure uniformity over the surface area (e.g., zinc MIO's pigmented materials).

4.20.16 For Primer, high quality surface preparation is necessary and good amount of moisture is required for proper curing. Below 70 % relative humidity, curing time may go up to 7 days or more. In such a case additional water sprinkling may be ensured for completion of curing. Additionally Inorganic zinc silicate cannot be recoated; even with itself. Typically it should be used when coating bare steel surface for first time.

4.20.17 The most frequent problem associated when top coating Primer is bubbling/pin-holing especially with non-weathered zinc silicate coatings. To a great extent, this bubbling of finish paint can be eliminated by applying a mist coat of intermediate/topcoat as the first pass of the product, allow the bubbles to subside and then apply a full coat, as required.

4.20.18 Touch up paintings on damaged areas: Surface preparation by manual tools, wire brush/ emery paper etc. Minimum 6 inches peripheral area, adjoining to damaged area to be covered. If metal surface is exposed, it is to be painted with Zinc rich epoxy (70 micron) or suitable primer with existing paint scheme. If primer is intact, intermediate & top coat to be done with specified DFT in scheme.

4.20.19 SPRAY APPLICATION

i) All adjacent areas to be masked properly to avoid spread of painting to non-target area.

ii) Approval of Owner / Engineer shall be obtained during spray painting which may cause interference to other works.

iii) Airless or pneumatic spray applications are preferred methods of application. Spraying shall be carried out keeping the spray gun at the minimum suitable distance from the work piece and consistently at 90° to the surface being painted.

iv) Correct spray tips, air pressures, etc, as recommended by the equipment supplier shall be followed, If spray painting is to be carried out.

v) Correct combination of air volume, air pressure and fluid flow are to be ensured, in case of conventional air spray, to get good atomisation, for a defect free painted surface. The major disadvantage of conventional air spray is that high build coatings can generally not be applied by this method as most paints have to be thinned to a suitable viscosity for satisfactory atomisation, and so lose their high build properties. Vendor shall follow manufacture's instruction.

vi) Air spray (pressure pot) is recommended in cases where large quantities of paint are to be applied as paint in the tank can be prevented from settling, reduces application time and also enables the gun to be turned to any angle to coat objects effectively without spilling paint.

vii) Airless spray is recommended as high build coatings can be applied without thinning, very rapid application is possible, giving an economic advantage, compared to conventional spray, overspray and bounce-back are reduced, leading to reduced losses of material and less dust and fume hazards.

viii) Each coat shall be applied uniformly and completely over the entire surface. All runs and sags shall be brushed out immediately or the paint shall be removed and the surface re-sprayed.

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ix) Very complex structures should be painted by brush instead of spray gun to avoid overspray, dry spray and unacceptable paint losses.

4.20.20 BRUSH APPLICATION

i) Brush application may be used for the following:

a) Wherever, paint manufacturer recommends brush application.

b) When areas cannot be properly coated by spraying for reasons such as material or environmental considerations

c) For the initial coat of paint to corners, edges, crevices, holes, welds or irregular surface prior to spray application

d) For 'touch up' or repairs to localize damaged paint or areas of incorrectly applied paint

e) Areas where spray painting cannot be applied properly, due to practical reasons such as, material or environmental.

ii) Brushes shall be of a style and quality that will permit the proper application of paint.

iii) Brush applications should be done in two passes that are perpendicular to each other 'wet on wet" so that a smooth coat, as near uniform in thickness as possible, is obtained thereby avoiding running and droplets. There should be no deep or detrimental brush marks. Paint shall be worked into all crevices and corners. Runs and sags shall be brushed out.

iv) During the application of each coat, all areas such as corners, edges, welds, small brackets, bolts, nuts and interstices shall receive additional paint to ensure that these areas have at least the minimum specified dry film thickness and to ensure continuity of coating.

4.20.21 ROLLER APPLICATION

i) Roller application shall only be used on relatively large surface areas and only if spraying is not on option.

ii) Roller application shall be in accordance with the paint Manufacturer's instructions.

iii) Roller application shall only be used if the first or priming coat of paint has been applied by brush.

4.20.22 COATING MATERIALS

i) The composition of the paint shall be at the discretion of the manufacturer, provided that the finished product meets the requirements of, specification, State or Local regulatory bodies.

ii) Material for coating shall be suitable for the intended use and shall be selected based on evaluation of all relevant aspects such as-

a) Corrosion protective properties

b) Health, safety and environment requirements

c) Properties related to application conditions, equipment and personnel

d) Experience with the coating materials and coating system

iii) All coating materials and solvents shall be protected from ignition sources and shall remain within storage temperatures and storage conditions recommended by the coating manufacturer.

iv) All coating materials and solvents shall be stored in the original container bearing the manufacturer's label and instructions.

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v) Performance standard as listed below shall be established by paint manufacturer and the quality records shall be submitted for review –

a) Adhesion test (pull off test)
b) Flexibility test
c) Salt spray test (min 1000 Hrs)
d) UV resistance test (external coating)
e) Cathodic dis bonding test (internal coating)
f) Abrasion test (internal coating)
g) Impact resistance test

vi) Performance tests of coating materials shall be as per the table below:

Abrasion Resistance	ASTM D4060
Adhesion / Pull-off strength of coatings	ASTM D4541
Dry heat resistance	ASTM D2485
Flexibility	ASTM D1737/522 (D522, 180º bend, for top coat only)
Pencil hardness (top coat only)	ASTM D3363
Salt fog resistance	ASTM B117, 2000 hrs
Weather resistance	ASTM G23, Type D
Density	ASTM D1475
Dripping properties	ASTM D883
Drying/curing or film formation	ASTM D1640
DFT/Coat	AS per SSPC guidelines
Water/Humidity resistance for 2000 hrs	ASTM D2247
Accelerated environment exposure resistance	ASTM D 822

4.20.23 STEEL STRUCTURES

i) *Primer coat*; All steel surfaces shall be provided with two component moisture curing zinc (ethyl) silicate primer coat (having minimum 80% of metallic Zinc content in dry film, solid by volume minimum 60% ±2%) of minimum 70 micron DFT to be applied over blast cleaned surface conforming to Sa 2 ½ finish of ISO 8501-1 with surface profile 40-60 Micron. The primer coat shall be applied in shop immediately after blast cleaning by airless spray technique. Zinc dust composition and properties shall be Type-II as per ASTM D520-00.

ii) *Intermediate coat*: Primer coat shall be followed with the application of Intermediate coat of two component polyamide cured epoxy with MIO Content (containing lamellar MIO minimum 30% on pigment, solid by volume minimum 80% ±2%) of minimum 100 micron DFT. This coat shall be applied in shop after an interval of minimum 24 hours (from the application of primer coat) by airless spray technique.

iii) *Final Coat*: Intermediate coat shall be followed with the application of finish coat of two pack aliphatic Isocyanate cured acrylic finish paint (solid by volume minimum 55% ±2%) with Gloss retention (SSPC Paint Spec No 36, ASTM D 4587, D 2244, D 523) of Level 2 (after minimum 1000 hours exposure, Gloss loss less than 30 and colour change less than 2.0 ΔE) and minimum 70 micron

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DFT. This coat shall be applied shop after an interval of minimum 10 hours and within six (6) months (from the completion of Intermediate coat), Colour and shade of the coat shall be as approved by the owner/consultant.

4.20.24 GRATINGS & STEP THREADS

i) Surface preparation: Gratings and step threads shall be cleaned by acid pickling as per SSPC-SP-08.

ii) *Hot dip galvanising*: The hot dip galvanising shall be done as per IS 2629 .The average mass of coating shall be 610 gm/m^2.

iii) *Post galvanising treatment*: Immediately after galvanising, post treatment such as chromating shall be applied to retard white rust attack.

iv) Touch up mechanical damages: The repair of damages coatings shall be done as per the recommended practice ASTM A 780.

4.20.25 All Mild steel (MS) handrails and ladders in outdoor locations and in pump valve pits shall be galvanised at the rate of 610 gm/m^2 as per IS 4736. All other MS handrails shall be painted as specified for structural steel

4.20.26 COATING OF MILD STEEL PARTS IN CONTACT WITH WATER

i) All mild Steel parts coming in contact with water or water vapour shall be hot dip galvanised. The Minimum Coating of Zinc shall be 610 gm/m^2 for galvanised structures and shall comply with IS: 4759 and other relevant Codes. Galvanising shall be checked and tested in accordance with IS: 2629.

ii) The galvanising shall be followed by the application of an etching Primer and dipping in black bitumen in accordance with BS: 3416, unless otherwise specified.

4.20.27 SG membrane walls and other flue gas swept pressure part surfaces shall be applied with appropriate primer for protection of surfaces during transit, storage and erection.

4.20.28 All un-insulated equipments, pipes, valves etc covered in Part-A, Section-2 (Steam Turbine & Auxiliary system) shall be painted with paint not inferior to Epoxy resin based paints with minimum DFT of 150 micron.

i) The paint shall be applied in three stages i.e. primer, intermediate and finish coats in following manner:

a) Primer coat – Epoxy based zinc phosphate

b) Intermediate coat – Epoxy based TiO_2 pigmented coat

c) Finish coat – Epoxy based finish coat / Two pack polyurethane coat

ii) Equipment, pipes etc. with high temperature shall be painted with heat resistant aluminium paint (to be selected based on the service condition of component as per IS- 13183). Two coats of paint shall be applied with total DFT 40 micron.

4.20.29 FGD SYSTEM

i) Surface preparation shall be blast cleaned conforming to Sa 2-1/2 Swiss Standard.

ii) Primer coat shall consist of epoxy resin based zinc phosphate primer having minimum DFT of 100 microns.

iii) Intermediate coat (or under coat) shall consist of epoxy resin based paint pigmented with Titanium dioxide with minimum DFT of 100 microns.

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iv) Top coat shall consist of one coat of epoxy paint suitable pigmented of approved shade and colour with glossy finish and DFT of 75 microns. Additionally finishing coat of polyurethane of minimum DFT of 25 microns shall be provided.

4.20.30 Specification for the application of Epoxy coating for internal protection of storage tank & other vessels/tanks (as applicable) shall be as follows:

i) Primer - One coat of unmodified epoxy resin along with polyamide hardener.

ii) Paint - Two (2) coats of unmodified epoxy resin along with Aromatic adduct hardener.

iii) Total thickness of primer and paint should not be less than 400 microns.

4.20.31 Specification for application of chlorinated Rubber paint for external protection vessel, tanks, piping, valves & other equipments shall be as follows:

i) For indoor tanks, vessels, piping, valves and other equipment:

a) Surface preparation shall be done either manually or by any other approved method.

b) Primer coat shall consist of one coat of chlorinated rubber based zinc phosphate primer having minimum DFT of 50 microns.

c) Intermediate coat (or under coat) shall consist of one coat of chlorinated rubber based paint pigmented with Titanium dioxide with minimum DFT of 50 microns.

d) Top coat shall consist of one coat of chlorinated rubber paint of approved shade and colour with glossy finish and DFT of 50 microns.

e) Total DFT of paint system shall not be less than 150 microns.

ii) For outdoor tanks, vessels, piping, valves and other equipment:

a) Surface preparation shall be blast cleared using non-siliceous abrasive after usual wire brushing, which shall conform to Sa 2-1/2 Swiss Standard.

b) Primer coat shall consist of one coat of epoxy resin based zinc phosphate primer having minimum DFT of 100 microns.

c) Intermediate coat (or under coat) shall consist of one coat of epoxy resin based paint pigmented with Titanium dioxide with minimum DFT of 100 microns.

d) Top coat shall consist of one coat of epoxy paint suitably pigmented of approved shade and colour with glossy finish and DFT of 75 microns. Additionally finishing coat of polyurethane of minimum DFT of 25 microns shall be provided.

e) The paint may be applied in one coat, in case high built paint is used, otherwise two coats shall be applied.

f) Total DFT of paint system shall not be less than 300 microns.

5.00.00 QUALITY CONTROL AND INSPECTION

5.01.00 Paint materials including primers and thinners brought to site by contractor for application shall be procured directly from manufactures as per specification and shall be accompanied by manufacturer's test certificates.

5.02.00 The painting work shall be subjected to inspection by Owner / engineer at specific stages. The vendor shall offer following stage of inspection:

5.02.01 Before and after surface preparation

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5.02.02 Before and after application of primer

5.02.03 Before and after application of subsequent coats

5.02.04 During paint qualification test

5.03.00 Following coating inspection and test shall be carried out:

5.03.01 Ambient and steel temperature, relative humidity and dew point min twice in a shift.

5.03.02 Surface finish & profile check each component or once per 10 m2 after surface preparation.

5.03.03 Salt contamination test – Free from salt contamination.

5.03.04 Dry Film Thickness as per ISO 2808 No.6.

5.03.05 Holiday Test as per ASTM D 5162/ NACE SP0188.

5.03.06 Adhesion Test as per ISO 2409 for cross-cut test, or a pull-off test as per ISO 4624/ ASTM D 4541.

5.04.00 Vendor shall provide the expert technical services of the paint manufactures as and when required by Owner / engineer to ensure both the surface preparation and applications are carried out as per their recommendations. This service shall be provided without any obligation to Owner.

6.00.00 SUGGESTED COLOUR CODES FOR PAINTING

6.01.00 Suggested colour codes, for some major items area as below:

Item / Service	Ground Colour (IS: 5)
Turbine (enclosure & pedestals)	Golden yellow (356)
Generator and exciter	Golden yellow (356)
Transformers	Light grey (631)
Boiler casing, ESP & ducting	Nut Brown (413)
Structures, platforms & ladders	Dark admiralty grey (632)
Handrails	Golden yellow (356)
Fans, pumps, motors	As per OEM
Water tanks	Sea Green (217)
Fuel oil (LDO) tanks	Light brown (410)
Other Tanks & vessels (without insulation and cladding)	Light grey (631)
Air receivers	Sky blue (101)
Machine guards	Signal red (537)
Crane/hoist Structure & trolley	Golden yellow (356)
Crane hook	Crimson (540)
Piping	As per IS: 9404
Other Electrical	As per electrical specs
Buildings	As per Civil specs

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7.00.00 COATING/PAINTING SCHEME/SCHEDULE

Sl. No.	Description	Surface preparation	Primer Coat			Intermediate Coat			Finish Coat			Total DFT (min.)
			Primer	No. of Coats	DFT (µ)	Primer	No. of Coats	DFT (µ)	Primer	No. of Coats	DFT (µ)	
1.	Boiler & Auxiliaries											
a.	All insulated surfaces with temperature <95 ºC	SP3/SP4 Sa 2	HB Zn Phosphate (Alkyd base)	2	60				Zinc Chrome (Alkyd base)	2[1]	40[1]	100
b.	All insulated surfaces with temperature >95 ºC	SP3/SP4 Sa 2	Heat resistant Al. (Grades as per IS: 13183)	1	20				Heat resistant Al. (Grades as per IS: 13183)	1	20	40
2.	HP Piping											
a.	All insulated Piping, fittings/ components, Pipe clamps, Vessels/Tanks, Equipments etc.	SP3/SP4 Sa 2	Heat resistant Al. (Grades as per IS: 13183)	1	20				Heat resistant Al. (Grades as per IS: 13183)	1	20	40
b.	All un-insulated Piping, fittings/ components, Pipe clamps, Vessels/Tanks, Equipment etc.											
i.	Design temperature < or equal to 60ºC	SP3/SP4 Sa 2	HB Zn Phosphate (Alkyd base)	2	50				Zinc Chrome (Alkyd base)	3	105	155

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ii.	Design temperature from 60ºC to 200ºC	SP3/SP4 Sa 2	Heat resistant Al. (Grades as per IS: 13183)	1	20				Heat resistant Al. (Grades as per IS: 13183)	1	20	40
iii.	Design temperature >200ºC	SP3/SP4 Sa 2	Heat resistant Al. (Grades as per IS: 13183)	1	20				Heat resistant Al. (Grades as per IS: 13183)	1	20	40
c.	Constant Load Hanger (CLH) and Variable Load Hanger (VLH)	SP4* Sa 2 ½	Zn rich epoxy (92% Zn. In dry film (min.) %VS=35 (min.)	1	40				Aliphatic acrylic polyurethane, 134, %V=40 (min.)	1	30	70
d.	Other piping hanger / supports. Un-insulated valves	SP4* Sa 2 ½	HB Zn Phosphate (Alkyd base)	2	50				Zinc Chrome (epoxy base)	2	50	100
e.	Un insulated valves, Cast/forged											
i.	Design temperature < or equal to 60ºC	SP3/SP5 Sa 2	HB Zn Phosphate (Alkyd base)	2	70				Zinc Chrome (epoxy base)	2	50	120

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ii.	Design temperature >60ºC	SP3/SP5 Sa 2	Heat resistant Al. (Grades as per IS: 13183)	1	20				Heat resistant Al. (Grades as per IS: 13183)	1	20	40
f.	Weld edges	SP6 Sa1	Weldable primer	1	25							25
3.	All LP piping, fittings, components, valves, associated equipment	SP3/SP5 Sa 2	HB Zn Phosphate (Alkyd base / Zinc Chrome (Alkyd base)	2	50	Zinc Chrome (Alkyd base)	1	30	Zinc Chrome (epoxy base)	2	70	150
4.	All auxiliary steel structural steel components (Outdoor)	SP4* Sa 2 ½	Inorganic Ethyl Zn silicate	1	75	HB MIO Epoxy (TiO_2 pigmented)	1	75	a) Epoxy coat b) Final coat of Aliphatic Acrylic PU, 134	2 1	70 30	250 µ

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5.	All auxiliary steel structural steel components (Indoor)	SP4* Sa 2 ½	Inorganic Ethyl Zn silicate	1	35	HB MIO Epoxy (TiO_2 pigmented)	1	35	a) Epoxy coat b) Final coat of Aliphatic Acrylic PU, 134	2 1	50 30	150 µ
6.	ESP											
a.	All surfaces with temperature <95 ºC	SP3/SP4 Sa 2	Zinc Chrome (Alkyd base)	1	25				Zinc Chrome (epoxy base)	1	30	55
b.	All insulated surfaces with temperature >95 ºC	SP3/SP4 Sa 2	HB Zn Phosphate (Alkyd base)	2	30							60
2.	Indoor structure	Sa 2 ½	HB Zn Phosphate	2	80	HB MIO Epoxy	1	120	Poly urethane	2	60	260 µ
3.	Insulated parts exposed to temp > 120ºC	Sa 2 ½	In organic Zn silicate	2	60							60 µ
16.	For insulated piping <125 ºC	Sa 2 ½	Polyamide cured epoxy coating	2	250							250 µ

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7.	Un insulated silencer, steel stacks >120 ºC	Sa 2 ½	Ethyl Zn silicate	1	40				HR silicone aluminium paint	2	40	80 µ
4.	Water treatment plant / CPU (external)	Sa 2 ½	Zn rich epoxy	2	80	HB MIO Epoxy	2	200	Aliphatic polyuretha ne	2	80	360 µ
6.	Coal fuel piping	Sa 2	Ethyl Zn silicate	1	40				HR aluminium paint	2	40	80 µ
8.	Above ground piping	Sa 2 ½	In organic Zn silicate	2	80	HB MIO Epoxy	1	120	Poly urethane	2	60	260 µ
9.	Buried piping (external)	Sa 2 ½	Coal tar primer, coal tar enamel, inner wrap of fibre glass, final outer wrap of enamel impregnated fibre									4 mm
Sl. No.	**Description**	**Surface preparation**	**Primer Coat**			**Intermediate Coat**			**Finish Coat**			**Total DFT (min.)**
			Primer	**No. of Coats**	**DFT (µ)**	**Primer**	**No. of Coats**	**DFT (µ)**	**Primer**	**No. of Coats**	**DFT (µ)**	
10.	Buried piping (internal)	Sa 2 ½	Solid rigid polyurethane 500 µ									500 µ
11.	Storage tanks (external)	Sa 2 ½	In organic Zn silicate	2	80	HB MIO Epoxy	1	120	Poly urethane	2	60	260 µ
12.	Storage tanks (internal)	Sa 2 ½	3 coats of amine adducts									400 µ
13.	DM water tanks (internal)	Sa 2 ½	In organic Zn silicate	2	80	HB MIO Epoxy	1	150	HB coal tar epoxy	1	150	380 µ
14.	Fuel oil tanks (internal)	Sa 2 ½	In organic Zn silicate	2	80	HB MIO Epoxy	1	150	HB coal tar epoxy	1	150	380 µ
15.	Insulated parts continuously exposed to condensing water	Sa 2 ½	In organic Zn silicate	2	75							75 µ

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17.	Electrical parts, control panels, valves, pumps & motors (indoor)*	Sa 2 ½	Zn phosphate epoxy	2	80				Chlorinated rubber	2	80	160 µ
18.	Electrical parts, control panels, valves, pumps & motors (outdoor)*	Sa 2 ½	Zn phosphate epoxy	2	80				Chlorinated rubber	2	100	180 µ
19.	Switch yard, floor grills, walkways	Sa 2 ½	Hot dip galvanised coating wt. 610 gm/m^2 (coating thickness of 80 µ)									80 µ

Note:

* Manufacturer to specify details of painting system capable of withstanding environmental conditions for a period of 10 years before first maintenance.

1) The first 2 finished coats (total min.DFT of 70 microns) shall be done at shop and the 3rd finish coat (min.DFT 35 Microns) shall be applied at site.

2) For valves below 65NB and temperature up to and including 540 ºC, Parkerizing/zinc phosphate corrosion resistant coating as per ASTM F1137 is also acceptable in lieu of Aluminium paint.

3) For corrosion protection of threaded hanger rods and variable spring cages, electro galvanizing in full compliance to minimum Corrosion category C3 as per EN ISO12944 is also acceptable.

4) For spring cages, 2 coats of 30 µm (min) zinc-rich epoxy resin primer with zinc content > 80 weight % in dry film followed by 2 coats of 30 µm (min) top coat of Acrylic resin Co-polymerisate with a total combined minimum DFT of 120µm is also acceptable in lieu of above specified paint scheme.

5) For corrosion protection, all inner parts of the hangers (CLH/VLH) shall be at least in full compliance to Corrosion category C3 as per EN ISO12944.

6) For Cast/forged valves up to & including design temperature 60Deg.C, Aluminium painting as per IS-13183 Gr-3 or better with total DFT 40Micron is also acceptable.

8.00.00 DRAWINGS AND DOCUMENTS TO BE SUBMITTED

8.01.00 **Drawings and Documents to be Submitted with the bid**

8.01.01 Write-up on Surface Preparation & Painting

8.01.02 Filled-in Data Sheet-B (if applicable)

8.02.00 **Drawings and Documents to be Submitted after Award of Contract**

8.02.01 Painting Scheme / Schedule (Project / Various areas)

8.02.02 Product and application data sheets of paints & associated materials (Various materials)

8.02.03 Quality Plan of shop painting (Various areas)

8.02.04 Field Quality Plan for surface preparation and painting at site (Project / Various areas)

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VOLUME - V, -

ANNEXURE - 8

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PAINTING REQUIREMENTS

PREPARED BY

(An ISO 9001:2015 certified Company)

STEAG Energy Services India Pvt. Ltd.

(A wholly owned subsidiary of STEAG Energy Services GmbH, Germany)

A-29, Sector-16, NOIDA-201301, India

FEBRUARY, 2024

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1.00.00 GENERAL

1.01.00 This section covers minimum requirements of PAINTING REQUIREMENTS for 2 x 660 MW pulverized fuel based thermal power plant; to meet well established engineering practices and other relevant codes and standards. PAINTING REQUIREMENTS will cover the following:

1.01.01 All un-insulated carbon steel and alloy steel equipment, structures, vessels, drums, tanks, etc.

1.01.02 All un-insulated carbon steel and alloy steel piping, fitting, valves, ducting, etc.

1.01.03 All structural steel work, pipe structural steel supports, walkways, handrails, ladders, platforms, etc.

2.00.00 SURFACE PEPARATION AND PAINTING

2.01.00 Surface preparation methods and painting shall be as specified herein.

2.02.00 If the bidder desires to use any method/materials (paint/primer) other than that specified, specific written approval shall be obtained from the owner/engineer, for using the substitute method/material.

2.03.00 Unless specified otherwise, paint shall Not be applied to following surfaces –

2.03.01 Surface of insulation

2.03.02 Surface of non-ferrous materials like, stainless steel / nickel / copper / brass / monel / aluminium / haste alloy / lead / galvanised steel

2.03.03 Surface of plastic and / or plastic coated materials

2.03.04 Valve stem

2.03.05 Pump rods, shafts

2.03.06 Bearings

2.03.07 Gauges

2.03.08 Lined surfaces

2.03.09 Clad surfaces

2.03.10 Nameplates

2.03.11 Code stampings

2.03.12 Push buttons

2.04.00 All pipelines shall be colour coded for identification, as per approved colour coding scheme, finalised during detailed engineering.

2.05.00 Where band colour is specified, same shall be provided at min. 30 meter intervals on long uninterrupted lines and also adjacent to valves and junctions.

2.06.00 **The scope includes-**

2.06.01 Supply of all necessary materials, equipment, weather and adjacent surface protection, scaffolding; to ensure the work is carried out in accordance with the specification and mutually agreed programme.

2.06.02 Surface preparation, application and quality control of painting and surface protection of all equipment, steel structures and piping of the project/plant.

2.06.03 Maintenance of the paint work until completion of the contract, this shall include repair of any damaged areas. Protection against any external damage, till handover of the project is the responsibility of the bidder.

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2.06.04 Disposal of painting waste resulting from painting, shall comply with applicable laws, regulations, ordinances etc., of the local authority, state or the nation pertains to the work and coating materials.

2.06.05 All necessary precautions to meet the requirements of the specification, taking into consideration safety (of personnel and equipment) and environment protection.

3.00.00 CODES AND STANDARDS

3.01.00 All materials, testing, and application shall be as per the stipulation of applicable approved International standards so far as they are equal to or more stringent than this specification. In addition to the codes and standard mentioned elsewhere in the specification, the latest edition of following standards and their amendments of any or their approved equivalent shall be followed:

Colours for ready mixed paints and enamels	IS: 5
Methods of Sampling and Test for Paints, Varnishes and Related Products	IS: 101 (All relevant Parts & Sections)
Specification for Ready Mixed Paint, Brushing, Zinc Chrome, Priming	IS: 104
Specification for ready mixed paint brushing, petrol resisting, Air drying for Interior paints of tanks and containers, Red oxide	IS: 144
Ready Mixed Paint, Brushing, Bituminous, Black, Lead-free, Acid, Alkali And Heat Resisting	IS: 158
Glossary of terms relating to paints	IS: 1303
Code of Practice for Painting of Ferrous Metals in Buildings	IS: 1477
Ready Mixed Paint, Air Drying, Red Oxide-Zinc Chrome, Priming	IS: 2074
Aluminium paints for general purposes	IS: 2339
Colour code for identification of pipe lines	IS: 2379
Code of practice for painting of concrete, masonry and plaster surfaces: Part 2 schedules.	IS 2932
Code of practice for painting of nonferrous metals in buildings	IS; 2524
Recommended Practice for Hot-Dip Galvanizing of Iron and Steel	IS: 2629
Enamel, Synthetic, Exterior : (a) Undercoating (b) Finishing	IS; 2932
Code of Practice for Whitewashing and Colour-washing	IS: 6278
Identification of pipeline used in thermal power plants	IS: 9404
Pictorial surface preparation standards for painting of steel surfaces	IS: 9954
Ready Mixed Paint, Air Drying, Red Oxide - Zinc Phosphate, Priming	IS; 12744

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Aluminium Paint, Heat Resistant	IS: 13183
Determination of dry film thickness	ISO 2808
Preparation of steel substrates before application of paint & related Products. Part-1: Rust grades & preparation grades of uncoated steel substrates & steel substrates after overall removal of previous coatings	ISO 8501-1
Assessment of dust on steel surface prepared for painting (Pressure sensitive tape method)	ISO 8502-3
Corrosion protection of steel structures by Protective paint systems	ISO 12944 (Part 1 to 8)
Paints & Varnishes (Performance requirements)	ISO 20340
Code of practice for protection of iron & steel structure against corrosion	BS EN ISO 14713
Swedish standard for surface preparation	SIS 55900
Society for Protective Coatings	SSPC
Surface preparation by Pickling	SSPC-SP-08
American Standard Test Method for paints and coatings	ASTM
Surface preparation & Protective coating	NORSOK M-501
Discontinuity (Holiday) testing of new protective coatings on conductive substrates	NACE SP0188

4.00.00 GENERAL REQUIREMENTS

4.01.00 The plant shall be designed to meet the complete requirements for a 2 x660 MW pulverized fuel based thermal power plant taking into consideration the plant location, environmental conditions, meteorological conditions, available input quality considerations to meet continuous, safe, efficient, economic and reliable working of the complete system for a period not less than 30 years.

4.02.00 All the equipments shall be protected against external corrosion by providing suitable painting.

4.03.00 Surface preparation and coatings should be durable enough, so that no repainting should be required for at least 10 years.

4.04.00 The painting should ensure optimal protection of the installation.

4.05.00 Painting should be environment friendly and easy to apply.

4.06.00 The surfaces to be provided with painting shall be properly & thoroughly properly prepared before painting.

4.07.00 Minimum requirements are specified herein.

4.08.00 Painting system for the plant shall be selected for medium corrosivity category, i.e. C3 and medium durability category, i.e. 7-15 yrs, as per ISO 12944. However, a minimum requirement of the specification has to be met.

4.09.00 System specific requirement of painting may be mentioned in other part/section of the specification. If there is any contradiction between this section and the other, the better painting scheme should be implemented.

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4.10.00 This specification covers the surface preparation, method of application and material to be used for all coating of equipment, steel structures and piping. Steel material subjected to surface preparation on shop/site shall have minimum requirements in accordance with Rust Grade B (SSPC/SSPM Volume-2).

4.11.00 Coating materials according to SSPC, EN ISO, ASTM, BIS or DIN standards, shall be used.

4.12.00 The paint manufacturers shall provide coating system data sheet for each coating system to be used containing the following information:

4.12.01 Surface preparation

4.12.02 Film thickness (min. & max.)

4.12.03 Min. & max. Recoating intervals at relevant temperatures

4.12.04 Mixing ratio, thinner details and coating repair systems

4.13.00 Owner/Engineer may take random sample of paint/materials, for testing, to ensure the quality of materials being used.

4.14.00 Shop fabricated equipment will be delivered to the site coated with a shop applied system or the manufacturer's standard finish, in accordance with the requirements of this specification.

4.15.00 For equipment that has received shop prime coat, touch-up prime coat and additional coats, as required, shall be applied in accordance with the coating schedule. It is responsibility of the vendor to ensure compatibility between shop and field applied paint systems.

4.16.00 During surface preparation and painting, necessary precautions should be taken to protect other (non target) surface from abrasive blasting, coating over spray and splatter. Any damage to other surfaces should be suitably repaired by the bidder, to the satisfaction of the owner/engineer.

4.17.00 Following should be covered in the painting schemes / schedules and quality plans-

4.17.01 Recommended paint scheme for the project.

4.17.02 Procedure for surface preparation & application.

4.17.03 Latest published product & instructions for application data.

4.17.04 Pre-qualification for equipment and blasting materials, product, procedure and personnel qualifications for the paint and painting systems.

4.17.05 Paint repair procedures.

4.18.00 Painting records shall contain:

4.18.01 Equipment/component/location, which is painted

4.18.02 Date of painting

4.18.03 Paint details such as specification no., colour, date of manufacturer, expiry date, shelf life & pot life.

4.18.04 Application method and equipment

4.18.05 Ambient conditions at the time of painting.

4.18.06 Surface temperature.

4.18.07 Drying time between coating, DFT and number of coatings.

4.19.00 **Surface Preparation**

4.19.01 All surfaces to be painted shall be thoroughly cleaned of oil, grease and other native & foreign materials.

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4.19.02 Surfaces shall be free from moisture and contamination from chemicals and solvents.

4.19.03 Rust, mill scale, weld spatter, flux, shall be removed by the methods indicated in the Painting Scheme/Schedule.

4.19.04 Removal of grease and oil contamination shall be in accordance with SSPC-SP1 prior to cleaning process described below.

4.19.05 Mechanical cleaning by power tool and scrapping with steel wire brushes shall be adopted to clear the surfaces. However, in certain locations where power tool cleaning cannot be carried out, hand scrapping may be permitted with steel wire brushes and/or abrasive paper.

4.19.06 Cleaning with solvents shall be resorted to only in such areas where, it is required, to achieve the desired results. Cleaning with solvents shall be adopted only after written approval of the Engineer.

4.19.07 Machined surfaces shall be protected during the cleaning operations.

4.19.08 The blast cleaned surface shall be checked for signs of salt contamination as per ISO 8502-6 &9. The maximum allowable level of contamination shall be 20 mg/m^2. Surfaces that do not meet these criteria should be reprocessed.

4.19.09 The following surface preparation schemes are majorly envisaged. Depending upon the requirement, any one or combination of these schemes, or equivalent, may be employed to achieve the necessary surface preparation before application of primer.

SP1	Solvent cleaning
SP2	Application of rust converter (Ruskil or equivalent grade)
SP3	Power tool cleaning
SP4	Shot blasting (shot blasting shall be used as surface preparation method for hot worked pipes, prior to application of primer)
SP4*	Shot blast cleaning/ abrasive blast cleaning to SA21/2 (near white metal) 35-50 microns
SP5	Shot blasting/ abrasive blasting
SP6	Emery sheet cleaning/Manual wire brush cleaning

4.19.10 MANUAL CLEANING

i) Manual/power tool cleaning shall be done as per grade St-2 or St-3, of ISO 8504-3. This method to be used for repair painting or on already painted surface and in case of usage on new construction painting, prior approval may be obtained from owner/engineer.

	Condition of surface	ISO 8504-3	SIS 55900	SSPC
Hand tool cleaning	Rusted	C St2	C St2	SP2
	Rusted & pitted	D St2	D St2	SP2
Power tool cleaning	Rusted	C St3	C St3	SP3
	Rusted & pitted	D St3	D St3	SP3

a) Grade St-2: Thorough scraping and wire brushing, machine brushing, grinding etc. This grade of preparation shall remove loose mill scale, rust and foreign matter. Finally the surface is to be cleaned with a vacuum

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cleaner or with clean compressed air or with clean brush. After preparation, the surface should have a faint metallic sheen. The appearance shall correspond to the prints designated St-2

b) Grade St-3: Very thorough scraping and wire brushing, machine brushing, grinding etc. After preparing the surface, it should have a pronounced metallic sheen and correspond to the prints designated St-3

4.19.11 BLAST CLEANING

i) *Compressors*: Compressed air supply for blast cleaning shall be free of water and oil. Air compressors shall not be allowed to deliver air at 110 ºC. The blasting activity shall be performed at ambient temperatures above 5ºC and relative humidity less than 85%. Steel temperature shall be 3ºC above dew point. Necessary safety precautions for equipment and operator shall be adhered to.

ii) *Abrasives*: Abrasives used for blast cleaning carbon steel and alloy steel shall be as per ISO 8504-2 and SSPC painting manual. Suggested abrasives may be chilled iron grit or shot steel and malleable iron grit and shots non metallic abrasive (aluminium oxide, copper slag, garnet etc.).

iii) Removal of mill scale and rust using abrasives such as grit or shot under high pressure. The grade of blasting performed in line with the approved painting scheme.

iv) The quality and grain size of abrasives and the parameter of their use are to be chosen to obtain the surface profile depth and cleanliness. Abrasives shall comply with applicable laws, regulations, ordinances etc., of the local authority, state or the nation pertaining to the work.

v) Profile measurements for abrasive blast cleaned surface shall be made with a Profile comparator and permanent record shall be maintained with Testex Press-O-Film.

vi) Surfaces prepared for coating shall be coated the same day and before any visible rusting occurs (the time elapsed between blast cleaning and commencement of painting shall under no circumstances exceed 6 hours, and in any case, must commence before signs of degradation occur).

vii) After blasting cleaning, depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 25 mm may be used.

4.20.00 **Application of Primer & Paint**

4.20.01 The paint/primer manufacturer's instructions regarding thinning, mixing, method of application, handling and drying time shall be strictly followed and considered as part of this specification. The Dry film thickness (DFT) of primer/paint shall be as specified herein.

4.20.02 Surfaces prepared as per the agreed/approved surface preparation scheme shall be applied with primer paint within 6 hours after preparation of surfaces.

4.20.03 Paint application shall be by brush, roller or spray gun. Local regulations regarding spray and roller coating shall be observed. A smooth uniform film shall be applied to the surfaces to be coated.

4.20.04 Where primer coat has been applied in the shop, the primer coat shall be carefully examined, cleaned and spot primed with one coat of the primer before applying intermediate and finish coats.

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4.20.05 When the primer coat has not been applied in the shop, primer coat shall be applied by brushing, rolling or spraying on the same day as the surface is prepared. Primer coat shall be applied prior to intermediate and finish coats.

4.20.06 Steel surfaces that will be concealed by building walls shall be primed and finish painted before the floor is erected. Tops of structural steel members that will be covered by grating shall be primed and finish painted before the grating is permanently secured.

4.20.07 Painting shall be performed when the temperature of the surface is greater than 3ºC above the dew point of the surrounding air and relative humidity of the air is less than 85%, unless local conditions dictate otherwise, and the Owner is in agreement. Guidance on the estimation of the probability of condensation can be found in ISO 8502-4. The measurement of these conditions is the responsibility of the bidder.

4.20.08 In addition, paints shall not be applied under the following conditions:

i) When the surface temperature is greater than 60 ºC, unless a higher temperature is agreed by the paint manufacturer.

ii) When the air temperature is less than approximately 5ºC, depending on local conditions.

iii) When there is the likelihood of an unfavourable change in weather conditions within two hours after painting.

iv) When there is a deposition of moisture in the form of rain, condensation, frost, etc., on the surface.

v) When the available light is less than 500 lux.

4.20.09 Paints shall not be applied within 50 mm of edges which will later have to be welded. Such weld edge preparation areas shall be applied with one coat of weldable primer for distance of 50 mm either side of the weld line.

4.20.10 For internal protection of pipes/tubes, VCI pellets shall be used at both ends after sponge testing and ends capped. VCI pellets shall not be used for SS components and composite assemblies.

4.20.11 On the internal surface of 1000 NB & above pipes (non-sea water application), a primer coat followed by hot coal tar enamel or coal tar epoxy painting (cold) shall be applied.

4.20.12 When zinc rich primers are used, care shall be taken to mask to avoid any possibility of over spraying onto duplex, austenitic stainless steels; nickel alloys or 9% nickel steel components.

4.20.13 Two pack coatings like Air drying epoxy, Polyurethane coatings etc shall be mixed in the ratio recommended by manufacturer to ensure proper and complete curing of the coatings. The base and hardener are to be separately mixed first to obtain a homogenous mixture. The hardener is to be added to the base slowly, with continuous mixing / agitation and not the reverse. Power agitation is preferred over hand mixing.

4.20.14 Any addition of thinner to achieve the application viscosity should be made only after the components are thoroughly mixed. Excess thinner is not recommended, as increase in volume, leads to lower DFT, sagging, longer curing time, etc.

4.20.15 Coating containing heavy or metallic pigments that have a tendency to settle shall be kept in suspension by continuous use of a mechanical agitator whilst

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being applied, to ensure uniformity over the surface area (e.g., zinc MIO's pigmented materials).

4.20.16 For Primer, high quality surface preparation is necessary and good amount of moisture is required for proper curing. Below 70 % relative humidity, curing time may go up to 7 days or more. In such a case additional water sprinkling may be ensured for completion of curing. Additionally Inorganic zinc silicate cannot be recoated; even with itself. Typically it should be used when coating bare steel surface for first time.

4.20.17 The most frequent problem associated when top coating Primer is bubbling/pin-holing especially with non-weathered zinc silicate coatings. To a great extent, this bubbling of finish paint can be eliminated by applying a mist coat of intermediate/topcoat as the first pass of the product, allow the bubbles to subside and then apply a full coat, as required.

4.20.18 Touch up paintings on damaged areas: Surface preparation by manual tools, wire brush/ emery paper etc. Minimum 6 inches peripheral area, adjoining to damaged area to be covered. If metal surface is exposed, it is to be painted with Zinc rich epoxy (70 micron) or suitable primer with existing paint scheme. If primer is intact, intermediate & top coat to be done with specified DFT in scheme.

4.20.19 SPRAY APPLICATION

i) All adjacent areas to be masked properly to avoid spread of painting to non-target area.

ii) Approval of Owner / Engineer shall be obtained during spray painting which may cause interference to other works.

iii) Airless or pneumatic spray applications are preferred methods of application. Spraying shall be carried out keeping the spray gun at the minimum suitable distance from the work piece and consistently at 90° to the surface being painted.

iv) Correct spray tips, air pressures, etc, as recommended by the equipment supplier shall be followed, If spray painting is to be carried out.

v) Correct combination of air volume, air pressure and fluid flow are to be ensured, in case of conventional air spray, to get good atomisation, for a defect free painted surface. The major disadvantage of conventional air spray is that high build coatings can generally not be applied by this method as most paints have to be thinned to a suitable viscosity for satisfactory atomisation, and so lose their high build properties. Vendor shall follow manufacture's instruction.

vi) Air spray (pressure pot) is recommended in cases where large quantities of paint are to be applied as paint in the tank can be prevented from settling, reduces application time and also enables the gun to be turned to any angle to coat objects effectively without spilling paint.

vii) Airless spray is recommended as high build coatings can be applied without thinning, very rapid application is possible, giving an economic advantage, compared to conventional spray, overspray and bounce-back are reduced, leading to reduced losses of material and less dust and fume hazards.

viii) Each coat shall be applied uniformly and completely over the entire surface. All runs and sags shall be brushed out immediately or the paint shall be removed and the surface re-sprayed.

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ix) Very complex structures should be painted by brush instead of spray gun to avoid overspray, dry spray and unacceptable paint losses.

4.20.20 BRUSH APPLICATION

i) Brush application may be used for the following:

a) Wherever, paint manufacturer recommends brush application.

b) When areas cannot be properly coated by spraying for reasons such as material or environmental considerations

c) For the initial coat of paint to corners, edges, crevices, holes, welds or irregular surface prior to spray application

d) For 'touch up' or repairs to localize damaged paint or areas of incorrectly applied paint

e) Areas where spray painting cannot be applied properly, due to practical reasons such as, material or environmental.

ii) Brushes shall be of a style and quality that will permit the proper application of paint.

iii) Brush applications should be done in two passes that are perpendicular to each other 'wet on wet" so that a smooth coat, as near uniform in thickness as possible, is obtained thereby avoiding running and droplets. There should be no deep or detrimental brush marks. Paint shall be worked into all crevices and corners. Runs and sags shall be brushed out.

iv) During the application of each coat, all areas such as corners, edges, welds, small brackets, bolts, nuts and interstices shall receive additional paint to ensure that these areas have at least the minimum specified dry film thickness and to ensure continuity of coating.

4.20.21 ROLLER APPLICATION

i) Roller application shall only be used on relatively large surface areas and only if spraying is not on option.

ii) Roller application shall be in accordance with the paint Manufacturer's instructions.

iii) Roller application shall only be used if the first or priming coat of paint has been applied by brush.

4.20.22 COATING MATERIALS

i) The composition of the paint shall be at the discretion of the manufacturer, provided that the finished product meets the requirements of, specification, State or Local regulatory bodies.

ii) Material for coating shall be suitable for the intended use and shall be selected based on evaluation of all relevant aspects such as-

a) Corrosion protective properties

b) Health, safety and environment requirements

c) Properties related to application conditions, equipment and personnel

d) Experience with the coating materials and coating system

iii) All coating materials and solvents shall be protected from ignition sources and shall remain within storage temperatures and storage conditions recommended by the coating manufacturer.

iv) All coating materials and solvents shall be stored in the original container bearing the manufacturer's label and instructions.

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v) Performance standard as listed below shall be established by paint manufacturer and the quality records shall be submitted for review –

a) Adhesion test (pull off test)
b) Flexibility test
c) Salt spray test (min 1000 Hrs)
d) UV resistance test (external coating)
e) Cathodic dis bonding test (internal coating)
f) Abrasion test (internal coating)
g) Impact resistance test

vi) Performance tests of coating materials shall be as per the table below:

Abrasion Resistance	ASTM D4060
Adhesion / Pull-off strength of coatings	ASTM D4541
Dry heat resistance	ASTM D2485
Flexibility	ASTM D1737/522 (D522, 180º bend, for top coat only)
Pencil hardness (top coat only)	ASTM D3363
Salt fog resistance	ASTM B117, 2000 hrs
Weather resistance	ASTM G23, Type D
Density	ASTM D1475
Dripping properties	ASTM D883
Drying/curing or film formation	ASTM D1640
DFT/Coat	AS per SSPC guidelines
Water/Humidity resistance for 2000 hrs	ASTM D2247
Accelerated environment exposure resistance	ASTM D 822

4.20.23 STEEL STRUCTURES

i) *Primer coat*; All steel surfaces shall be provided with two component moisture curing zinc (ethyl) silicate primer coat (having minimum 80% of metallic Zinc content in dry film, solid by volume minimum 60% ±2%) of minimum 70 micron DFT to be applied over blast cleaned surface conforming to Sa 2 ½ finish of ISO 8501-1 with surface profile 40-60 Micron. The primer coat shall be applied in shop immediately after blast cleaning by airless spray technique. Zinc dust composition and properties shall be Type-II as per ASTM D520-00.

ii) *Intermediate coat*: Primer coat shall be followed with the application of Intermediate coat of two component polyamide cured epoxy with MIO Content (containing lamellar MIO minimum 30% on pigment, solid by volume minimum 80% ±2%) of minimum 100 micron DFT. This coat shall be applied in shop after an interval of minimum 24 hours (from the application of primer coat) by airless spray technique.

iii) *Final Coat*: Intermediate coat shall be followed with the application of finish coat of two pack aliphatic Isocyanate cured acrylic finish paint (solid by volume minimum 55% ±2%) with Gloss retention (SSPC Paint Spec No 36, ASTM D 4587, D 2244, D 523) of Level 2 (after minimum 1000 hours exposure, Gloss loss less than 30 and colour change less than 2.0 ΔE) and minimum 70 micron

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DFT. This coat shall be applied shop after an interval of minimum 10 hours and within six (6) months (from the completion of Intermediate coat), Colour and shade of the coat shall be as approved by the owner/consultant.

4.20.24 GRATINGS & STEP THREADS

i) Surface preparation: Gratings and step threads shall be cleaned by acid pickling as per SSPC-SP-08.

ii) *Hot dip galvanising*: The hot dip galvanising shall be done as per IS 2629 .The average mass of coating shall be 610 gm/m^2.

iii) *Post galvanising treatment*: Immediately after galvanising, post treatment such as chromating shall be applied to retard white rust attack.

iv) Touch up mechanical damages: The repair of damages coatings shall be done as per the recommended practice ASTM A 780.

4.20.25 All Mild steel (MS) handrails and ladders in outdoor locations and in pump valve pits shall be galvanised at the rate of 610 gm/m^2 as per IS 4736. All other MS handrails shall be painted as specified for structural steel

4.20.26 COATING OF MILD STEEL PARTS IN CONTACT WITH WATER

i) All mild Steel parts coming in contact with water or water vapour shall be hot dip galvanised. The Minimum Coating of Zinc shall be 610 gm/m^2 for galvanised structures and shall comply with IS: 4759 and other relevant Codes. Galvanising shall be checked and tested in accordance with IS: 2629.

ii) The galvanising shall be followed by the application of an etching Primer and dipping in black bitumen in accordance with BS: 3416, unless otherwise specified.

4.20.27 SG membrane walls and other flue gas swept pressure part surfaces shall be applied with appropriate primer for protection of surfaces during transit, storage and erection.

4.20.28 All un-insulated equipments, pipes, valves etc covered in Part-A, Section-2 (Steam Turbine & Auxiliary system) shall be painted with paint not inferior to Epoxy resin based paints with minimum DFT of 150 micron.

i) The paint shall be applied in three stages i.e. primer, intermediate and finish coats in following manner:

a) Primer coat – Epoxy based zinc phosphate

b) Intermediate coat – Epoxy based TiO_2 pigmented coat

c) Finish coat – Epoxy based finish coat / Two pack polyurethane coat

ii) Equipment, pipes etc. with high temperature shall be painted with heat resistant aluminium paint (to be selected based on the service condition of component as per IS- 13183). Two coats of paint shall be applied with total DFT 40 micron.

4.20.29 FGD SYSTEM

i) Surface preparation shall be blast cleaned conforming to Sa 2-1/2 Swiss Standard.

ii) Primer coat shall consist of epoxy resin based zinc phosphate primer having minimum DFT of 100 microns.

iii) Intermediate coat (or under coat) shall consist of epoxy resin based paint pigmented with Titanium dioxide with minimum DFT of 100 microns.

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iv) Top coat shall consist of one coat of epoxy paint suitable pigmented of approved shade and colour with glossy finish and DFT of 75 microns. Additionally finishing coat of polyurethane of minimum DFT of 25 microns shall be provided.

4.20.30 Specification for the application of Epoxy coating for internal protection of storage tank & other vessels/tanks (as applicable) shall be as follows:

i) Primer - One coat of unmodified epoxy resin along with polyamide hardener.

ii) Paint - Two (2) coats of unmodified epoxy resin along with Aromatic adduct hardener.

iii) Total thickness of primer and paint should not be less than 400 microns.

4.20.31 Specification for application of chlorinated Rubber paint for external protection vessel, tanks, piping, valves & other equipments shall be as follows:

i) For indoor tanks, vessels, piping, valves and other equipment:

a) Surface preparation shall be done either manually or by any other approved method.

b) Primer coat shall consist of one coat of chlorinated rubber based zinc phosphate primer having minimum DFT of 50 microns.

c) Intermediate coat (or under coat) shall consist of one coat of chlorinated rubber based paint pigmented with Titanium dioxide with minimum DFT of 50 microns.

d) Top coat shall consist of one coat of chlorinated rubber paint of approved shade and colour with glossy finish and DFT of 50 microns.

e) Total DFT of paint system shall not be less than 150 microns.

ii) For outdoor tanks, vessels, piping, valves and other equipment:

a) Surface preparation shall be blast cleared using non-siliceous abrasive after usual wire brushing, which shall conform to Sa 2-1/2 Swiss Standard.

b) Primer coat shall consist of one coat of epoxy resin based zinc phosphate primer having minimum DFT of 100 microns.

c) Intermediate coat (or under coat) shall consist of one coat of epoxy resin based paint pigmented with Titanium dioxide with minimum DFT of 100 microns.

d) Top coat shall consist of one coat of epoxy paint suitably pigmented of approved shade and colour with glossy finish and DFT of 75 microns. Additionally finishing coat of polyurethane of minimum DFT of 25 microns shall be provided.

e) The paint may be applied in one coat, in case high built paint is used, otherwise two coats shall be applied.

f) Total DFT of paint system shall not be less than 300 microns.

5.00.00 QUALITY CONTROL AND INSPECTION

5.01.00 Paint materials including primers and thinners brought to site by contractor for application shall be procured directly from manufactures as per specification and shall be accompanied by manufacturer's test certificates.

5.02.00 The painting work shall be subjected to inspection by Owner / engineer at specific stages. The vendor shall offer following stage of inspection:

5.02.01 Before and after surface preparation

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5.02.02 Before and after application of primer

5.02.03 Before and after application of subsequent coats

5.02.04 During paint qualification test

5.03.00 Following coating inspection and test shall be carried out:

5.03.01 Ambient and steel temperature, relative humidity and dew point min twice in a shift.

5.03.02 Surface finish & profile check each component or once per 10 m2 after surface preparation.

5.03.03 Salt contamination test – Free from salt contamination.

5.03.04 Dry Film Thickness as per ISO 2808 No.6.

5.03.05 Holiday Test as per ASTM D 5162/ NACE SP0188.

5.03.06 Adhesion Test as per ISO 2409 for cross-cut test, or a pull-off test as per ISO 4624/ ASTM D 4541.

5.04.00 Vendor shall provide the expert technical services of the paint manufactures as and when required by Owner / engineer to ensure both the surface preparation and applications are carried out as per their recommendations. This service shall be provided without any obligation to Owner.

6.00.00 SUGGESTED COLOUR CODES FOR PAINTING

6.01.00 Suggested colour codes, for some major items area as below:

Item / Service	Ground Colour (IS: 5)
Turbine (enclosure & pedestals)	Golden yellow (356)
Generator and exciter	Golden yellow (356)
Transformers	Light grey (631)
Boiler casing, ESP & ducting	Nut Brown (413)
Structures, platforms & ladders	Dark admiralty grey (632)
Handrails	Golden yellow (356)
Fans, pumps, motors	As per OEM
Water tanks	Sea Green (217)
Fuel oil (LDO) tanks	Light brown (410)
Other Tanks & vessels (without insulation and cladding)	Light grey (631)
Air receivers	Sky blue (101)
Machine guards	Signal red (537)
Crane/hoist Structure & trolley	Golden yellow (356)
Crane hook	Crimson (540)
Piping	As per IS: 9404
Other Electrical	As per electrical specs
Buildings	As per Civil specs

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7.00.00 COATING/PAINTING SCHEME/SCHEDULE

Sl. No.	Description	Surface preparation	Primer Coat			Intermediate Coat			Finish Coat			Total DFT (min.)
			Primer	No. of Coats	DFT (µ)	Primer	No. of Coats	DFT (µ)	Primer	No. of Coats	DFT (µ)	
1.	Boiler & Auxiliaries											
a.	All insulated surfaces with temperature <95 ºC	SP3/SP4 Sa 2	HB Zn Phosphate (Alkyd base)	2	60				Zinc Chrome (Alkyd base)	2[1]	40[1]	100
b.	All insulated surfaces with temperature >95 ºC	SP3/SP4 Sa 2	Heat resistant Al. (Grades as per IS: 13183)	1	20				Heat resistant Al. (Grades as per IS: 13183)	1	20	40
2.	HP Piping											
a.	All insulated Piping, fittings/ components, Pipe clamps, Vessels/Tanks, Equipments etc.	SP3/SP4 Sa 2	Heat resistant Al. (Grades as per IS: 13183)	1	20				Heat resistant Al. (Grades as per IS: 13183)	1	20	40
b.	All un-insulated Piping, fittings/ components, Pipe clamps, Vessels/Tanks, Equipment etc.											
i.	Design temperature < or equal to 60ºC	SP3/SP4 Sa 2	HB Zn Phosphate (Alkyd base)	2	50				Zinc Chrome (Alkyd base)	3	105	155

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ii.	Design temperature from 60ºC to 200ºC	SP3/SP4 Sa 2	Heat resistant Al. (Grades as per IS: 13183)	1	20				Heat resistant Al. (Grades as per IS: 13183)	1	20	40
iii.	Design temperature >200ºC	SP3/SP4 Sa 2	Heat resistant Al. (Grades as per IS: 13183)	1	20				Heat resistant Al. (Grades as per IS: 13183)	1	20	40
c.	Constant Load Hanger (CLH) and Variable Load Hanger (VLH)	SP4* Sa 2 ½	Zn rich epoxy (92% Zn. In dry film (min.) %VS=35 (min.)	1	40				Aliphatic acrylic polyurethane, 134, %V=40 (min.)	1	30	70
d.	Other piping hanger / supports. Un-insulated valves	SP4* Sa 2 ½	HB Zn Phosphate (Alkyd base)	2	50				Zinc Chrome (epoxy base)	2	50	100
e.	Un insulated valves, Cast/forged											
i.	Design temperature < or equal to 60ºC	SP3/SP5 Sa 2	HB Zn Phosphate (Alkyd base)	2	70				Zinc Chrome (epoxy base)	2	50	120

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ii.	Design temperature >60ºC	SP3/SP5 Sa 2	Heat resistant Al. (Grades as per IS: 13183)	1	20				Heat resistant Al. (Grades as per IS: 13183)	1	20	40
f.	Weld edges	SP6 Sa1	Weldable primer	1	25							25
3.	All LP piping, fittings, components, valves, associated equipment	SP3/SP5 Sa 2	HB Zn Phosphate (Alkyd base / Zinc Chrome (Alkyd base)	2	50	Zinc Chrome (Alkyd base)	1	30	Zinc Chrome (epoxy base)	2	70	150
4.	All auxiliary steel structural steel components (Outdoor)	SP4* Sa 2 ½	Inorganic Ethyl Zn silicate	1	75	HB MIO Epoxy (TiO_2 pigmented)	1	75	a) Epoxy coat b) Final coat of Aliphatic Acrylic PU, 134	2 1	70 30	250 µ

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5.	All auxiliary steel structural steel components (Indoor)	SP4* Sa 2 ½	Inorganic Ethyl Zn silicate	1	35	HB MIO Epoxy (TiO_2 pigmented)	1	35	a) Epoxy coat b) Final coat of Aliphatic Acrylic PU, 134	2 1	50 30	150 µ
6.	ESP											
a.	All surfaces with temperature <95 ºC	SP3/SP4 Sa 2	Zinc Chrome (Alkyd base)	1	25				Zinc Chrome (epoxy base)	1	30	55
b.	All insulated surfaces with temperature >95 ºC	SP3/SP4 Sa 2	HB Zn Phosphate (Alkyd base)	2	30							60
2.	Indoor structure	Sa 2 ½	HB Zn Phosphate	2	80	HB MIO Epoxy	1	120	Poly urethane	2	60	260 µ
3.	Insulated parts exposed to temp > 120ºC	Sa 2 ½	In organic Zn silicate	2	60							60 µ
16.	For insulated piping <125 ºC	Sa 2 ½	Polyamide cured epoxy coating	2	250							250 µ

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7.	Un insulated silencer, steel stacks >120 ºC	Sa 2 ½	Ethyl Zn silicate	1	40				HR silicone aluminium paint	2	40	80 µ
4.	Water treatment plant / CPU (external)	Sa 2 ½	Zn rich epoxy	2	80	HB MIO Epoxy	2	200	Aliphatic polyuretha ne	2	80	360 µ
6.	Coal fuel piping	Sa 2	Ethyl Zn silicate	1	40				HR aluminium paint	2	40	80 µ
8.	Above ground piping	Sa 2 ½	In organic Zn silicate	2	80	HB MIO Epoxy	1	120	Poly urethane	2	60	260 µ
9.	Buried piping (external)	Sa 2 ½	Coal tar primer, coal tar enamel, inner wrap of fibre glass, final outer wrap of enamel impregnated fibre									4 mm
Sl. No.	**Description**	**Surface preparation**	**Primer Coat**			**Intermediate Coat**			**Finish Coat**			**Total DFT (min.)**
			Primer	**No. of Coats**	**DFT (µ)**	**Primer**	**No. of Coats**	**DFT (µ)**	**Primer**	**No. of Coats**	**DFT (µ)**	
10.	Buried piping (internal)	Sa 2 ½	Solid rigid polyurethane 500 µ									500 µ
11.	Storage tanks (external)	Sa 2 ½	In organic Zn silicate	2	80	HB MIO Epoxy	1	120	Poly urethane	2	60	260 µ
12.	Storage tanks (internal)	Sa 2 ½	3 coats of amine adducts									400 µ
13.	DM water tanks (internal)	Sa 2 ½	In organic Zn silicate	2	80	HB MIO Epoxy	1	150	HB coal tar epoxy	1	150	380 µ
14.	Fuel oil tanks (internal)	Sa 2 ½	In organic Zn silicate	2	80	HB MIO Epoxy	1	150	HB coal tar epoxy	1	150	380 µ
15.	Insulated parts continuously exposed to condensing water	Sa 2 ½	In organic Zn silicate	2	75							75 µ

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17.	Electrical parts, control panels, valves, pumps & motors (indoor)*	Sa 2 ½	Zn phosphate epoxy	2	80				Chlorinated rubber	2	80	160 µ
18.	Electrical parts, control panels, valves, pumps & motors (outdoor)*	Sa 2 ½	Zn phosphate epoxy	2	80				Chlorinated rubber	2	100	180 µ
19.	Switch yard, floor grills, walkways	Sa 2 ½	Hot dip galvanised coating wt. 610 gm/m^2 (coating thickness of 80 µ)									80 µ

Note:

* Manufacturer to specify details of painting system capable of withstanding environmental conditions for a period of 10 years before first maintenance.

1) The first 2 finished coats (total min.DFT of 70 microns) shall be done at shop and the 3rd finish coat (min.DFT 35 Microns) shall be applied at site.

2) For valves below 65NB and temperature up to and including 540 ºC, Parkerizing/zinc phosphate corrosion resistant coating as per ASTM F1137 is also acceptable in lieu of Aluminium paint.

3) For corrosion protection of threaded hanger rods and variable spring cages, electro galvanizing in full compliance to minimum Corrosion category C3 as per EN ISO12944 is also acceptable.

4) For spring cages, 2 coats of 30 µm (min) zinc-rich epoxy resin primer with zinc content > 80 weight % in dry film followed by 2 coats of 30 µm (min) top coat of Acrylic resin Co-polymerisate with a total combined minimum DFT of 120µm is also acceptable in lieu of above specified paint scheme.

5) For corrosion protection, all inner parts of the hangers (CLH/VLH) shall be at least in full compliance to Corrosion category C3 as per EN ISO12944.

6) For Cast/forged valves up to & including design temperature 60Deg.C, Aluminium painting as per IS-13183 Gr-3 or better with total DFT 40Micron is also acceptable.

8.00.00 DRAWINGS AND DOCUMENTS TO BE SUBMITTED

8.01.00 **Drawings and Documents to be Submitted with the bid**

8.01.01 Write-up on Surface Preparation & Painting

8.01.02 Filled-in Data Sheet-B (if applicable)

8.02.00 **Drawings and Documents to be Submitted after Award of Contract**

8.02.01 Painting Scheme / Schedule (Project / Various areas)

8.02.02 Product and application data sheets of paints & associated materials (Various materials)

8.02.03 Quality Plan of shop painting (Various areas)

8.02.04 Field Quality Plan for surface preparation and painting at site (Project / Various areas)

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BHEL	**PRODUCT STANDARD** **TURBINES & COMPRESSORS** **HYDERABAD**	

SAMPLE QUALITY PLAN

BHEL Ranipet	MANUFACTURER'S NAME AND ADDRESS M/S BHEL: BAP: RANIPET 632 406 TAMIL NADU	**STANDARD QUALITY PLAN**												
		ITEM: OXIDATION BLOWER SYSTEM: FGD							QP NO		FGS:722			
									REV. NO:		00			
									DATE:		12.02.2019			
									PAGE NO:		Page 1 of 2			

SL. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK M	QUANTUM OF CHECK B	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	D*	AGENCY M	AGENCY C	AGENCY N	REMARKS
1.	2.	3.	4.	5.	6.		7.	8.	9.		** 10.			11.
1.1	Blower parts – (Casing Impeller Shaft etc.)	Chem.& Mech. Dimensions Surface Defects	MA MA MA	Review of MTC Measurement Visual	1/Heat 100% 100%		Appd. Dwg./Datasheet		TC & IR	√	P P P	V - -	V - -	
1.2	Shaft	UT	MA	Testing	100%		ASME Section-V	Tech. Spec./ Manufacturer UT Procedure	UT Report	√	P	V	V	
2.0	**CASING**													
2.1	Machining of Components	Dimensions Surface Defects	MA	Measurement Visual	100% 100%		Appd.Dwg.		IR		P	-	-	
2.2	Hydro test of Casing	Hydro test 1.5times of Max work pr for 30 min	MA	Measurement & Visual	100%		Appd. Dwg	No leakage	IR	√	P	V	V	
3.0	**ROTATING COMPONENTS**													
3.1	Machining of components	Dimensions Surface Defects(Rotor & Shaft)4	MA	Measurement MT/PT	100% 100%		Appd. Dwg.		IR		P	V	V	
3.2	Assembly	Dimensions Completeness	MA	Measurement Visual	100% 100%		Appd. Dwg.		IR		P P	-	-	
3.3	Rotor Assembly	Dynamic balance test	MA	Measurement Visual	100%		ISO 1940	G 2.5	IR	√	P	V	V	
4.0	Blower Inspection	Job Motor/ Motor of similar rating to be used for Blower Testing.												
4.1	Assembly	Dimensions, Completeness	MA	Measurement Visual	100%	100%	Appd. Dwg.		IR	√	P	W	W	Inspection at manufacturer works. *1 No. for NTPC 100% for
4.2	Performance Test	Volume, Power & Discharge Pressure	MA	Measurement	100%	100%	ASME PTC10	Approved data sheet / drawing	TR	√	P	W	W	
4.3	Mechanical Run	Noise	MA	Measurement	100%	100%	ANSI S5.1:1971	-DO-	TR	√	P	W	W	

LEGEND: * RECORD, IDENTIFIED WITH "TICK" (√) UNDER COLUMN 'D' SHALL BE SUBMITTED TO CUSTOMER AS A QA DOCUMENTATION PACKAGE.
M: MANUFACTURER / SUB SUPPLIER, **C:** MAIN CONTRACTOR(BHEL)/BHEL AIA
N: CUSTOMER/CONSULTANT **P:** PERFORM **W:** WITNESS **V:** REVIEW OF RECORDS
MA: MAJOR AND **MI:** MINOR

PREPARED BY	REVIEWD & APPROVED BY
Rakesh Kumar Madhu,(SEr/QA)	K C Gandhi Parimalam,(DGM/QA)

THIS SAMPLE QUALITY PLAN DESCRIBES TYPICAL STANDARD TEST REQUIREMENTS OF OXIDATION BLOWER AND

VENDOR TO PREPARE & SUBMIT QUALITY PLAN IN NTPC QP FORMAT AS PER APPROVED ENGINEERING DOCUMENTS (DRAWING / DATA SHEET) FOR BHEL & NTPC APPROVAL.

ANY ADDITIONAL TEST OR INSPECTION REQUIREMENT SPECIFIED BY BHEL / NTPC DURING QP APPROVAL SHALL ALSO BE APPLICABLE & COMPLIED BY VENDOR.

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PRODUCT STANDARD
TURBINES & COMPRESSORS
HYDERABAD

MANUFACTURER'S NAME AND ADDRESS	STANDARD QUALITY PLAN		
M/S BHEL: BAP: RANIPET 632 406 TAMIL NADU Ranipet	ITEM: OXIDATION BLOWER SYSTEM: FGD	QP NO	FGS:722
		REV. NO:	00
		DATE:	12.02.2019
		PAGE NO:	Page 2 of 2

SL. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
					M	B					M	C	N	
1.	2.	3.	4.	5.	6.		7.	8.	9.	D*	** 10.			11.
	Test	Vibration Level	MA	Measurement	100%	100%	ISO 10816-7	-DO-	TR	√	P	W	W	BHEL
		Bearing temperate rise,	MA	Measurement	100%	100%	Approved Drawing /Data Sheet		TR	√	P	W	W	
5.0	BOUGHT-OUT PARTS (Gear Box)													
5.1	Heat Treatment of Gear Wheel	Hardness	MA	Measurement	100%		Approved Data Sheet/Drawing		TR	√	P	V	V	
5.2	Assembly	Dimensions Completeness	MA	Measurement Visual	100% 100%		Appd.Dwg.		IR		P P	-	-	
6.0	FINAL BLOWER PACKAGE INSPECTION													
6.1	Final Complete Assembly	Dimensions, Completeness	MA	Measurement Visual	100%	01 No	Appd. Dwg		IR	√	P	W	V	
7.0	PAINTING													
7.1		Surface treatment and inspection	MI	Visual	100%		NTPC Approved Painting Schedule		IR	√	P	V	-	
7.2		Paint Quality – Colour & DFT Check	MI	Visual Measurement	10%				IR	√	P	V	-	
8.0	Review of QA Documents	Verification of QA Documents	MA	Verification	100%		As per Appd. MQP		IR	√	P	V	-	
9.0	Inspection before Delivery													
9.1	Packing	Size, appearance & Firmness	MI	Measurement Visual	100%		As per Appd. "Packing Procedure"		IR		P	-	-	

Note : Motor for Oxidation Blower is Separate MQP will be submitted for same.

Separate MQPs for VFD & Transformer shall be submitted for BHEL & NTPC review/approval.

LEGEND: * RECORD, IDENTIFIED WITH "TICK" (√) UNDER COLUMN 'D' SHALL BE SUBMITTED TO CUSTOMER AS A QA DOCUMENTATION PACKAGE.
M: MANUFACTURER / SUB SUPPLIER, **C:** MAIN CONTRACTOR(BHEL)/BHEL AIA
N: CUSTOMER/CONSULTANT **P:** PERFORM **W:** WITNESS **V:** REVIEW OF RECORDS
MA: MAJOR AND **MI:** MINOR

PREPARED BY	REVIEWD & APPROVED BY
Rakesh Kumar Madhu,(SEr/QA)	K C Gandhi Parimalam,(DGM/QA)

THIS SAMPLE QUALITY PLAN DESCRIBES TYPICAL STANDARD TEST REQUIREMENTS OF OXIDATION BLOWER AND

VENDOR TO PREPARE & SUBMIT QUALITY PLAN IN NTPC QP FORMAT AS PER APPROVED ENGINEERING DOCUMENTS (DRAWING / DATA SHEET) FOR BHEL & NTPC APPROVAL.

ANY ADDITIONAL TEST OR INSPECTION REQUIREMENT SPECIFIED BY BHEL / NTPC DURING QP APPROVAL SHALL ALSO BE APPLICABLE & COMPLIED BY VENDOR.

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ANNEXURE-VII Reference P&ID drawing indicating the scope between BHEL & Vendor

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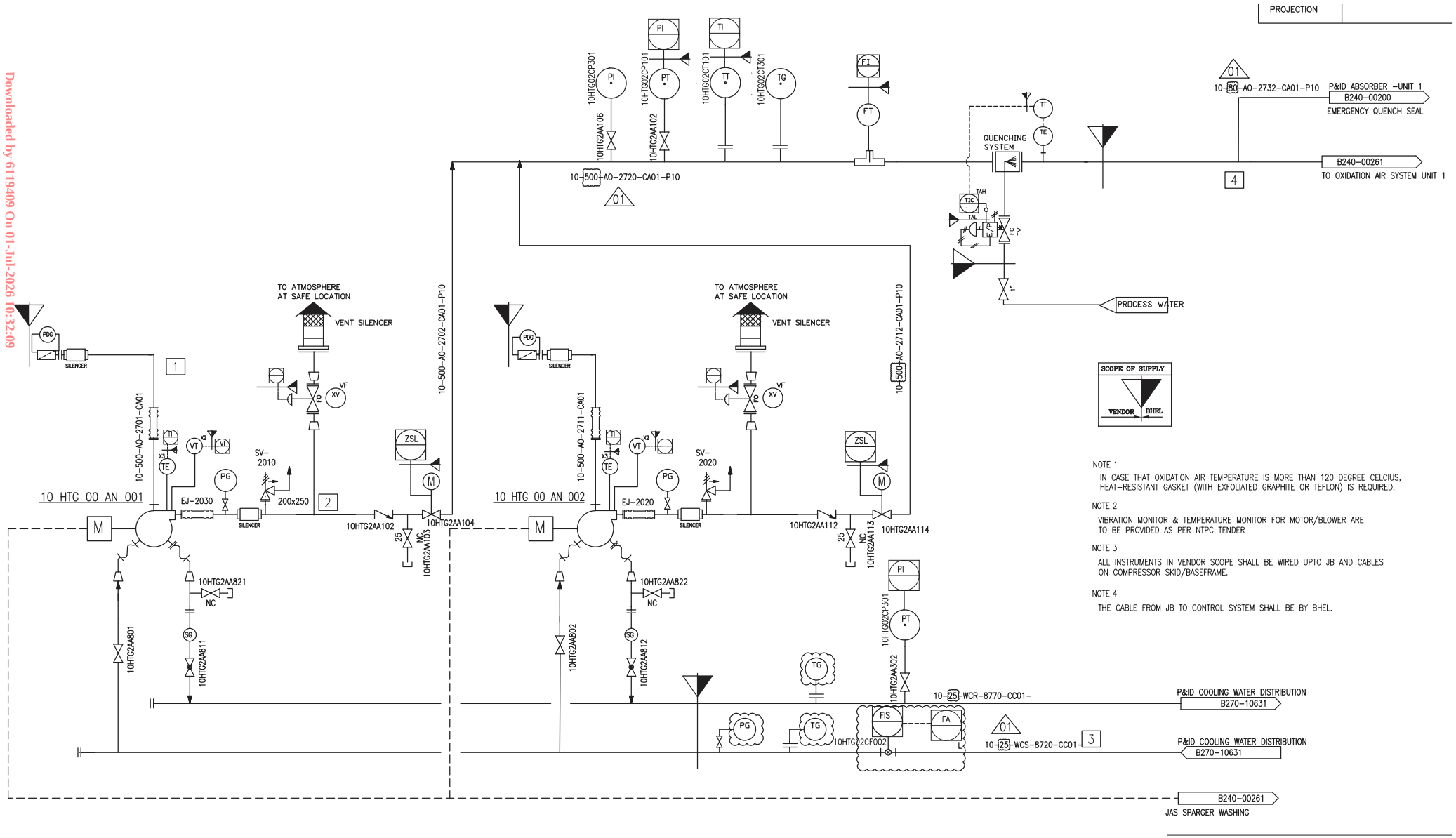

ANNEXURE-VIII

VOLUME IIB

TECHNICAL SPECIFICATION
FOR
SEAWORTHY PACKING FOR EXPORT JOBS

SPECIFICATION NO. PE-TS-888-100-A001

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NEW DELHI, INDIA

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1.0 Purpose

The purpose of this specification is to describe minimum packing requirements for the different items/equipment for all export Project and also to define marking and shipping requirements during transportation by ship, road and air for all export jobs.

2.0 SCOPE

For export jobs, sea worthy packing capable of performing all necessary functions like prevention of damage to the contents, sufficient to support frequent handling and lengthy period of outdoor storage in adverse weather conditions are required. Workmanship and materials used shall be of high standard meeting the technical requirements and in accordance with best commercial export packing practices. Vendor shall be responsible for sea worthy export packing, however it shall meet the minimum requirements specified herein. Equivalent or better packing methods may be deployed subject to approval of the BHEL/Purchaser. Vendor shall submit the packing procedure for its equivalent for purchaser's approval during detailed engineering.

The scope this specification is to define VENDOR's responsibilities in terms of:

- Preservation of the GOODS/items/equipments before packing.
- Packing of the GOODS for road, rail, sea and/or air transportation to desired destination i.e. project site
- Making cases/crates
- Chemical Treatment/Fumigation before packing to prevent fungus, damage due to termite, borer, rats, etc.
- Marking of cases/crates.
- Other Services required.

3.0 Application

This specification is applicable to all the goods to be transported to project site and requires to be in transit for longer duration. *However, for "Misc cable erection items", "Fire sealing system" & "Exothermic welding material", the packing requirements shall be as per the procurement specification.*

4.0 Definitions

"BHEL" : Main EPC vendor

"OWNER" : Customer for a particular export project.

"VENDOR" : Company(ies)/VENDOR(s) to whom the BHEL has placed Purchase Order for GOODS/ items/system/package.

"GOODS": means all or part of the articles, material, equipment supplies including technical documentation, as described in the Purchase Order, to be supplied by VENDOR.

"PACKER": Packaging Company to whom VENDOR intends to sub-contract the packing in case they do not have own packing capability/facilities .

"FREIGHT FORWARDER" : Means the Company responsible for performing freight forwarding activities.

5. General Information

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The following requirements are intended as minimum requirements, and compliance to these requirements in no way absolves or relieves VENDOR of any responsibility or obligation outlined in the Purchase Order. In all circumstances, the packing will be designed and constructed in order to support GOODS during transportation as well as to prevent the Goods from damage due to impact, extreme climatic conditions, sun and rain. It must be ensured that the delivery of the GOODS to the jobsite by sea, road or air, in good condition.

GOODS shall be export packed in compliance with the best-established practices for international projects, in accordance with the following instructions. In the event of any conflict between these specified requirement and the established practices, specification requirement shall govern.

Due to climatic conditions and the complex transport operation(s), it is essential that protection and packing is of the highest standard. Packing means to efficiently protect the GOODS during the total transport operation; from the moment they leave the factory until they are delivered to the jobsite, including handling operations (loading/unloading) and storage.

When VENDOR do not have packing capabilities/facilities of their own and therefore intends to sub-contract, VENDOR have to inform BHEL/Purchaser of the name and address of proposed PACKER(s) for approval.

6.0 Criteria for Selection of Packaging

Packages are to be made according to categories, described in articles 8.1 to 8.5, depending on the type of materials, their fragility and size.

These categories have been established for the protection of equipment and material during multi-mode transports, i.e.: combination of overland and sea transport; containerization, air transportation.

In a general manner, the GOODS have to be packed in such a way that crates, bundles, pallets can be stored into General Purpose containers, wherever possible.

If VENDOR has any doubt about the correct method of protection or packing, he should contact BHEL/Purchaser in order to mutually agree on the adequate type of packing to be used.

Materials can be classified in following categories

- Hazardous Material
- Non-Hazardous Material
-

Further to above categorisation, non-hazardous materials can be sub- categorised for selection of packing.

6.1 Hazardous Materials

Though handling of hazardous material may is not applicable in the scope of this specification. All hazardous material must be packed in adherence to the detailed requirement relating to packing, marking and labelling set out in the most recent report of the Board's Standard Advisory Committee on the Carriage of Dangerous Goods in Ships for sea freight, and the Restricted Articles Regulations, laid down by the International Air Transport Association for airfreight.

6.2 Non-Hazardous GOODS

The scope of this specification is to provide necessary guidelines for packing for power plant equipment, components, Pipings & Valves, Fittings, other structural items, electrical items, spare parts and erection materials. The procedure is defined in subsequent paragraphs in details in clause no. 8.0.

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7. 0 Marking Instructions & Despatch details, Storage Code

7.1 Marking Instructions & despatch details

Packages and crates will be marked with indelible black paint, resistant to seawater. Marking must be perfectly legible.

The shipping marks, which will be as per fig-13, shall be stencilled on two sides and one end in clear characters at least 5 centimetres high (where crate size permits, otherwise use optimum size for each package dimension).

When the GOODS are to be shipped in containers then marking may be stencilled on one end only. However, packages must be stowed in a manner that shows these marks.

Crates containing fragile articles must be packed with special precaution against risk of breakage and must be stencilled on all sides "FRAGILE - HANDLE WITH CARE". Where crates are not to be overturned, VENDOR must show on the crates, clear and readily visible identification as per fig-12, to ensure they are kept in the correct position.

Packages/equipment of 2,000 kg or more must be marked with slinging points on all sides, in addition to the centre of gravity marks.

Number packages consecutively i.e. 1 of 10, 2 of 10, etc. Do not duplicate package numbers. VENDOR is responsible for any loss or damage caused by incorrect marking.

All cases/crates shall also be marked with the appropriate international standard graphic symbols for handling as shown in Fig 12.

As a minimum, all cases/crates are to be marked clearly on all four sides with:

- "HANDLE WITH CARE"
- "RIGHT SIDE UP"
- **"KEEP DRY"**

In the case of packages with a single gross weight totalling 2,000 kg and/or a height of more than 1m, the centre of gravity shall be clearly marked with the symbol on two adjoining sides. For all items of equipment with an eccentric centre of gravity this symbol shall be marked at the bottom, side and top of the package.

The slinging and lashing points shall be marked with a chain symbol.

When packing in cases/crates, these packages shall also have metal corners at the slinging points. (Fig-11)

External front and rear sides of the boxes to be planed for writing instructions.

Dispatch details such as consigner/consignee address, contract and case details, country of origin, port of delivery, stacking instructions shall be written on one side of the boxes. An anodized aluminum plate as per details and specifications given in fig-13 shall be provided on one side of the boxes.

One copy of packing slip wrapped in polyethylene bag covered with aluminum packing slip holder to be nailed on the external surface of the box. One more copy of the packing slip wrapped in polyethylene bag is to be kept inside the box at the pertinent place.

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7.2 Storage Code

The type of storage required is required to be specified, it will be shown on each packaging in **RED colour.**

X Crates or packages to be stored outdoor without covers
XX Crates or packages to be stored under tarpaulin
XXX Crates or packages to be stored in covered or enclosed premises
XXXX Crates or packages which must be stored in air-conditioned premises

8.0 GUIDELINES FOR PACKING GOODS

8.1 In the subsequent paragraphs details of different types of packings for different types of GOODS are defined. Vendor shall make packing details/procedure based on the guidelines and submit for approval.

8.1.1 Packing for Pipe, Fittings, Flanges and Valves, Structural Steel

Particular attention should be brought to pipe, fittings, flanges, valves and structural steel. Packing categories for piping and fittings will differ according to the diameter and wall thickness of these products. VENDOR shall comply with the following established practice.

IMPORTANT NOTE:
Depending on the project schedule and availability of ocean vessels, the piping and structural steel may be shipped in containers. In this event, VENDOR has to arrange the packages in such a way it allows the stuffing into Open Top in gauge containers.

8.1.2 Pipe

Where practicable, pipe lengths shall be limited to 11.8 meters.
All pipes **2"** included and below shall be packed in crates. All pipes to be capped and ends sealed with waterproof tape.

Pipes over 2" up to 6", shall be bundled and banded in bundles of uniform length. Bundling is carried out with U-IRON or traversal planks, joined with threaded connecting rods with locknuts. Quantities and strapping positions depend on the lengths, with a 120 cm spacing to prevent distortion. Bundle weight shall not exceed 2,000 kg. All pipes are to be capped and ends sealed with waterproof tape (tape is not necessary if end caps are of the pre-shrunk or self-sealing type).

Pipes larger than 6" shall be shipped as single lengths with the ends capped. End caps are to be of the recessed type to enable the use of soft faced hooks, but still completely sealing the end and also protecting the weld.
All stainless steel piping must be packed separately in wooden crates. Any banding of bundles is to be with the same material.

8.1.3 Pipe Fittings, Flanges and Valves

All pipe fittings, flanges and valves up to 6", are to be packed in cases/crates. For items over 6", these may be fixed securely to a pallet base and enclosed in a crate, for protection. Where valves have actuators attached, rigidity must be ensured for the valve and actuator. The vulnerable parts of the actuator are to be completely protected within a wooden crate.

All stainless steel fittings, flanges and valves of all sizes, must be packed separately in wooden crates. Any strapping is to be with the same material.

8.1.4 Structural Steel

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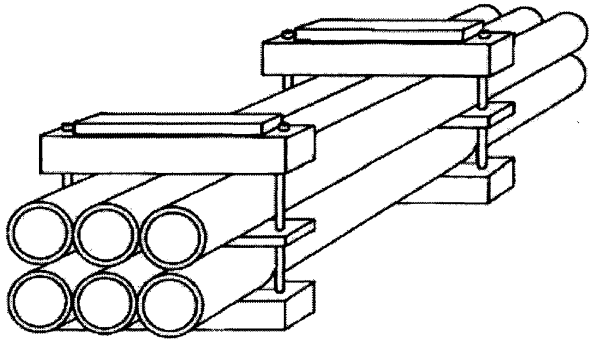
Structural Steel, reinforcing rods, bars, etc., should be packed in bundles of uniform length. Refer to articles 8.1.2, for strapping requirements. Bundle weight not normally to exceed 2,000 kg. Fabricated structures and structural steelwork, etc, should be bundled and packed using wooden beams and long bolting to secure the load.

8.2 Bundling – Packing Category I

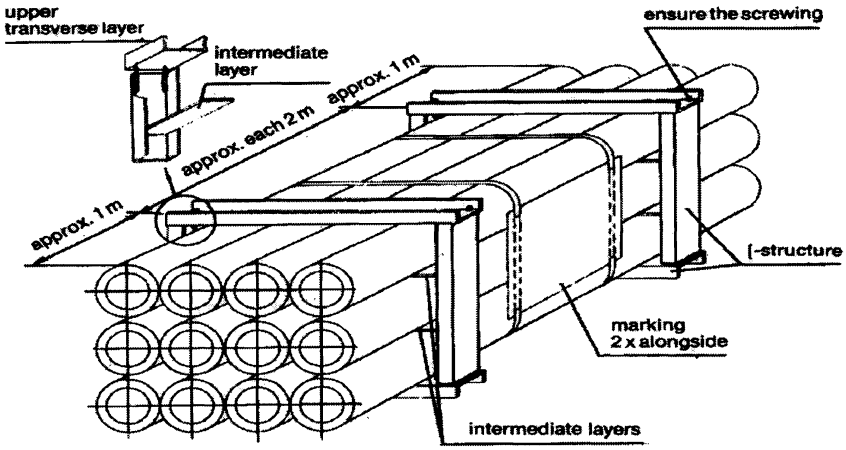
8.2.1 Type of Equipment

Equipment which is not subject to damage by corrosion or mechanical effect, i.e. pipes, piping, structural steel.

Packing category I



Bundling by U-shaped iron – packing category I A



8.2.2 Type of Construction

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Bundling has to be effected

- By squared timber and threaded rods.
- With an intermediate layer (threaded on tightening bolts) according to the weight of the package.
- Wedge-shaped timbers must be added at the outer points of lower layer.
- Between the bolts a spacer must be nailed.
- The bolts must be secured (e.g. by locking nut).
- If single parts could protrude, an appropriate protection must be installed (flat iron or plates).
- Bundling with steel straps or PVC straps is not accepted.

8.3 Skids, Square Timber Constructions, Casings – Packing (Category II)

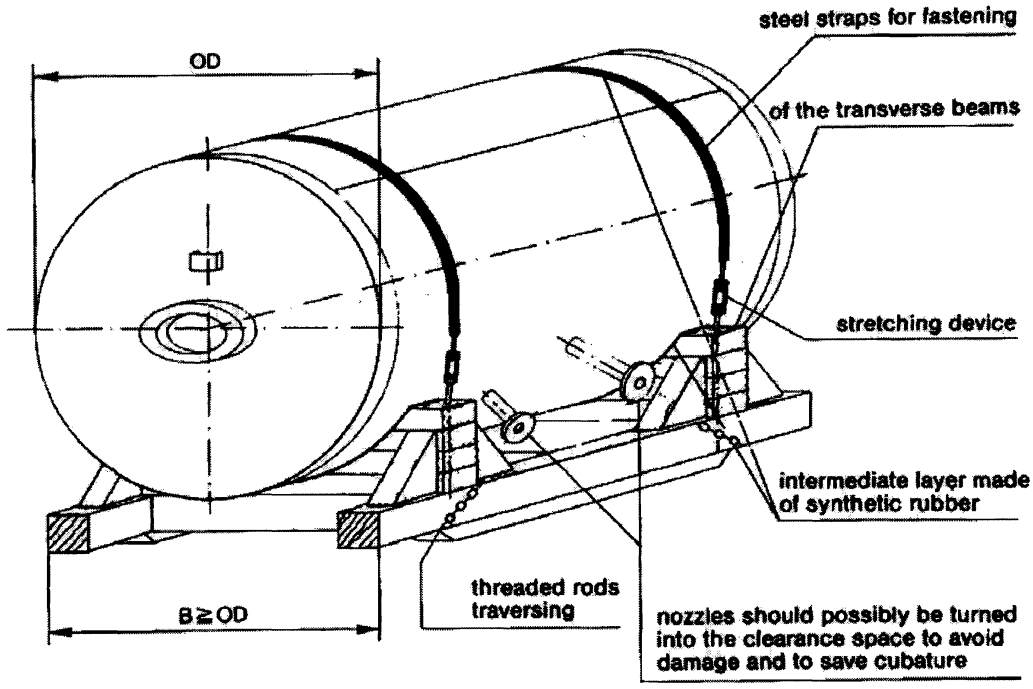
8.3.1 Type of Equipment

Voluminous apparatus, tanks and/or heavy pieces those are not vulnerable to mechanical or corrosive effects.

8.3.2 Type of Construction

- The construction skid can be made of wood or of metal.
- The fastening of the packages on the skid will be made by steel straps (flat iron) which have to be elastically lined, non-slip and securely bolted onto the skids.
- Flange openings have to be closed with gaskets and blind flanges or, if necessary, provided with cover.
- Skid constructions may not be less than the dimensions of the package in length or in width.
- Tanks and apparatus with their own support cradles must be supplied with an anti-slip lining.

PACKING CATEGORY-II



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8.4 Packing of GOODS in Wooden Crates/Cases/Boxes

The construction of wooden crate/cases/boxes shall be as per the details indicated in clause 9.0 & Fig 1 to 11. Details indicated in the sketches for different categories Packing crates/boxes are only for a typical equipment considered for illustration.

8.4.1 Packing Category III

8.4.1.1 Type of Equipment

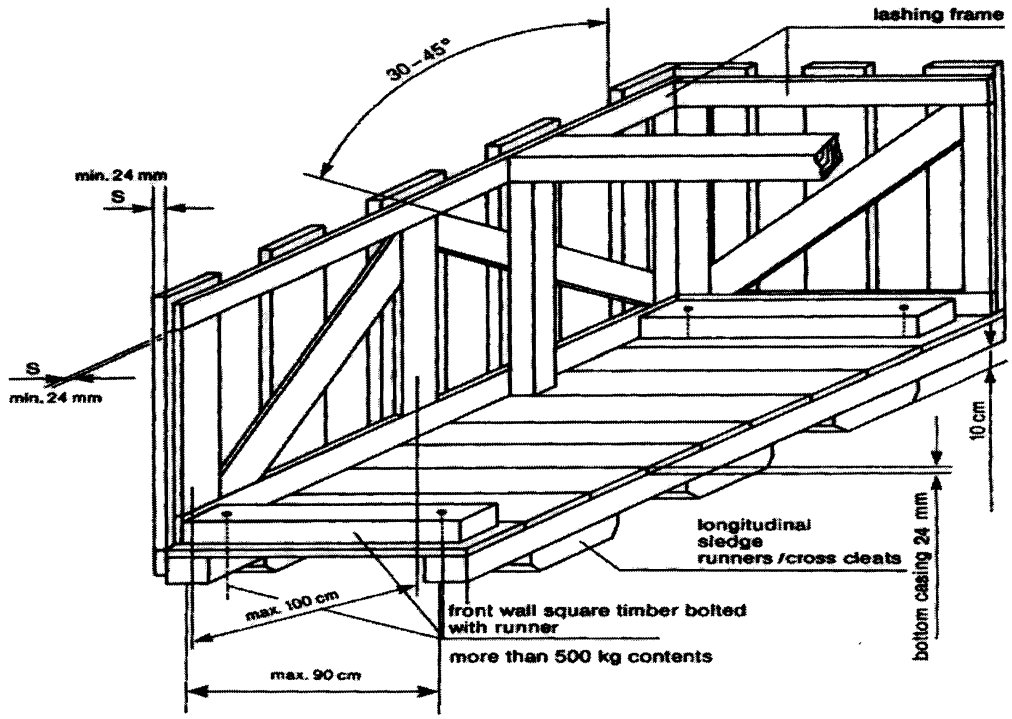
Fabricated equipment, which cannot be transported on cradles; frame-works, prefabricated piping and fittings, mechanical and electrical assemblies. *This type of packing is recommended where many parts of the equipment/component/assembly are not protruding out.*

8.4.1.2 Type of Construction

The equipment must be safely fastened to the bottom with bolts, possibly by the runners or to be spread in such a manner that no protruding parts are possible. For parts, sensitive to rainwater and/or debris, a protection has to be made by a foil cap.

If it is possible that single part could protrude through the front/back side wall, they shall be closed completely. The marking of the package shall be done on plywood plates at the prescribed sides.

Packing Category III



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8.4.2 Cases with Lining – Packing Category IV

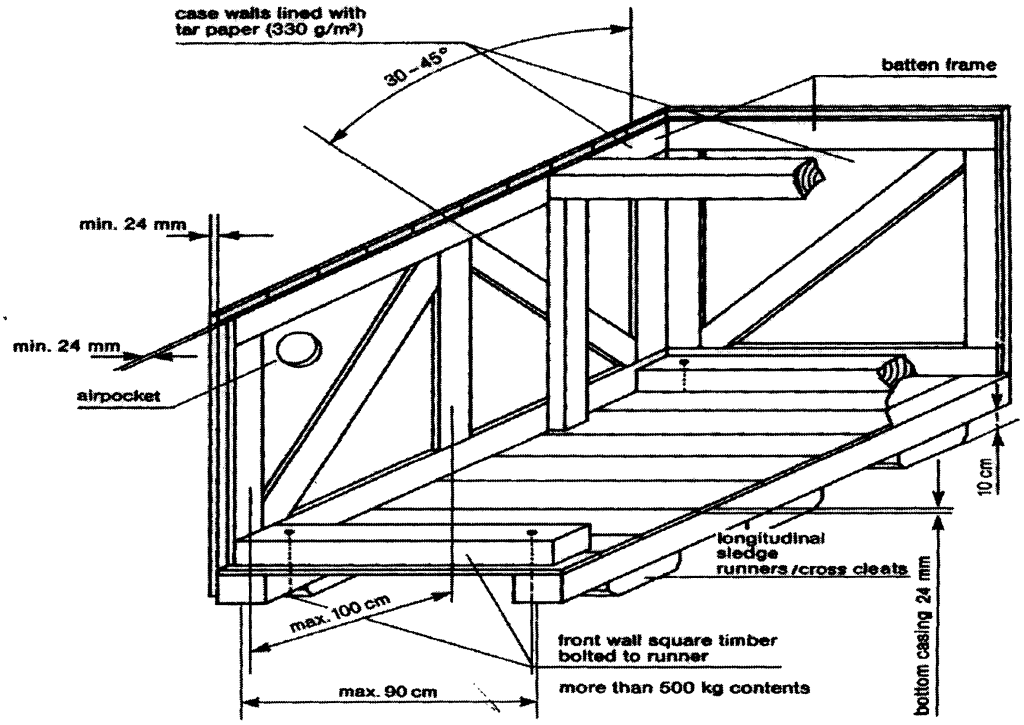
8.4.2.1 Type of Equipment

Recommended for equipment and mechanical parts Equipment sensitive to mechanical damage or parts and components that are particularly at risk of theft or loss; pumps, elbows, flanges, fittings, tools, erection materials, etc.

8.4.2.2 Type of Construction

The same type of construction as article 8.4.1.2, but with all sides completely boarded without space between the boards. Sides to be provided with waterproof lining; fabric-reinforced waterproof tar paper or polyethylene-foils resistant to ultraviolet rays can be used. Polyethylene-foil shall be fixed under the lid cover to avoid penetration of water. At weights of more than 500 kg the longitudinal runner must be bolted to the front all square timber. For ventilation inside the case, an opening in the waterproof lining must be placed between the diagonal battens and diagonal joists.

Packing Category IV



8.4.3 Cases with Alternative Surface Materials

8.4.3.1 Plywood Box – Packing Category IV A

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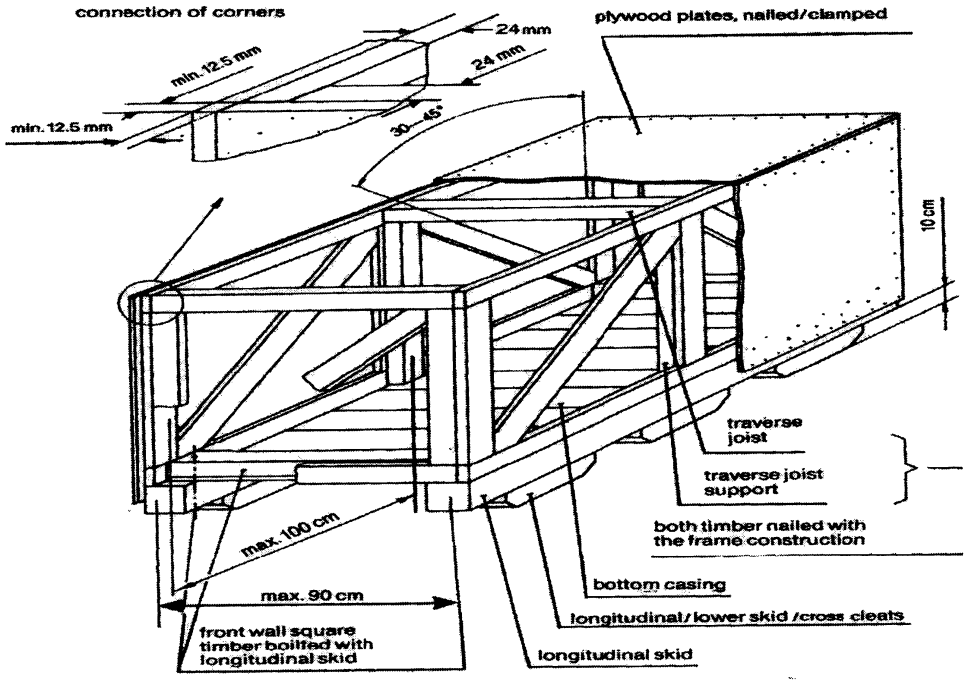

Case constructed of 5 layers of watertight, glued plywood with a total thickness of 12.5 mm. The frame must be constructed from minimum 24 mm timber or as per guide lines given above against clause 8.0, Fig 1 to 11 and must be suitable for the weight and nature of the parts to be packed. Planed square timber must be bolted with longitudinal skid and covered with diagonal joists. If applicable, construction of the cover and sides is to include diagonal bracing. Covers consisting of several layers of plywood are to be sealed with durable elastic putty or additional water-resistant sheets to be fixed.

8.4.4 Case with Barrier Material – Polyethylene Foil – Packing Category V

8.4.4.1 Type of Equipment

Sensitive equipment, simple electrical equipment, insulation materials, fire-resistant materials, with non-corrosion- guarantee for a period up to twelve (12) months.

8.4.4.2 Type of Construction

Preservation by welding in polyethylene-foil with addition of desiccants and if necessary, application of non-corrosive contact agents, otherwise, type of construction as indicated in article 8.4.2.2.
Additional marking:

- Case with desiccants.

8.4.5 Case with Barrier Material – Aluminium Compound Foil – Packing Category VI

8.4.5.1 Type of Equipment

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Electrical equipment such as, switchboards, electric motors, sensitive equipment, with non-corrosion guarantee, for a period up to twelve (12) months.

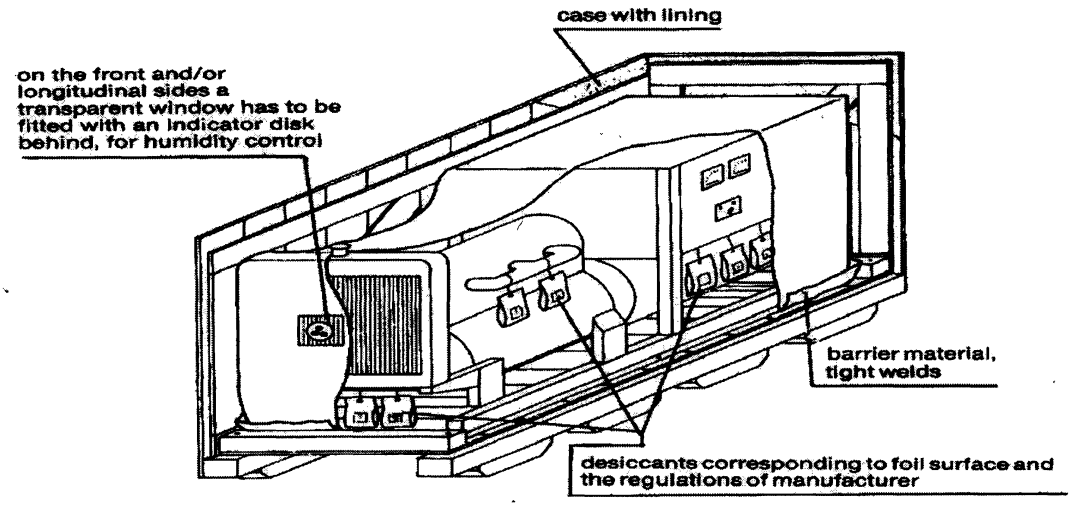
8.4.5.2 Type of Construction

Type of construction as indicated in article 8.4.2.2. Preservation by sealing an aluminium compound foil, with the addition of desiccants. Humidity indicators, if required and installed in the barrier wrapping, shall allow easy control from the outside.

Additional marking:

- Case with desiccants.

Packing Category V/VI



8.4.6 Double Case – Packing Category VII

8.4.6.1 Type of Equipment

GOODS which are of high sensitivity to shock, impact and vibration, for instance, special electrical equipment like computers, switchboards, laboratory instruments

8.4.6.2 Type of Construction

Case construction as indicated in article 8.4.2.2, with additional floating inner packing (case-in-case principle), padding corresponding to weight and sensitiveness. Preservation by sealing in aluminium compound foil with the addition of desiccants. The inner case has to be made of plywood or equivalent material with a thickness of 8-12 mm, depending on the weight of the GOODS to be packed. The inner buckles and/or frame borders have to be dimensioned so that the full stability of the inside case will be reached and no twisting is possible. The inner sides of the inside case will be lined with bituminous kraft paper on all sides (except bottom).

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8.4.7 Cable Drum – Packing Category VIII

8.4.7.1 Type of Equipment

All type of cables, wires, ropes, hoses.

8.4.7.2 Type of Construction

For all type of cables refer clause no. 11.1. For other items (wires, ropes, hoses) new or practically new drums are to be used. Planking of the e drums by use of boards, thickness minimum 20 mm, with additional double steel strapping, nailed, and carefully preserved/ protected cable ends prior to packing.

8.4.8 Hazardous Materials – Packing Category IX

8.4.8.1 Type of Equipment

Hazardous materials according to the law are explosives, compressed gases, liquefied gases dissolved under pressure or deeply refrigerated, flammable liquids, flammable solids: substances liable to spontaneous combustion; substances which, on contact with water, emit flammable gases, oxidizing substances, organic peroxides, poisonous (toxic) and infectious substances; radioactive materials, corrosives, miscellaneous dangerous goods.

8.4.8.2 Type of Construction

Hazardous materials shall always be packed and documented separately from any other material. Selection of packaging materials, execution of packing and marking as well as documentation shall always be in compliance with the applicable laws and regulations. Any certificates required for transportation or for authorities to be supplied before shipment of the GOODS.

8.4.9 Wooden Floor as a Transport Support – Packing Category X

8.4.9.1 Type of Equipment

Any materials to be stuffed in containers or on flat racks and that are not stowed on standard pallets or otherwise suitably packed

8.4.9.2 Type of Construction

- Longitudinal internal square timbers bolted to the front wall runners, longitudinal skid.
- Maximum distance between longitudinal runners 90 cm (middle to middle of the runner).
- Full boarding of the floor.
- Attaching of lifting lugs and/or iron ropes for lifting/pulling the units off the transport equipment.
- If applicable, preservation of the equipment by sealing in polyethylene-foil or aluminium compound foil and the addition of desiccants.

8.5 Air Transport Packing

8.5.1 General

Certain types of material may have to be shipped by air from their country of origin. This means of transport will be exceptional, and will be used only:

- For GOODS, which are highly sensitive to shock or vibrations, such as computers, electronic instruments, or those of small dimensions and weight.
- For GOODS urgently required at the module yard(s) and/or jobsite.

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8.5.2 Type of Packing

Depending on the goods to be packed, VENDOR may use one of the following types:

- A triple-corrugated cardboard container made with waterproofed glue and a barrier layer of polyethylene on the outsides to keep out humidity.
- Wooden/cardboard packing cases: the wood being used for the framework and base of the cases, waterproofed triple-corrugated cardboard being used for the sides and top. These cases are of the "Bell" type, and used for material of small or medium dimensions.
- For larger dimensions, plywood cases are acceptable. The timber characteristics, cross-sections and thickness will be systematically determined by the nature of the loads to be packed.

8.5.3 Dimensions

In order to optimize the existing transport facilities (passenger or cargo aircraft), the dimensions of:

- Triple-corrugated containers.
- Wooden/cardboard packing cases.
- Plywood cases.

Are to be adapted to pallets used for air transportation.

9.0 Detailed specification for Wooden Crates/Boxes/Cases and other packing materials

9.1 **Technical specification for wood**

The wood shall be Fir, Chir, Silver Oak (Gravillea Robusta), chemically treated mango and Pinewood with moisture content not exceeding 50%. The wood shall have flexural and compressive strength, stiffness, shock absorption and nail retention properties. The wood shall be free from common defects such as warp, bone, twist, knot, crakes, splits, end splits, bend, visible sign of infection and any kind of decay caused by insects or fungus, etc. Surface cracks with maximum depth of 3mm are permissible. A continuous crack of any depth all along the length is not allowed.

9.2 **Chemical Treatment of Wood**:

The wood shall be chemically treated to provide protection against deterioration due to fungi and attack by termites, borers, marine organism and any other kind of infection. It shall be treated only after final processing like cutting, planning, joint grooving, etc.

9.3 **TYPE, DESIGN & DIMENSION OF WOODEN PACKING CASES**:

9.3.1 **PACKING OF EQUIPMENTS**

Various mechanical, electrical and C&I equipment e.g. Pumps, motors, equipment skids, heat exchangers, control panels, switch gears, transformers, etc. shall be wrapped in weather proof packing and then secured in wooden packing cases. The construction of wooden packing cases/crates shall be as per details given below and also given in figure 1 to 11.

9.3.1.1 **Bottom Frame**

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The construction of bottom frame shall be as per Fig-2. The No. of slides/runners for bottom frames shall be selected depending upon the weight and overall dimensions of the load to be carried. The equipment shall be secured by fixing their base frame/plate with the help of bolt and nuts etc. to bottom frame of the wooden packing cases/crates. The equipment not provided with base frame/plate like cylindrical vessels, etc to be secured to the bottom frame of the wooden cases with "C" clamps fabricated from steel channels/ angle iron.

9.3.1.2 **TOP FRAME**

The construction of top frame shall be as per fig-3.

9.3.1.3 **END PANELS**

The dimension of the end and lateral panels shall be calculated according to overall dimensions of the items to be packed. Diagonal braces shall be used for packing cases having height exceeding 500mm. Details of bracings shall be as per fig 5 to 9.

9.3.1.4 **Sling Plate**

To facilitate lifting of cases, longitudinal under slide boards shall be fixed. To avoid damage to the box while lifting sling plates shall be provided. Refer fig-11.

9.3.1.5 **Angle Iron Cleats**

Angle iron cleats shall be used for strengthening the joints as indicated in fig-10

9.3.1.6 **Other Requirements**

- The thickness of planks for top, bottom, side and end panels shall be at least 25mm. Planks used for this purpose shall be joined with each other by tongue and groove joint. The groove dimension shall be such that tongue fits tightly into groove to make the joint.
- Runners/slides, traverse bars, etc shall be of single length I.e. without any joint. Planks for sheathing, diagonal bracing etc shall also be of single length up to 2400mm, proper jointing is permitted for planks for sheathing and diagonal bracings.
- Each equipment to be individually covered with double polyethylene petticoat. Sheet thickness of polythene sheet shall not be less than 0.175 mm (175 microns). The sealing shall be such so as not to allow moisture inside.
- The inner surface of 4 sides of shooks shall be nailed with bituminized water proof craft paper. Wherever 2 pieces of kraft paper are used, joint shall have an overlap of minimum 20 mm.
- All the inner sides of the box shall be nailed with bitumen coated HESSIAN POLYTHYLENE KRAFT PAPER. For top frame it shall project on all sides by 100mm and shall be nailed on sides. Wherever 2 pieces of kraft paper are used, joint shall have an overlap of minimum 20 mm.
- For delicate equipment like control panels and switchgears, lighting panels and lighting transformers, suitable cushioning material like rubberised coir (min. 50 mm thick and 100 mm wide) shall be provided on their bottom support and the gap between the panel and casing

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shall be filled with rubberized coir with distance between consecutive supports less than 500 mm (ref fig15). For other equipment suitable support from sides of the casing shall be provided.

- Switchgear cubicles, control panels and control desks shall be packed and shipped in separate convenient sections. The components e.g. circuit breakers relays and instruments etc. which are removed from panels for shipping purpose and shall be separately packed and shipped as per packing instructions in clause 10.4.

- Packing case for control panels and switchgear panels shall be finally covered with GI sheet of minimum thickness of 0.4mm.

- Packing cases shall be bound at edges by nailing MS clamps/brackets at sufficient intervals. Further heavier boxes shall be strapped with C clamps (ref fig-4) fabricated from steel channels/angles and lighter boxes shall be strapped with hoop iron strips.

- Silica gel is used for this purpose to protect contents over sufficiently long time from corrosion. Silica gel shall be indicating type confirming to IS-304 (1979) packed in cotton bags placed at different positions inside the packing for absorbing moisture and shall not come into directly contact with equipment/material inside the package. The quantity of silica gel shall be adequate for storage period of one year, however it shall not be less than 4 gm. per ltr. Volume of case subject to minimum 400 gm. Per case.

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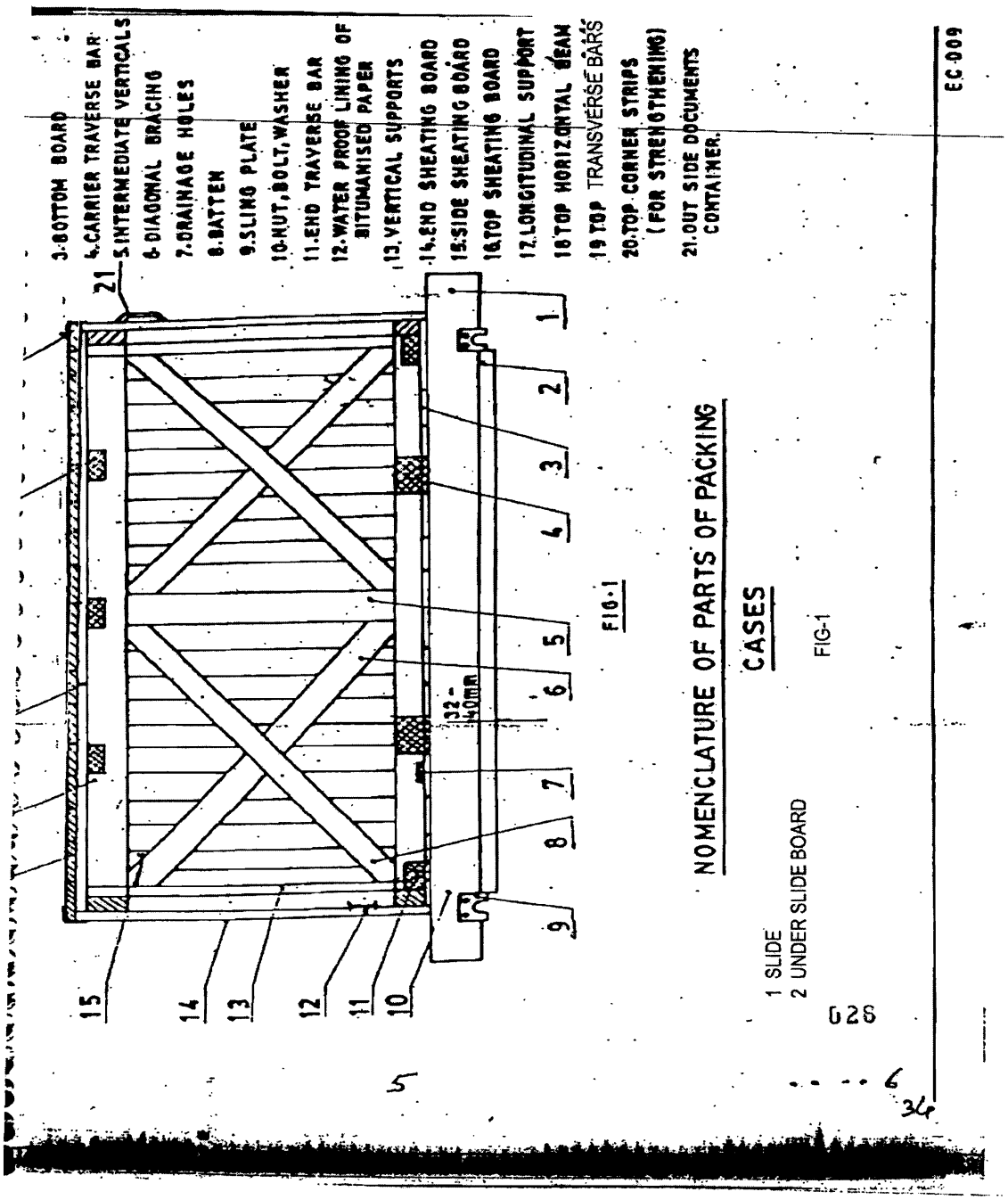

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BOTTOM FRAME ARRANGEMENTS

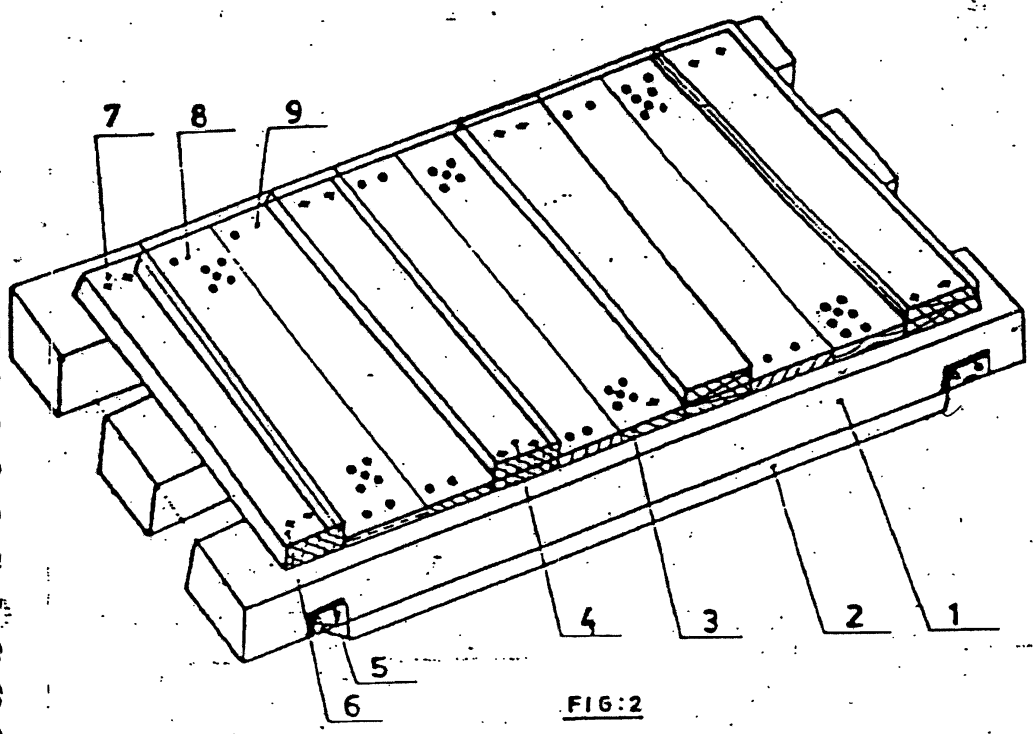

FIG:2

Nos. of slides : Minimum 2 Nos.
For length more than 1800 mm or load more than 1000kg, Nos. of slides shall be minimum 3 Nos.
For dimensions of slides, refer Table 1
Cross section of end traverse bar; 100 X 100 mm (minimum)

1. SLIDE
2. UNDER SLIDE BOARD
3. BOTTOM BOARD
4. CARRIER TAVERSE BAR
5. SLING PLATE
6. END TRAVERSE BAR
7. BOLT, NUT & WASHER
8. DRAINAGE HOLES
9. NAILS

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TOP FRAME ARRANGEMENT

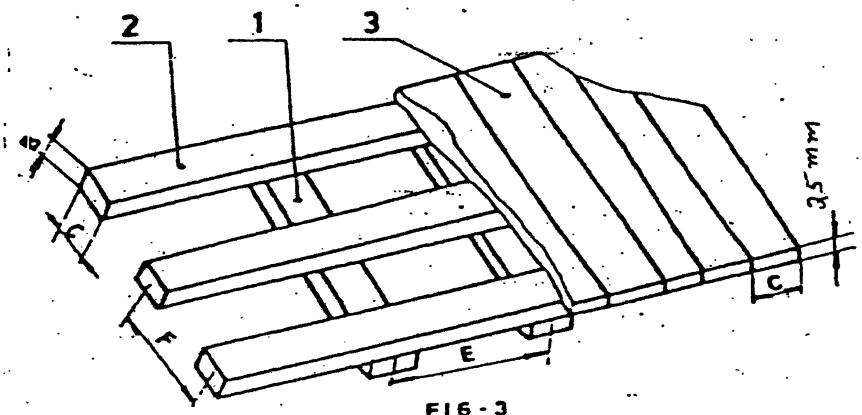
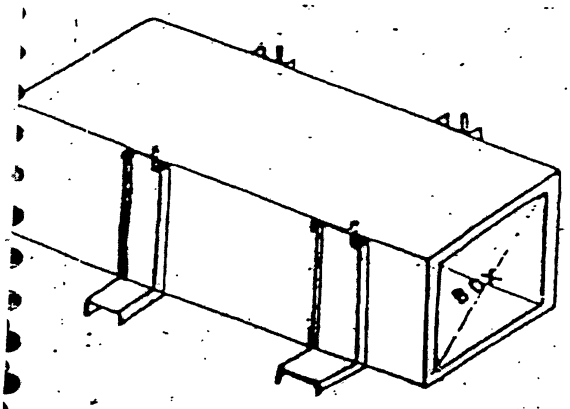


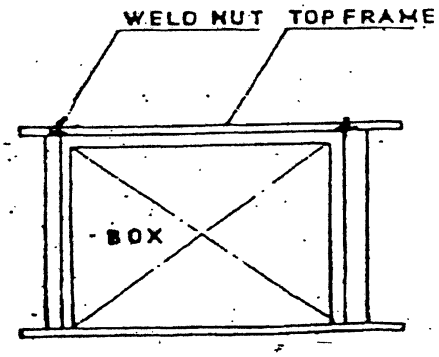
FIG-3

F : 700 t 1000 mm
E : 500 t 900 mm
: 30 X 100 mm.

1 - Treverse Bers
2 - Horizontal Soans
3 - Top Board

ARRANGEMENT OF C-CLAMPS AROUND CASES





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ARRANGEMENT OF DIAGONAL BRACING AND HORIZONTAL SUPPORT

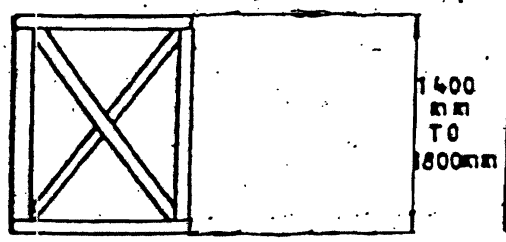

FIG:6

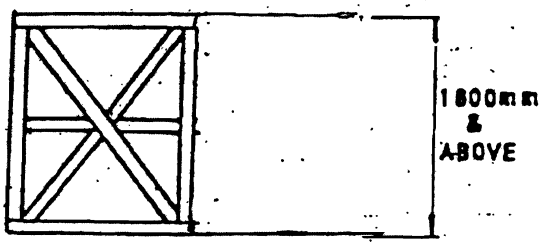

FIG:8

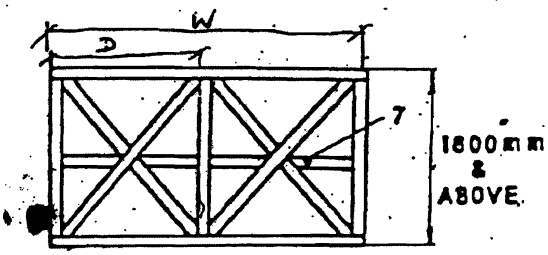

FIG:9

7- Middle Horizontal Support

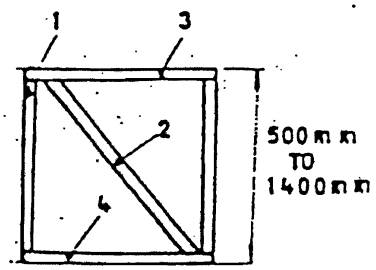

FIG:5.

1- Vertical Support

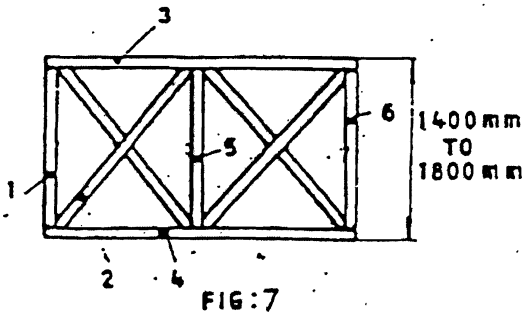

FIG:7

1, 5, 6 - Vertical Support

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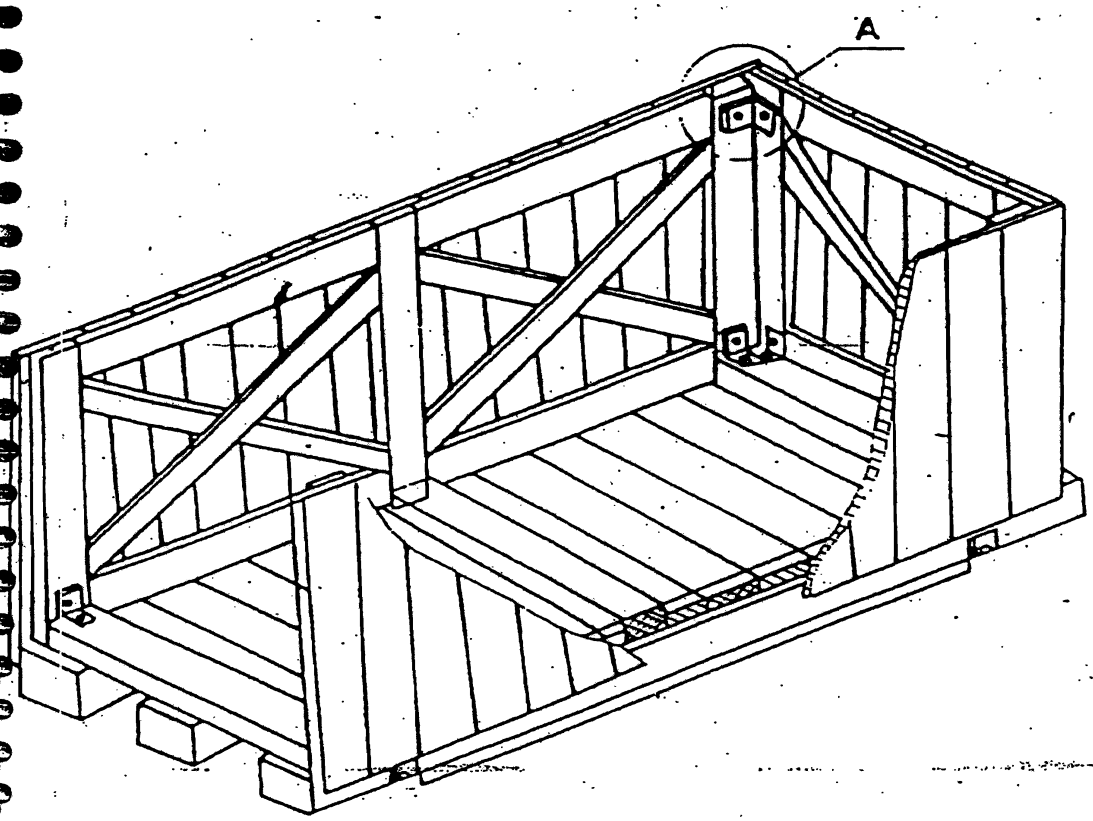
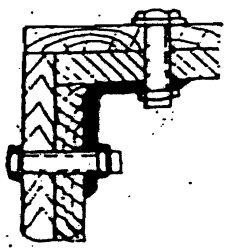
ARRANGEMENT OF PACKING CASE





DETAIL-A

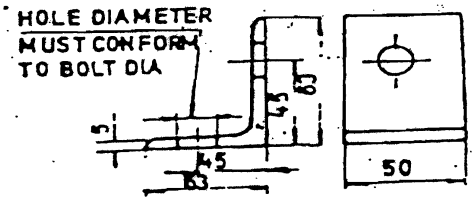


FIG:10

030

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ARRANGEMENT OF SLING PLATE ON CASES

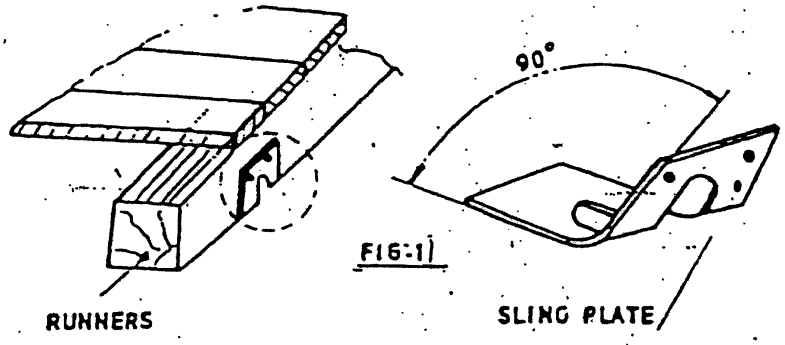

FIG:1

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TABLE-1

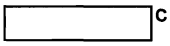
LOADS	LENGTHS OF SLIDES						
	600	800	1000	1200	1300	1500	2000
	Cross section b x c						
500	50 X 100	50 X 100	50 X 100	50 X 100	75 X 100	75 X 100	100 X 100
800	50 X 100	50 X 100	75 X 100	75 X 100	75 X 100	75 X 100	100 X 100
1000	75 X 100	75 X 100	75 X 100	100 X 100	100 X 100	100 X 110	100 X 150
1500	75 X 100	75 X 100	100 X 100	100 X 100	100 X 100	100 X 150	100 X 150
2000	75 X 100	100 X 100	100 X 100	100 X 150	100 X 150	100 X 150	150 X 150
2500	75 X 100	100 X 100	100 X 150	100 X 150	100 X 150	150 X 150	150 X 150
3000	100 X 100	100 X 150	150 X 150	150 X 150	150 X 150	150 X 150	150 X 150

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Table-2

End and side panels	Width of the panel "W"	Distance between longitudinal support (Dimension "D")						
		600	800	1000	1200	1400	1600	1800
		Cross section b x c				Item 1 to 7		
Fig- 5 to Fig-9	600 to 1200	30 X 100	30 X 100	30 X 100	30 X 130	30 X 130	30 X 130	30 X 130
	1201 to 1600	30 X 130	30 X 130	30 X 130	30 X 130	30 X 130	30 X 130	30 X 130
	1601 to 2000	30 X 130	30 X 130	30 X 130	30 X 130	30 X 130	30 X 130	30 X 130
	2001 to 3000	30 X 130	30 X 130	30 X 130	30 X 130	30 X 130	30 X 130	40 X 150
	3001 to 4000	40 X 150	40 X 150	40 X 150	40 X 150	40 X 150	40 X 150	40 X 150

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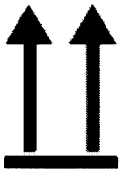
INDICATION MARKS ON CASES/BOXES/CRATES

Designation	Symbol	Explanation
Fragile, Handle with care		The symbol should be applied to easily broken cargoes. Cargoes marked with this symbol should be handled carefully and should never be tipped over or slung.
Use no hooks		Any other kind of point load should also be avoided with cargoes marked with this symbol. The symbol does not automatically prohibit the use of the plate hooks used for handling bagged cargo.
Top		The package must always be transported, handled and stored in such a way that the arrows always point upwards. Rolling, swinging, severe tipping or tumbling or other such handling must be avoided.
Keep away from heat (solar radiation)		Compliance with the symbol is best achieved if the cargo is kept under the coolest possible conditions. In any event, it must be kept away from additional sources of heat. It may be appropriate to enquire whether prevailing or anticipated temperatures may be harmful.
Protect from heat and radioactive sources		Stowage as for the preceding symbol. The cargo must additionally be protected from radioactivity.
Sling here		The symbol indicates merely where the cargo should be slung, but not the method of lifting. If the symbols are applied equidistant from the middle or center of gravity, the package will hang level if the slings are of identical length. If this is not the case, the slinging equipment must be shortened on one side.
Keep dry		Cargo bearing this symbol must be protected from excessive humidity and must accordingly be stored under cover. If particularly large or bulky packages cannot be stored in warehouses or sheds, they must be carefully covered with tarpaulins.

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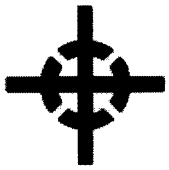
Center of gravity		This symbol is intended to provide a clear indication of the position of the center of gravity. To be meaningful, this symbol should only be used where the center of gravity is not central. The meaning is unambiguous if the symbol is applied onto two upright surfaces at right angles to each other.
No hand truck here		The absence of this symbol on packages amounts to permission to use a hand truck on them.
Stacking limitation		The maximum stacking load must be stated as "... kg max.". Since such marking is sensible only on packages with little loading capacity, cargo bearing this symbol should be stowed in the uppermost layer.
Clamp here		Stating that the package may be clamped at the indicated point is logically equivalent to a prohibition of clamping anywhere else.
Temperature limitations		According to regulations, the symbol should either be provided with the suffix "...°C" for a specific temperature or, in the case of a temperature range, with an upper ("...°C max.") and lower ("...°C min.") temperature limit. The corresponding temperatures or temperature limits should also be noted on the consignment note.
Do not use forklift truck here		This symbol should only be applied to the sides where the forklift truck cannot be used. Absence of the symbol on other sides of the package amounts to permission to use forklift trucks on these sides.
Electrostatic sensitive device		Contact with packages bearing this symbol should be avoided at low levels of relative humidity, especially if insulating footwear is being worn or the ground/floor is nonconductive. Low levels of relative humidity must in particular be expected on hot, dry summer days and very cold winter days.

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Do not destroy barrier		A barrier layer which is (virtually) impermeable to water vapor and contains desiccants for corrosion protection is located beneath the outer packaging. This protection will be ineffective if the barrier layer is damaged. Since the symbol has not yet been approved by the ISO, puncturing of the outer shell must in particular be avoided for any packages bearing the words "Packed with desiccants".
Tear off here		This symbol is intended only for the receiver.

FIG-12

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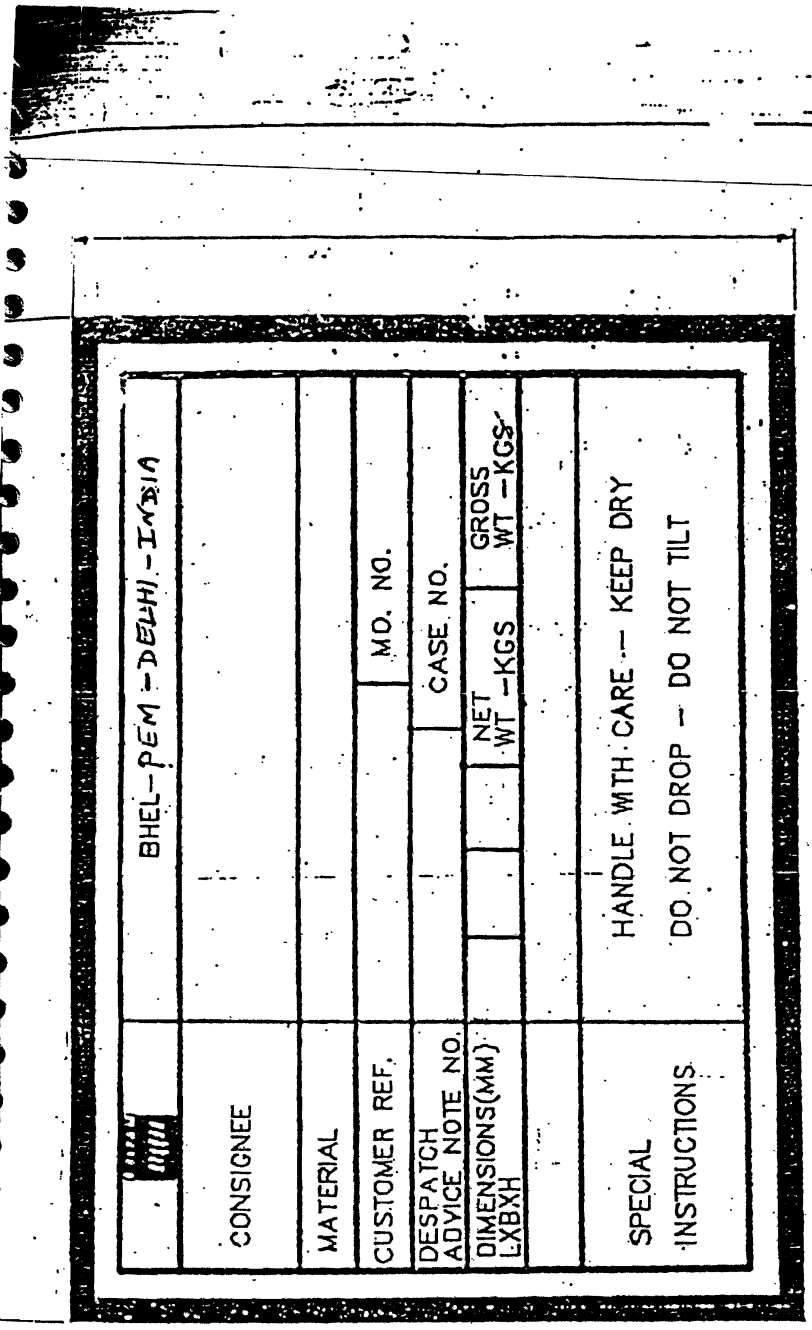

FIG-13: MARKING PLATE

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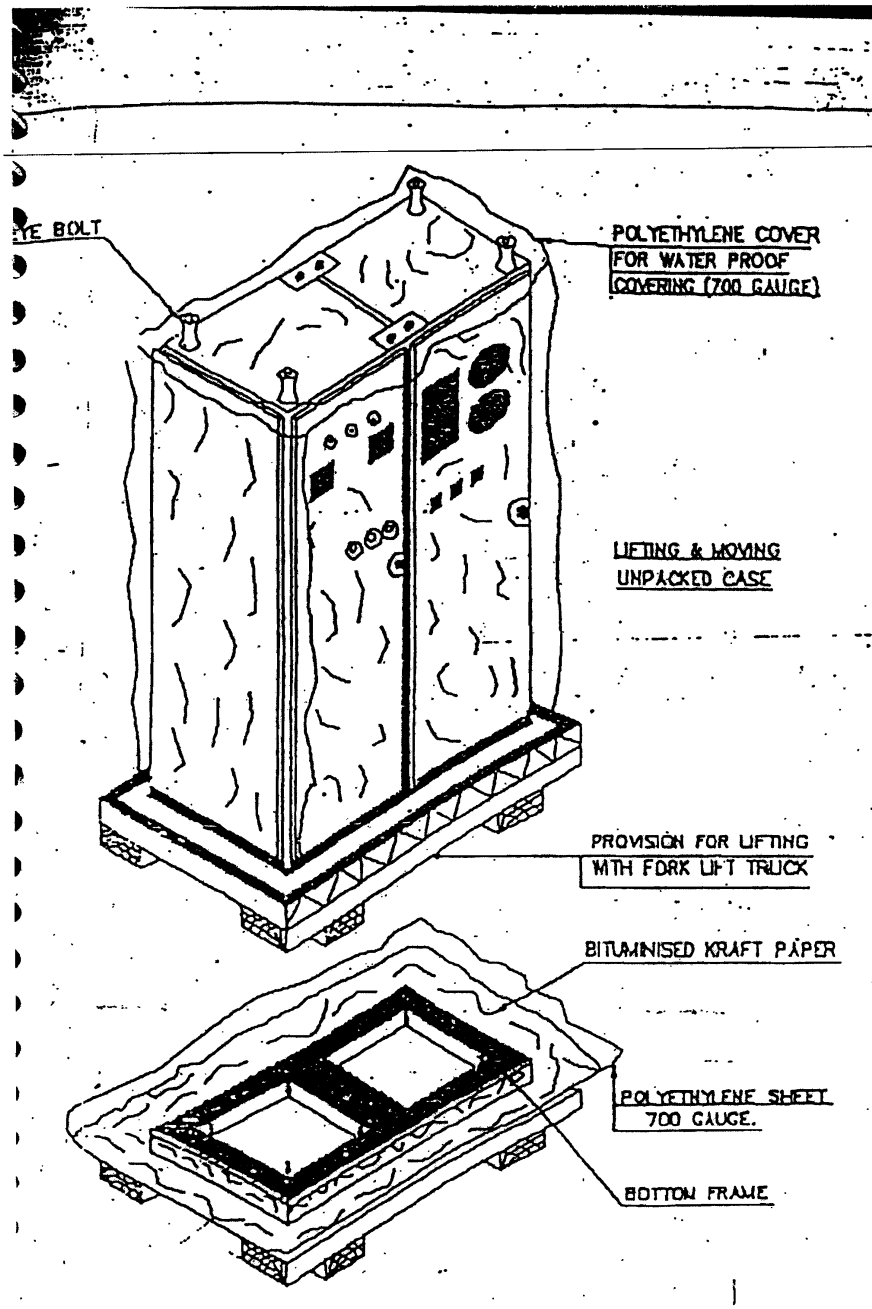

FIGURE–14

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Sht 16 of 17

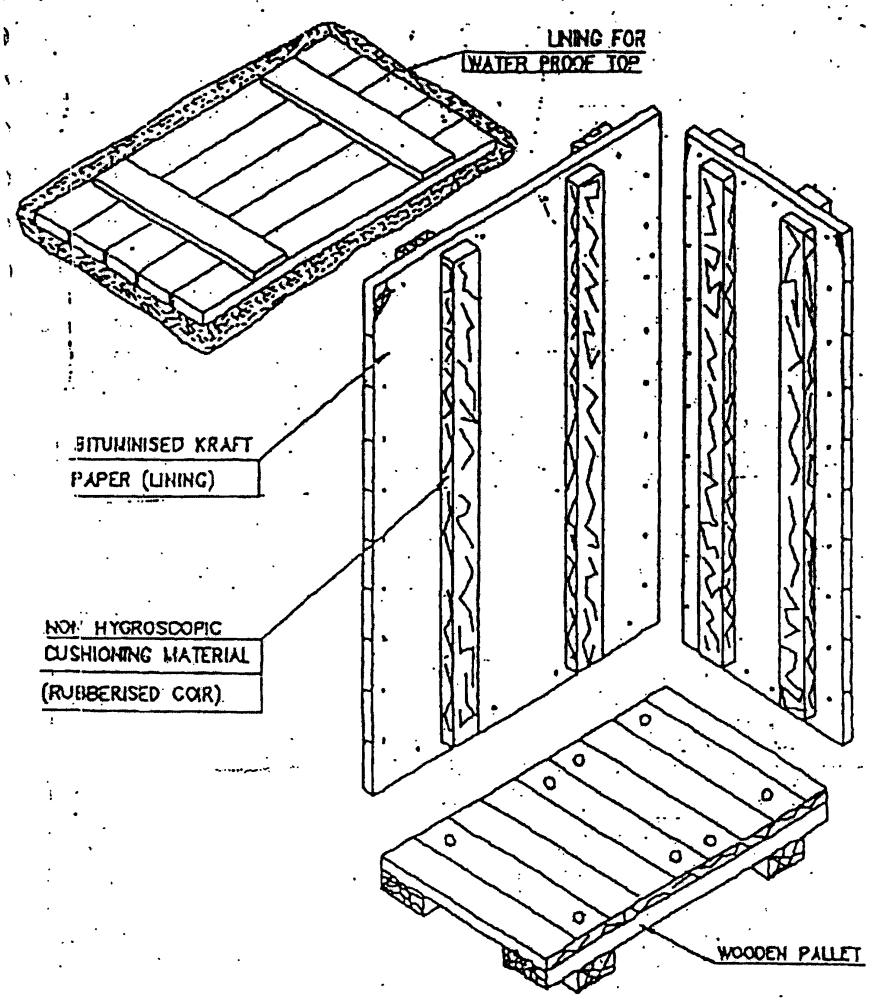

FIGURE-15

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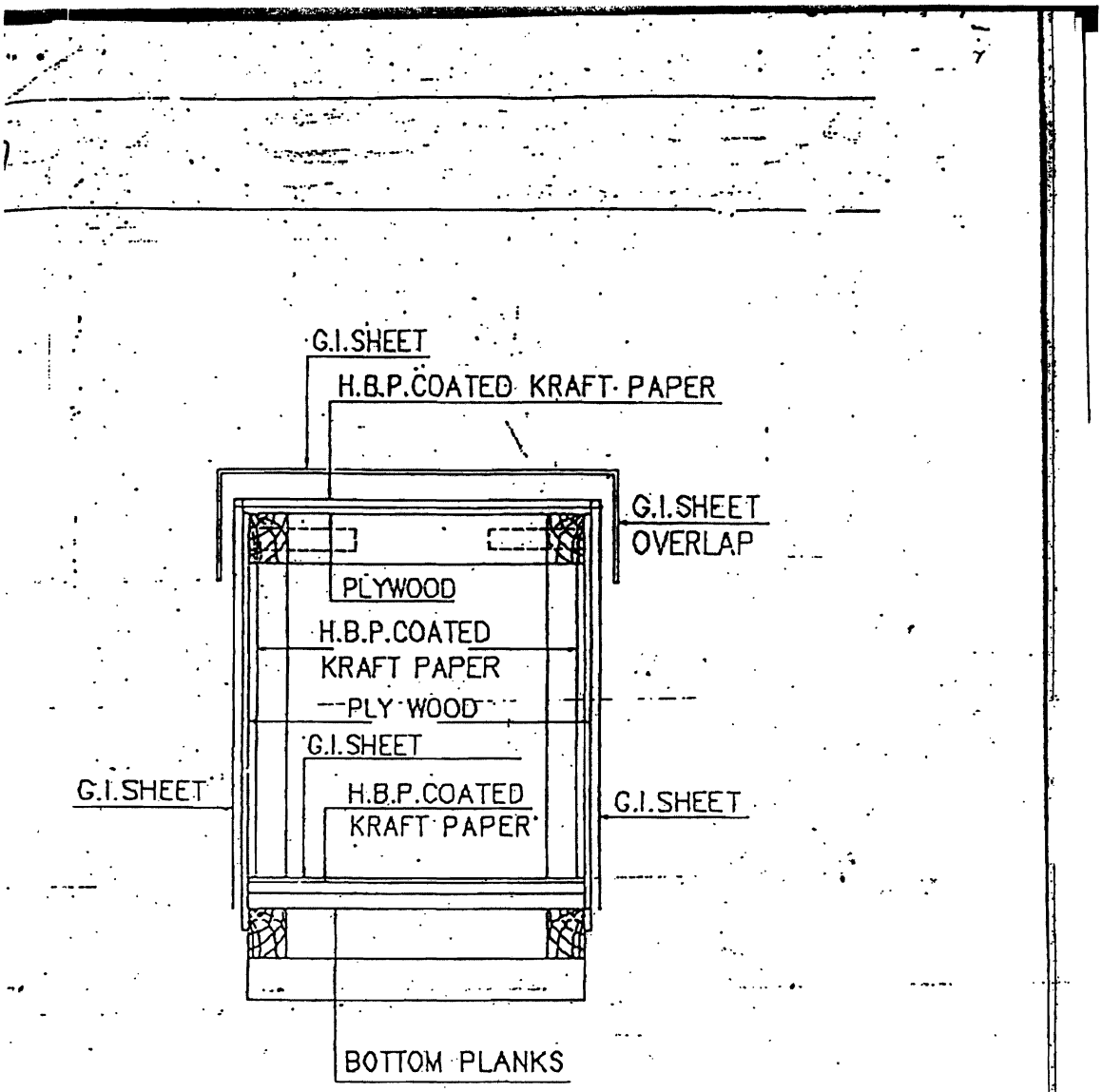

FIG-16 : CLOSED PACKING CASE WITH G.I.SHEET SHOWING LAYERS OF PACKING MATERIALS.

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10.0 TYPICAL PACKING DETAILS/PROCEDURE FOR MECHANICAL ITEMS

10.1 INSULATION MATERIAL (MINERAL WOOL MATTRESSES)

This specification covers the requirements of seaworthy packing and marking for bonded mineral (rock) wool mattresses having metallic hexagonal wire netting as facing on one or both sides.

10.1.1 TYPE OF CONSTRUCTION

Mattress shall be packed in Polythene (of 0.2 mm thickness) all around and sealed to prevent moisture absorption during transit and storage. Further it shall be wrapped with Bitumen coated Polythene bonded/lined Hessian and stitched and then packed in 5 ply DFC carton box.

Silica gel is used for this purpose to protect contents over sufficiently long time from corrosion. Silica gel shall be of indicating type conforming to IS:304-1979 packed in cotton bags placed at different positions inside the packing for absorbing moisture and shall not come into direct contact with the material inside the package. The quantity of silica gel shall be enough for storage period of one year. However, it shall not be less than 4 gms per litre volume of case subject to minimum of 400 gms per case.

Each mattress as well as the packages shall be serial numbered. Also, printed sheets indicating the nominal thickness, density and wire netting details (i.e. material and size) shall be placed below the wire netting.

Following details shall be legibly written on the packages. The details shall also be typed on a sheet of paper & kept in a sealed Polythene cover, inside the packages

a) Project Name
b) Purchase Order No.
c) Sl. No. of package
d) Size of mattress (Thickness x Length x Width)
e) Density
f) Wire netting material and size
g) Weight of the package

10.2 INSULATION MATERIAL (ALUMINIUM COIL)

Heavy Gauge Aluminium Coil Packaging are done by Eye-to-Sky packaging or by Eye to eye packaging as per the proven practice being followed by manufacturer of Aluminium sheets.

10.2.1 Type of construction for Eye to Sky packaging

a. Strapping of coil with polyester strap around circumference at one place.

b. Putting paper I. D. Edge protector.

c. Wrapping the coil with VCI stretch film after putting silica gel bags (4 nos.) Inside the coil.

d. Wrapping the coil with HDPE film.

e. Covering the coil including its build up & bore with masonite / particle board.

f. Putting metallic I. D on coil.

g. Putting O.D edge protector (paper) on coil.

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h. Putting circumferential polyester strap (3 nos.) & eye polyester strap (4 nos.).

i. After placing the coil on coil tilter ply wood (10mm thick) of suitable size along with wooden pallet is to be put at the bottom side of the coil.

j. Coil is to be tilted to eye-to-sky position.

k. Final strapping with metallic strap to unit coil and skid at 2 places with top cover of plywood.

l. Fixing the coil with wooden blocks at 4 corners.

m. Labeling 2 nos.(one metallic & one adhesivetype) For specification, net wt. & gross wt.

10.2.2 Type of construction for Eye to Eye packaging

a. Strapping of coil with polyester strap around circumference at one place.

b. Putting paper I. D. Edge protector.

c. Wrapping the coil with VCI stretch film after putting silica gel bags (4 nos.) Inside the coil.

d. Wrapping the coil with HDPE film.

e. Covering the coil including its build up & bore with masonite / particle board.

f. Putting metallic I. D on coil.

g. Putting O.D edge protector (paper) on coil.

h. Putting circumferential polyester strap (3 nos.) & eye polyester strap (4 nos.).

i. Placing of coil on wooden skid Coil is to be tilted to eye-to-sky position.

j. Final strapping of coil and skid at 2 places with steel strap. Fixing the coil with wooden blocks at 4 corners.

Labeling 2 nos.(one metallic & one adhesive type) For specification net wt. & gross wt.

10.3 Packing Procedure for Online Tube Cleaning System and accessories

This procedure is applicable for the shipment of Onload Tube Cleaning System and accessories by sea.

10.3.1 Packing details:

- The Packing case shall be made of treated rubber wood. The design of the case shall be as per Annexure IIIA & IIIB.
- The Equipments shall be placed on the wooden base of the Packing case and fastened if required to arrest the movement of the same.
- Equipment shall be covered by Polythene sheet and inside wall surfaces of the wooden cases also shall be covered by polythene sheet.
- All Nozzles shall be closed with plywood dummies.
- All electrical components assembled or loose shall be covered with polythene sheets along with silica gel pack.
- Silica gel desiccants shall be kept inside each case in sufficient quantities in order to absorb the moisture.

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- Thermocol packing shall be made for glass items like Ball vessel sight glass, Vpiece
- sight glass & pressure gauge.
- Silica gel desiccants shall be kept inside of each case to absorb the moisture.
- A Packing list covered in a polythene envelope shall be fixed inside and outside of each packing case.
- Shipping marks and consignee address shall be painted on the outer surface of the case.
- All handling instruction required for the case like top, sling, rain, handle with care etc, shall be marked on the case as per the symbol attached.
- Machined surface will be applied with Anti rust oil and covered by polyurethane sheet to protect from external oxidation.
- All valves will be closed with dummies to protect the internals and placed in the wooden case which will covered by polyurethane sheet.

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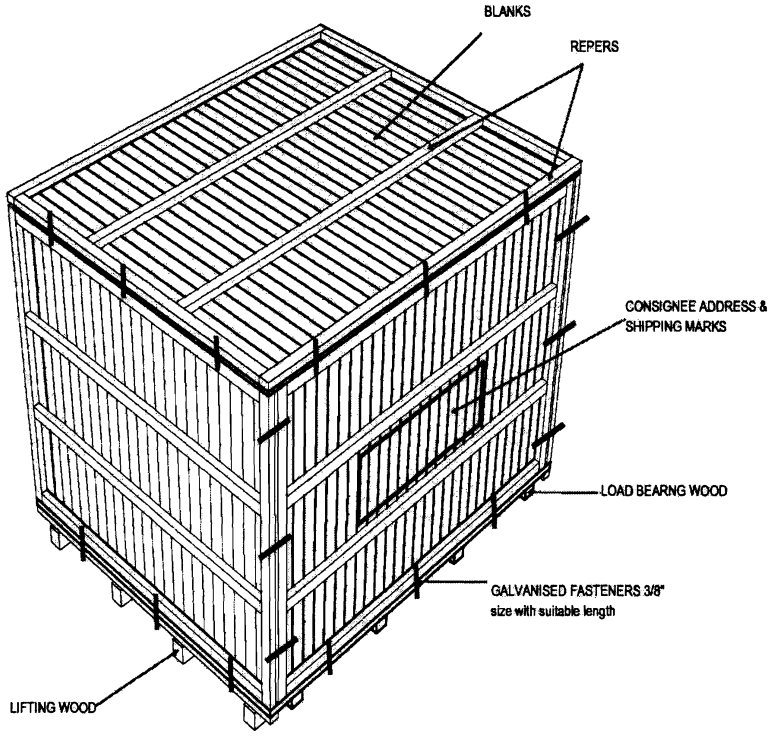
MODEL: FASTNERS TYPE (BASE, SIDE &TOP ATTACHED WITH BOLT, NUT & WASHER)

This Type of case to be used for following items:
1. BALL SEPERATOR
2. BALL COLECTOR SKID



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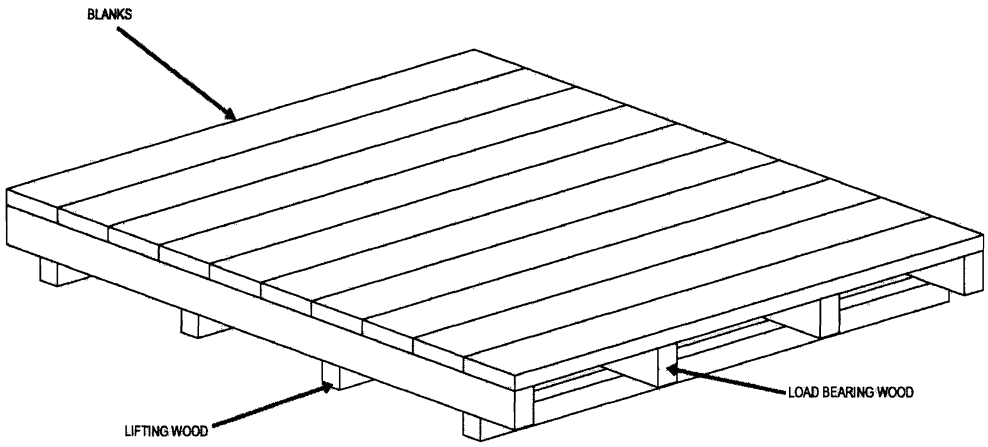
BASE FRAME



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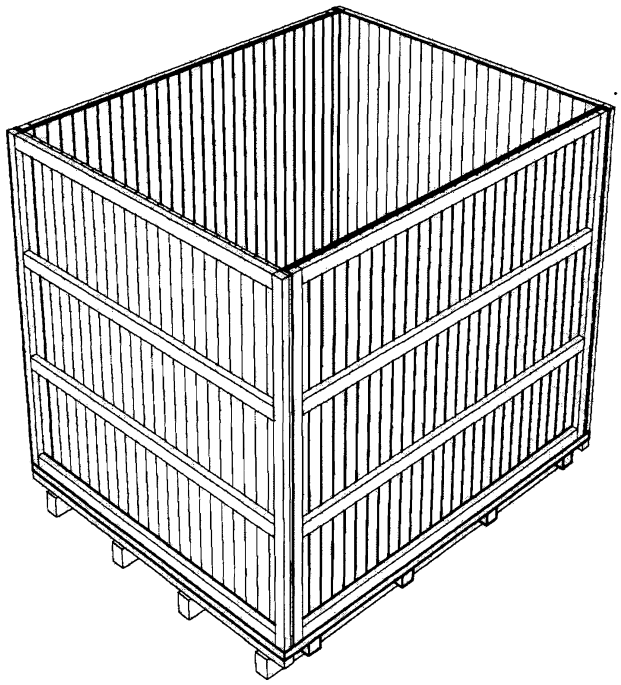
MODEL: FASTNERS TYPE - WITHOUT TOP



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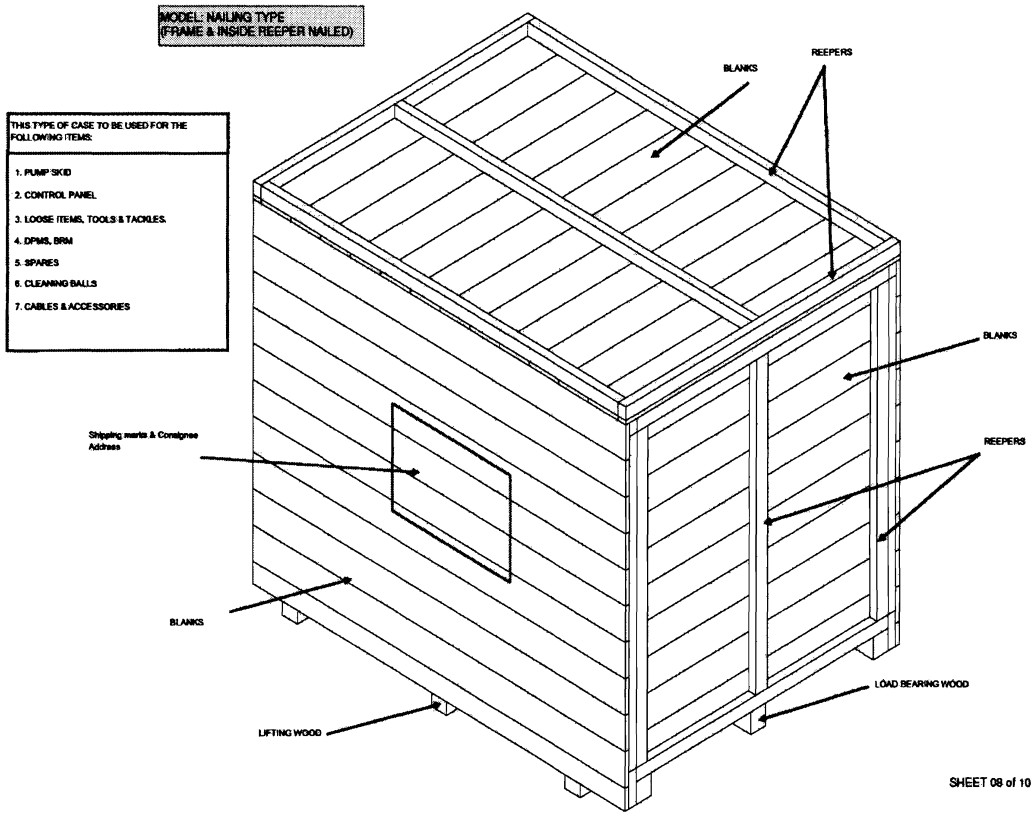

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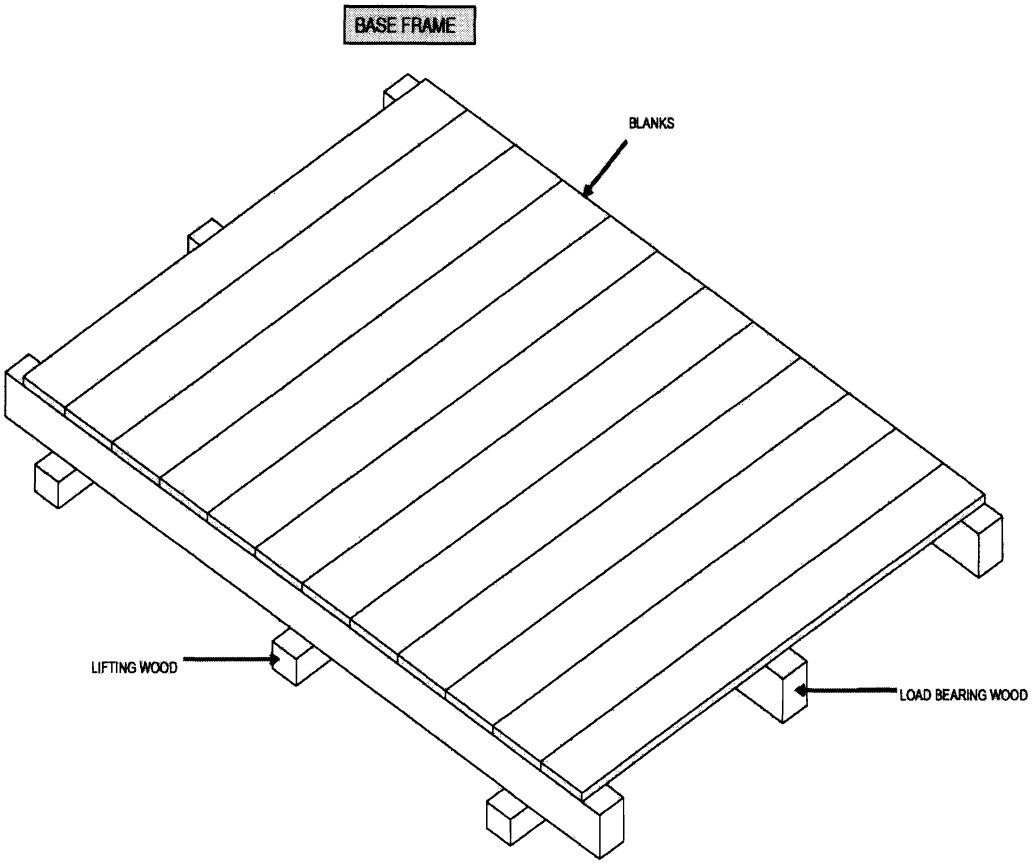

SHEET 09 of 10

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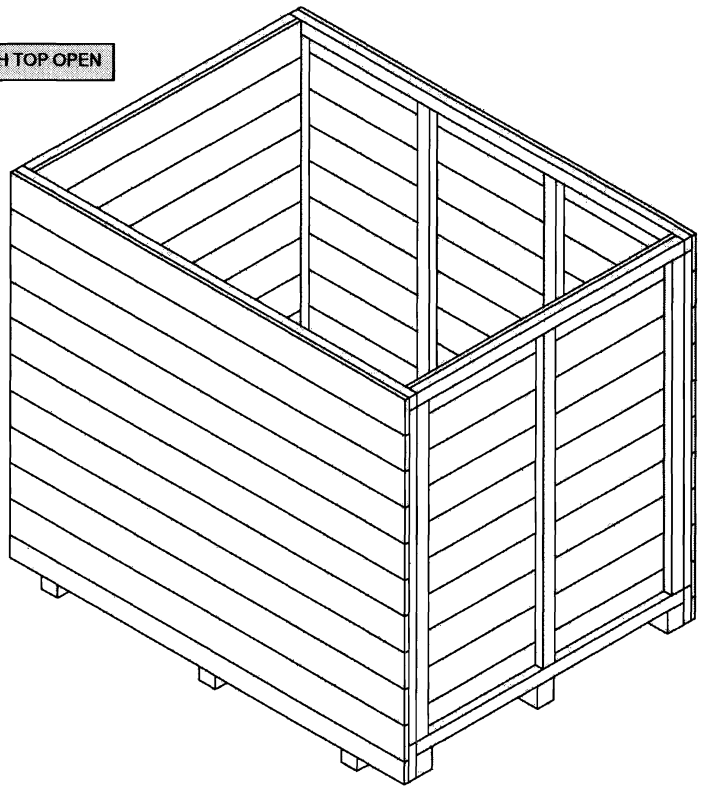
NAILING TYPE MODEL WITH TOP OPEN



SHEET 10 of 10

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10.4 PACKING OF LOOSE ITEMS

Loose mechanical, electrical and C&I items e.g. valves, fittings, pressure/temperature gauges/switches, circuit breakers, relays etc shall be individually wrapped using polyethylene sheets/U foam/ thermocol sheets/air bubble sheets depending upon the items and then packed in wooden boxes. The left out spaces and top of the boxes shall be filled with rubberized coir to get proper cushioning effect, Special attention shall be paid to relays, instruments etc for arresting the movements of their operating mechanism during transportation.

The construction of wooden packing cases shall be as per clause 9.3.1 retaining its all features concerning strength of the box. The construction of wooden packing case for electrical and C&I items shall be as per fig-16.

Inner surface of 6 sides of the box shall be lined with bitumen coated hessian polyethylene kraft paper. Rubberized coir of min. 25mm thickness and 100 mm width shall be nailed to inner surfaces of bottom and 4 sides of the boxes.

11.0 PACKING OF ELECTRICAL ITEMS

11.1 CABLES

11.1.1 Type of Equipment
All type of cables..

11.1.2 Type of Construction

New or practically new cable drums made of steel and painted with epoxy resin paint are to be used. Cable ends are carefully protected before packing. Over the cables polyethylene sheet shall be wrapped and then sealed properly. Cable drum can be put in wooden crates for ease in transportation and handling. (Wooden cable drum is also acceptable, however vendor to furnish constructional details for approval).

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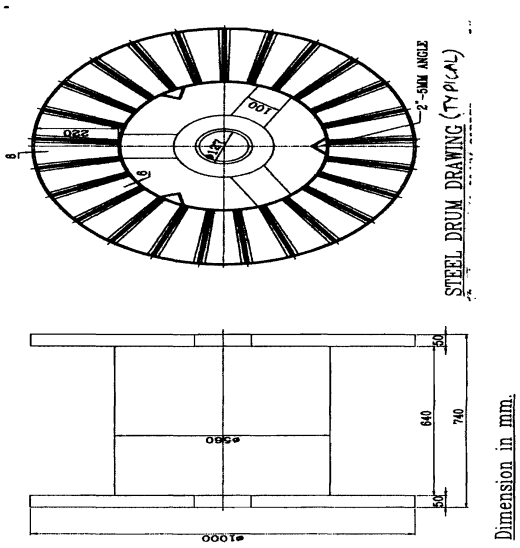

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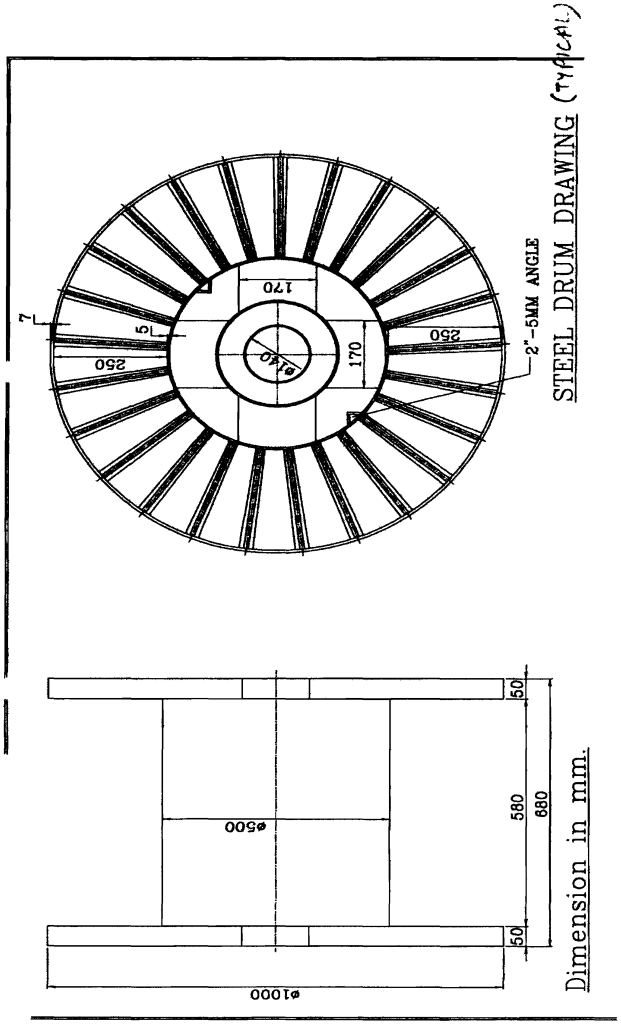

11.2 PACKING OF CABLE TRAYS & ACCESSORIES AND CABLE TRAY SUPPORT MATERIAL

11.2.1 Cable trays can be packed in wooden boxes as per fig 1 to 11 or in steel boxes. Details of steel box construction is as indicated below.

1) All Dimensions are in "mm" unless otherwise stated.
2) Packing Box shall be fabricated using 50x50x6mm MS Angle, 50x3mm Flat, 2.5 mm thick C Channel, 1mm & 1.6mm Thick sheet.
3) Finish of Packing Box Shall be Galvanized.
4) Angle & Channel Section forming part of the Main frame shall be welded thoroughly with each other to give a rigid structure.
5) Sheet Section and Flat section shall be bolted/ Riveted/ Welded suitably to the Main frame stated in '4' above.

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6) Welding Portion on galvanized surfaces shall be painted with Zinc Rich Paint.

7) Dispatch details such as consignor/consignee address, contract and case details, 'country of origin, port of delivery, stacking instructions shall be written on one of the side of boxes. An anodized aluminium plate as per details and specifications given in page 3 of 5 shall be provided on the boxes

8) One copy of packing slip wrapped in polythylene bag covered with suitable aluminium .packing slip holder to be nailed on the external surface of the box. One more copy 9f the packing Slip wrapped in polythylene bag to be kept inside the box at the prominent place.

9) **INDICATION MARKS ON THE BOXES:** Markings shall be provided on the boxes indicating position of Boxes for handling, storage and nature of consignment. For guidelines referred page 4 of 5. The ink issued for this purpose as well as for marking dispatch instruction shall be indelible/non-washable marking ink.

10) Each item as mentioned in BOQ shall be packed & supplied as a set comprising of required numbers of associated fasteners & hardware etc

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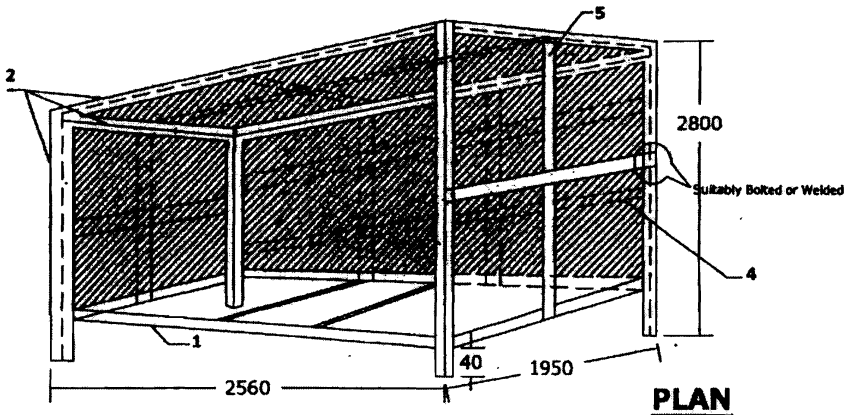
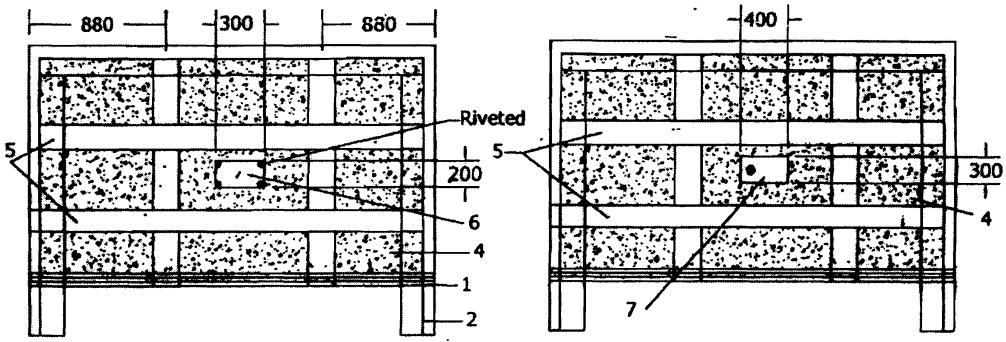
STEEL PACKING (TYPICAL DETAILS)



PLAN

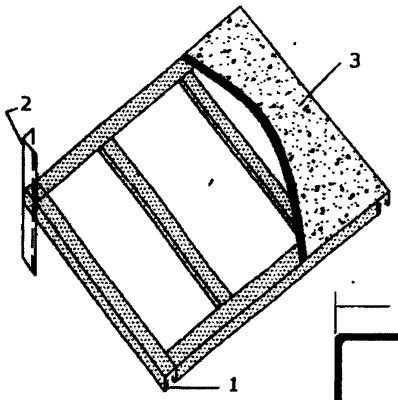


FRONT SIDE OF BOX

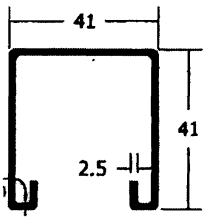
BACK SIDE OF BOX

Note:

1. "C" Channel to be used on Bottom Frame.
2. 50x50x6 Angle to be used Vertically on four sides of the Box and Horizontally on four sides on the top Frame.
3. 1.6mm thick sheet (plain) on Bottom Plate.
4. 1.0mm thick sheet to cover top & four sides of BOX.
5. 50x3 Flat as additional cross members to be used Horizontally & Vertically on top & Four Sides of Box.
6. Anodised Alluminium Plate for Marking.
7. Hinged Inspection Window.



BOTTOM FRAME ARRANGEMENT



DETAILS OF "C" CHANNEL

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11.3 PACKING FOR STATION LIGHTING SYSTEM

Aspects of packing specific to equipments / items of station lighting system are given here. All other instructions / aspects as per the main specification of export packing which are not covered here shall also be applicable.

11.3.1 For LIGHTING TRANSFORMER, DISTRIBUTION BOARDS, LIGHTING PANELS,

a) Construction of packing case for LIGHTING DIATRIBUTION BOARDS, LIGHTING PANELS, TRANSFORMER . shall be EITHER as per FIGURE 1,2,3,5,6,7,8,9,10,11 OR FIGURE 14,15,16.

b) Each Panel/Transformer shall be individually covered with double polythene sheet of thickness 175 microns minimum.

c) All the 6 inner surfaces of packing shall be nailed with bitumen coated hessian polythene craft paper. Wherever 2 pieces of craft paper are used, the joint shall have minimum overlap of 20mm.

For the top frame it shall be project on all sides by 100mm and shall be nailed on sides .

d) The gap between the panels and packing case shall be filled with rubberized coir of thickness 50mm minimum and width 100mm. The distance between two consecutive supports of rubberized coir shall be less than 500mm.

e) Silica get packed in cotton bags shall be placed at different positions inside the packing.

f) Packing case shall be finally covered with GI sheet of thickness 0.4mm minimum.

11.3.2 For LUMINARIES, RECEPTACLES. EMERGENCY LIGHT, 240/24V TRANSFORMER, CEILING FAN, SWITCH BOARDS, FLEXIBLE CONDUIT, WIRES, EARTH WIRE. JUNCTION BOXES, ERECTION COMMIOSSIONING SPARES, RECOMMENDED SPARES , ERECTION MATERIAL AND CONSUMBALES

a) Construction of packing case for THE ABOVE MATERIAL shall be as per FIGURE 1to11.

b) Items placed inside the case shall be covered with double polythene sheet of thickness 175 microns minimum.

c) All the 6 inner surfaces of packing shall be nailed with bitumen coated hessian craft paper. wherever 2 pieces of craft paper are used, the joint shall have minimum overlap of 20mm. For the top frame it shall be project on all sides by 100mm and shall be nailed on sides.

d) Silica get packed in cotton bags shall be placed at different positions inside the packing.

11.3.3 For CONDUIT PIPE

As per international practice pipes are shipped in open bundles with metal strapping. Packing as per attached figure A shall be provided which is described as following:

a) Each bundle shall be wrapped with 2 layers of 175 microns thick polythene sheet.

b) Then bundle will be wrapped with bitumen coated hessian craft paper.

c) Bundle shall be strapped with steel straps.

d) An anodized aluminium packing description plate as per Figure No. 13 shall be provided.

11.3.4 For POLES

Poles will be wrapped with 2 layers of minimum 175 microns thick polythene sheet and then with bitumen coated hessian craft paper, packed as per Figure – C i.e. bundling.

11.3.5 For STRUCTURAL STEEL

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Structural steel will be different sizes and shapes. Hence it will be packed as per Figure No. B and described as following :

a) Each bundle shall be wrapped with 2 layers of 175 microns thick polythene sheet.
b) Then bundle will be wrapped with bitumen coated hessian craft paper.
c) Bundle shall be strapped with steel straps.
d) An anodized aluminium packing description plate as per Figure No. 13 shall be provided.

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PACKING PROCEDURE FOR CONDUIT PIPE

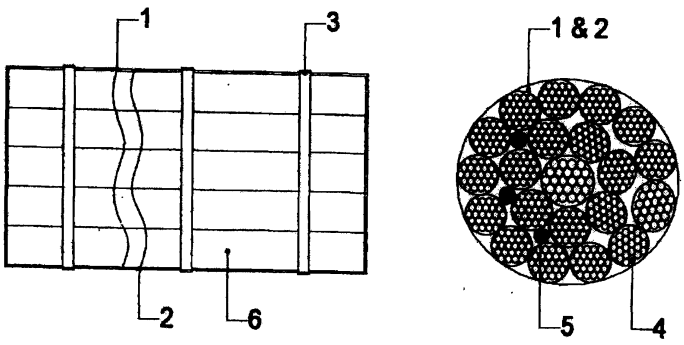

FIGURE "A"

1) LAYER OF BITUMEN COATED HESSIAN KRAFT PAPER.
2) LAYER OF POLYTHENE SHEET.
3) METAL STRAPPING.
4) CONDUIT PIPES.
5) SILICA GEL POUCHES.
6) BUNDLES OF CONDUIT PIPES.

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PACKING PROCEDURE FOR STRUCTURAL STEEL

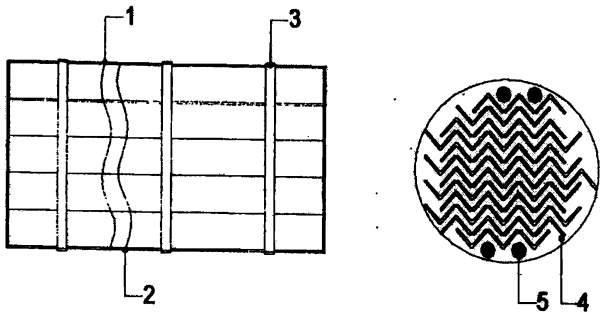

FIGURE "B"

1) LAYER OF BITUMEN COATED HESSIAN KRAFT PAPER.
2) LAYER OF POLYTHENE SHEET.
3) METAL STRAPPING.
4) STRUCTURAL STEEL.
5) SILICA GEL POUCHES.

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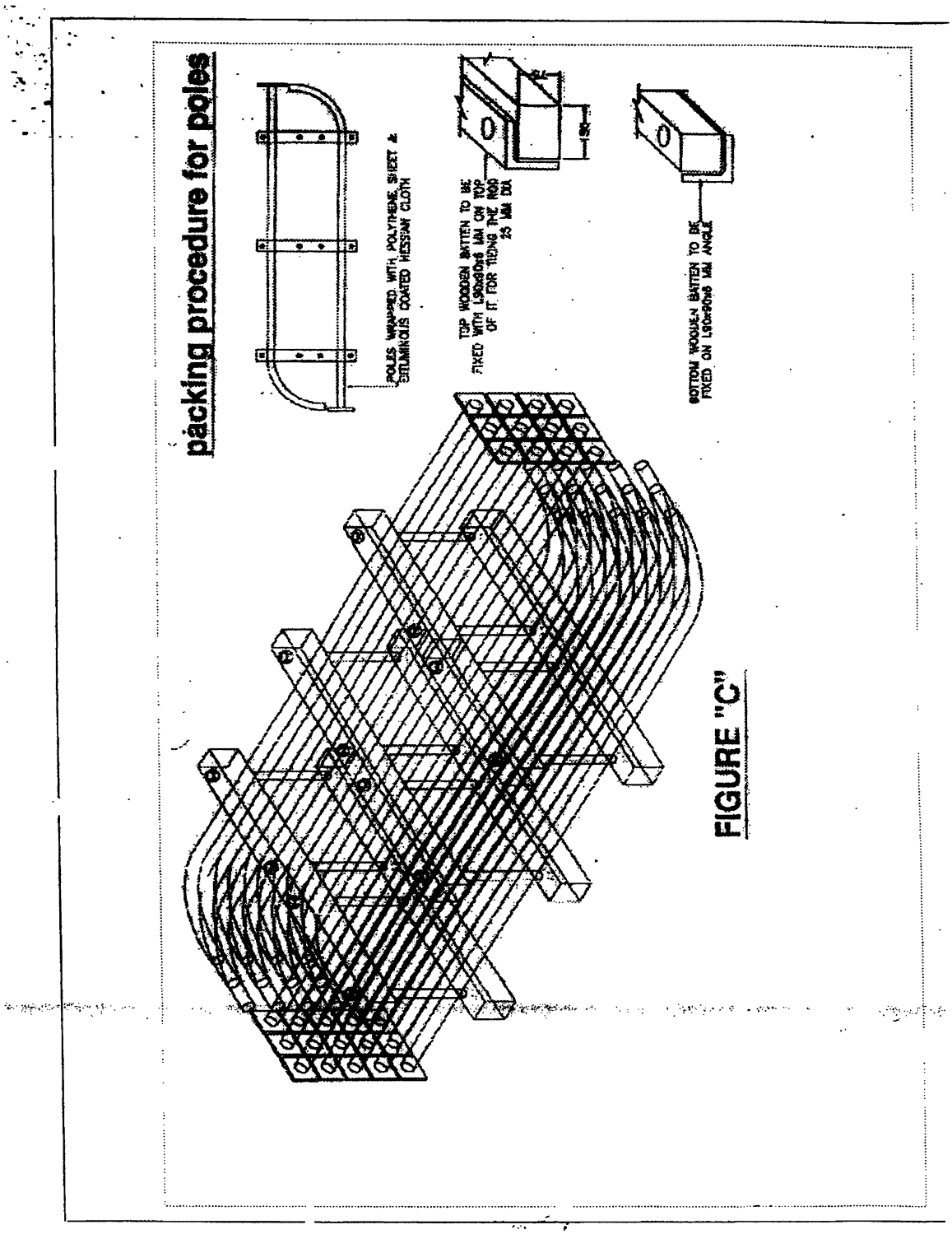

FIGURE "C"

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11.4 PACKING FOR DC BATTERY

The packing procedure for seaworthy packing of DC Battery is defined below, which is capable of withstanding impacts, compression, vibration, toppling, sea water spray, prevention against rust, temperature and extreme atmospheric conditions. Aspects of packing specific to equipments / items of DC Battery are given here. All other instructions / aspects as per the main specification of export packing which are not covered here shall also be applicable.

The packing procedure consists of various stages namely primary packing, cushioning, securing, desiccant, outside packing box, Runners/ sliders/ transverse bars of plywood, etc., provided for each movement.

a) The packing boxes shall be made up of plywood boxes (thickness 9mm min.) with blocks at the bottom of the box for provision for handling the boxes using the forklift. The packing boxes sizes are generally standardized to half-euro size (capable of handling equipment's weight).

b) Rubberized coir of 25mm thickness shall be provided as cushioning material at the bottom and thermocole of 20mm shall be provided inside on all four sides. Other than this polyethylene film wrap or cover also will be provided. Left out spaces to be filled with rubberized coir/ thermocol to get cushioning effect.

c) Silica gel in dust free air permeable cotton/paper bag shall be placed in the packing boxes for storage period of 1 year as per IS 304 (1979)

d) While packing the cells, transit caps (polypropylene) of red and blue shall be used for big size cells for ensuring that cells does not get damaged during the transport due to vibrations etc.

e) The battery accessories shall be packed with suitable precautions as follows:

i) Copper connectors shall be packed after making bunches with lead wire seals to avoid misplacement.

ii) Hardware items shall be packed in polyethylene bags (Thickness ≥ 0.175mm) with item slip

iii) Battery rack shall be packed in dismantled condition, wrapped with polyethylene sheet

iv) For Ni-Cd type battery, electrolyte in solid form for dry cells shall be packed in cans with KOH, LiOH being packed separately.

f) Galvanized Steel straps are provided for binding the packing box sides.

g) The handling instructions shall be marked in indelible/ non-washable ink, indicating the upright position.

11.5 PACKING OF SERVICE TRANSFORMERS(OIL FILLED) & ACCESSORIES

This instruction is applicable for packing of transformers (oil filled), its accessories and components so as to ensure safe delivery to end user. Aspects of packing specific to equipments / items of transformers(oil filled) are given here. All other instructions / aspects as per the main specification of export packing which are not covered here shall also be applicable.

11.5.01 PACKING DETAILS :

a Items shall be packed in case / crates as per the shipping list.

b All fragile items and small items shall be packed in cases and to be marked as "Fragile, handle with care Fragile items".

c Fragile accessories are to be first packed in their original boxes (VENDOR's packing). Very

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small / delicate items such as glass thermometer, door keys shall be packed in separate box.

d In case original box is found damaged, suitable alternate box or packing method using felt or foam sheet and polythene wrap to be used.

e These boxes are then placed in identified wooden boxes. Inside of such boxes are lined with a layer of polythene sheet, packing wool / grass and another layer of polythene sheet before placing the boxes. All boxes are then wrapped with this polythene sheet before closing the box. Fragile items shall not be placed loose, one above the other inside the case.

f All wiring cables, connection flats of non-ferrous materials, CTs, valves bellows shall also be packed.

g Items like CTs, Oil communicating bushings, insulators, wired equipments and housings such as RTCC Panel, M. Box, Drive Mechanism, thermometers, gauges shall be wrapped in polythene from all around.

h Buchholz relay and OSR relay openings will be blanked using covers, before putting them in the box

i Items shall be carefully lowered and arranged inside the crate / case and each item shall be locked from all sides in such a way to avoid its movement in any way. Wooden stoppers and separators shall be provided for this and nailed to the crate / case wood.

j Wooden planks and batons in contact with fragile items shall be provided with kit foam at the locations of contact.

k Oil communication bushings shall be packed in separate case on V or U shape wooden felted supports, as in case of condenser bushings.

l While placing and arranging the items inside the crates / cases, these shall be verified for correctness and then the packing note shall be signed. The cover top of the crate / case shall then be closed.

m The main equipment like transformer tank shall be packed suitably to prevent any damage during transit / storage. Support structures like frame, header supports etc. shall be crated. Conservator headers shall also be crated. Radiators pipe work and other instruments & components shall be packed in cases. All the cases shall be lined with polythene from inside.

11.6 ALTERNATIVE PACKING CASES FOR CONTROL PANELS AND SWITCH GEARS

For Control and switch gear panels, construction of wooden packing cases may be provided as per fig 14 & 15 and as detailed below.

Thickness of planks for all sides, binding and jointing battens shall be at least 25 mm. Width of the plank shall be at least 125mm and that of binding and jointing planks shall be at least 100mm.

Top frame shall be suitable so that it does not collapse due to sandwiching between slings while lifting. Longitudinal and traverse bars for the bottom wooden pallet to be suitably selected.

Diagonal bracings shall be as per cl 9.3.1.3 and all other requirements shall be as per clauses 9.3.1.4 to 9.3.1.6.

12.0 Containerization

As required by BHEL, the VENDOR shall stuff the GOODS into 20 or 40 foot containers (dry, open top, flat racks, etc.).
The maximum inside dimensions of containers are to be considered:

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- 40 foot containers: 11.80 m x 2.20 m x 2.05 m
- 20 foot containers: 5.80 m x 2.20 m x 2.05m
-

The present definition of containerization is valid for sea containers only. Vendor to check the size of containers before start of packing of equipment.

12.1 Protection of Cases/Crates

Since shipping containers are in general not water tight, packing in contact with the floor of the container shall be raised in order to prevent it from being damaged by the accumulation of water.

12.2 Mechanical Constraints

The mechanical constraints for "general use" closed containers are of a different nature (height of "stacking" being limited inside the containers), the packing for the GOODS may be of a lighter structure. However, it is necessary that the packing be appropriate so as to protect the GOODS on site during the storage period, as required after discharging of the GOOD'S from the containers.

Note:

It is the responsibility of the VENDOR to ensure that the cases/crates are stowed, secured and fastened inside the container. The VENDOR will take all necessary precautions to conform to the maximum weight allowed and the centre of gravity of the container. The securing and fastening of the cases/ crates can be carried out by nailing timbers on the bottom or on the vertical sides of the container.

13.0 Other Services to be provided by Vendor

In addition to the packing and shipping documents, VENDOR must also carry out the following services, which shall be included in his quotation:

Carriage of VENDOR's sub-contracted equipment and material, which must be re-grouped in VENDOR's or PACKER's workshops, whilst waiting for packaging.

BHEL reserves the right to postpone the shipping of the GOODS. In this event, any storage and insurance costs during the first ninety (90) days shall be borne by the VENDOR.

Loading, including lifting, securing, lashing, and stowing, of all cases, crates, or packages onto means of transportation such as, but not limited to, trailers, containers, etc.

14.0 Responsibilities and Guarantees

VENDOR is responsible for the choice of category for packing according to the transport facilities used, and on the basis of the present document. In case of doubt or disagreement regarding the choice, VENDOR must inform BHEL prior to packing and await BHEL's approval. All phases of packaging, marking, loading, etc. will be subject to BHEL inspection.

BHEL reserves the right to reject the packing when the packing does not conform to these instructions and/or when the packing does not ensure perfect protection of the GOODS.
VENDOR is responsible for the weights and dimensions declared, and the marking of the packages.

The documents must be in strict conformity with the packing contents.
The packing specified in these "Packing, Marking and Shipping Instructions" is guaranteed for a twelve (12) months storage period after delivery on site.

VENDOR is responsible for providing storage recommendation adapted to the GOODS. According to this guarantee, VENDOR is held responsible in the event of goods becoming

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useless, damaged or broken, as a result of poor packing and/or stowing, or due to corrosion, subsequent to insufficient or inadequate protection. All direct or indirect costs resulting thereof, will be back-charged to VENDOR.

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ANNEXURE-IX

OXIDATION AIR BLOWER TECHNICAL DATA SHEET

Sl. No	Description		Data
1.0	**GENERAL**		
	a. Client	:	BHEL-HPEP Hyderabad
	b. Project	:	MAHAGENCO Koradi- 2X660 MW (UNIT-11 &12)
	c. End Customer	:	MAHGENCO
	d. Location	:	Nagpur District, Maharashtra
	e. Service	:	Continuous
	f. Installation	:	In-door
	g. No of Blowers for each unit	:	1 Working + 1 Standby
	h. Total number of Blowers	:	4 No's
2.0	**MANUFACTURER DETAILS**		
	a. Model	:	
	b. Type	:	Positive displacement blower
	c. Type of Driver	:	As per specification
	d. Area classification	:	Safe
	e. No of Stage	:	Not Applicable

3.0 OPERATING CONDITION

Sl. No	Description	Requirement			
1	Quantity	1 No. Working + 1 No. Standby for each unit; Total 4 No's for the project.			
2	Type of Blower	Positive Displacement Type Blower.			
3	Duty	Continuous			
4	**Parameters**				
5	Operating Points	**(1) Blower Design Point**	**(2) Design point BMCR WC**	**(3) Guarantee Point**	**(4) Guarantee Point Aux. power**
6	Blower capacity Nm^3/hr-wet	14250	8850	6500	5600
7	Inlet (Atmospheric) pressure	985 hPa	985 hPa	985 hPa	985 hPa
8	Inlet/Suction temperature	45.0° C	45.0° C	27.0° C	27.0° C
9	Relative humidity	60%	60%	60%	60%
10	Discharge pressure (min) mmWC-g	9350	8400	6700	6000
11	Air Flow at Blower inlet (with Temp, Pr. & Humidity Correction) ($M^3/hr.$)				
12	Flow at discharge ($M^3/hr.$)				
13	Discharge Air temperature				
14	Efficiency (min)				75%
15	Shaft Brake Power (BKW)				
16	Operating Speed (RPM)				
17	Critical Speed (RPM)				
18	Motor Rating (KW)				
19	Drive Arrangement				
20	Type of Lubrication				
21	Discharge pipe size (mm)				
22	Mechanical Design Pressure of Blower (Kg/Cm^2)				
23	Casing Hydrotest Pressure (Kg/cm^2)				
24	Shaft Seal				

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OXIDATION AIR BLOWER TECHNICAL DATA SHEET

25	Noise Level (with Acoustic Enclosure)	<85dBA			
26	Rotor Balancing Grade				
27	Vibration Level				
28	**Cooling Water for Blower**				
29	Inlet temperature				
30	Increase in temperature	Max 10°C			
31	Pressure loss	< 0.05 MPa (Max)			
32	Flow (m3/hr.)				
33	Cooling system for reducing the temperature of air at the blower outlet to < 70°C	Quenching with water injection arrangement to be provided. Water analysis is given below in Table. Quenching Nozzle back pressure < 1.0 bar (g)			
34	Cooling Water Requirement for Quenching system. (m^3/Hr.)				
35	Cooling Water Requirement for Lubrication system. (m^3/Hr.)				
36	**Air Composition (Wet)**	**(1) Blower Design Point**	**(2) Design point BMCR WC**	**(3) Guarantee Point**	**(4) Guarantee Point Aux. power**
37	H2O (Vol %)	5.86	5.88	2.18	2.18
38	O2 (Vol %)	19.76	19.76	20.54	20.54
39	N2 (Vol %)	Balance	Balance	Balance	Balance

4.0	**PERFORMANCE DATA**			
	a. Capacity	Nm^3/Hr	:	#
	b. Static efficiency	%	:	#
	c. BKW Normal / Maximum	KW	:	#
	d. BKW at minimum suction temperature	KW	:	#
	e. Motor rating	KW	:	#
	f. Motor Speed	rpm	:	#
	g. Discharge pressure static (inclusive of losses)	mmWc	:	#
	h. Differential pressure (inclusive of losses)	mmWc	:	#
	i. Speed Maximum/ Normal/Minimum		:	#
	j. Noise level		:	#
	k. Performance curve		:	#
5.0	**CONSTRUCTION DATA**			
	a. Manufacturer		:	
	b. Model No.		:	#
	c. Suction		:	Single
	d. Suction Rating / Size		:	#
	e. Discharge Rating / Size		:	#
	f. Type of rotor		:	#
	g. Size of rotor Dia	mm	:	#
	h. Journal bearing: Type / Size:		:	#
	i. Thrust bearing: Type / Size:		:	#
	j. Bearing cooling required		:	Yes / No - Bidder to confirm
	k. Cooling water required		:	Bidder to confirm the quantity
	l. Type of drive		:	As per specification
	m. Shaft seal		:	Packing / Rubber seal

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OXIDATION AIR BLOWER TECHNICAL DATA SHEET

	n. Size / Code	:	#
	o. Type of coupling	:	#
	p. Service factor	:	#
	q. GD^2 at drive shaft end	:	#
	r. Rotation viewed from coupling end	:	Clock wise / Counter clock wise
	s. Fluid Coupling	:	Yes / No - Bidder to confirm
	t. Fluid Coupling make	:	#
	u. Fluid Coupling control	:	#
	v. Suction filter	:	Required
	w. Degree of filtration	:	#
	x. Base plate common to Blower. Inboard bearing housing and fluid coupling & Motor	:	Yes / No - Bidder to confirm
	y. Total weight kg	:	#
	z. Maximum Erection weight of single component and its dimension kg	:	#
6.0	**MATERIALS**		
	a. Casing	:	#
	b. Rotor	:	#
	c. Shaft	:	#
	d. Packing Seal	:	#
	e. Suction filter elements/ housing	:	#
	f. Base frame	:	#

Note – Bidder to fill up the data sheet as per offered Model.

SIGNATURE OF BIDDER ----------

NAME ----------

DESIGNATION ----------

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ANNEXURE-X

2X660 MW MAHAGENCO KORADI
Blower instrumentation spare

MAHAGENCO Clause No	Item Description	Qty	UOM	Remarks
1.10	**Monitoring System**			
1.10.1	**Vibration Monitoring System**			
(i)	Sensors along with interfacing cables (*If prefab cable or prefab extension cable is used same should be supplied in proportion)	20% or minimum 2 nos of each make and type whichever is more	No	
(ii)	Power Supply Module Cards	5 nos. of each make and type	No	
(iii)	Driver / Interface Cards & all other electronic cards	5 nos. of each make and type	No	
1.11	**MEASURING INSTRUMENTS (for all other systems in BTG package which is not covered above)**			
1.11.1	**Transmitters**			
(i)	Transmitters of all type, range and model no. (For the measurement of Pressure, differential pressure flow, level, temperature etc.)	10% or minimum 2 nos. of each type and model whichever is more	No	
1.11.2	**Temperature elements**			
i)	RTD's	10% or 2 nos. of each type and length, whichever is more	No	
ii)	Thermocouples	10% or 2 nos. of each type and length, whichever is more	No	
iii)	Thermo well for all applications (with head assembly, terminal block and nipple)	10% or 2 nos. of each type and length, whichever is more	No	
iv)	Pressure, Differential Pressure, Flow, Level and Temperature Switches	20% of the total population or minimum 2 nos. of each type and model whichever is more	No	
v)	Pressure, Differential Pressure, Flow, Level and Temperature Gauges	20% of the total population or minimum 2 nos. of each type and model whichever is more	No	
1.11.6	**Electrical Actuators**			
	For ON & Off Valve and Control Valves			
(i)	Actuators	1 no. of each type and rating	No	
(ii)	Power unit for modulating actuator	2 nos. of each type	No	
(iii)	DC-DC unit / Power Units	2 nos. of each type	No	
(iv)	Electronic cards	2 nos. of each type	No	
(v)	Position feedback transmitters	2 nos. of each type	No	
(vi)	Control Unit	2 nos. of each type	No	
(vii)	Torque And limit switch assembly of each unit	2 nos. of each type	No	
(viii)	Electronic PCB of all types	10% of each type & model	No	
(ix)	Absolute Encoder (replaceable part)	5% of each type & model	No	
(x)	Electronic Torque sensor	5% of each type & model	No	
1.12	**PROCESS CONNECTION PIPING (FOR IMPULSE PIPING/TUBING, SAMPLING PIPING / TUBING AND AIR SUPPLY PIPING AS APPLICABLE)**			
1.12.1.	Valves of all types and models	20 Nos. of each type and model	No	
1.12.2.	2 way, 3way, 5way valve manifolds	10 Nos. of each type, class, size and model	No	
1.12.3.	Fittings	100 Nos. of each type	No	
1.12.4.	Purge meters	20 nos. of each type and model	No	
1.12.5.	Filter regulators	20 nos. of each type and model	No	

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2X660 MW MAHAGENCO KORADI
Blower instrumentation spare

MAHAGENCO Clause No	Item Description	Qty	UOM	Remarks
1.14	**CONTROL VALVES, ACTUATORS & ACCESSORIES (for all other systems in BTG package which is not covered above)**			
1.14.1.	Pneumatic and electro-hydraulic actuator assembly	1 No. of each type, model and rating	No	
1.14.2.	Diaphragms, 0' rings, seals etc. of all types make etc.	5 Nos. of each type and model	No	
1.14.3.	Solenoid valves (if applicable)	2 Nos.	No	
1.14.4.	Positioner units /smart positioners (complete unit) & accessories (link assembly)	2 Nos.	No	
1.14.5.	Pneumatic air-filter/Regulator of each type, make rating etc.	2 Nos. of each type	No	
1.14.6.	Air lock relays	2 Nos. of each type, model and rating	No	
1.15.	**PNEUMATICALLY OPERATED ISOLATION/ BLOCK VALVES, ACTUATORS & ACCESSORIES (for all other systems in BTG package which is not covered above)**			
1.15.1.	Pneumatic actuator assembly	1 No. of each type, model and rating	No	
1.15.2.	Diaphragms, O' rings, seals etc. of all types make etc.	5 Nos.	No	
1.15.3.	Limit switches (complete unit) & accessories (link assembly)	2 nos.	No	
1.15.4.	Pneumatic air-filter/Regulator of each type, make rating etc.	2 nos.	No	

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ANNEXURE-XI

CORPORATE QUALITY ASSURANCE
SUB-VENDOR QUESTIONNAIRE

i.	**Item/Scope of Sub-contracting**			
ii.	**Address of the registered office**	**Details of Contact Person (Name, Designation, Mobile, Email)**		
iii.	**Name and Address of the proposed Sub-vendor's works where item is being manufactured**	**Details of Contact Person: (Name, Designation, Mobile, Email)**		
iv.	**Annual Production Capacity for proposed item/scope of sub-contracting**			
v.	**Annual production for last 3 years for proposed item/scope of sub-contracting**			
vi.	**Details of proposed works**			
1.	**Year of establishment of present works**			
2.	**Year of commencement of manufacturing at above works**			
3.	**Details of change in Works address in past (if any)**			
4.	**Total Area**			
	Covered Area			
5.	**Factory Registration Certificate**	**Details attached at Annexure – F2.1**		
6.	**Design/ Research & development set-up (No. of manpower, their qualification, machines & tools employed etc.)**	**Applicable / Not applicable if manufacturing is as per Main Contractor/purchaser design) Details attached at Annexure – F2.2 (if applicable)**		
7.	**Overall organization Chart with Manpower Details (Design/Manufacturing/Quality etc)**	**Details attached at Annexure – F2.3**		
8.	**After sales service set up in India, in case of foreign sub-vendor (Location, Contact Person, Contact details etc.)**	**Applicable / Not applicable Details attached at Annexure – F2.4**		
9.	**Manufacturing process execution plan with flow chart indicating various stages of manufacturing from raw material to finished product including outsourced process, if any**	**Details attached at Annexure – F2.5**		

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	CORPORATE QUALITY ASSURANCE **SUB-VENDOR QUESTIONNAIRE**

10.	**Quality Control exercised during receipt of raw material/BOI, in-process , Final Testing, packing**	**Details attached at Annexure – F2.6**
11.	**Manufacturing facilities** **(List of machines, special process facilities, material handling etc.)**	**Details attached at Annexure – F2.7**
12.	**Testing facilities** **(List of testing equipment)**	**Details attached at Annexure – F2.8**
13.	**If manufacturing process involves fabrication then-** **List of qualified Welders** **List of qualified NDT personnel with area of specialization**	**Applicable / Not applicable** **Details attached at Annexure – F2.9** **(if applicable)**
14.	**List of out-sourced manufacturing processes with Sub-Vendors' names & addresses**	**Applicable / Not applicable** **Details attached at Annexure. –F2.10** **(if applicable)**
15.	**Supply reference list including recent supplies**	**Details attached at Annexure – F2.11** **(as per format given below)**

Project/ package	*Customer Name*	*Supplied Item (Type/Rating/Model /Capacity/Size etc)*	*PO ref no/date*	*Supplied Quantity*	*Date of Supply*

16.	**Product satisfactory performance feedback letter/certificates/End User Feedback**	**Attached at annexure - F2.12**
17.	**Summary of Type Test Report (Type Test Details, Report No, Agency, Date of testing) for the proposed product (similar or higher rating)** **Note:- Reports need not to be submitted**	**Applicable / Not applicable** **Details attached at Annexure – F2.13** **(if applicable)**
18.	**Statutory / mandatory certification for the proposed product**	**Applicable / Not applicable** **Details attached at Annexure – F2.14** **(if applicable)**
19.	**Copy of ISO 9001 certificate** **(if available)**	**Attached at Annexure – F2.15**
20.	**Product technical catalogues for proposed item (if available)**	**Details attached at Annexure – F2.16**

Name:		**Desig:**		**Sign:**		**Date:**	

Company's Seal/Stamp:-

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VOLUME - V

ANNEXURE - 4

SUB-VENDOR LIST

PREPARED BY

(An ISO 9001:2015 certified Company)

STEAG Energy Services India Pvt. Ltd.

(A wholly owned subsidiary of STEAG Group, Germany)

A-29, Sector-16, Noida - 201301, INDIA

FEBRUARY, 2024

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SR. NO.	ITEM		Koradi 2x660 MW
8.00	AIR BLOWER (LOBE TYPE)		
		1	EVEREST TRANSMISSION
		2	SWAM PNEUMATICS PVT LTD., NOIDA
		3	ROOTS BLOWERS
9.00	BUTTERFLY VALVES (Manual & Pnumatic)		
		1	KIRLOSKAR BROTHERS LTD.
		2	FOURESS
		3	L & T
		4	AUDCO
		5	INSTRUMENTATION LTD
		6	HAWA VALVES
		7	BHEL
		8	FLOW VEL
		9	LEADER VALVES
10.00	RUBBER EXPANSION JOINT		
		1	D'WAREN & CO
		2	CORI ENGINEERS
11.00	STRAINERS		
		1	SPIRAX MARSHALL
		2	MICON VALVES (I) PVT. LTD.
		3	FLOWTECH ENGINEERS
		4	FOURESS LTD.
		5	KSB LTD.
		6	L & T
		7	LEADER
		8	PROCEDYNE ENGINEERS
12.00	CAST IRON VALVE (GATE /GLOBE/CHECK/AIR RELEASE VALVE)		
		1	LEADER VALVE
		2	VENUS PUMP
		3	FOURESS
		4	LEVCON
		5	L & T
		6	FLUIDLINE VALVES CO PVT LTD
		7	NSSL PVT LTD
14.00	CAST STEEL VALVES (GATE/GLOBE/CHECK/ BALL VALVE)		
		1	L & T

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SR. NO.	ITEM		Koradi 2x660 MW
		2	KIRLOSKAR BROS. LTD
		3	CRESENT VALVES
		4	AUDCO
		5	KSB
		6	LEVCON
		7	FOURESS
		8	FLUIDLINE VALVES
		9	NSSL LIMITED
		10	VENUS PUMP
		11	HAWA VALVES
14.01	Return Valves for Refrigerated Type Air Dryer for Compressed Air System.)	1	HAWA Engineers Ltd., Ahmedabad
14.02	Ball Valves for Service Air & Instrumrntation Air System)	1	G M Engineering Pvt. Ltd.,Rajkot
		2	HAWA Engineers Ltd., Ahmedabad
15.00	**STAINLESS STEEL (GATE/GLOBE/CHECK VALVE)**		
		1	CRESCENT
		2	FOURESS
16.00	**GUN METAL/BRASS/ BRONZE VALVES**		
		1	LEADER VALVES
		2	SARKAR
		3	LEVCON
		4	BOMBAY METAL & ALLOYS
		5	BANKIM & COMP.
		6	BDK
17.00	**FORGED STEEL VALVE**		
		1	FOURESS LIMITED
		2	KSB LIMITED
		3	L & T
		4	BANKIM
		5	BDK VALVES
		6	LEADER
		7	CRESCENT
		8	BHEL
		2	

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SR. NO.	ITEM		Koradi 2x660 MW
19.00	**L.P.PIPING**		
		1	UNITECH MACHINES, NEW DELHI
		2	AARTI INFRASTRUCTURE, NAGPUR
		3	ZUBERI ENGINEERING CONSTRUCTION PVT LTD
		4	RATNAMANI METALS AND TUBES LIMITED, GUJRAT
		5	S.G. HEAVY ENGINEERING AND PVT. LTD. PALGHAR
		6	JINDAL SAW LIMITED, KARNATAKA
		7	ARCELORMITTAL NIPPON STEEL INDIA LIMITED, GUJRAT
20.00	**DIESEL ENGINES**		
		1	
		2	
		3	
21.00	**FLANGES & FITTINGS**		
		1	
		2	
		3	
22.00	**AIR DRYING UNIT (Refrigerant Type)**		
		1	
		2	
23.00	**EOT CRANE**		
23.01	EOT CRANE (More than 100 Ton)	1	
		2	
		3	
		4	
		5	
		6	
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		9	

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SR. NO.	ITEM		Koradi 2x660 MW
		10	
23.02	EOT CRANE(Less than 100 T)	1	
		2	
		3	
		4	
		5	
		6	
		7	
		8	
		9	
		10	
		11	
		12	
		13	
		14	
		15	
		16	
23.03	SINGLE GIRDER EOT CRANES	1	
		2	
		3	
		4	
		5	
		6	
		7	
		8	
		9	
		10	
24.00	MANUAL HOIST & CHAIN PULLEY BLOCK		
		1	
		2	
		3	
		4	
		5	
		6	
		7	

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SR. NO.	ITEM		Koradi 2x660 MW
		8	
25.00	ELECTRICAL HOIST		
		1	
		2	
		3	
		4	
		5	
		6	
		7	
		8	
		9	
		10	
		11	
		12	
		13	
		14	
		15	
		16	
		17	
26.00	**PAINTINGS**		
		1	ASIAN PAINTS (I) LTD.
		2	BERGER PAINTS INDIA LTD.
		3	SHALIMAR PAINTS LTD.
		4	NEROLAC
		5	JHONSON & NICHOLSON
27.00	ANTI COROSSIVE COAL TAR COATING		
		1	
		2	
29.00	FABRICATED MS STEEL TANK		
		1	
		2	
		3	
		4	
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		7	

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SR. NO.	ITEM		Koradi 2x660 MW
		2	
		3	
		4	
34.08	HEAT DETECTOR	1	
		2	
		3	
		4	
		5	
		6	
34.09	INFRARED DETECTOR	1	
		2	
		3	
		4	
		5	
		6	
		7	
34.10	FRANJIBLE BULB DETECTORS	1	
		2	
		3	
		4	
34.11	WATER MONITORS	1	
		2	
		3	
		4	
		5	
34.12	BRANCH PIPES & NOZZLES	1	
		2	
		3	
		4	
		5	
		6	
34.13	CAST STEEL NON RETURN VALVE	1	R & D MULTIPLE
		2	UPADHYA
		3	SHIVDURGA
		4	FOURESS
		5	DEWRANCE

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SR. NO.	ITEM		Koradi 2x660 MW
		6	MECHANELL AKSON MECH INDIA
		7	CRESENT TUBE
		8	PRODUCTS INDIA
		9	BUMKIN
		10	IVC
		11	DURGA ENGINEERING CORPORATION , THANE
34.14	CAST IRON SLUICE VALVE	1	
		2	
		3	
		4	
		5	
		6	
		7	
		8	
		9	
		10	
		11	
		12	
		13	
		14	
		15	
		16	
34.15	CAST IRON SLUICE VALVE / Gate Valve	1	
		2	
		3	
34.16	CAST IRON SLUICE VALVE / GATE VALVE	1	
34.17	BUTTERFLY VALVE / PLUG VALVE	1	
		2	
		3	
		4	
		5	
		6	
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		9	
34.18	GM BRASS BRONZE VALVE	1	

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SR. NO.	ITEM		Koradi 2x660 MW
35.02	AIR FILTER	1	PUROLATOR
		2	TENACITY
		3	UCCO
		4	JOHN FLOWER
		5	AIR TECH
		6	DYNAFILTERS
35.03	FRESH AIR FANS	1	
		2	
35.04	V.BELTS & PULLEY	1	
		2	
35.05	FIRE DAMPAR	1	
		2	
		3	
		4	
35.06	BEARINGS	1	SKF
		2	NORMAN
		3	NBC
		4	FAG
36.00	**AIR CONDITIONING**		
36.01	REFRIGERATION RECIPROCATING COMPRESSOR	1	
		2	
		3	
		4	
		5	
36.02	CONDENSER & CHILLER	1	
		2	
		3	
		4	
		5	
		6	
36.03	COOLING COILS	1	
		2	
		3	
		4	
		5	
36.04	AIR HANDLING UNITS	1	

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SR. NO.	ITEM		Koradi 2x660 MW
		2	
		3	
		4	
		5	
		6	
		7	
36.05	CONDENSER CHILLED WATER PUMPS	1	
		2	
		3	
		4	
		5	
		6	
		7	
36.06	FRESH AIR FANS	1	
		2	
		3	
		4	
36.07	AIR FILTER	1	PUROLATOR
		2	TENACITY
		3	UCCO
		4	JOHN FLOWER
		5	AIR TECH
		6	DYNA FILTERS
36.08	COLD INSULATION MATERIAL	1	
		2	
		3	
		4	
		5	
36.09	FAN COIL UNITS	1	
		2	
		3	
		4	
36.10	BEARINGS	1	SKF
		2	NORMAN
		3	FAG
		4	NBC

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SR. NO.	ITEM		Koradi 2x660 MW
		2	
		3	
49.00	**OIL MODULE**		
		1	
		2	
		3	
50.00	**APRDS ITEMS**		
		1	
		2	
		3	
51.00	**OIL HANDLING PLANT**	**1**	
		2	
		3	
		4	
		5	
		6	
		7	
		8	
		9	
		10	
51.01	CONDENSATE TANK	1	
51.02	FITTINGS	1	
52.00	**WEIGH BRIDGE**		
		1	
		2	
		3	
		4	
		5	
		6	
53.00	**FGD**		
53.01	HIGH ANGLE CONVEYOR	1	
53.02	BUCKET ELEVATOR	1	
53.03	WET BALL MILL	1	
53.04	SLURRY RECIRCULATION PUMPS	1	
		2	

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SR. NO.	ITEM		Koradi 2x660 MW
53.05	GYPSUM DEWATERING SYSTEM (SUPPLY OF VACUUM BELT FILTER)	1	
		2	
		3	
53.06	AGITATOR	1	
		2	
		3	
		4	
53.07	SLURRY PUMPS	1	
		2	
53.08	FGD GLASS FLAKE COATING(LINING)/BOROSILICATE GLASS BLOCK LINING /C276	1	
		2	
53.09	BLOWERS	1	
53.10	DEHUMIDIFIERS	1	
53.11	FABRICATED MECHANICAL ITEM	1	
53.12	AIR COOLED HEAT EXCHANGER	1	
55.13	HEAT EXCHANGER	1	
53.14	REFRIGERATED TYPE AIIR DRIER FOR COMPRESSED AIR SYSTEM.	1	
53.15	WASTE WATER PUMPS (SUMP PUMPS)	1	
		2	
53.16	ROTARY AIR LOCKS & ROTARY VANE FEDDERS	1	
53.17	WEIGH BRIGE AND INSTRUMENT	1	
53.18	WATER SUPPLY PIMP	1	
53.19	BIN VIBRATOR	1	
53.20	COMPRESSOR PACKAGE	1	M/s. Atlas Copco (India) Ltd., Pune.
		2	M/ s. ELGI Equipments Limited, Coimbatore.
53.21	GLOBE VALVE AND CHECK VALVE	1	
53.22	EXPANSION JOINTS/EXPANSION BELLOWS.	1	
53.23	VENT FILTER (DUST COLLECTOR)	1	
53.24	BALL VALVES & BUTTERFLY VALVE	1	
53.25	DUCT EXPANSION JOINT(ABSORBER,RAW FLUE GAS & BYPASS FLUE GAS)	1	
53.26	DAMPER (BOOSTER FAN INLET & OUTLET DAMPER, BYPASS DAMPER, SEAL AIR FAN, ASSOCIATED ELECTRIC HEATER	1	

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SR. NO.	ITEM		Koradi 2x660 MW
		4	
55.19	Dust Extraction & Suppression System	1	
		2	
		3	
		4	
		5	
		6	
		7	
		8	
		9	
		10	
		11	
		12	
		13	
		14	
55.20	Bag Filter/Vent Filter	1	
		2	
		3	
		4	
		5	
		6	
		7	
		8	
55.21	Hold Back	1	
		2	
		3	
		4	
	Bearings	1	SKF
55.22		2	NBC
		3	NORMA
		4	FAG
		5	KOYO
		6	NTN
		7	COOPER (SPLIT CASE BEARINGS)
		8	HKT (SPLIT CASE BEARINGS)
55.23	Plummer Block (Beaing Housing)	1	

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SR. NO.	ITEM		Koradi 2x660 MW
		4	
		5	
55.34	PADDLE FEEDER	1	
		2	
		3	
		4	
55.35	THRUSTER BRAKE	1	
		2	
		3	
		4	
55.36	BELT VULCANIZING MACHINE	1	
		2	
		3	
55.37	CABLE REELING DRUM	1	
55.38	SYSTEM INTEGRATOR FOR HYDRAULIC SYSTEM	1	
55.39	CONVEYOR TECHNOLOGICAL STRUCTURES	1	
55.40	CONVEYOR PACKAGE	1	
		2	
		3	
55.41	POROUS TILES	1	
		2	
		3	
55.42	PLUG VALVE (SLURRY DUTY) (FULL BORE, REGULAR PATTERN)	1	
		2	
		3	
		4	
55.43	CONVEYING ANDI NSTRUMENT AIR COMPRESSOR (OIL FREE, NON LUBRICATED)	1	
		2	
		3	
		4	
44.44	FLUIDISING BLOWER	1	KAY INTERNATIONAL
		2	SWAM PNEUMATIC
		3	EVEREST
		4	KULKARNI POWER TOOLS
		5	INDCOM
		6	SWAM

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SR. NO.	ITEM		Koradi 2x660 MW
		10	
		11	
		12	
55.52	MS PIPE SEAMLESS	1	
		2	
		3	
		4	
55.53	CAST IRON PIPES	1	
		2	
		3	
55.54	G.I PIPES & FITTINGS	1	
		2	
		3	
		4	
55.55	SS TUBES & PIPES	1	
		2	
		3	
55.56	GEAR BOX	1	
		2	
		3	
		4	
		5	
55.57	DOUBLE DISK SWING VALVE	1	
55.58	VENTILATION FAN	1	FLAKT
		2	C.B. DOCTOR
		3	GEC
		4	ALSTOM
		5	CG
		6	BATLIBOI
		7	BAJAJ
		8	USHA
55.59	AGITATOR WITH GEAR BOX / ACCESSORIES	1	
55.60	PISTON DIPHRAGM PUMP PUMP HCSD SYSTEM	1	
55.61	**HIGH ANGLE CONVEYOR**		
		1	
55.62	**BUCKET ELEVATOR**		
		1	

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SR. NO.	ITEM		Koradi 2x660 MW
		(e)	VIJAY ELECTRICALS
		(f)	KIRLOSKAR
		(g)	BHARAT BIJLEE LTD (BBL)
		(h)	MEGAWIN
		(i)	BHEL
		(j)	STAR DELTA,BHOPAL
		(k)	EMCO
		(l)	TOSHIBA
		(m)	TRANSFORMERS & ELECTRICALS KERALA LTD. (TELK)
6.00	LT POWER AND CONTROL CABLES	(a)	UNIVERSAL CABLES LTD. (UCL)
		(b)	CABLE CORPORATION OF INDIA LTD. (CCI)
		(c)	KEI INDUSTRIES LTD.
		(d)	FINOLEX
		(e)	FORT GLOSTER
		(f)	POLYCAB WIRES PVT LTD.
		(g)	DELTON
		(h)	RALLISON ELECT
		(i)	NICCO CO.LTD.
		(j)	PARAMOUNT CABLE CORPN
		(k)	PARAGON CABLE
		(l)	KRISHNA ELECT.INDUSTRIES
		(m)	DASHMESH CABLES
		(n)	INCOM WIRES & CABLES LTD
		(o)	TERACOM LTD
		(q)	RAYCHEM
		(r)	ROVIN
7.00	EPR INSULATED FIRE SURVIVAL CABLE	(a)	APAR INDUSTRIES LTD
		(b)	NANGALWALA INDUSTRIES PVT LTD
		(c)	SUYOG ELECTRICALS LT
8.00	CONTROL CABLES ONLY	(a)	CORDS CABLE INDUSTRIES LTD.
	HT POWER CABLE (HT cable	(b)	THERMO CABLES LTD, HYDERABAD
	manufacturers having Triple extrusion	(c)	KEI INDUSTRIES LTD.
	Dry cur (ccv) process using Nitrogen	(a)	UNIVERSAL CABLES LTD
	only are to be selected.)	(b)	CABLE CORPORATION OF INDIA
		(c)	FORT GLOSTER INDUSTRIAL LTD
		(d)	CRYSTAL CABLE INDUSTRIES

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SR. NO.	ITEM		Koradi 2x660 MW
III	**Control and Instrumentation**		
A	**Instruments**		
1.00	RTD & Thermocouples	1	Pyro Electric Instruments Goa Pvt. Ltd.
		2	General Instruments Consortium, Mumbai
		3	Detrive, Mumbai
		4	Temsens Instruments(I) Pvt. Ltd, Udaipur
		5	Toshniwal Industries Pvt. Ltd, (TIPL), Ajmer
2.00	Smart Electronic Transmitters (Pressure, Diff. Pressure)	1	Emerson Process Management (I) Ltd
		2	Fuji, Japan
		3	Yokogawa, Japan/ Yokogawa India
		4	ABB, Germany / Faridabad
		5	Honeywell, USA / Pune
		6	Toshniwal Industries Pvt. Ltd, (TIPL), Ajmer
		7	SMAR (Baldota Control & Equipments Pvt. Ltd.)
3.00	Displacer Type Level transmitter	1	Endress+Hauser, Germany/India
		2	V-Automat, Delhi
		3	Eckardt, Germany
4.00	Level Transmitters (Ultrasonic Type)	1	Endress+Hauser, Germany/India
		2	Krohne, France
		3	Pepperl+Fuchs, Germany/India
		4	Vega, Germany
		5	KAB Instruments Ltd.
		6	EIP Enviro (BMTI SRL, Italy)
		7	Toshniwal Industries Pvt. Ltd, (TIPL), Ajmer
5.00	Level Transmitter (Radar Type)	1	Siemens Milltronics
		2	Emerson
		3	SBEM
		4	Endress+Hauser, Germany/India
		5	Toshniwal Industries Pvt. Ltd, (TIPL), Ajmer
		6	EIP Enviro (LIMACO, Russia/BMTI, Italy
		7	Yokogawa, Japan/ Yokogawa India
6.00	Magnetic Level Switches	1	Levcon Instruments Pvt. Ltd., Kolkata
		2	V.Automat, New Delhi
		3	Asian Industrial Valves, Chennai
7.00	Level Switches Conductivity Type	1	Bharat Heavy Electricals ltd.
		2	Yarway, USA

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SR. NO.	ITEM		Koradi 2x660 MW
		3	Levelstate, UK
		4	Solarton, UK (presently called as MOBREY)
		5	Level State (Hitech systems)
8.00	Flow Switches	1	Switzer, Chennai
		2	Kronhe Marshall.,Pune
		3	General Instruments, Mumbai
9.00	Bypass Rotameter	1	IEPL, Hyderabad
		2	Placka Instruments India Pvt. Ltd.,Chennai
		3	TRAC, Hyderabad
		4	Eureka Industrial Eqpt. Pvt. Ltd.Pune
10.00	Rotameter	1	Instrumentation Engineers Pvt. Ltd.
		2	Sigma Instruments Co.
		3	Eureka Industrial Eqpt. Pvt. Ltd.Pune
		4	Telace Equipment Pvt. Ltd., Mumbai.
11.00	Flow integrator Totalizer (Electronic type)	1	ABB, Germany / Faridabad
		2	Masibus, Gandhinagar
		3	Yokogawa, Japan/ Yokogawa India
		4	Lekktrotek, Pune
		5	Emerson
		6	Forbes Marshall., Pune
		7	Endress+Hauser, Germany/India
12.00	Gauges (Pressure, Diff. Pressure)	1	A N Instruments Pvt. Ltd., Kolkata
		2	General Instruments Consortium, Goa/Mumbai
		3	Goa Thermostatic Instruments, Goa
		4	Forbes Marshall Ltd., Hyderabad
		5	Waaree Industries, Mumbai
		6	H.Guru Instruments (South India),Bangalore
		7	Wika Instruments India Pvt. Ltd., Pune
		8	B.C. Technomation (For WAREE Instruments), Bhopal
		9	Goa Instruments Pvt. Ltd., (old name:-Pyro Electric Goa)
		10	Monometer, Mumbai
		11	Bells Controls Ltd., Kolkata
		12	Switzer Instruments Ltd., Chennai
		13	Wika Alexander Wiegand GMBH & Co., Germany
		14	Budenburg Guage Co. Ltd
		15	Instrumentation Pvt. Ltd., Bangalore

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SR. NO.	ITEM		Koradi 2x660 MW
		16	Indosonic Instruments , Mumbai
		17	Precision
		18	Ashcroft
		19	Walchandnagar Industries Ltd.,Pune
13.00	Temperature Gauge	1	Goa Thermostatic Instruments, Goa
		2	General Instruments Consortium,
		3	A.N. Instruments Pvt. Ltd., Kolkata
		4	H. Guru Instruments (South India), Bangalore
		5	Forbes Marshall, Hyderabad
		6	WIKA Instruments India Pvt. Ltd., Pune
		7	Waree, Dadra
		8	B.C. Technomation (For WAREE Instruments), Bhopal
		9	Goa Instruments Pvt. Ltd., (old name:- Pyro Eletric Goa)
		10	Bells Controls Ltd., Kolkata
		11	Switzer Instruments Ltd., Chennai
		12	Wika Alexander Wiegand GMBH&Co.,Germany
		13	Budenburg Guage Co. Ltd.
		14	Indosonic Instruments , Mumbai
		15	Walchandnagar Industries Ltd.
14.00	Switches (Pressure, Diff. Pressure)	1	Indfoss Industries Ltd., Ghaziabad
		2	Switzer Instruments Company, Chennai
		3	SOR Inc., USA
		4	Pyroelectric, Goa
		5	Dresser Industries Inc, USA
		6	Regulateurs Georgin, France
		7	Delta Controls Ltd., U.K.
		8	KDG Instruments Ltd. U.K.
		9	Ashcroft
		10	Dwayer, USA
		11	General Instruments Consortium
		12	Trafag Controls India Pvt. Ltd, Haryana
15.00	Temperature Switch	1	Indfoss Industries Ltd., Ghaziabad
		2	Switzer Instruments Company, Chennai
		3	General Instruments Consortium, Mumbai
		4	SOR Inc., USA
		5	Pyroelectric, Goa

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		6	Regulateurs Georgin, France
		7	Delta Controls Ltd., U.K.
		8	KDG Instruments Ltd. U.K.
		9	Trafag Controls India Pvt. Ltd, Haryana
16.00	Air Filter Regulator	1	Placka, Chennai
		2	Shavo Norgren, India
17.00	Mass Flow Meter (Coriolis Principle)	1	Emerson Process Management (I) Ltd
		2	ABB
		3	Yokogawa
		4	Endress + Hauser
		5	GE Sensing and Inspection Technologies
		6	Forbes Marshall
18.00	I/P Converter	1	Eckhardt, Germany
		2	MTL, Chennai
		3	ABB
		4	Watson Smith (presently Norgren)
		5	Moore
		6	Rosemount
19.00	Flow Elements (Orifice plate)	1	Instrumentation Ltd.
		2	Micro Precision Products
		3	Engineering Specialties Pvt. Ltd
		4	Star-Mech Controls (I) Pvt. Ltd.
		5	General Instruments
		6	Eureka Industrial Eqpt. Pvt. Ltd.Pune
20.00	Solid Mass Flow Meter	1	Siemens Milltronics
		2	Thermo Fisher
		3	Siemens Instruments, Canada
21.00	Pull Cord Switch	1	Jayashree Eletrodevices Pvt. Ltd.
		2	A.G.System Controls, Mumbai
22.00	Belt Sway Switch	1	Jayashree Eletrodevices Pvt. Ltd.
		2	A.G.System Controls, Mumbai
23.00	Zero Speed Switch	1	Jayashree Eletrodevices Pvt. Ltd.
		2	A.G.System Controls, Mumbai
24.00	Belt Watch Panel	1	Jayashree Eletrodevices Pvt. Ltd.
		2	A.G.System Controls, Mumbai
25.00	Heavy Duty Limit Switch	1	A.G.System Controls, Mumbai

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SR. NO.	ITEM		Koradi 2x660 MW
		2	Bhartiya Cutler & Hammer, Faridabad
26.00	Proximity Switch	1	Jayashree Eletrodevices Pvt. Ltd.
		2	A.G.System Controls, Mumbai
27.00	Level Gauge (float type)	1	Levcon
		2	SB Electro
		3	Sigma
		4	V-Automat
		5	Asian Industrials Valves
28.00	Density Meter (Nucleonic type)	1	Endress+Hauser, Germany/India
		2	EIP Enviro (NTC Ecophyspribor, Russia)
		3	Thermo Fisher
		4	Thermo Measure Tech.
29.00	Density Meter (Non-Nucleonic type)	1	Endress+Hauser, Germany/India
		2	Siemens Militronics
		3	Vega
		4	Ametek
		5	Mobery
		6	Thermo Measure Tech.
		7	Thermo Fisher
30.00	Level Switch (RF/Rotary type)	1	EIP Enviro Level Controls / EIP (Bin Master)
31.00	3D Acoustic Level Transmitter for Silo	1	EIP Enviro (APM Automation)
32.00	Radio Modem	1	Sheetal Wireless Technologies Pvt. Ltd.
		2	Lotus Wireless Technologies India Pvt. Ltd
33.00	ORP Transmitters	1	Forbes Marshall
B	**DCS, HMI, Monitoring and PLC Systems:**		
		1	
		2	
		3	
		4	
		5	
		6	
		1	
		2	
		3	
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		5	

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SR. NO.	ITEM		Koradi 2x660 MW
		6	Fisher Xomos Sanmar ltd.
		7	HORA (Holter Regelarmaturen GMBH & CO.)
		8	Mascot Valves Pvt Ltd.
10.00	Solenoid Valve	1	ASCO, Chennai
		2	Rotex Automation Ltd., Gujrat
		3	Avcon Controls, Mumbai
11.00	HP /LP Bypass Valves	1	BOPP & Reuther GMBH Control Components Inc. (CCI)
12.00	Electro – Hydraulic Actuator	1	Leonardo Automation (India) Pvt. Ltd.
G	**Erection Hardwares**		
1.00	Local Instrument Rack (LIR) & Local Instrument Enclosure (LIE)	1	Sajas Electricals
		2	
		3	Instrumentation Ltd.Kota
		4	Electronics Corporation of India Ltd Hydrabad
		5	Chemin Controls Pondicherry
		6	Prammen Industries
2.00	Instrument valves	1	Excel Hydro Pneumatics Pvt. Ltd., Mumbai
		2	BHEL
		3	Metpress Engineering Works, Kolkata
		4	Baldota valve & fitting Co. Pvt. Ltd., Mumbai
		5	Aura Inc., New Delhi
		6	Instrumentation Ltd. Palghat
		7	Precission Engg. Industries, Mumbai
		8	Vikas Industrial Products, New Delhi
3.00	Valve Manifolds	1	Excel Hydro Pneumatics Pvt. Ltd., Mumbai
		2	Metpress Engineering Works, Kolkata
		3	Baldota valve & fitting Co. Pvt. Ltd., Mumbai
		4	Aura Inc., New Delhi
		5	Precission Engg. Industries, Mumbai
		6	HP Valves and Fittings, Chennai
4.00	Impulse & Sample Pipings	1	TPS Technitube Rohren Werke GMBH, Germany
		2	Maharashtra Seamless Ltd.
		3	BHEL
		4	Choksi Tube Company Ltd., India
		5	Indian Seamless Metal Tubes Ltd., India

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