

**MAHARSHTRA POWER GENERATION CO. LTD.
(MAHAGENCO)**

**KORADI THERMAL POWER STATION
2X660 MW UNITS 11 & 12 PROJECT**

TECHNICAL SPECIFICATION

FOR

AIR CONDITIONING SYSTEM

**SPECIFICATION NO.: - PE-TS-527-553-A001 (REV-00)
(AUGUST-2026)**



**BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
BHEL SADAN
SECTOR-16A, PLOT NO.-25, NOIDA, INDIA**



TITLE:
2X660 MW KORADI STP (UNITS-11&12)
TECHNICAL SPECIFICATION FOR AIR
CONDITIONING SYSTEM

SPECIFICATION No: PE-TS-527-553-A001

SECTION: INDEX

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SECTION - I



TITLE:
2X660 MW KORADI STP (UNITS-11&12)
AIR CONDITIONING SYSTEM
INTENT OF SPECIFICATION

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SECTION-I

SUB-SECTION-A

INTENT OF SPECIFICATION

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1.0 INTENT OF SPECIFICATION

- 1.1 The specification covers design (i.e. Preparation and submission of drawing /documents including “As Built” drawings and O&M manuals), engineering, manufacture, supply / procurement, inspection and testing at vendor’s / sub vendor’s / manufacturer’s works, painting, maintenance tools & tackles (as applicable), fill of lubricants & consumables including chemicals for softening plant (as applicable) till handing over, ~~mandatory spares along with~~ spares for erection, start-up and commissioning as required, forwarding, proper packing and shipment till site, unloading, handling & on-site transportation, storage, preservation , security / safety at site , Erection & Commissioning, final painting at site, minor civil & structural works (as applicable) as required, trial run at site and carrying out Performance guarantee / Functional / Demonstration tests at site (As applicable), training of customer/client O&M staff, operation of the AC system after commissioning till handing over and handover in flawless condition of the package to the end customer complete with all accessories for the total scope defined as per BHEL NIT & tender technical specification as specified above, amendment & agreements till placement of order for **2X660 MW KORADI STP (UNITS-11&12) AIR CONDITIONING SYSTEM**.
- 1.2 The contractor shall be responsible for providing all material, equipment & services, which are required to fulfil the intent of ensuring operability, maintainability, reliability and complete safety of the complete work covered under this specification, irrespective of whether it has been specifically listed herein or not. Omission of specific reference to any component / accessory necessary for proper performance of the equipment shall not relieve the contractor of the responsibility of providing such facilities to complete the supply, erection and commissioning, performance and guarantee/demonstration testing of **AIR CONDITIONING SYSTEM**.
- 1.3 It is not the intent to specify herein all the details of design and manufacture. However, the equipment shall conform in all respects to highest standards of design, engineering and workmanship and shall be capable of performing the required duties in a manner acceptable to purchaser who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material which in his judgement is not in full accordance herewith.
- 1.4 The extent of supply under the contract includes all items shown in the drawings, notwithstanding the fact that such items may have been omitted from the specification or schedules. Similarly, the extent of supply also includes all items mentioned in the specification and /or schedules, notwithstanding the fact that such items may have been omitted in the drawing. Similarly, the extent of supply also includes all items required for completion of the system and not withstanding that they may have been omitted in drawings / specifications or schedules.
- 1.5 The general term and conditions, instructions to tenderers and other attachment referred to elsewhere are made part of the tender specification. The equipment materials and works covered by this specification is subject to compliance to all attachments referred to in the specification. The bidder shall be responsible for and governed by all requirements stipulated herein.

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1.6

While all efforts have been made to make the specification requirement complete & unambiguous, it shall be bidders’ responsibility to ask for missing information, ensure completeness of specification, to bring out any contradictory / conflicting requirement in different sections of the specification and within a section itself to the notice of BHEL and to seek any clarification on specification requirement in the format enclosed under SECTION-II of the specification **within 10 days of receipt of tender documents**. In absence of any such clarifications, in case of any contradictory requirement, the more stringent requirement as per interpretation of Purchaser / Customer shall prevail and shall be complied by the bidder without any commercial implication on account of the same. Further in case of any missing information in the specification not brought out by the prospective bidders as part of pre-bid clarification, the same shall be furnished by Purchaser/ Customer as and when brought to their notice either by the bidder or by purchaser/ customer themselves. However, such requirements shall be binding on the successful bidder without any commercial & delivery implication.

1.7

The bidder’s offer shall not carry any sections like clarification, interpretations and /or assumptions.

1.8

Deviations, if any, should be very clearly brought out clause by clause along with cost of withdrawal in the enclosed schedule (in Vol – III); otherwise, it will be presumed that the vendor's offer is strictly in line with NIT specification. If no cost of withdrawal is given against the deviation, it will be presumed that deviation can be withdrawn without any cost to BHEL/its customer.

1.9

In the event of any conflict between the requirements of two clauses of this specification documents or requirements of different codes and standards specified, Section – C1 shall prevail, however more stringent requirement as per the interpretation of the owner shall apply.

Further, in case of any discrepancy in section 'C1' and section ‘C2’, Section-C2 shall prevail (customer specification). however more stringent requirement as per the interpretation of the owner shall apply.

1.10

In case all above requirements are not complied with, the offer may be considered as incomplete and would become liable for rejection.

1.11

For definition of word like Contractor, bidder, supplier, vendor, Customer/ Purchaser Employer, consultant, please refer relevant clause of NIT.



TITLE:
2X660 MW KORADI STP (UNITS-11&12)
AIR CONDITIONING SYSTEM
PROJECT INFORMATION WITH WIND AND
SEISMIC DESIGN CRITERIA

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PROJECT INFORMATION WITH WIND & SEISMIC DESIGN CRITERIA
AND WATER ANALYSIS



1.00.00 PROJECT OVERVIEW

- 1.01.00 The proposed power project, i.e. 2x660MW Supercritical Thermal Power Project, at Koradi in Nagpur, Maharashtra, is being developed with the primary objective of generating and supplying efficient and reliable electricity to meet the increasing power demands of the State of Maharashtra, which is one of the economically advanced and fastest growing states in India.
- 1.02.00 To meet this objective, Maharashtra State Power Generation Company Limited (MSPGCL or MAHAGENCO), which is one of the largest state power utilities in India, intend to establish a modern power plant incorporating the state-of-the-art technological features on standalone basis.
- 1.03.00 MAHAGENCO has decided and initiated action to install a 1320MW power plant, with two new 660MW pulverised coal-fired units, based on state of the art supercritical technology, as an extension project, at Koradi Thermal Power Station, near Koradi village, which is situated at about 11km from Nagpur city, in Maharashtra state, India.
- 1.04.00 All the utilities and offsite systems shall be new with minimum dependence on the existing plant and its facilities; However, being an extension project, to synergise, some of the existing infrastructure of the power station, which is already available, will be utilised for the proposed units as follows:
- 1.04.01 Existing available land within KTPS
- 1.04.02 Existing Power evacuation facility of KTPS
- 1.04.03 Auxiliary Steam from existing 3x660MW units of KTPS
- 1.04.04 Fuel Oil (LDO) from existing 3x660MW units of KTPS
- 1.04.05 A portion of the existing railway siding of KTPS, will be utilised for this project.

2.00.00 GENERAL

- 2.01.00 Koradi Thermal Power Station of Mahagenco is located on the outskirts of Nagpur, Maharashtra. It is one of the oldest thermal power stations in the state started in 1960s. The power station has installed capacity as under:

1.	Units 1,2,3,4	120 MWs each	Decommissioned & Demolished
2.	Unit 5	200 MW	Decommissioned & Demolished
3.	Units 6	210 MW each	In operation since 1982
4.	Unit 7	210 MW	Decommissioned
5.	Units 8,9,10	660 MW each	In operation since 2016-17

- 2.02.00 Mahagenco has initiated action for setting up a 1320MW (2X660MW) extension station to Koradi TPS, taking advantages of the inherent features and



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2X660 MW UNITS - 11 & 12 PROJECT**

RFx No. 3000046202 (BTG Package)

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infrastructures of existing Koradi TPS. The present proposal is for installation of 2 x 660 MW each (Units 11 & 12) at the land generally reclaimed by scrapping the auxiliaries of Units 1 to 5. Vacant land is available within the boundary wall of the existing TPS, which is adequate to accommodate the proposed units along with all its auxiliary systems.

1.	Units 11 & 12	660 MW each	Proposed Units

3.00.00 SALIENT FEATURES

3.01.00 Project Information

1.	Project Title	2X660 MW UNITS - 11 & 12 PROJECT, of KORADI THERMAL POWER STATION
2.	Owner	MAHARASHTRA STATE POWER GENERATION CO. LTD. (MAHAGENCO)
3.	Owner's Consulting Engineer	STEAG Energy Services India Pvt. Ltd.
4.	Project Location	Koradi of Nagpur District in Maharashtra
5.	Longitude	79° 5' 48" E
6.	Latitude	21° 14' 3" N
7.	Nearest Town	Nagpur
8.	Access by Road	From Nagpur-Bhopal National Highway NH-69)
9.	Access by Rail	The coal rakes shall be moved up to Nagpur on the Kokata-Mumbai main line and then to Kalamna on the Nagpur-Ramtek (BG) section
10.	Access by Air	Nagpur Airport
11.	Seismic Intensity Zone	Zone-II as per 1893-1984
12.	Ambient Temperature	47.8°C (High) 3.9°C (Low)
13.	Relative Humidity (max.)	RH – 61% in dry season and 85% in monsoon season
14.	Average Annual Rainfall	1112.7 mm



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15.	Max. Rainfall in 24 hrs.	315 mm
16.	Max. Wind Velocity	44 m/sec
17.	H.F.L.	The high flood level of nearest Kolar river at a distance 2 km. from plant area, is 292.5 m above M.S.L.

3.02.00 The contractor should collect the actual data from the nearest observatory or Regional Meteorological Centre, Nagpur, India pertaining to the site location and design the plant accordingly.

3.03.00 Type and Rating of Plant

3.03.01 Two units of 660MW turbine generator sets fed by steam with supercritical steam parameters from pulverised coal fired boiler.

3.03.02 The steam generators shall be super critical, once through, water tube type, direct pulverized coal fired, top supported, balanced draft furnace, single reheat, radiant, dry bottom type, suitable for outdoor installation. The gas path arrangement shall be single pass (Tower type) or two pass type.

3.04.00 Land

3.04.01 The site is located at latitude 21° 14' 3" N and longitude 79° 5' 48" E about 11 Km north of Nagpur City. It lies on the east of Nagpur-Bhopal National Highway (NH-69). Access to the site will be from this highway.

3.04.02 This plot is within the existing boundary wall of Koradi thermal power station.

3.04.03 Power block can be established at the land retrieved mainly by demolishing the auxiliary structures of the retired units of 4X120MW units & 1x200MW unit. Other utilities can be accommodated within the available space of MAHAGENCO's existing power station and after demolishing other existing but retired structures, as required.

3.04.04 Mahagenco already did most of the above ground demolition and site clearance.

3.04.05 The entire station will be laid at average level of 304.75 m above mean sea level (MSL) which is above the highest flood level (HFL) of the area.

3.05.00 Fuel

3.05.01 Coal linkage - Coal for the project is envisaged to be made available from captive coalmines at Gare Palma II coalmine, in Chhattisgarh, which is allotted to MAHAGENCO. Existing coal linkages of the retired/decommissioned units will also be utilised for this plant.

3.05.02 COAL TRANSPORTATION

i) Coal is envisaged to be transported from the coalmines to the power plant mainly by BOXN railway wagons; receipt by BOBR wagons is also envisaged.

3.05.03 PRIMARY FUEL (COAL)

ANALYSIS OF COAL

Sl. No.	Parameters	Design Coal	Worst Coal
1.	Inherent Moisture	9.86%	8%
2.	Total Moisture	15.77%	16%
3.	Volatile Matter (VM)	23.30%	21.66%
4.	Ash Content	39.91%	42.49%
5.	Gross Calorific Value ARB (GCV-ARB)	3229 Kcal/Kg	3012 Kcal/Kg
6.	Hard grove Index	88	-
7.	Size	0 to 100 mm	-
8.	Ash Fusion Temperature	>1400 deg C	-

ULTIMATE ANALYSIS OF COAL

Sl. No.	Chemical Composition	Design Coal	Worst Coal
		% By Weight	
1.	Carbon	36.35	33.82
2.	Hydrogen	4.06	0.58
3.	Sulphur	0.52	3.60
4.	Nitrogen	0.71	0.73
5.	Oxygen	18.45	18.76
6.	Moisture	8.6 – 9.8	

3.05.04 SECONDARY FUEL (FUEL OIL)

- i) Auxiliary liquid fuel, viz. LDO would be required for cold start-up and flame stabilization. Fuel Oil will transferred from existing facility of unit 8, 9 &10 and will be stored in unit 11 & 12 Storage cum day tanks.


ANALYSIS OF LIGHT DIESEL OIL (LDO)

Sl. No.	Parameters	Value
1.	Specification	IS-1460 (Latest Revision)
2.	Acidity (Inorganic)	Nil
3.	Ash Content	0.02% (maximum) by weight
4.	Flash Point (Pensky-Martens, closed)	66 deg C
5.	Pour Point (deg C)	
a.	Pour Point (Winter)	12 deg C
b.	Pour Point (Summer)	18 deg C
6.	Kinematic Viscosity at 50 deg C	2.5 to 15.7 Centistokes
7.	Sediment by weight	0.10% (maximum)
8.	Water content by volume	0.25% (maximum)
9.	Sulphur by weight	1.8% (maximum)
10.	Carbon Residue (Ramsbottom) by weight	1.5% (maximum)
11.	Gross Calorific Value	10,000 Kcal/kg.
12.	Specific gravity	0.85 at 15 deg C

3.06.00 Water

- 3.06.01 Tertiary treated sewage water from a Sewage Treatment Plant (STP) of Nagpur Municipal Corporation (NMC) will be used to meet the process requirement of the plant. Treated sewage water will be brought to the plant through a cross country pipeline from a STP located at a distance of about 11 km.
- 3.06.02 Closed cycle cooling water system, using this tertiary treated sewage water is envisaged for this project.
- 3.06.03 Water from Pench dam will be used, only for potable purpose.
- 3.06.04 CW system blow down water is proposed to be used in Ash Handling System, FGD process water and CHP dust suppression etc. (Refer Plant Water Scheme). Further, the filtered/clarified tertiary treated sewage water will be used for other



plant requirements like, service water, Ash Handling plant, make-up to fire water system, APH/ESP wash & Clear water requirements of FGD system. The waste service water collected from various areas shall be treated in ETP (in BoP Contract Scope) as per requirement and reused.

TREATED SEWAGE WATER ANALYSIS

Sl. .No.	Parameters	Unit	Average Parameters
1.	PH		7.80
2.	Conductivity	$\mu\text{S}/\text{cm}^2$	1000
3.	Total Dissolved Solids	mg/l	600
4.	Total Suspended Solids	mg/l	~
5.	Turbidity	NTU	20
6.	Free Residual chlorine	mg/l	~
7.	Hardness Total	mg/l as CaCO_3	260
8.	Calcium	mg/l as CaCO_3	160
9.	Magnesium	mg/l as CaCO_3	100
10.	Total Alkalinity	mg/l as CaCO_3	230
11.	Chlorides	mg/l as Cl^-	100.0
12.	Ortho - Phosphate	mg/l	2.50
13.	Total Phosphate	mg/l	6.00
14.	Silicate as SiO_2	mg/l	30.00
15.	Sulphates	mg/l	45.00
16.	Iron	mg/l	0.20
17.	Zinc	mg/l	0.10



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Sl. .No.	Parameters	Unit	Average Parameters
18.	KMnO ₄ Value		~
19.	BOD	mg/l	20
20.	COD	mg/l	100

RAW WATER ANALYSIS FROM PENCH DAM

Sl. No.	Parameters	Result
1.	pH	7.47
2.	Conductivity	345
3.	Total Hardness	126 ppm
4.	Ca-Hardness	91 ppm
5.	Mg-Hardness	35 ppm
6.	Chlorides	0.24 ppm
7.	P-value	Nil
8.	M-Value	122

3.07.00 Ash Disposal

3.07.01 Dry extraction and disposal with provision for high concentration slurry disposal for fly ash and dry/semi-dry disposal for bottom ash is considered.

3.07.02 Ash bund at Khasara (around 314 hectare) for existing plant shall be utilised for ash disposal which is 3 km from site.

3.08.00 Power Evacuation

3.08.01 The nearest substation to the proposed installation i.e. Unit 11 & 12 of MSPGCL at Koradi Thermal Power Station is 400/220 kV Koradi I Sub Station.

3.08.02 Power will be evacuated by MAHATRANSCO through the existing 400 kV switchyard at Koradi Thermal Power Station.

i) Proposed GT – 11 can be connected to existing 400 kV GT Bay - 5.

ii) Proposed GT – 12 can be connected to existing 400 kV GT Bay - 6.



- iii) Connection from HV bushings of proposed new GTs (11 & 12) HV to the switchyard has to be done by MAHATRANSCO.

3.08.03 Station transformers will be connected to the spare bays of existing 220 kV switchyard, by using 220 kV underground cable.

3.09.00 Construction Power

3.09.01 Refer Volume – 1,

3.10.00 Auxiliary Power Supply

		Auxiliary electrical equipment to be supplied against this specification shall be suitable for operation on the following supply system
	For motors rated above 1500kW	11000V, 3 phase, 3 wire, 50Hz non-effectively earthed AC
1.	For motors rated above 200kW and up to 1500KW	3300V, 3 phase, 3 wire, 50Hz non-effectively earthed AC
2.	For motor rated 200 kW and below	415, 3 phase, 4 wire solidly earthed AC
3.	For motor control centre	415V, 3 phase, 4 wire solidly earthed AC
4.	DC. motor starters, DC solenoids, DC alarm, control and protections	220 V DC, 2 wire, unearthed DC
5.	AC control & protective devices	240 V 1 phase, 50Hz, 2 wire AC supply. The single-phase 240V AC supply shall be derived by Contractor by providing 415V/240V control transformers of adequate rating with MCCB /MCB on both the primary and secondary sides
6.	Uninterrupted power supply	240 V, 1 phase, 50Hz, 2 wire AC supply from UPS system for I&C (including indicator recorders) and UCMS only
7.	Construction supply	11 kV, 3 phase, 4 wire, 50 Hz AC supply with neutral lead solidly earthed

3.11.00 Environmental Aspects

3.11.01 The plant shall be located more than 500 m away from NH-69. Green belts have been planned on all sides to minimise impact of windblown pollution to the surrounding areas. Villages adjoining the ash disposal area would also be protected by green belt buffer. The plant water system is being designed for maximum usage of waste water to attain 'zero discharge'.



3.11.02 Chimney of adequate height (150 m) along with ESP, FGD & SCR is considered to contain ground level concentration of SPM, SO_x, NO_x etc. within acceptable limits prescribed by MOEF.

3.12.00 Other Infrastructural Availability

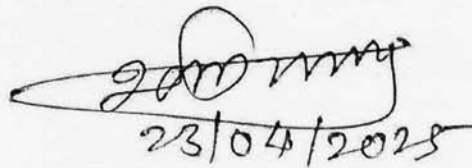
3.12.01 Amenities like market, hospital, schools, college, small-scale industries to support construction of the plant are available in Nagpur town (11 Km). The local villages can also be of assistances for workforce to be deployed at the initial stage. To accommodate a large workforce during construction of the project, it is envisaged that some housing facilities viz. temporary labour hutments may be developed along with necessary civic amenities. The facilities in the township will also be suitably mobilized for the expansion project.

Annexure- 3

Tertiary Treated Water Quality Parameter (At filter water tank)

For 2x660 MW Koradi Project Unit 11&12.

Sr. No	Description	Unit	Parameter
1	pH	-	6.5-7.5
2	Total Dissolved Solids (TDS)	ppm	< 300
3	Total Hardness	ppm as CaCO ₃	< 100
4	Alkalinity	ppm as CaCO ₃	< 125
5	Chlorides	ppm	< 50
6	Silica	ppm	< 30
7	BOD	ppm	< 5
8	TSS	ppm	< 5
9	Turbidity	NTU	5
10	Total Nitrogen	ppm	< 10
11	Total Phosphorus	ppm	< 0.5
12	Free Residual Chlorine	ppm	0.5 to 1.0
13	Total Phosphate	ml	< 2
14	Coliforms	MPN/100 ml	< 1000



Executive Engineer (P&P)



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TECHNICAL SPECIFICATION



TITLE:
2X660 MW KORADI STP (UNITS-11&12)
AIR-CONDITIONING SYSTEM
SPECIFIC TECHNICAL REQUIREMENT

SPECIFICATION No: PE-TS-527-553-A001

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TECHNICAL SPECIFICATION

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1. FUNCTION

The purpose of the system is to provide Air Conditioning & Ventilation system for different areas of 2X660 MW KORADI STP (UNITS-11&12) under the scope of this tender.

2. SYSTEM DESCRIPTION

2.1 AC Plant-1: Central Air Conditioning System for Main Plant areas (Control Room, CER, UPS & Battery Charger room, CEP VFD room etc.

- 2.1.1 As per spec. clause no. 2.03.00 of Section 7, part A, Vol. III and 2.13.07 i) of Section 2, Vol. II under sub-section-C2 (Customer specification).
- 2.1.2 One (1) No. Vapour Absorption machine (**Working**) complete with all accessories as described hereinafter. Capacity of VAM shall be **minimum 315 TR (actual)**.
- 2.1.3 One (1) No. of PRDS for regulating the steam parameter as per VAM operating requirement.
- 2.1.4 One (1) No. Water cooled Screw Type Chillers (**Standby**) complete with all accessories as described hereinafter. Capacity of Screw chiller shall be **minimum 315 TR (actual)**.
- 2.1.5 Two (2) Nos. Horizontal Split Casing/Back pullout type Centrifugal Condenser Water Pump Sets (1 No. working and 1 No. standby) each complete with all accessories as described hereinafter. These pumps shall be common for 1 x 100% working VAM and 1 x 100% standby screw chilling machine.
- 2.1.6 Two (2) Nos. Horizontal Split Casing/Back pullout type Centrifugal Chilled Water Pump Sets (1 No. working and 1 No. standby) each complete with all accessories as described hereinafter. These pumps shall be common for 1 x 100% working VAM and 1 x 100% standby screw chilling machine.
- 2.1.7 Two (2) Nos fiber glass reinforced plastic (FRP) construction induced draft cooling Towers (1 No. working and 1 No. standby) each complete with all accessories i.e. fan, motor, FRP basin, nozzles, level switch, make up connection, drains, piping, valves & fittings, strainer, ladder and supporting structure etc. These cooling tower shall be common for 1 x 100% working VAM and 1 x 100% standby screw chilling machine.
- 2.1.8 Three (3) Nos AHU (2 No. working and 1 No. standby) in AHU Room at 25.5 M level for CCR/CER.
- 2.1.9 Two (2) Nos AHU (1 No. working and 1 No. standby) in AHU Room at 8.5 M level for UPS room and CEP VFD room.
- 2.1.10 One (1) Pan type humidifier in each AHU room.
- 2.1.11 One (1) lot strip type duct heaters for each AHU room.
- 2.1.12 Lot – Pre-filters, Fine filters.
- 2.1.13 Lot- chilled water piping with insulation interconnecting chiller, air-handling units and pumps sets complete with valves and fittings such as elbows, tees, reducers, flanges etc.
- 2.1.14 Lot- Condenser water piping interconnecting from make-up tank to water softening plant, cooling tower, chiller, condenser water pump, pan humidifiers of AHU room complete with valves and fittings such as elbows, tees, reducers, flanges etc.
- 2.1.15 One (1) No. MS/FRP chilled water expansion tank (of minimum 1 m3 capacity) complete with valve, Level Gauge, Level Switch, Make-up connection, overflow, insulation and drain etc. The tank shall provide with level gauge glass.
- 2.1.16 One (1) No. MS/FRP make-up water storage tanks (2 m3 capacity) complete with valve, Level Gauge, Level Switch, Make-up connection, overflow and drain etc.

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2.1.17 Two (2) Nos. MS storage water tanks (8 m3 capacity each) complete with valve, Level Gauge, Level Switch, Make-up connection, overflow and drain etc.

2.1.18 Lot-Drain water piping out of MS pipes conforming to IS-1239, Part I, heavy grade and galvanized as per IS:4736, from various equipment like chillers, pumps, AHUs, Cooling tower etc. up to the nearest drain point within the room & for Cooling tower up to nearest drain point or rainwater pipe on the roof) with Thermal insulation (for chiller, chilled water pump & AHU drains).

2.1.19 The conditioned air from AHUs is distributed to the air-conditioned areas by galvanized sheet steel ducting and extruded aluminum grilles / diffusers. The return air is led back to the AHU room in ducts for air-conditioned areas at 17.0M level in control tower, for balance areas, i.e. air-conditioned areas at 8.5M level in control tower, the return air is collected above the false ceiling and led back to the AHU rooms which acts as mixing plenum for return and fresh air.

2.1.20 The supply and return air duct shall be provided with motor operated fire damper at locations where duct pass through walls & floors.

2.1.21 Lot – GSS Ducting (as per IS-277) with 275 g/sq.m. of zinc coating sheet metal work, complete with volume control dampers, extruded aluminium supply air (with VCD) and return air grills, hangers, supports, flexible connections, including thermal insulation on complete supply air duct & return air duct and acoustic insulation (as applicable).

2.1.22 1x100% duty Fresh air fan complete with pre-filter & fine filter shall be provided for each AHU room.

2.1.23 2x100% Water Softening Plant complete with all accessories with pump, valves, piping, fitting etc.

2.1.24 Controls for the AC plant-1 shall be DDCMIS based.

Note: DG-backed operation of following AC equipment for CCR-CER shall be provided

a) 1 no. Chilling machine (Screw Chiller)

b) 1 no. Chilled water pump

c) 1 no. Condenser water pump

d) 1 no. Cooling tower fan

e) AHU’s for CR & CER & UPS

f) 1 no. Fresh air fan for CR& CER & UPS.

Special note: 3-Phase 3-wire system-based emergency power supply shall be provided by BHEL.

2.2 AC Plant-2 & 3: Central Air Conditioning System with Air Cooled Inverter type precision package AC for ESP cum FGD Control Rooms for Unit 11 and 12.

2.2.1 As per spec. clause no. 2.02.21 of Section 7, part A, Vol. III and 2.13.07 ii) of Section 2, Vol. II under sub-section-C2 (Customer specification).

2.2.2 Air Cooled inverter type Precision type package AC Plant shall be provided to cater the air conditioning requirements of each ESP cum FGD control room.

2.2.3 3x50% Air Cooled Inverter type Precision Package AC complete with filters, heaters and humidifiers.

2.2.4 1 Lot of Copper piping with insulation for interconnecting indoors unit, outdoors units etc.

2.2.5 1 Lot of PVC/MS type Drain piping

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2.2.6 The conditioned air from PACs is distributed to the air-conditioned areas by galvanized sheet steel ducting and extruded aluminum grilles / diffusers. The return air is collected above the false ceiling and led back to the PAC room which acts as mixing plenum for return and fresh air.

2.2.7 The supply air duct and return air path shall be provided with motor operated fire damper at locations where duct pass through walls & floors.

2.2.8 Lot – GSS Ducting (as per IS-277) with 275 g/sq.m. of zinc coating sheet metal work, complete with volume control dampers, extruded aluminium supply air (with VCD) and return air grills, hangers, supports, flexible connections, including thermal insulation on complete supply air duct and acoustic insulation (as applicable).

2.2.9 1x100% duty Fresh air fan complete with pre-filter & fine filter shall be provided for each PAC room.

2.3 Air Cooled Ducted Inverter Split Air-Conditioning Plant for Service building

2.3.1 As per spec. clause no. 2.02.22 of Section 7, part A, Vol. III and 2.13.07 iii) of Section 2, Vol. II under sub-section-C2 (Customer specification).

2.3.2 Air Cooled Ducted Inverter Split AC shall be provided to cater the air conditioning requirements of each floor of Service building.

2.3.3 1 Lot of Copper piping with insulation for interconnecting indoors unit, outdoors units etc.

2.3.4 1 Lot of PVC/MS type Drain piping

2.3.5 The conditioned air from Split AC is distributed to the air-conditioned areas by galvanized sheet steel ducting and extruded aluminum grilles / diffusers. The return air is collected above the false ceiling.

2.3.6 Lot – GSS Ducting (as per IS-277) with 275 g/sq.m. of zinc coating sheet metal work, complete with volume control dampers, extruded aluminium supply air (with VCD) and return air grills, hangers, supports, flexible connections, including thermal insulation on complete supply air duct.

2.4 Split Air-Conditioning inverter type for Offsite Building. Offsite Control Rooms/Rio Room etc.

2.4.1 Please refer Customer spec. clause no. 2.05.00 of Section 7, part A, Vol. III and 2.13.07 iv) of Section 2, Vol. II under sub-section-C2 (Customer specification).

2.4.2 Split AC shall be supplied along with isolation switch, i.e MCB of suitable rating as specified, voltage stabilizer, cabling, all supporting structure, refrigerant piping to suite actual site condition, drain piping up to nearest drain etc.

2.4.3 Air cooled Split type air conditioners (Hi wall/cassette type) shall be provided to cater to the air conditioning requirements of office, PLC/UPS room, conference etc for all auxiliary plants; and such areas which are not covered by other centralized / ducted systems described above.

2.4.4 For conference rooms and dining rooms, Cassette type indoor units shall be used.

2.4.5 Hi wall Air cooled Split air conditioners (inverter type) shall be provided for the following areas:

- CW pump house control room
- Fuel oil transfer/forwarding pump house control room and associated offices
- SWAS Room (Dry Panel)
- Laboratories and associated offices
- Air compressor control room and associated offices (if any)



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- Field maintenance Offices
- HT Switch gear operator room and associated offices
- Offices associated to stores
- Storage shed for electronic items like PLC panels, DCS panels, cards etc,

3.0 DESIGN CRITERIA: As per section C2-A, Technical Specification section-7, part-A, Vol-III, clause number 4.11.00.

Sr. no	System Design Criteria:	System Design Parameters			
1.	The outside design conditions:	(deg C)	Summer	Monsoon	Winter
		DBT	50	29.4	15.6
		WBT	27	27.2	11.1
		RH (%)	18	82	58
2.	The Inside design conditions:	The inside design conditions to be maintained for power house CCR/CER & UPS battery charger room, ESP/FGD Control room and other Control rooms (except areas where split AC are envisaged) are as follows: - Temperature : 22 +/- 1°C Relative humidity : 50% +/- 5%			
		The inside design conditions to be maintained for offices, conference rooms etc., (except areas where split AC are envisaged) are as follows: - Temperature : 24 +/- 1°C Relative humidity : 50% +/- 5%			
		The inside design conditions to be maintained for SWAS room and offsite control room areas where split AC are envisaged, are as follows: - Temperature : 22 +/- 1°C No humidity control shall be provided.			
		The inside design conditions to be maintained for service building and areas like offices, conference rooms etc., where split AC are envisaged, are as follows: - Temperature : 24 +/- 1°C No humidity control shall be provided.			
3.	Fresh air requirement	For control room/ control equipment room, UPS panel room- 0.45M3/min/person or 1.5 air changes per hour (ACPH), whichever is higher			
		For AC Area served by Duct-able split ACs and Non-duct-able split AC, no fresh air provision shall be envisaged.			
4.	Winter heating load calculation	50% of combined light load and eqpt. /panel load as available in the room			
5.	Design margin	10% & 10% margins on sensible heat & latent heat respectively.			
		10% design margin on grand total heat.			
		110% of rated cooling water requirement.			



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		10% margin on friction head of the pumps shall be provided For pumps continuous motor rating (at 50 Deg C ambient) shall be at least 10% above the maximum load demand of the pump in the entire operating range
6.	Lighting load	2 W / Sq. ft. or actual whichever is higher
7.	Occupancy	a) For general areas - one person per 10 m2 b) For conference rooms - one person per 3 m2 c) In the manned areas of control room - one person per 20 m2. Occupancy of various floors in service building shall be considered based on approved sitting arrangement.
8.	Design Chilled water flow	0.7 Cu.M./Hr per TR air-conditioned load.
9.	Design Condenser cooling water flow	1.0 Cu.M./Hr per TR air-conditioned load
10.	Fire dampers	The supply & return air ducts shall be provided with automatic (motorised) fire dampers (of 120 minutes fire rating) at locations where ducts pass through walls & floors. Operation of these dampers shall be interlocked with the fire alarm system and shall also be possible to operate manually from the remote-control panel.
11.	Insulation for duct	Thermal Insulation: All supply and return air duct shall be thermally insulated Acoustic insulation: Up to Six (6) meter from AHU/ Five (5) meter PAC limited to plenum.
12.	Return Air	Due to ceiling height constraint, non-ducted return air to AHU/PAC room shall be provided for UPS room of power house, ESP control room, FGD control room in addition to service building. Ducted return air to AHU room shall only be provided for main CCR/CER of power house.
13.	Make up water requirement	Tertiary Treated Sewage Water (TTSW) for the complete Air Conditioning System shall be made available at the make-up water terminal of the AC system. The bidder shall be solely responsible for designing and sizing the water softening/ treatment plant to ensure that the water quality supplied to the VAM/Chiller system meets the respective OEM's water quality requirements.
14.	Filtration	Two Stage Filtration (i.e. Pre-& fine Filter) shall be provided for AHUs of CCR/CER, UPS room of power house. Pre-filters shall be provided at the suction of each individual AHUs whereas Fine Filter shall be provided in common discharge plenum for easy operation and maintenance for filters. For Areas catering through precision package AC/Ducted Split AC, filters as per OEM standard shall be provided.



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		All fresh air supply shall also be filtered using pre-& fine filter.
15.	Air and water Velocity (m/s) through face area (Max.) of different system equipment.	
i	Main ducts	7.6 m/s, in case of space constraint in certain areas velocity restrictions shall be relaxed.
ii	Branch duct	4-8 m/sec
iii	Occupied room zones	2 m/sec
iv	Diffusers (Supply / return)	2.5 m/s
v	Grills (Supply / return)	5.0 m/s
vi	VCD	10.5 m/s
vii	Air Pre-filter	2.4 m/s (max.)
viii	Air Fine-filter	Not more than 1.2 m/sec for 150 mm and not more than 2.4 m/sec. for 300 mm.
ix	AHU coil (Face velocity)	2.5 m/s
x	Water velocity in piping	2.5 m/s
xi	Water velocity in piping (Gravity flow/ pump suction)	1.5 m/s
16.	Motor design ambient Temp	50-degree C ambient
17.	Belt	Belts shall be sized for 150% of the rated power and there shall be minimum of two belts per drive.
18.	Noise level	Noise level within the air conditional space shall be restricted to 35-45 NC level
19.	Tentative Heat Dissipation data for various Air-Conditioned Rooms to be served with Central AC System	UPS room & CEP VFD Room at 8.5M Power House served by AHUs located at 8.5M elev: 164 kW.
		CCR at 17.0M PH served by AHU at 25.5M: 184 kW.
		ESP cum FGD building Unit-11: 63 kW
		ESP cum FGD building Unit-12: 57 kW



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		The above heat dissipation data is for the estimation of AHU capacities envisaged for various areas. However, total capacity of the working AHUs shall match with the working capacity of the corresponding chilling plant / PAC Unit. This heat dissipation data shall be finalized during detail engineering, any variation in the AHUs capacity of any area keeping overall capacity of working AHU's same corresponding to respective chiller capacities as already mentioned in BOQ shall not have any commercial impact.
19.	Special Consideration	I. Head Load due to AHU fan Motor shall be considered in heat load calculation. II. Heater Box and Filter Box should be separated and a minimum gap of 1M should be maintained in between for each AHU room. III. Removable ladder shall be provided for the elevated plenum for each AHU room. IV. Pump head in Chilled water system shall be optimized by selecting higher pipe size for long routed pipes.

4. LAYOUT CONSIDERATION:

4.1 AC PLANT -1 FOR POWER HOUSE

4.1.1 The central chilled water plant comprising of VAM, Screw chiller, Condenser Water & Chilled Water Pumps for AC Plant Plant-1 shall be housed in AC Plant Room at 0.0 M level in F-G-H-14-16 Bay Power House Building.

4.1.2 The AHUs for this AC Plant would be located as under:

- AHU Rooms at 8.5 M level of Power House Building in C-D-13-15 Bay.
- AHU Room at 25.5 M level of Power House Building in B-C-13-17 Bay.

4.1.3 The Cooling Towers, Make-up water Storage Tank, Expansion Tank, water softening plant and soft water storage tank shall be located at 35.5 M level in F-H Bay between grid 14-16.

4.2 AC PLANT -2 & 3 FOR ESP CUM FGD CONTROL ROOM (UNITS 11 & 12)

4.2.1 Air Cooled inverter type Precision package units shall be kept inside each PAC room at Roof of ESP cum FGD control room of Unit 11 & 12 respectively.

4.2.2 Outdoor units shall be place on the roof of the ESP cum FGD Control Room of each unit.

4.3 AC PLANT-4 (SERVICE BUILDING)

4.3.1 Air cooled ducted inverter split ACs shall be located above false ceiling of each floor. Outdoor unit shall be located on terrace/extended platform.

Note: The location of equipment's as described above, may change during detail engineering.

5.0 EQUIPMENT AND SERVICES TO BE PROVIDED FOR AC SYSTEM:

Brief scope of supply and services shall be as under:



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5.1 VAPOUR ABSORPTION MACHINE (VAM)

A	Vapor Absorption type Chilling Packages shall comprise of following.	
1.1	Vapour absorption machine shall comprise of high temperature generator, low temperature generator / condenser assembly, Evaporator / absorber assembly with eliminators, regenerative heat exchangers, purge recovery units, absorbent pumps, refrigerant pumps, all interconnecting piping, valves, and other accessories, microprocessor based Control panel incorporating controls safety & interlocks, required charge of lithium bromide solution and refrigerant for all the units, cooling/heating switch valves, structural mounting base for all components etc. including steam piping with PRDS, Safety valves, Condensate piping within AC plant room, Condensate pumps, Condensate tank etc.	
1.2	Suitable pressure reducing station shall be provided with the following	
1.2.1	One number electro-hydraulic / electro-pneumatic operated pressure reducing valve, rated for full duty.	
1.2.2	One number motor operated pressure reducing valve rated for full duty on the bypass line to main pressure reducing valve.	
1.2.3	One number motorised isolation valve at the inlet of the motor operated pressure reducing valve on bypass line and one number manual isolation valve on the outlet of main pressure reducing valve.	
1.3	Type of VAM	Steam fired
1.4	Chilled water inlet temperature to evaporator	12°C
1.5	Chilled water outlet temperature from evaporator	7°C
1.6	Evaporator passes	1+1 No.
1.7	Chilled water fouling factor	0.0001 m2hr °C/kcal
1.8	Chilled water working pressure	8 Kg/cm2
1.9	Cooling water fouling factor	0.0001 m2hr °C/kcal
1.10	Working pressure	8 Kg/cm2
1.11	Design pressure	12 Kg/cm2
1.12	Capacity control range	10 - 100%
1.13	Vibration pads	Yes
B	MOC for VAM	
2.1	Evaporator tube material	Copper or Cupro-Nickel 70/30 as per manufacturer standard
2.2	Absorber tube material	Copper or Cupro-Nickel 70/30 as per manufacturer standard
2.3	Condenser tube material	Copper or Cupro-Nickel 70/30 or Carbon Steel as per manufacturer standard
2.4	High Temperature Generator tube	Stainless Steel 316L as per manufacturer standard
2.5	Low Temperature Generator tube	Copper or Cupro-Nickel or Carbon Steel as per manufacturer standard
2.6	Shell	MS plate as per IS: 2062.



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2.7	Shaft for the refrigerant and absorbent pumps	Stainless steel
2.8	impeller for the refrigerant and absorbent pumps	Cast iron

5.2 VAPOR COMPRESSION TYPE CHILLING PACKAGES:

A	Vapor Compression type Chilling Packages shall comprise of following.	
1.1	Screw compressors (suitable for Refrigerant R-134a/R407c/410a OR any other environment friendly manufacturer standard) with motors complete with suction and discharge shut off valves, oil pumps, high pressure cut-out, low pressure cut-out, oil pressure cut-out, built-in automatic capacity control etc.	
1.2	One (1) No. shell and tube type water cooled condenser and integrally finned copper tubes complete with hot gas inlet, liquid outlet, relief and purge connection for refrigerant and water inlet, water outlet, drain connection etc.	
1.3	One (1) No. shell and tube type water chiller and seamless copper tubes, plain from outside, integrally surface enhanced complete with liquid inlet and vapour outlet connection for refrigerant and water inlet, water outlet, drain connection etc.	
1.4	One Lot-MS heavy class seamless refrigerant piping, valves and fittings, inter-connecting compressor, condenser and chiller.	
1.5	Lot-MS structural frame work with anti-vibration pads.	
1.6	Initial fill of refrigerant and compressor lube oil	
1.7	Lot- insulation of suction line and chiller	
1.8	Lot-Controls comprising the following:	
1.8.1	All controls for Screw chiller are sensor based as part of Screw chiller package.	
1.8.2	Water flow switch at the outlet of each condenser and chiller.	
1.9	Type of chiller	Water cooled
1.10	Design code	IS 16590
1.11	Chilled water inlet temperature to evaporator	12°C
1.12	Chilled water outlet temperature from evaporator	7°C
1.13	Evaporator	DX type, 1 no. per unit
1.14	Refrigerant	R-134a/R407c/410a OR any other environment friendly manufacturer standard
1.15	Compressor	Semi hermetic screw compressor
1.16	Chilled water fouling factor	0.0001 m ² hr °C/kcal
1.17	Cooling water fouling factor	0.0002 m ² hr °C/kcal
1.18	Capacity control	25% - 100%, Stepless automatic
1.19	Vibration pads	Yes
1.20	Evaporator tube material	Copper
1.21	Condenser tube material	Copper

5.3 AIR COOLED INVERTER TYPE PRECISION PACKAGE AC

A	Each air-cooled precision package AC shall generally comprise of the following as per Manufacturer standard:



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1.1	The system shall contain Scroll compressor, evaporator blower and coil, heater, humidifier, air cooled condenser, externally equalized electronic expansion valve, microprocessor-based control panel etc. Package AC shall be air cooled type, of modular construction.	
1.2	The package AC shall have inverter compressor equipped with electronically controlled VFD motor for stepless capacity control.	
1.3	Combination of inverter and fixed scroll compressors may also be used to optimise the system.	
1.4	Accumulator shall be provided suitable for long refrigerant piping requirement.	
1.5	Anti-corrosive fins shall be provided on the copper condenser.	
1.6	The unit shall be suitable for operation on 415 V, 50 Hz, AC supply. The panel shall display values, operating conditions, signal faults and collective faults limiting values.	
1.7	Compressor shall be high efficiency (EER shall be not less than 3.5) scroll design and shall have inbuilt protection for overloads. It shall be mounted on anti-vibration mountings.	
1.8	The distance between fins in evaporation coil shall not be less than 1.8mm and face velocity shall not exceed 2.5m/s.	
1.9	Filter chamber shall be integral part of the system and withdrawable from the unit.	
1.10	All items except condenser shall be contained within the cabinet of the unit, which shall be placed inside a room.	
1.11	Pan-humidifier and strip heater as required.	
1.12	External finish shall be powder coated GI Sheet	
1.13	R32/410a or any other environment friendly refrigerant shall be used	
1.14	Design Code	IS 8148 / 1391
1.15	Compressor	Inverter or (Inverter + fixed) scroll/rotary compressor
1.16	Capacity control	Stepless
1.17	Control panel	Digital micro control /Inbuild or pendant type
1.18	Controller	Intelligent microprocessor controller
1.19	Refrigerant	R410a/32 or any other environment friendly refrigerant
1.20	Humidifier	Steam electrode type (as required)
1.21	Heater	Electric strip type (as required)
1.22	Vibration pads	Yes
1.23	Noise	Less than 68db @1m
1.24	Cabinet material and Finish	Powder coated on GI sheet, with insulation as required
1.25	Indoor Unit	
1.25.1	Filters	Washable with HDPE filter media
1.25.2	Filter efficiency	95% down to 3 microns
1.25.3	Blower	Centrifugal fan, double inlet
1.26	Outdoor unit	
1.26.1	Fan	Propeller type
1.26.2	MOC of fan	ABS/AL/GI
1.26.3	Condenser coil	Copper
1.26.4	Fins	Non-corrosive



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5.4 COOLING TOWER:

A	Induced draft, cross or counter flow fibre glass reinforced plastic (FRP) construction Cooling Towers shall comprises of following.	
1.1	Fan, motor, FRP basin, nozzles, level switch, make up connection, drains, piping, valves & fittings, strainer, ladder and supporting structure etc.	
1.2	Cooling tower shall be designed as under: - Design wet bulb: 27.5 deg. C. Approach: 5 deg. C. Range: 5 deg. C.	
1.3	Recirculation allowance	0.5 °C
B	MOC for Cooling Tower	
2.1	Casing & Sump tank	FRP
2.2	Fan	Cast Aluminium / FRP Propeller type and multi-blade aerofoil construction with adjustable pitch.
2.3	Fan stack	FRP
2.4	Fill	PVC, 0.25mm thick
2.5	Louvers	FRP /PVC/ Aluminium
2.6	Nozzles	PVC/Polypropylene/Brass with chrome plating
2.7	Eliminators	PVC/ In removable sections to reduce the drift loss to 0.005%
2.8	Supporting structure	Mild steel with HDG or epoxy painting.
2.9	Strainer at water outlet	Plate strainer made of GI/SS wire mesh of 16 gauge.
2.10	Bird screen on top of tower	25 mm square made of GI/SS wire mesh of 16 gauge.
2.11	Ladder	Hot dip/spray galvanised/epoxy painted steel ladder for each tower.
2.12	Distribution Pipe (if any)	MS HDG/spray galvanised
2.13	Fasteners	HDG steel
2.14	Accessories	a) Drain connection with isolation valve b) Make up connection with ball - float valve, back up gate valve and a bypass with a gate valve for manual operation. c) Overflow connection d) Equalizing connection to connect sump of all the towers wherever applicable. e) Access door in louvers / fan deck.

5.5 AIR HANDLING UNITS (AHU):

A	Each air-handling unit shall comprise of the following: -
1.1	Casing, fan impeller section, cooling coil section with drains and vents connections, damper section, steel frame with anti-vibration mountings (AVMs), flexible connection on fan discharge, isolation damper, pre-filters.



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1.2	One No adequately sized TEFC sq. cage induction motor suitable for 415 V, 3 phase, 50 Hz AC supply with drive package comprising fan pulley, motor pulley, V-belt and belt guard.	
1.3	Cooling coil section (integral with filter section) with suitably sized chilled water-cooling coil made of seamless copper tubes with aluminium fins, number of fins as per manufactures' standard but not greater than five per cm (thirteen per inch). It shall be provided with suitable drains and vents connections.	
1.4	Fan section shall be complete with backward curved multi-bladed centrifugal fan mounted on a shaft with adjustable motor base.	
B	MOC for AHU	
2.1	Casing	Double skin construction. Double skin sandwich panels (inside and outside) shall be fabricated using minimum 0.8mm (22G) galvanised steel, with 25 mm thick polyurethane (PUF) foam insulation of minimum 40 kg/m ³ density in between. 16G galvanised steel sheet channel shall be used as reinforcing to give structural strength. Supports made in a 16 G M.S structure of sectionalized construction with one coat of rust proof anticorrosive paints followed by two coat of final paint and complete with insulated drain pan, insulated drain piping etc. The AHU's shall be cabinet type with Fan section, coil section and filters section.
2.2	Cooling coil	seamless copper tubes with Aluminium fins
2.3	anti-vibration mountings (AVMs)	Serrated rubber vibration pads
2.4	flexible connection	flame retardant, water proof neoprene impregnated
2.5	AHU tray	min 18SWG SS 304.

5.6 CENTRIFUGAL FAN FOR AHU

A	Each centrifugal fan shall be complete with	
1.1	Fan impeller (backward curved) with casing & supports	
1.2	Electric drive motor	
1.3	Drive Pulleys, V-belt, belt guards, slide rails etc.	
1.4	Dampers and flexible connection with matching flanges.	
1.5	Vibration isolators, foundation bolts and nuts.	
B	MOC for Centrifugal fan	
2.1	Fan Scroll:	3mm thick MS plate for fan dia. up to 750mm & 5mm thick MS plate for fan dia. above 750mm as per IS 1079 / 2062 Gr. B
2.2	Fan Casing (side plates & stiffeners):	MS plate to IS 2062 / 1079 Minimum thickness shall be 3.15mm
2.3	Impeller:	MS sheet/plate (IS 2062 Gr. B) with spray galvanisation zinc deposit confirm to class 370 of IS 277



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2.4	Impeller hub:	Cast aluminium alloy (LM-6)
2.5	Impeller back plate blade & shroud:	MS to IS 2062, Gr. B
2.6	Shaft:	EN-8
2.7	Shaft sleeve:	EN-8
2.8	Fan Supports, frames and structure:	MS to IS 2062, Gr. B
2.9	Flexible connection at outlet/inlet:	Fire resistant type plastic impregnated canvas with M.S. flange and cleats (3 mm thick).
2.10	V Belt (matched sets):	ISI marked (Reinforced rubber section to (IS: 4776)
2.11	V Pulley:	CI multi groove to IS 210, Gr. 20
2.12	Belt guard	Yes, removable
2.13	Slide rails:	M.S. / C.I.
2.14	Connection pieces:	G.I.
2.15	Fasteners:	Galvanized MS.
2.16	Vibration isolation pads, washers & spring if any	Hard synthetic rubber of hardness 40°C shore
2.17	Dampers:	Heavy Gauge MS (IS-2062 Gr. B).
2.18	Critical speed	First critical speed of rotating assembly shall be at least 25% above the operating speed.
2.19	Noise	Less than 85 db (a) at 1m away (in free field condition)

5.7 CENTRIFUGAL PUMP FOR CHILLED AND CONDENSER WATER LINE

A	Each circulating water pump set shall comprise of the following	
1.1	Centrifugal pump Back pull out / Horizontal Split Casing type centrifugal pumps of adequate capacity to match the package chiller/system requirement.	
1.2	One no. adequately sized TEFC sq. cage induction motor suitable for 415V, 3 phase, 50 Hz AC supply	
1.3	One no. Pot type strainer at inlet complete with screen, drain arrangement etc.	
1.4	150 mm dia. Dial Type pressure gauges one each at discharge side of the pump set.	
1.5	Gate valve, one each at suction and Globe valve, one each at discharge side of the pump set.	
1.6	One no. non-return (check) valve at discharge side of each pump set.	
1.7	One set of base plate, coupling, coupling guard, anti-vibration mountings, foundation bolts etc.	
1.8	Speed of the pump shall be maximum 1500 RPM.	
B	MOC for Water Pump Set	
2.1	Casing:	2% Ni, CI, IS 210 Gr. FG 260
2.2	Impeller:	Closed, Bronze LTB2, IS 318
2.3	Wearing ring:	Bronze LTB2/LTB5, IS 318
2.4	Pump shaft:	SS 410
2.5	Shaft Sleeve:	SS 410
2.6	Lantern ring	Bronze LTB2/LTB5, IS 318
2.7	Base plate:	Epoxy coated, CS, IS 2062
2.8	Bolt and nuts:	M.S. (Epoxy painted / Galvanised).



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2.9	Type of seal:	Mechanical seal
2.10	Pump motor coupling:	Pin & bush type.

5.8 INVERTER TYPE SPLIT AIR CONDITIONERS:

A	Split/ Cassette air conditioners shall in general consist of the following as applicable as per OEM standard:	
1.1	Split air conditioners shall consist of indoor unit and outdoor units:	
1.2	The indoor unit consist of the evaporator coil, evaporator blower with its own separate motor, capillary tube, control panel, air filter grills etc. It shall be installed inside the room to be conditioned	
1.3	The outdoor unit has the other parts of the system like Compressor, air cooled condenser fan & its own motor and shall be installed at outside. In case of ducted split air-conditioning plant, multi-outdoor unit system shall be provided.	
1.4	Aluminium fins shall be provided on the 100% copper condenser.	
1.5	The indoor unit & outdoor unit are connected by refrigerant (copper) piping.	
1.6	Design Code	IS 1391, Part-2
1.7	Compressor	Inverter rotary compressor
1.8	Control	Hand held cordless remote
1.9	Refrigerant	R410a/R32 or any other environment friendly Refrigerant as per manufacturer's standard.
1.10	BEE rating	5 star/Best rating as per latest BEE.
1.11	ISEER	4.5 w/w (min.) (except for cassette type)
1.12	Noise level indoor/outdoor	46dBA/58dBA (Max.)
1.13	Filter	PM 2.5-micron filter
1.14	Supports/stand with vibration pads	Yes
1.15	Automatic voltage stabiliser	Yes (Suitable for Inverter ACs)
1.16	Refrigerant piping	Insulated Copper
1.17	Indoor Unit-LED display	Yes

5.9 STRIP HEATING & HUMIDIFICATION PACKAGE

A	One common set of electrical strip heaters package shall comprise of the following	
1.1	Contactor, air-stat, humidistat (room or mounted on strip heater control box), safety thermostat, heater box with insulation etc. for winter heating and monsoon reheat.	
1.2	It shall be mounted inside the AC duct plenum/duct for each AHU Room.	
B	One No. Pan humidification system shall comprise of the following	
1.1	Stainless steel immersion heater, humidistat, water tank (22-gauge SS 304), low level switch over flow, draining, make up connection, float valves with stainless steel valve etc for each AHU Room.	



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5.10 WATER SOFTENING PLANT

A	Water softening plant shall be provided to meet the make water requirement for AC system. Water softening plant skid shall include the following
1.1	Multi grade filter (MGF)- Two (02) numbers (design code- IS 2825 or equivalent, MOC- MSRL 4.5 mm thick rubber lining) of suitable capacity; backwashing interval- once in a day
1.2	Ion exchange softener – Two (02) numbers (design code – IS 2825 or equivalent, MOC – MSRL 4.5mm thick rubber lining) suitable capacity; regeneration interval- once in a day.
1.3	ACF – Two (02) numbers (design code- IS 2825 or equivalent, MOC- MSRL 4.5 mm thick rubber lining) of suitable capacity.
1.4	Two charges of resin (one charge means resin required for one softener) – Strongly acidic cation resin in sodium form.
1.5	Brine preparation cum dosing tank- 01 number, MOC- MSRL or SS, Capacity shall be based on one regeneration requirement of saturated fresh brine; however, the same shall not be less than 500 litres.
1.6	Clarified water transfer pumps – 2x100% of suitable capacity and head
1.7	2 nos. MS Soft water storage tank having a total storage capacity of 4 hours make-up for cooling towers.
1.8	All associated piping, valves, instruments, motors etc – MOC of valves to suit the system requirement; piping shall be as per IS 1239 heavy grade.
1.9	Suitable system for disposal of waste. Regeneration waste shall be routed to the neutralisation pit.
1.10	Suitable backwashing arrangement of ACF, filter and softener.

5.11 FRESH AIR FAN

A	The fresh air unit shall consist of:	
1.1	Wall cowl with bird screen, tube axial fan with motor.	
1.2	Pre-filter & Fine Filters.	
1.3	Volume control damper, ducting, fixing frame and necessary supports, as applicable.	
1.4	Fresh air fans shall be 1 x 100% for each AHU room.	
B	MOC for Axial fan	
2.1	Casing:	2mm thick MS plate for fan dia. up to 750mm 3mm thick MS plate for fan dia. above 750mm as per IS 1079/2062 Gr. B
2.2	Impeller:	Cast aluminium alloy (LM-6), BS 1490, Aerofoil
2.3	Hub:	Cast aluminium alloy (LM-6)
2.4	Support frame and structure:	M.S. to IS-2062 Gr.B. (Galvanized / painted)
2.5	Vibration isolator (As required)	Neoprene rubber pads
2.6	Coned inlet (As required)	MS (IS-2062 Gr.B)
2.7	Protective screen at inlet:	Yes (Min 14 SWG Galvanized wire knitted in 1"



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		square mesh).
2.8	Rain Protection Cowl:	Suitably painted after fabrication from MS/ Aluminium or GI
2.9	Mounting flange on casing:	At inlet and outlet.
2.10	Painting / protecting coating	MS parts shall be galvanised or epoxy painted or protected with one primer coat and two coats of synthetic enamel paint.
2.11	Filter frame	Flanged Aluminium

5.12 AIR-FILTERS

A	PRE-FILTER	
1.1	Filter Medium	Fabric filter: Fibrous material (extruded polyethylene) or felt filter fabric; Dry type with element of 5 ply construction for fabric type. The filter media shall be supported with HDPE mesh on air inlet side & Aluminium expanded metal on exit side or GI wire mesh on both sides.
1.2	Frame	GI sheet (minimum 18SWG thick) or Aluminium alloy of (minimum 16SWG thick) supported by galvanised steel wire mesh 10mm square with handles.
1.3	Frame finish	Enamel painted
1.4	Sealing	Neoprene sponge rubber / Felt
1.5	Suitable of being cleaned by water flushing	Yes
1.6	Minimum Thickness	50mm for fabric type
1.7	Efficiency	90% down to 10 microns
1.8	Inspection & Testing code	BS:6540/ASHRAE – 52 – 76
1.9	Face velocity	2.4 m/s (max.)
1.10	Initial pressure drop	2-5 mm WC
1.11	Maximum pressure drop	10-12 mm WC
1.12	Other requirements	Suitable aluminium spacers to be provided for uniform air flow
1.13	Size & type	610 x 610 mm (Approx.) & Flange / Cassette / Box
1.14	Location:	a. At the suction of each AHUs b. At discharge of each Fresh air fan
B	FINE-FILTER	
1.1	Filter Medium	High efficiency synthetic non-woven media. The filter media shall be supported with HDPE mesh on air inlet side & Aluminium expanded metal on exit side or GI wire mesh on both sides.
1.2	Frame	GI sheet (minimum 18SWG thick) or Aluminium alloy of (minimum 16SWG thick) supported by galvanised steel wire mesh 10mm square with handles.
1.3	Frame finish	Enamel painted
1.4	Sealing	Neoprene sponge rubber / Felt / Epoxy Adhesive
1.5	Suitable of being cleaned	Yes



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	by water flushing	
1.6	Minimum Thickness	150mm or 300mm
1.7	Efficiency	99% down to 5 microns
1.8	Inspection & testing code	BS 6540 / ASHRAE 52 76
1.9	Face velocity	2.4 m/s (max.) for 300mm & 1.2 m/s (max.) for 150mm
1.10	Initial pressure drop	4-7 mm WC
1.11	Maximum pressure drop	15-20 mm WC
1.12	Other requirements	Suitable aluminium spacers to be provided for uniform air flow
1.13	Size & type	610 x 610 mm (Approx.) & Flange / Cassette / Box
1.14	Location:	a. In common discharge plenum of AHU. b. At the discharge of each Fresh air fan.

5.13 PIPING AND VALVES

A	Piping shall comprise followings:
1.1	Piping for sizes upto 150 mm NB shall be continuous welded Galvanized steel pipes to IS: 1239 heavy class. Piping for sizes above 150 mm shall conform to IS: 3589 with minimum 6 mm thickness.
B	Valves shall comprise followings:
2.1	All water line valves shall be of cast iron body for sizes 65 NB and above conforming to IS: 780 and Gun metal construction for sizes less than 65 NB conforming to IS: 778. Cast iron parts shall conform to IS: 210 Gr. FG 220.
2.2	The butterfly valves shall be designed as per AWWA C 504 and designed to fit between flanges. The butterfly valves shall be provided with flow control lever, black nitrile rubber integrally moulded seating, disc of aluminium bronze to BS 1400 Gr. AB2/AB1, shafts of stainless steel AISI 410. The butterfly valve shall be rated for 8 bar; body/disc tested at 12 bar and seat at 7 bar (air test).
2.3	Valves shall have full sizes port and suitable for horizontal and as well as vertical installation.
2.4	Valves for regulating duty shall be of globe type suitable for controlling throughout its lift.
2.5	Gate, Globe and stop check valves shall have bonnet back seat to facilitate easy replacement of packing with the valves in service.
2.6	All safety / relief valves shall be so constructed that the failure of any part does not obstruct the free discharge.
2.7	Manual gear operators be provided for valves of size 200 NB and above.
2.8	All valves with rising stem shall have position indicators.
2.9	All valves shall be provided with locking arrangement.



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5.14 SHEET METAL WORK

A	Sheet metal work shall be designed as under.	
1.1	GSS supply and return air ducting (as per IS 655) fabricated with GSS sheet (as per IS 277) having zinc coating of 275 g/sqm. The ducting shall be complete with of accessories such as vanes, splitters, dampers, hangers, supports, anchor bolts, sealing components, gaskets etc.	
1.2	Equal Friction method shall be employed for duct sizing. Duct may be site fabricated or factory fabricated and installed at site.	
1.3	The ductwork shall be properly reinforced to prevent sagging, buckling or vibration. Interior of all ducts shall be smooth and free from obstruction. All duct sections shall be cross-broken. All longitudinal joints for the ducts shall be Pittsburgh Lock seam type.	
1.4	The thickness of rectangular ducts shall be as follows.	
Sr.No.	Larger dimensions of Duct (mm)	Thickness of GI sheet (mm)
a.	Up-to 750	0.63 (24 G)
b.	751 to 1500	0.80 (22 G)
c.	1501 to 2250	1.00 (20 G)
d.	2251 & above	1.25 (18 G)
1.5	The longitudinal seams and transverse joints shall be flat and smooth inside the duct.	
1.6	All ducting work includes:	
1.6.1	Volume control dampers inside duct with control arrangement at each branch off and wherever necessary. Thickness of VCD shall be minimum 20 G GI sheet.	
1.6.2	Thickness of Splitter and dampers shall be made from 18 gauge GS sheet and thickness of louvers shall be of minimum 20 gauge GI sheet.	
1.6.3	Flexible connections of rubberized canvas.	
1.6.4	Sealing compound and jointing gasket for ducts	
1.6.5	Motorized fire dampers (spring return type) shall be provided in the supply air duct which shall close and stop the air flow in the event of fire. These dampers shall be operated with the help of a signal from smoke detectors/thermal sensors. The dampers shall operate on "De-energized to close "mode. In the event of fire, the dampers shall close automatically and Air washer / UAF fan shall also stop. Necessary interlocks shall be provided for this purpose in IO panel / DCS control system. Fire damper shall be of rating 120 minute (min.).	
1.6.6	Supply air grilles shall be of mill finished extruded aluminium construction. Grilles shall be provided with volume control dampers of opposed blade type.	
1.6.7	Supports and hangers including anchor bolts as required. Duct with larger side greater than 2250 mm shall be supported by 16mm MS rods and 65x65x5 mm MS Angles while those below 2250 mm shall be supported by 10mm MS Rods and 50x50x4 MS angles. All the duct plenum shall be supported on 40x40x6 mm MS angle frames. The duct supports shall be at a distance of not more than 1800 mm. MS rods and angles shall be given two coats of primer paint and final coat of silver colour. In addition to conventional duct support, wire rope support may also be accepted for supporting duct on account of speedy erection, flexibility in adjustment and good aesthetic view.	



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5.15 THERMAL AND ACOUSTIC INSULATION

A	Thermal insulation shall be as under.				
1.1	Type of insulation & Finish				
S.No	Surface	Insulation Material	Insulation Form	Thickne ss (mm)	Finish
a.	Supply & Return air duct of AC system	Resin bonded glass wool or	Roll/ Slab Sheet	50	F-3
		Aluminium faced Nitrile Rubber	Roll/ Slab Sheet	13	No separate finish required
b.	Refrigerant (Suction & Liquid Lines)	Closed cell elastomeric Nitrile rubber	Tube	19	As per manufacturer's std.
c.	AHU Drain pipe	Expanded Polystyrene or	Pipe Section	25	F-1
		Mineral Wool	Pipe Section	25	F-1
d.	Chilled water piping, valves & specialties	Expanded Polystyrene or	Pipe Section	75	F-1
		Mineral Wool	Pipe Section	75	F-1
e.	Chiller (Insulation if required)	As per manufacturer's std.			
f.	Chilled Water Pumps	Expanded Polystyrene or	Slabs	50	F-1
		Mineral Wool	Slabs	50	F-1
g.	Expansion tank with associated piping	Expanded Polystyrene or	Slab/ Pipe section	50	F-1
		Mineral Wool or		50	F-1
		Nitrile Rubber		6	With UV Protection Coating
h.	Exposed air duct	Resin bonded glass wool	Roll	50	F-4
i.	Under deck Insulation (By BHEL-Civil) of exposed roof slabs of air-conditioning areas and AHU rooms.	Under deck insulation of 50 mm nominal thickness of fibre glass of density48 kg/cum finished with 26 SWG aluminium cladding shall be provided			
1.2	Finish F-1				
a.	Step – 1: Wrapping of Poly- Bonded Hessain (PBH- to act as vapour seal) on outer surface of insulation with 50 mm overlap stitching and sealing of overlap with synthetic adhesive like CPRX or equivalent compound.				



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b.	Step – 2: The surface then shall be wrapped with 19 mm mesh 24 SWG GI wire netting, butting all the joints and laced down with 22 SWG lacing wire.				
c.	Step – 3: The surface shall be covered with 30-gauge Aluminium sheet and locking of joints with self-locking screws at a pitch of minimum 100 mm.				
1.3	Finish F-3				
a.	Step – 1: Insulation shall be covered with 500 g polythene with 50 mm overlap and sealing of overlap with synthetic adhesive like CPRX or equivalent compound.				
b.	Step – 2: The polythene shall be covered with 30-gauge Aluminium sheet and locking of joints with self-locking screws at a pitch of minimum 100 mm.				
1.4	Finish F-4				
a.	Step – 1: Wrapping of Poly- Bonded Hessain (PBH- to act as vapour seal) on outer surface of insulation with 50 mm overlap stitching and sealing of overlap with synthetic adhesive like CPRX or equivalent compound.				
b.	Step – 2: The surface then shall be wrapped with 19 mm mesh 24 SWG GI wire netting, butting all the joints and laced down with 22 SWG lacing wire.				
c.	Step – 3: Application of 3 mm thk coat of water proofing compound “SHALIKOTE 30” or equivalent and wrapped with fibre glass RP tissue followed by final coat of 3 mm thk water proofing compound “SHALIKOTE 30” or equivalent over thr RP tissue.				
d.	Step – 4: The surface shall be covered with 30-gauge Aluminium sheet and locking of joints with self-locking screws at a pitch of minimum 100 mm.				
1.5	Insulation Material shall be as specified herein.				
S.No	Insulation Material	Code	Thermal Conductivity MW/cm deg C	Density, kg/ m3	
a.	Resin bonded mineral wool/glass wool	IS:8183	0.49 at 50 Deg C	i) 24 (for thermal insulation) ii) 48 (for acoustic insulation)	
b.	Mineral wool pipe section Min Gr 2	IS 9842	0.43 at 50 Deg C	At least 81	
c.	Expanded Polystyrene	IS:4671	0.37 at 50 °C	At least 15	
d.	Closed cell Elastomeric Nitrile rubber		0.036 at 20 Deg C	60-70	
B	Acoustic insulation shall be as under.				
S.No	Surface	Insulation Material	Insulation Form	Thickness (mm)	Finish
1.1	Acoustic insulation of first 6M of ducting after AHUs but limited to plenum	Glass Wool or	Slab	25	As below
		Nitrile Rubber base open elastomeric foam	Slab	10	No separate finish required
1.2	Glass Wool Insulation shall be applied with 26 gauge perforated Aluminium sheet having 5 mm dia perforation at 8 to 10 mm centre to centre distance. Perforation area shall be 30% of free area.				



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1.3	Insulation shall be fixed on wooden frame of 600 x 600 mm dimension
1.4	Fibre glass tissue sheet shall be applied over the outer surface of insulation before applying perforated Aluminium sheet.

6.00 CONTROL PHILOSOPHY

SYSTEM CONTROL FOR AC PLANTS

- The operation of the Chiller and associated AHUs shall be done from the DDCMIS based control panel. The AC Plant compressor can be started only when its associated cooling tower fan, condenser & chilled water pumps are in operation.
- Vapour Absorption Machine (VAM) RTU connection shall be provided to the DCS for monitoring purposes only.
- Chiller Package shall be provided with skid mounted microprocessor-based control panel.
- All the drives of the AC system shall have the provision of manual starting.
- DDCMIS shall suitably interface with microprocessor-based control units of chiller units.
- The operation of the Split air conditioners of service building and other areas shall be done from local MCB.

7.0 Terminal Points, Ducting Interface, and Performance Testing

7.1 Terminal Points:

Terminal Points shall be downstream of the wall openings / floor openings of AHU Room duct, downstream of the fire dampers for inverter type duct-able split AC. Final Connection of the high side Equipment with the ducting system shall be in the scope of bidder.

7.2 Ducting System (Design & Approval):

The design, engineering, and drawing submission for approval from the end customer AC System along with the entire ducting system & associated accessories shall be in the scope of the bidder.

7.3 Duct Leak/Smoke Test:

The Leak Test / Smoke Test required to establish a leak-proof ducting system shall be conducted by the Low side /Duct System Supplier. However, the bidder shall supervise and certify the execution of such tests to ensure that the ducting system performance meets the technical requirements.

7.4 Performance Guarantee (PG) Test:

The Performance Guarantee (PG) Test for the entire AC System (including ducting & accessories) shall be carried out by the bidder as per approved procedures to meet performance parameters as per the specification.

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8.0 General

- 8.1 Basis of design all calculations including heat load calculations for summer seasons, equipment selection criterion, layout drawings/ schemes/G.A. dwg and documents like data sheet/ technical particulars etc are subject to Customer approval during detail engineering stage.
- 8.2 Bidders shall make Site visit in order to familiarize themselves with existing condition of site before submitting the bid in order to make their offer complete. BHEL shall also not entertain any cost implication for any lack of input data with regard to site during detail engineering.
- 8.3 All drawings and documents shall be computer based. Auto-cad file shall be shared with BHEL.
- 8.4 All commissioning spares & consumables for trouble free operation until handing over of the system shall be provided.
- 8.5 The bidder shall be responsible for providing necessary storage facilities for materials supplied.
- 8.6 Quality Requirements in the Technical Specification are indicating minimum requirements for inspection and testing. Vendor shall note that quality plan is subject to Customer & BHEL approval during detail engineering stage.
- 8.7 The drawings/ documents submitted by vendor shall be complete in all respects with revised drawing submitted incorporating all comments. Any incomplete drawing submitted shall be treated as non- submission with delays attributable to vendor's account. For any clarification/discussion required to complete the drawings, the bidder shall himself depute his personal to BHEL / Customer's place any number of time as per the requirement for across the table discussions/ finalizations/ submissions of drawings.

9.0 SCOPE OF SERVICES

Scope of services by bidder will include but not necessarily limited to the following:

- 9.1 Unloading, Storage, handling and transportation at site.
- 9.2 Erection & Commissioning of AC System.
- 9.3 Necessary supports and structures / frames etc. as required for supporting the duct / piping /equipment etc. as lump-sum basis is in the scope of Vendor and no unit rates shall be applicable for these items.
- 9.4 Minor civil work like chipping of foundation, grouting below base plate for all structures, equipment, grouting of anchor bolts wherever these are not placed in the foundation during casting of foundation itself including special type of grouting like GPX2 etc, making opening to suit / finishing of opening after completion of AC Equipment erection, sealing of duct / pipe opening.
- 9.5 Making Good / Repairing / replacement of and damaged done by bidder to adjacent structure, pipes etc. while erecting equipment's related to AC System.
- 9.6 Drain piping up to the drain point to be provided by the Vendor.
- 9.7 Pre-Commissioning work such as flushing, hydraulic testing etc. Necessary consumables and instrumentation like refrigerant, grease, lubricants, anemometer, tachometer, ammeter, voltmeter etc. for inspection and testing at works as well as at site including pre-commissioning activities shall be arranged by the successful bidder at their own cost.
- 9.8 Inspection & testing, Performance Requirements and Performance Guarantees as per the specification.
- 9.9 Painting of equipment's, valves, pipes and other accessories within scope of supply.
- 9.10 Electrical scope as per enclosure elsewhere in the specification.



TITLE:
2X660 MW KORADI STP (UNITS-11&12)
AIR-CONDITIONING SYSTEM
SPECIFIC TECHNICAL REQUIREMENT

SPECIFICATION No: PE-TS-527-553-A001

SECTION: I

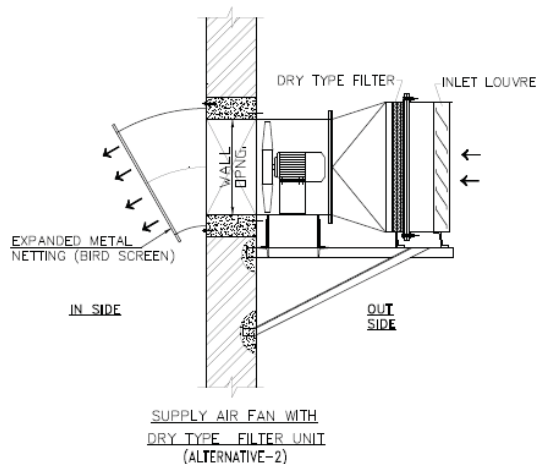
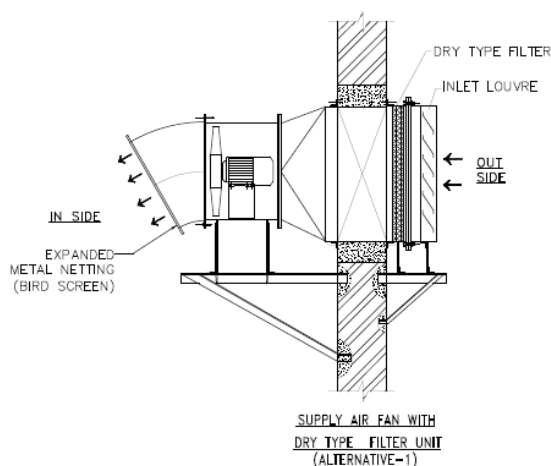
SUB-SECTION: C-1

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- 9.11** Training of plant Owner's personnel O&M operators' personnel on plant operation and maintenance as per Customer specification.
- 9.12** Relevant requirements as per GTR, GCC & SCC.
- 9.13** Any other service required for making the installation complete in all respect within battery limits and for satisfactory erection & commissioning of the system as well as to meet any statutory requirement relevant to the package, unless specifically EXCLUDED from scope of services.
- 9.14** For motorized fire damper / 3 Way valve actuators / motorized valves, power supply shall be derived by vendor from respective control panels. Suitable transformer shall be provided by bidder (if required) to derive the power input. Further distribution through junction box / distribution board shall be in vendor scope and shall have provision for isolation of individual fire damper/ valves.
- 9.15** Bidder should suitably group the signals coming from various instruments etc. & the same shall terminate in local JB, from Local JB common cable to DCS / panel / MCC shall be selected. Any Electrical / C&I items and accessories like junction box, glands etc. shall be included by vendor in his scope.
- 9.16** Supports required for supporting the fan and/or filter section for Axial fans shall be under bidder's scope.



- 9.17** All VVFD drives shall be provided with enclosure.
- 9.18** 3 phase 3 wire supply shall be provided for the equipment's (Chiller, AHUs, Pumps CT etc.) operated through DG supply (emergency Supply). Any requirement of single-phase power supply for the internal operation of the equipment shall be derived internally by the equipment supplier.
- 9.19** In case of chiller unit with multiple compressor, single source of power supply shall be provided by BHEL and further distribution shall be in the scope of the bidder.
- 9.20** Local push button station shall be provided for local operation of the Air Handling Unit (AHU). In case multiple AHU's are kept in a room or in vicinity, common Local Push Button Station shall be provided for local operation of all the AHUs in the room or located in vicinity.

	TITLE: 2X660 MW KORADI STP (UNITS-11&12) AIR-CONDITIONING SYSTEM SPECIFIC TECHNICAL REQUIREMENT	SPECIFICATION No: PE-TS-527-553-A001	
		SECTION: I	
		SUB-SECTION: C-1	
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10.0

Operation services & consumables

10.1

Commissioning of various AC plants & Equipment’s under scope of this tender is expected in phased manner depending upon front availability and other site conditions. Bidder shall include in their scope operation of such AC plants and equipment’s which are commissioned, until final handing over of complete system to customer. Consumables like chemicals for softening plant (if applicable), lube oils, refrigerants, etc. during this period of operation shall also be considered by bidder in their scope. Any shortcoming in the System which may have happened during the operation of the plant, due to regular wear and tear or otherwise, shall be made good before handing over of complete AC system to customer.

10.2

Instruments to be used for PG test shall be additionally supplied over and above the instruments shown in tender P&IDs. PG test equipment being supplied, installed and commissioned for each unit, shall be retained by employer after completion of PG test.

11.0

EXCLUSIONS

Items of works listed below are excluded from scope of the air-conditioning System supplier.

11.1

Construction of AC plant room, air handling unit room, foundations for AC equipment’s i.e. Chillers, Condensing Units, Package AC, AHU, Pumps, roof/wall openings for ducts, dampers/louvres.

11.2

False ceiling, drop ceiling.

11.3

Slab cut out for running ducts, pipes, cables, grilles/dampers. Underground masonry trenches and masonry risers.

11.4

Various cable & pipe trenches, pipe pedestals, drains, sumps, insert plates for pedestals for pipe supports.

11.5

DCS Control panel for Operation and control of AC System. However, all logic for implementation of control and monitoring from DCS shall be provided by successful bidder during detail engineering.

11.6

For Electrical scope, refer Electrical scope matrix sheet.

12.0

PAINTING / CORROSION PROTECTION REQUIREMENT

Refer customer specification, C-2A.

13.0

CONTROL PHILOSOPHY

Control of AC system shall be done from DCS based control panel located CCR area at 17.0M. Refer Customer Specification in Sub Section C2 A for details.

14.0

QUALITY ASSURANCE, QUALITY PLANS, INSPECTION & TESTING PROCEDURE:

As per the details given elsewhere in the specification.

15.0

SUB-VENDOR ITEMS

Sub-Vendor for AC System is enclosed under Annexure-I, Sub- Section – E

16.0

DOCUMENTS TO BE SUBMITTED WITH THE BID

The documents to be submitted with the bid shall strictly as per list given under **SECTION-II**. Any documents other than those indicated in the list will not be reviewed and will not be considered as part of bid.



TITLE:
2X660 MW KORADI STP (UNITS-11&12)
AIR-CONDITIONING SYSTEM
SPECIFIC TECHNICAL REQUIREMENT

SPECIFICATION No: PE-TS-527-553-A001

SECTION: I

SUB-SECTION: C-1

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17.0 DRAWINGS/ DOCUMENTS REQUIRED DURING DETAIL ENGINEERING

List of drawings / documents along with submission schedule is attached in Annexure-V,
Sub- Section –E



TITLE:
2X660 MW KORADI STP (UNITS-11&12)
AIRCONDITIONING SYSTEM
CUSTOMER SPECIFICATIONS

SPECIFICATION No: PE-TS-527-553-A001

SECTION: I

SUB-SECTION: C 2

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DATE: AUGUST 2026

SECTION: I
SUB-SECTION: C 2
CUSTOMER SPECIFICATIONS



TITLE:
2X660 MW KORADI STP (UNITS-11&12)
AIRCONDITIONING SYSTEM
CUSTOMER SPECIFICATIONS
TECHNICAL REQUIREMENT

SPECIFICATION No: PE-TS-527-553-A001

SECTION: I

SUB-SECTION: C 2A

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SECTION: I

SUB-SECTION: C 2A

CUSTOMER SPECIFICATIONS
TECHNICAL REQUIREMENT



2.13.07 AIR CONDITIONING AND VENTILATION SYSTEM

i) *Air Conditioning for Main Plant and Control Building*

- a) 1x100% Vapour absorption machine (working) and 1 x 100% Screw chilling machine (standby) complete with all accessories as described here in after.
- b) 1 no. of PRDS for regulating the steam parameter as per VAM operating requirement.
- c) Two (2) Nos. Back pull out or Horizontal Split Casing Centrifugal Condenser Water Pump Sets (1W + 1SB) each complete with all accessories as described here in after. These pumps shall be common for 1 x 100% VAM working and 1 x 100% standby screw chilling machine.
- d) Two (2) Nos. Back pull out or Horizontal Split Casing Centrifugal Chilled Water Pump Sets (1W + 1SB) each complete with all accessories as described here in after. These pumps shall be common for 1 x 100% VAM working and 1 x 100% standby screw chilling machine.
- e) Two (2) Nos. Fibre glass reinforced plastic (FRP) construction Cooling Towers ('N'W + 1SB) each complete with all accessories i.e. fan, motor, FRP basin, nozzles, level switch, make up connection, drains, piping, valves & fittings, strainer, ladder and supporting structure etc. The capacity of the cooling tower shall be equal to the condenser cooling capacity. These cooling towers shall be common for 1 x 100% VAM working and 1 x 100% standby screw chilling machine.
- f) ~~PLC~~ DCS based control, common for AC Plant.
- g) Air Handling Unit (AHU) / Fan Coil Units (FCU) as below:
 - 1) Three (3) nos. (2W and 1S) sheet metal cabinet type (double skin) air handing units of sectionalized construction each complete with all accessories, to match the AC load of Central Control Room, Control



Equipment Room, Computer Room etc at operating level of TG Building.

- 2) Two (2) nos. (1W and 1S) sheet metal cabinet type (double skin) air handing units of sectionalized construction each complete with all accessories, to match the AC load of 24V DC Charger & DCDB and UPS etc.
- 3) Three (3) nos. (3 no working) FCU, to match the AC load of Dry Room etc at 0.0 M level of TG Building.
- h) Pan type humidifier in each AHU room and Electric Strip heater shall be provided in common supply air ducting from AHU's for monsoon reheating or winter heating purpose.
- i) One Lot of Pre-filters (inside the pre-filter section of the AHUs)
- j) One Lot of Fine filters (shall be provided in Common discharge of AHUs).
- k) Condenser Water Piping
 - 1) One Lot of condenser water piping interconnecting condensers, cooling tower, pumps etc. complete with strainers, valves, fittings etc. Black steel pipe conforming to IS-1239, Part I, heavy grade or IS-3589 (6mm thk) depending upon pipe size shall be used.
 - 2) The piping up to 100 mm dia shall be galvanized steel and those above 100 mm black steel.
- l) *Chilled Water Piping*
 - 1) One Lot of chilled water piping with insulation and cladding, interconnecting chiller, air-handling units and pumps sets complete with valves and fittings etc. Black steel pipe MS ERW conforming to IS-1239, part I, heavy grade or IS-3589 (min. 6mm thk) depending upon pipe size shall be used. The piping up to 100 mm dia shall be galvanized steel and those above 100 mm-black steel.
 - 2) One No. MS / FRP chilled water expansion tank (of minimum 1m³ capacity) complete with valve, Level Gauge, Level Switches, Make-up connection, overflow and drain etc. The tank shall provide with level gauge glass and shall be completely insulated.
- m) One Lot of Drain water piping out of MS pipes conforming to IS-1239, Part I, heavy grade and galvanized as per IS:4736, from various equipments like chillers, pumps, AHUs, cooling tower area etc. up to the nearest drain point. (Within the room & for Cooling tower up to nearest drain point or rain water pipe on the roof) with Thermal insulation.
- n) One No. Make up water tank made of MS / FRP complete with valves, level gauge, level switches, make up connection, over flow and drain etc.
- o) Two nos. Storage water tank (8m³ capacity each) made of MS complete with valves, level gauge, level switch, make up connection, over flow and



drain etc. This tank will supply make-up water to cooling towers, expansion tank and humidifier.

- p) Fire Dampers - The supply and return air ducts shall be provided with motor operated fire damper at locations where duct pass through walls & floors for ease of isolation, maintenance fire protection purpose & should also be possible to operate manually and as well as for emergency operation. The operation of these automatic dampers shall be interlocked the fire alarm system.
- q) One Lot of GSS Ducting (as per IS-277) with 200 g/m² or better of zinc coating sheet metal work including thermal insulation on complete supply air duct & return air duct (as applicable) and acoustic insulation for initial length of 6m from the AHU outlet.
- r) 2x100% Water Softening Plant complete with all accessories with pump, valves, piping, fitting etc.
- s) 1x100% Duty fresh air fan with pre-filter & fine filter in all AHU Rooms.
- ii) *Air Cooled Precision Package Air-Conditioning Plant*
 - a) 3x50% or 2x100% Air Cooled Inverter Package AC will be used for each area; as mentioned the technical specifications.
 - b) 1 Lot of Fine filters (shall be provided in common discharge of each Precision AC).
 - c) 1 Lot of Copper piping with insulation for interconnecting indoors unit, outdoors units etc.
 - d) 1 Lot of PVC type Drain piping
 - e) 1 Lot of GSS Ducting with 200 g/sqm or better of zinc coating sheet metal work including thermal insulation on complete supply air duct and acoustic insulation for initial length of 5m from the indoor outlet.
 - f) Thermostat and dampers for each office room/zone.
 - g) 1x100% Duty fresh air fan with pre-filter & fine filter in all Precision AC Rooms
- iii) *Ducted Split Air-Conditioning Plant*
 - a) Ducted Inverter Split AC will be used for each area; as mentioned the technical specifications.
 - b) 1 Lot-Fine filters
 - c) 1 Lot of Copper piping with insulation for interconnecting indoors unit, outdoors units etc.
 - d) 1 Lot of PVC type Drain piping
 - e) 1 Lot of GSS Ducting with 200 g/sqm or better of zinc coating sheet metal work including thermal insulation on complete supply air duct and acoustic insulation for initial length of 5m from the indoor outlet.
 - f) Thermostat and dampers for each office room/zone.



iv) *Split type Air-Conditioners*

- a) Split type air conditioners (air cooled) are provided to cater to the air conditioning requirements with 3 x 50% or 2 x 100% or ('N'W + 1S) duty configuration; for all DCS and UPS areas, I/O panel rooms, SWAS Rooms, rooms associated with labs, stores etc. of the power plant, all control rooms in auxiliary plant areas; as mentioned in the technical specifications; where 'N' is the no. of working units.
 - b) For office cabin rooms, no standby unit is envisaged.
- v) Any other areas if requires air conditioned environment, shall be provided with suitable AC plant.



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VOLUME - III

KORADI THERMAL POWER STATION
2X660 MW UNITS - 11 & 12 PROJECT

PART - A

RFx No. 3000046202 (BTG Package)

SECTION - 7

TECHNICAL SPECIFICATION AC & VENTILATION SYSTEM

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1.00.00 GENERAL

1.01.00 This section covers minimum requirements for design, engineering, manufacture & assembly, inspection, supply, erection, testing commissioning and performance testing of complete Air Conditioning and Ventilation System for 2 x660 MW pulverized fuel based thermal power plant; to meet well established engineering practices, safety codes and other relevant codes and standards. This system will cover the following:

1.01.01 Air Conditioning System,

1.01.02 Ventilation System

2.00.00 SYSTEM DESCRIPTION

2.02.00 Air Conditioning is provided for controlled environment in respect of temperature, relative humidity, cleanliness and noise, for effective functioning of the sophisticated control panels and other equipment as well as maintaining comfortable and healthy working conditions for the occupants.

2.01.00 **Air Conditioning will be provided for the following areas:**

2.02.01 All Control Rooms & associated equipment rooms.

2.02.02 All PLC rooms

2.02.03 All Battery Charger rooms

2.02.04 All UPS rooms

2.02.05 All VFD rooms

2.02.06 SWAS panel room

2.02.07 All Office rooms

2.02.08 All conference rooms

2.02.09 Any other rooms to be occupied by Plant Personnel on continuous/intermittent basis.

2.02.10 Any other area where controlled environment is required, for example C&I Lab/Stores



2.03.00 Air Conditioning System for Main Plant Building/s

2.02.16 Central Control Room (Common for both the Units), Computer Rooms, Control Equipment Room (CER), Uninterrupted Power Supply (UPS) Room, Shift Charge Engineer's Room (Common for both the Units), C & I Maintenance room, Relay Panel room (if separate), Record room. Automatic Voltage Regulator Room (AVR)/Excitation Room/Cubicle (as applicable) and all office areas in the main plant building/s. Other associated office areas telephone exchange room, library and laboratory etc, if any.

2.02.17 The air conditioning plant shall comprise of 1x100% working VAM and 1x100% standby Screw Chilling machines. The condenser cooling & chilled water shall be circulated through these units by means of 2x100% horizontal centrifugal pump sets and 2x100% FRP cooling towers. The chilled water produced by the chilling units shall be circulated to the air handling units (AHU) located adjacent to air-conditioned areas as above in Power House Building by means of horizontal centrifugal pump sets. The conditioned air from AHUs is distributed to the air-conditioned areas by galvanized sheet steel ducting (Zn coating at least 200 gm/m² as per IS 277) and powder coated extruded Aluminium grilles / diffusers.

2.02.18 Steam for VAM shall be tapped from an appropriate source, preferably from the auxiliary steam tapping, through a PRDS station; such that availability of steam from both units is ensured.

2.02.19 The return air is led back to the AHU Room in ducts for all areas except Service Building, Charger and UPS room where, return air is collected above the false ceiling and led back to the AHU room which acts as mixing plenum for return and fresh air.

2.02.20 Zone control thermostats have to be provided for each room in the office area, especially those which are not used continuously, i.e. on 24 hr basis.

2.04.00 Air Cooled Precision Package Air-Conditioning Plant

2.02.21 Following areas will be air-conditioned by dedicated 3 x 50% or 2x100% Air Cooled Inverter Package Air-Conditioning Plant:

- i) ESP Control Buildings
- ii) FGD Control Building

2.02.22 Following areas will be air-conditioned by dedicated Air Cooled Ducted Inverter Split Air-Conditioning Plant:

- i) Service Building



- 2.02.23 To optimise the components required for ducted split air conditioning and ducting system, floor wise units shall be considered for service ~~and administrative~~ buildings. Configuration shall be finalised during detailed engineering (DDE).
- 2.02.24 Multi-outdoor unit system shall be provided for service building so that optimum cooling is ensured even if one of the outdoor unit fails.
- 2.03.00 The conditioned air from these AC systems is distributed to the air-conditioned spaces by galvanised sheet steel ducting (Zn coating at least 200 gm/m² as per IS 277) and powder coated extruded Aluminium grilles / diffusers.
- 2.04.00 The return air is collected above the false ceiling and led back to the PAC room / indoor unit which acts as mixing plenum for return and fresh air.
- 2.05.00 Zone control thermostats have to be provided for each room in the office area, especially those which are not used continuously, i.e. on 24 hr basis.
- 2.05.00 **Split Type Air Conditioners**
- 2.05.01 Split type air conditioners (air cooled) with 3 x 50% or 2 x 100% or (N + 1) duty configuration, i.e. 'N' working + 1 standby, will be provided to cater to the air conditioning requirements of human occupancy, PLC and UPS areas, for all auxiliary plants; and such areas which are not covered by other centralised / ducted systems described above; where 'N' is the no of working units, to meet the maximum design load.
- 2.05.02 These air-conditions shall be operated with Push Button Station / Remote control type.
- 2.05.03 Inverter type, Hi wall type split AC is generally envisaged.
- 2.05.04 For office cabin rooms, no standby unit is envisaged.
- 2.05.05 For conference rooms and dining rooms:
- i) Cassette type indoor units shall be used
 - ii) Multi-outdoor unit system shall be provided for conference rooms, so that optimum cooling is ensured even if one of the outdoor unit fails.
 - iii) Inverter type AC is not envisaged for conference and dining rooms.
- 2.05.06 Split type air conditioning system shall be provided for the following areas:
- i) All conference rooms in the plant.
 - ii) CW pump house control room (if applicable)
 - iii) Fuel oil transfer/forwarding pump house control room and associated offices
 - iv) SWAS Room (Dry Panel)
 - v) Laboratories and associated offices
 - vi) Air compressor control room and associated offices (if any)



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~~vii) Ash water recovery pump house control room~~

viii) Elevators (including machine room)

ix) All Operator cabins of cranes etc

x) Field maintenance Offices

xi) HT Switch gear operator room and associated offices

xii) Offices associated to stores

xiii) Storage shed for electronic items like PLC panels, DCS panels, cards etc.,

xiv) Dining rooms



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3.00.00 CODES AND STANDARDS

3.01.00 All materials, design, fabrication, manufacture, testing, and installation shall be as per the stipulation of applicable approved National & 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:

American Society for Heating, Refrigeration and Air Conditioning Engineers	ASHRAE Handbook, Standards, Guidelines & Publications
Indian Society for Heating, Refrigeration and Air Conditioning Engineers	ISHRAE Handbook
Sheet Metal & Air Conditioning Contractors National Association	SMACNA
Forced Circulation Air-Cooling and Air Heating Coils	ARI 410
Central station Air Handling Units	ARI 430
Water-Cooled Refrigerant Condensers, Remote Type	ARI 450


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Grey Iron Castings – Specification	IS 210
Galvanised Steel	IS 277
Metal Air Ducts	IS 655
Safety code for Air Conditioning	IS 659
Safety code for Mechanical Refrigeration	IS 660
Mild Steel Tubes, Tubulars & other Wrought Steel Fittings	IS 1239
Room Air Conditioner, Part-2 Split AC	IS 1391-2
Hot Rolled low, medium and high tensile structural steel	IS 2062
Industrial Ventilation	IS 3103
Axial Fans	IS 3588
Methods of measurement of noise emitted by machines	IS 4758
Centrifugal Fans	IS 4894
Testing of Refrigerant Compressors	IS 5111
Method of testing panel type air filters for air conditioning and ventilation purposes	IS 7613
Data for Outside Design Conditions for Air Conditioning for Indian Cities	IS 7896
Packaged Air Conditioners	IS 8148
Treatment of water for cooling towers	IS 8188
Specification of Thermostatic Expansion valves	IS 10594
Hermetic Compressors	IS 10617
Wrought copper tubes for refrigeration & air conditioning	IS 10773
Requirements of Refrigerants Condensing Units	IS 11327
Finned type Heat Exchanger for Room Air Conditioner	IS 11329
Thermostats for use in Refrigerators, Air Conditioners & Coolers	IS 11338
Testing of Water Cooling Towers	IS 11561
Water Cooled Chilling Packages using Vapour Compression Cycle	IS 16590
Refrigerants – Designation System	IS 16656
Fire Dampers	UL 555
Piping	ANSI-B31.5
Steel Pipes Flanges and Fittings	ANSI-B16.5
Butterfly Valves	BS 5155 / AWWA C 504



4.00.00 GENERAL TECHNICAL REQUIREMENTS

4.01.00 The plant/system shall be designed to meet the complete requirements for a 2x660 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. The steel surfaces to be supplied with painting shall be thoroughly cleaned before applying painting by brushing, shot blasting etc. Galvanized surfaces shall not be applied with any painting

4.03.00 For calculating friction loss in piping system: Hazen Williams formula shall be used with C value as 100.

4.04.00 For pumps, continuous motor rating (at 50 °C ambient) shall be at least 10% above the maximum load demand of the pump in the entire operating range.

4.05.00 For fans, compressors and blower continuous motor rating (at 50 °C ambient) shall be at least 10% above the maximum load demand, at the design duty point.

4.06.00 Wherever belt drives are used the belts shall be sized for 150% of the rated power and there shall be minimum of two belts per drive.

4.07.00 Velocity of water flow shall be limited to 2.5 m /sec and for gravity flow the same shall be limited to 1.5 m/sec.

4.08.00 The maximum efficiency of pumps shall be preferably within + 10% of the rated design flow indicated in data sheets.

4.09.00 Fans in hazardous areas shall have anti-spark characteristics.

4.10.00 Minimum design requirements are specified herein.

4.11.00 Design Criteria

4.11.01 The outside design conditions to be considered area as follows:

	Summer	Monsoon	Winter
DBT (°C)	50	29.4	15.6
Humidity (%)	18	82	58
WBT (°C)	27	27.2	11.1

4.11.02 DESIGN CRITERIA FOR AIR CONDITIONING SYSTEM IS AS BELOW

- i) Plant for all air-conditioned areas shall be designed to operate continuous (24 hours a day, 7 days a week except during loss of normal power failure).
- ii) The inside design conditions to be maintained are as follows:
 - a) All air-conditioned areas having sensitive electronic equipment shall be maintained at 22°C ± 1°C and relative humidity of 50% ± 5%
 - b) For Control Room areas: 22 ± 1°C & RH 50% ± 5%.



- c) For DC Battery Charger Room areas: $22 \pm 1^{\circ}\text{C}$ & RH $50\% \pm 5\%$.
- d) For SWAS Room areas: $22 \pm 1^{\circ}\text{C}$ & RH $50\% \pm 5\%$.
- e) For ESP/FGD Control Room & VFD Room: $22 \pm 1^{\circ}\text{C}$ & RH $50\% \pm 5\%$.
- f) For Service Building: $24 \pm 1^{\circ}\text{C}$ & RH $50\% \pm 5\%$.
- g) Air-conditioned areas, like offices, conference rooms etc., the temperature shall be maintained at $24 \pm 1^{\circ}\text{C}$ & RH $50\% \pm 5\%$.
- h) Relative humidity shall be maximum 60% for areas being air conditioned by High wall split ACs. Specific RH control is not envisaged for this case.
- iii) Fresh air requirement shall be as follows:
 - a) Minimum 1.5 air change per hour or minimum $0.45\text{m}^3/\text{min}$ per person (20 CFM), whichever is higher.
 - b) The Air-conditioning spaces shall be maintained at positive pressure of 2 mmWC to avoid any infiltration of dust.
- iv) Solar load, all internal loads due to equipment, lighting, fresh air, occupants etc shall be considered while calculating the heat load.
- v) Following margins shall be considered for calculating heat load:
 - a) 10% & 10% margins on sensible heat & latent heat respectively is to be considered while calculating the plant capacity.
 - b) For winter heating load calculation, 50% of combined light load and equipment / Panel load in the room shall be considered.
 - c) A design margin of 10% on grand total heat is to be considered while designing the AC Plant capacity for each area.
- vi) Lighting load shall be minimum 2 W / Sq. Ft or actual which is higher.
- vii) Occupancies shall be considered as below:
 - a) For general areas - one person per 10 m^2
 - b) For conference rooms - one person per 3 m^2
 - c) In the manned areas of control room - one person per 20 m^2 .
- viii) Coil face area of air handling units shall be designed considering a face velocity of not more than 2.5 m/sec.
- ix) Design Criteria for Volume Control Dampers – Velocity across the Damper shall not exceed 10.5 m/s.
- x) Design Criteria for Air Inlet Louvers – Face velocity of the louver shall be 2.5 m/s (max.).
- xi) The air distribution system shall be sized to have a constant frictional drop along its length and velocity through main ducts shall not exceed 7.6 m/sec, for branch duct 4-8 m/sec and 2 m/sec in occupied room zones.
- xii) The number of air handing units and its locations shall be finalised considering the overall performance and ducting requirement.
- xiii) In air conditioning system the return air shall be through ducts and use of plenum space for return air shall be avoided. However, where various floors are air



- conditioned and no intermediate or intervening floor are left non air conditioned, the space above false ceiling can be used as return air plenum.
- xiv) Volume Control Damper shall be provided at all the AHU outlet. And splitter damper shall be provided for air balancing, wherever is required.
 - xv) The supply & return air ducts shall be provided with automatic (motorised) fire dampers (of 120 minutes fire rating) at locations where ducts pass through walls & floors. Operation of these dampers shall be interlocked with the fire alarm system and shall also be possible to operate manually from the remote control panel. Required electrical contacts shall be provided in control panel of A/C plant by the contractor for further wiring up to fire alarm panels.
 - xvi) Necessary arrangement shall be incorporated in the ducts for providing duct-mounted smoke detectors in the supply and return air ducts.
 - xvii) Makeup water, for various equipment like cooling tower, expansion tank, humidifier etc, shall be taken from the service water tapping.
 - xviii) Water softening plant as required for to meet these make-up shall be provided.
 - xix) Design Chilled water flow shall not be less than 0.7 m³/hr per TR air- conditioning load. Design Condenser cooling water flow shall not be less than 1 m³/hr per TR air-conditioning load.
 - xx) Refrigerant suction, discharge/hot gas lines & liquid lines shall be sized such that the total pressure drop is equivalent to not more than 1.1°C in saturation temperature of refrigerants. However, refrigerant velocity shall not be greater than 0.5 m/sec in liquid line.
 - xxi) All windows in the air conditioned area shall be fixed type double glass with air space in between.
 - xxii) False sealing shall be provided in all ducted air conditioned areas.
 - xxiii) To reduce the air-conditioning load the exposed roof slabs (Including beams and column etc.) of air-conditioning areas, air handling units room shall be insulated with 50 mm thickness fibre glass insulation of density 48 kg/m³ finished with 26 SWG aluminium cladding.
 - xxiv) First 6 meters of supply air duct from AHU air outlet shall be acoustically insulated with 25 mm thick fiberglass crown 150 of density 48 kg/m³ and shall be covered with 26 SWG aluminium perforated sheet. Perforation area shall be 30% of free area.
 - xxv) Noise level within the air conditional space shall be restricted to 35-45 NC level with suitable acoustic attenuation/ duct silencers/ acoustic insulation, etc.
 - xxvi) Air conditioning system of Chemical Lab shall be designed with 100% fresh air. Cooled & supplied air to AC area shall not be taken back. Exhaust air fans shall also be provided suitably to exhaust the air from Chemical lab.
 - xxvii) Minimum capacity of make-up water tank shall be 2m³.
 - xxviii) Minimum capacity of expansion tank shall be 1m³.



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4.12.00 **Vapour Absorption Machine (VAM)**

4.12.01 The Vapour absorption machine shall be highly efficient, steam fired, double effect, packaged, factory assembled and tested and shall be complete in all respects.

4.12.02 The steam required for the units shall be tapped off appropriately from the auxiliary steam system in such a way that even when any of the unit is under shutdown, operation of the unit shall not be jeopardized.



- 4.12.03 Vapour absorption machine shall comprise of high temperature generator, low temperature generator / condenser assembly, Evaporator / absorber assembly with eliminators, regenerative heat exchangers, purge recovery units, absorbent pumps, refrigerant pumps, all interconnecting piping, valves, and other accessories, microprocessor based Control panel incorporating controls safety & interlocks, required charge of lithium bromide solution and refrigerant for all the units, cooling/heating switch valves, structural mounting base for all components etc. including steam piping with PRDS, Safety valves, Condensate piping within AC plant room, Condensate pumps, Condensate tank etc.
- 4.12.04 Suitable pressure reducing station shall be provided with the following
- One number electro-hydraulic / electro-pneumatic operated pressure reducing valve, rated for full duty.
 - One number motor operated pressure reducing valve rated for full duty on the bypass line to main pressure reducing valve.
 - One number motorised isolation valve at the inlet of the motor operated pressure reducing valve on bypass line and one number manual isolation valve on the outlet of main pressure reducing valve.
- 4.12.05 High Temperature Generator tube shall be of Stainless Steel as per manufacturer standard.
- 4.12.06 The tubes of low temperature generator and condenser shall be of copper or Cupro-Nickel or Carbon Steel as per manufacturer standard.
- 4.12.07 The evaporator and absorber tubes shall be of Copper or Cupro-Nickel as per manufacturer standard.
- 4.12.08 The shell shall be fabricated from MS plate as per IS: 2062.
- 4.12.09 Shaft & impeller for the refrigerant and absorbent pumps shall be of stainless steel & cast iron respectively.
- 4.13.00 **Water Cooled Screw Chiller Plant**
- 4.13.01 Each Chiller plant shall include the following:
- 4.13.02 Screw compressors (suitable for Refrigerant R-134a/407c/410a) with motors complete with suction and discharge shut off valves, oil pumps, high pressure cut-out, low pressure cut-out, oil pressure cut-out, built-in automatic capacity control etc.
- 4.13.03 One (1) No. shell and tube type water cooled condenser made of tested quality steel plate shell and integrally finned copper tubes complete with hot gas inlet, liquid outlet, relief and purge connection for refrigerant and water inlet, water outlet, drain connection etc.
- 4.13.04 One (1) No. shell and tube type water chiller made of tested quality steel plate shell and seamless copper tubes, plain from outside, integrally surface enhanced



complete with liquid inlet and vapour outlet connection for refrigerant and water inlet, water outlet, drain connection etc.

4.13.05 One Lot-MS heavy class seamless refrigerant piping, valves and fittings, inter-connecting compressor, condenser and chiller.

4.13.06 Lot-MS structural frame work with anti-vibration pads.

4.13.07 Initial fill of refrigerant and compressor lube oil

4.13.08 Lot- insulation of suction line and chiller

4.13.09 Lot-Controls comprising the following:

i) All controls for Screw chiller are sensor based as part of Screw chiller package.

ii) Water flow switch at the outlet of the each condenser and chiller.

4.14.00 **Precision Package Air Conditioning Plant**

4.14.01 Package AC shall be air cooled type, of modular construction.

4.14.02 Precision air conditioning system shall be designed for delivering the desired cooling capacity as specified & high sensible heat ratio.

4.14.03 The system shall contain scroll compressor, evaporator blower and coil, heater, humidifier, air cooled condenser, externally equalized electronic expansion valve, microprocessor based control panel etc.

4.14.04 The package AC shall have inverter compressor equipped with electronically controlled VFD motor for stepless capacity control.

4.14.05 Combination of inverter and fixed scroll compressors may also be used to optimise the system.

4.14.06 In case of ducted split air-conditioning plant, multi-outdoor unit system shall ensure uninterrupted comfort.

4.14.07 Accumulator shall be provided suitable for long refrigerant piping requirement.

4.14.08 Condenser fan shall be propeller type and blower fan shall be DIDW type.

4.14.09 Anti-corrosive fins shall be provided on the copper condenser.

4.14.10 The unit shall be suitable for operation on 415 V, 50 Hz, AC supply. The panel shall display values, operating conditions, signal faults and collective faults limiting values.

4.14.11 Compressor shall be high efficiency (EER shall be not less than 3.5) scroll design and shall have inbuilt protection for overloads. It shall be mounted on anti vibration mountings.

4.14.12 The distance between fins in evaporation coil shall not be less than 1.8mm and face velocity shall not exceed 2.5m/s.



- 4.14.13 Filter chamber shall be intergal part of the system and withdrawable from the unit. Filters shall be capable of filtering air to 95% down to 3 micron efficiency.
- 4.14.14 All items except condenser shall be contained within the cabinet of the unit, which shall be placed inside a room. In case of ductable unit, these items shall be placed within/above the false roofing.
- 4.14.15 Air cooled condenser unit shall be located outdoor.
- 4.14.16 Pan-humidifier and strip heater as required and specified shall be provided.
- 4.14.17 External finish shall be powder coated GI Sheet
- 4.14.18 R32/410a refrigerant shall be used
- 4.14.19 Specifications of ducted split AC system shall be similar to that of Precision Package AC.
- 4.15.00 **Split type air-conditioning system**
- 4.15.01 Split air conditioners shall be as per IS 1391, Part-2
- 4.15.02 All split Air Conditioners, except the Cassette type ACs used in Conference rooms and Dining rooms shall be as follows:
- i) Minimum ISEER rating shall be 4.5
 - ii) High efficiency Inverter type with Brushless DC (BLDC) Motor
- 4.15.03 Split air conditioners shall consist of indoor unit and outdoor units.
- 4.15.04 The indoor unit consist of the evaporator coil, evaporator blower with its own separate motor, capillary tube, control panel, air filter grills etc.. It shall be installed inside the room to be conditioned.
- 4.15.05 Indoor units shall have LED display.
- 4.15.06 Noise level of indoor units shall be less than 50dBA.
- 4.15.07 The outdoor unit has the other parts of the system like Compressor, air cooled condenser fan & its own motor and shall be installed at outside. The indoor unit & outdoor unit are connected by refrigerant (copper) piping.
- 4.15.08 Anti-corrosive fins shall be provided on the 100% copper condenser.
- 4.15.09 Control shall be through a hand held cordless remote control for each AC, however it should be able to control all ACs of similar type.
- 4.15.10 R32/410a refrigerant shall be used
- 4.15.11 Appropriate Digital type Automatic and Safe Voltage Regulator to be provided for split air conditioners.
- 4.16.00 **Air Handling Unit (Double Skin Type)**
- 4.16.01 The casing of AHU shall be of double skin construction. Double skin sandwich panels (inside and outside) shall be fabricated using minimum 0.8 mm (22G)



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galvanized steel, with 25 mm thick polyurethane insulation of minimum 40 kg/m³ density in between 16G galvanised steel sheet channel shall be used as reinforcing to give structural strength. Supports made in a 16 G M.S structure of sectionalized construction with one coat of rust proof anticorrosive paints followed by two coat of final paint and complete with insulated drain pan, insulated drain piping etc. The AHU's shall be cabinet type with Fan section, coil section and filters section.

- 4.16.02 Fan section shall be complete with forward / backward curved multi-bladed centrifugal fan mounted on a shaft with adjustable motor base.
- 4.16.03 Adequately sized TEFC sq. cage induction motor suitable for 415 V, 3 phase, 50 Hz AC supply.
- 4.16.04 Cooling coil section (integral with filter section) with suitably sized chilled water cooling coil made of seamless copper tubes with aluminium fins, number of fins as per manufactures' standard but not greater than five per cm (thirteen per inch). It shall be provided with suitable drains and vents connections.
- 4.16.05 Filters shall be as follows:
- i) The pre-filter section shall be washable synthetic type filter panels suitably arranged in holding GSS frames having a minimum efficiency of 90% down to 20 micron size.
 - ii) Fine Filters shall be provided in the common supply duct. The fine filter section shall be synthetic non-woven washable filter panels, suitably arranged in holding frames having a minimum efficiency of 99% down to 5 micron size. A differential pressure indicator & switch across the fine filter shall be indicated in the PLC or fully clogged condition shall be indicated.
- 4.16.06 Drain piping from the AHUs shall be routed to the nearest drain such that there should not be any chance of blockage.
- 4.16.07 Following controls shall be provided:
- 4.16.08 3-way mixing valve with actuator and bypass arrangement
- i) Temperature and RH sensor
 - ii) Proportioning thermostat for each AHU
- 4.16.09 All filter plenum shall be provided with a walking platform inside the plenum chamber for filter cleaning purpose. Inspection door shall be provided at the plenum chamber and a removable type ladder shall be attached to plenum.
- 4.16.10 Mixing box shall be complete with fresh and return air dampers. Mixing box shall be provided whenever the return air is ducted back to the AHU.
- 4.16.11 AHU tray shall be of min 18SWG SS 304.
- 4.16.12 Serrated rubber vibration pads shall be provided.



4.17.00 Strip Heating & Humidification Package

4.17.01 One common set of electrical strip heaters package of suitable capacity complete with contactor, airstat, humidistat (room or mounted on strip heater control box), safety thermostat, heater box with insulation etc. for winter heating and monsoon reheat, mounted inside the AC plenum/duct for each AHU Room.

4.17.02 One No. Pan humidification system comprising heater, humidistat, water tank, low level switch over flow, draining, make up connection, float valves etc for each AHU Room.

4.18.00 Fresh Air Fan units for Air Conditioning System

4.18.01 Fresh air unit shall consist of wall cowl with bird screen, tube axial fan with motor

4.18.02 HDPE based Pre-filter and efficiency 90% down to 10 microns and maximum face velocity of 2.25 m/s.

4.18.03 HDPE based Fine-filter and efficiency 99.5% down to 3 microns and maximum face velocity of 2.25 m/s.

4.18.04 Volume control damper, ducting, fixing frame and necessary supports.

4.18.05 Filter frame shall be of flanged aluminium

4.18.06 Specification of fans as mentioned in relevant clauses herein, are also applicable.

4.19.00 Cooling Tower

4.19.01 Cooling towers shall be induced draft counter/cross flow FRP type.

4.19.02 Fans shall be propeller type, with blades of aerofoil profile.

4.19.03 Fan blade pitch shall be adjustable type

4.19.04 CT basin and Louvres shall be FRP type

4.19.05 Nozzles and drift eliminators shall be made of PVC

4.19.06 It shall include all accessories like make-up, drain & overflow piping, valves and fittings, brass wire strainer mesh, ladder, supporting structure etc.

4.19.07 Design wet bulb temperature: 27.5°C

4.20.00 Water Softening Plant

4.20.01 Water softening plant shall be provided to meet the make water requirement for AC & Ventilation system.

4.20.02 Water softening plant skid shall include the following

- i) Multi grade filter (MGF)- Two (02) numbers (design code- IS 2825 or equivalent, MOC- MSRL 4.5 mm thick rubber lining) of suitable capacity; backwashing interval- once in a day



- ii) Ion exchange softener – Two (02) numbers (design code – IS 2825 or equivalent, MOC – MSRL 4.5mm thick rubber lining) suitable capacity: regeneration interval- once in a day.
 - iii) ACF – Two (02) numbers (design code- IS 2825 or equivalent, MOC- MSRL 4.5 mm thick rubber lining) of suitable capacity.
 - iv) Two charges of resin (one charge means resin required for one softener) – Strongly acidic cation resin in sodium form.
 - v) Brine preparation cum dosing tank- 01 number, MOC- MSRL or SS, Capacity shall be based on one regeneration requirement of saturated fresh brine; however the same shall not be less than 500 litre.
 - vi) Clarified water transfer pumps – 2x100% of suitable capacity and head
 - vii) 2 nos. MS Soft water storage tank having a total storage capacity of 4 hours make-up for cooling towers.
 - viii) All associated piping, valves, instruments, motors etc – MOC of valves to suit the system requirement; piping shall be as per IS 1239 heavy grade.
 - ix) Suitable system for disposal of waste. Regeneration waste shall be routed to the neutralisation pit.
 - x) Suitable backwashing arrangement of ACF, filter and softener
- 4.21.00 **Non-Chemical Type Scale Preventer**
- 4.21.01 Non-chemical water treatment system should prevent the formation of hard scale in cooling circuits of air conditioning equipment.
- 4.21.02 The unit should be a non-chemical on-line type scale preventer not requiring any chemicals.
- 4.21.03 It should work with a combination of Adsorption, and Turbulence.
- 4.21.04 The inner core should be able to convert the hardness salts into colloidal particles.
- 4.21.05 The unit should not require any electricity or any other source of energy. The unit should not have any recurring, operating and maintenance cost.
- 4.21.06 The size of the unit shall be determined based on the water quality and water flow rate.
- 4.21.07 The unit shall be installed in the condenser water circuit.
- 4.21.08 The outer casing should be of stainless steel.
- 4.21.09 The method of checking the performance of system through computer simulation shall be provided
- 4.22.00 **Sheet Metal Work**



4.22.01 GSS supply and return air Ducting (as per IS-277) with 200 g/sqm or better of zinc coating complete with vanes, damper, hangers / supports etc.

4.22.02 Insulation of supply air AC duct and return air duct (as applicable).

4.22.03 Supply air diffusers / grilles (Frame and Louvers of Diffuser/Grilles shall be of extruded aluminium of 1.2 mm thick section duly powder coated) with volume control dampers. Return air Diffusers will have no Volume control Damper.

4.22.04 Minimum thickness of rectangular ducts shall be as follows:

Larger Dimension of duct (mm)	Thickness of GI sheet (mm)	Thickness of Aluminium sheet (mm)
up to 750 mm	0.63 (24 G)	0.80
751 to 1500	0.80 (22 G)	1.00
1501 to 2250	1.00 (20 G)	1.50
2251 & above	1.25 (18 G)	1.80

4.22.05 The longitudinal seams and transverse joints shall be flat and smooth inside the duct.

4.22.06 All rectangular ducts shall be flat on face and Pittsburgh on corner of duct. Duct pieces shall be joined together by 'S' and drive slip joints or by angle iron flanges.

4.22.07 The size of connecting flanges shall be same as that of the bracing angle.

4.22.08 The interconnecting flanges shall be connected with 10 mm galvanised bolts and nuts at about 125 mm centres.

4.22.09 All flanges shall be connected to the ducts by rivets at about 125 mm centres. The ducts shall be tapped 6 mm across the flanges.

4.22.10 All flanged joints shall have 6 mm thick felt packing stuck to the flanges with shellac varnish or approved equal adhesive. The holes in the felt packing shall be burnt through.

4.22.11 Ducts 2250 mm and larger require special field study for supporting. Unless otherwise specified, the ducts with larger side greater than 2250 mm shall be supported by 15mm MS rods and 65x65x5 mm MS angles while those below 2250 mm shall be supported by 10 mm MS rods and 50x50x4 mm MS angles. MS rods and angles shall be given two coats of primer paint and final coat of silver colour.

4.22.12 The duct support shall be at a distance of not more than 1800 mm. MS rods shall be hung from the building steel with provision of necessary auxiliary steel members or approved means fixed to the ceiling slab. The auxiliary steel members, hooks, coach screws and all other supporting materials required shall be provided by the bidder.



- 4.22.13 Wherever in passage, if overhead vertical hanger supports are not possible for the duct length, then channel/beam shall be used, grouted in floor foundation is in the scope of bidders.
- 4.22.14 Flexible joints shall be provided on the inlet and outlet of each fan and unit to which duct connections are made or where fan sections are isolated from other air handling sections. Connections shall be made from non-combustible heavy glass fabric 1.02 kg/m² (30 Oz per yd²) double coated with Du Pont's Neoprene (polychloroprene) or Hypalon. Fire standards shall comply with UL214 and NFPA Pamphlet 90A paragraph 2.1.2.3 outlining standards for vibration isolation connectors to duct systems. Minimum 25 mm stack shall be allowed in these connections to isolate transmission of vibration from fan or fan section. The fabric shall either be folded in with the metal or attached with metal collar frames at each end to prevent leakage. The width of the joints from metal edge to metal edge shall be not less than 80 mm and not more than 250 mm. The ends of the ducts or duct and fan connection shall be in line. Canvas or fiberglass shall not be accepted for flexible joints.
- 4.22.15 All curves, bends, offsets and other transformations shall be made for an easy and noiseless flow of air.
- 4.22.16 The throat of every branch duct shall be sized to have the same resistance in the main duct to which the branch duct is connected.
- 4.22.17 All elbows shall have the throat radius of at least seventy five (75) percent of the duct width. In case the throat radius is smaller, suitable single thickness vanes of approved details shall be provided.
- 4.22.18 Wherever duct passes through wall, all the openings between masonry and duct work shall be neatly caulked or sealed to prevent movement of air from one space to the adjoining space.
- 4.22.19 Where duct passes through the floor, at the lowest point in the elbow a drain trap of 100 mm width across the width of the duct and 50 mm deep shall be provided with suitable gauge valve.
- 4.22.20 An adequately sized access doors lined with substantial felt edgings shall be provided in the duct work where required. The access doors shall be built up construction, structurally strong and each shall have two rust proof window sash locks of approved type. All doors shall be set out so as to flush with any insulation or plaster finish on the duct.
- 4.22.21 Splitters and dampers shall be placed at approved locations for proportional volume control of the system. Splitters and dampers shall be made in 18 gauge GSS of quadrant type with suitable locking device, mounted outside of duct in an accessible location. The metal shall be bent over at each side of the splitter to form a reinforced edge. Each splitter shall be securely attached with a locking device to rods which shall be installed through ducts. On one end of these rods,



there shall be locking device with a mark to show the final adjusted position of the splitter

- 4.22.22 All the plenum chambers or connections to fans, dampers etc, shall be constructed in 18 gauge GSS, supported on 40x40x6 mm MS angle frames. All vertical angles shall be rivetted at approximately 125 mm centres to the casing. 'Pecora' or equivalent caulking compound shall be inserted between the base of angle and all masonry construction to which angles are fastened.
- 4.22.23 If pipe hangers or rods pass through the ducts, light and stream lined casement around the same shall be provided to maintain smooth flow of air.
- 4.22.24 Supply air grilles shall be of mill finished extruded aluminium construction. Grilles shall be provided with volume control dampers of opposed blade type. Supply air grilles shall be of double deflection type. All the required steel/wooden frame work for fixing grilles shall be furnished by the bidder.
- 4.22.25 All air terminals shall be of mill finish extruded aluminium profile construction.
- 4.22.26 The ducting scheme, duct sizes, location of supply air grilles etc shall be finalized during detailed engineering.
- 4.22.27 Each branch line shall have dampers to isolate the branch for maintenance purpose.
- 4.22.28 **FACTORY FABRICATED DUCTS**
- i) All ducting shall be fabricated of LFQ (Lock forming quality) grade prime GI.
 - ii) Unless otherwise specified here, the construction, erection, testing & performance of the ducting system shall conform to SMACNA – 1995 standards ("HVAC Duct Construction Standards – Metal and Flexible – second Edition – 1995" SMACNA)
 - iii) All ductworks including straight sections, tapers, elbows, branches, show pieces, collars, terminal boxes and transformation pieces must be factory fabricated by utilizing the machines and processes as specified in SMACNA or by equivalent technology. In equivalent method, the fabrication shall be done by utilizing the following machines and process to provide the requisite quality of ducts and speed of supply :
 - a) Coil lines to ensure location of longitudinal seams at corners/ folded edges only to obtain the required duct rigidity and low leakage characteristics. No longitudinal seams permitted along any face side of the duct.
 - b) All ducts, transformation pieces and fittings to be made on CNC profile cutters for required accuracy of dimensions, location and dimensions of notches at the folding lines.
 - c) All edges to be machine treated using lock formers, flanges and roll bending for turning up edges.



- d) Sealant dispensing equipment should be used for applying built in sealant in Pittsburgh lock where sealing of longitudinal joints are specified. Sealing of longitudinal joints are specified. Sealing of longitudinal joint is compulsory for ducts over 2" w.g static pressure.
- e) All traverse connectors shall be 4-bolt slip no flange system with built in sealant, if any. To avoid any leakage, additional

4.23.00 **Insulation**

4.23.01 Insulation as below shall be provided

Sr. No.	Surface	Insulation Material	Insulation Form	Thickness (mm)	Finish
1.	AC Duct (Supply & Return)	Resin bonded Glass Wool (IS:8183) Or	Roll / Slab	50	F-3
		Aluminium faced Nitrile Rubber	Roll / Slab	13	No separate finish required
2.	AHU drain pipe (Suction & Liquid line)	a) Expanded Polystyrene or	Pipe Section	25	F-1
		b) Mineral Wool	Pipe Section	25	F-1
3.	Chilled water piping, valves & specialties	a) Expanded Polystyrene or	Pipe Section	75	F-1
		b) Mineral Wool	Pipe Section	75	F-1
4.	Chilled Water Pumps	a) Expanded Polystyrene or	Slabs	50	F-1
		b) Mineral Wool	Slabs	50	F-1
5.	Chiller	As required			As per manufacture r's standard
6.	Expansion tank with pipe	a) Expanded Polystyrene or	Slabs/Pipe Section Slab	50	F-1
		b) Mineral Wool or		50	F-1
		c) Nitrile Rubber		6	With UV Protection Coating
7.	Acoustic insulation of first 6M of ducting after	Glass Wool or	Slab	25	Refer Relevant Clause in this section


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	AHUs but limited to plenum	Nitrile Rubber base open elastomeric foam	Slab	10	No separate finish required
8.	Chiller	Nitrile Rubber	Slab/Roll		As per OEM
9.	Supply ventilation Duct exposed to Sun	Resin bonded Mineral Wool (IS:8183) Or	Roll / Slab	25	F-4
		Nitrile Rubber		13	With UV Protection coating
10.	Refrigerant (Suction & Liquid lines)	Closed cell elastomeric Nitrile rubber	Tube	19	As per manufacturer's Standard

4.23.02 Insulation material shall be as specified herein:

Sr. No.	Insulation	Code	Thermal Conductivity in MW/cm deg C	Density in kg/cm ²
1.	Resin bonded mineral wool / glass wool	IS:8183	0.49 at 50 °C	At least 24 For Thermal Insulation & 48 for Acoustic Insulation
2.	Mineral Wool Pipe Section (min. Gr.2)	IS:9842	0.43 at 50 °C	At least 81
3.	Expanded Polystyrene	IS:4671	0.37 at 50 °C	At least 15
4.	Closed cell Elastomeric Nitrile rubber		0.036 at 20°C	60-70

4.23.03 All surfaces to be insulated both thermally and acoustically shall be thoroughly cleaned, dried and an adhesive be applied @ 1.5 kg/ sqm on the surface (CPRX compound of Shalimar Tar products or equivalent).

4.23.04 All joints shall be sealed by bitumen

4.23.05 Specification for various finishes shall be as follows:

i) *Finish F-1*

a) Step-1: Wrapping of Poly-Bonded Hessain (PBH- to act as vapour seal) on outer surface of insulation with 50mm overlap stitching and sealing of overlap with synthetic adhesive like CPRX or equivalent compound.



- b) Step-2: The surface then shall be wrapped with 19 mm mesh 24 SWG GI wire netting, butting all the joints and laced down with 22 SWG lacing wire.
 - c) Step-3: Sand cement (4:1) plaster shall be applied in two layers totalling to 12.5 mm thick, the second layer being brought to a smooth finish. A water proofing compound shall be added to the cement before its application.
 - ii) *Finish F-2*
 - a) Step-1: Insulation shall be covered with 500g polythene with 50 mm overlap and sealing of overlap with synthetic adhesive like CPRX or Equivalent compound.
 - b) Step-2: Same as step-2 of Finish F-1 above.
 - c) Step-3: Same as step-2 of Finish F-1 above.
 - iii) *Finish F-3*
 - a) Step-1: Same as Step-1 of Finish F-2 above
 - b) Step-2: The polythene shall be covered with 30 gauge Aluminium sheet and locking of joints with self-locking screws at a pitch of minimum 100mm.
 - iv) *Finish F-4*
 - a) Step-1: Same as step-1 of Finish-1 above
 - b) Step-2: Same as step-2 of Finish-1 above
 - c) Step-3: Same as step-3 of Finish-1 above
 - d) Step-4: Application of 3 mm thick coat proofing compound "SHALIKOTE 30" or equivalent and wrapped with fibre glass RP tissue followed by final coat of 3 mm thick proofing compound "SHALIKOTE 30" or equivalent over the RP tissue.

4.23.06 Acoustic insulation shall be as mentioned elsewhere in the specification.



4.26.00 Centrifugal Fan

- 4.26.01 The casing shall be of welded construction, fabricated with heavy gauge galvanised sheet steel (minimum 60 micron DFT). The minimum thickness of casing shall be 3mm.
- 4.26.02 It shall be rigidly reinforced and supported by structural members.
- 4.26.03 The seams shall be permanently sealed air tight.
- 4.26.04 Split casings shall be provided for larger size fans.
- 4.26.05 Casing drains with valves shall be provided wherever required.
- 4.26.06 The impeller shall be die formed backward curved blades tie welded to the rim and back plate to have a non-overloading characteristic of the fan.
- 4.26.07 Rim shall be spun to have a smooth contour. If required intermediate stiffening rings shall be provided.
- 4.26.08 Shaft sleeves shall be provided as required.
- 4.26.09 The impeller, pulley and shaft sleeves shall be secured to the shaft by keys and/or fasteners.
- 4.26.10 The bearing shall be self-aligning, heavy duty, ball/roller or sleeve bearing. They shall be easily accessible for lubrication from outside.
- 4.26.11 Inlet guard shall be spun to have a smooth contour. Inlet screen, if provided, shall be galvanised wire mesh of 25mm square.



- 4.26.12 Base plate with necessary number of spring / ribbed neoprene rubber type vibration isolators or cushy foot mountings shall be provided. The vibration isolators should have a minimum efficiency of 70%.
- 4.26.13 The first critical speed of the rotating assembly shall be at least 25% above the opening speed.
- 4.26.14 The fans shall be direct driven / V-belt driven as per OEM standard. The belts as applicable shall be sized for 150% of the rated power and there shall be minimum of two belts per drive.
- 4.27.00 **Wall Mounted Axial Flow Fan/Re Unit**
- 4.27.01 Each axial fan comprises of fan, fan motor, inlet & outlet cone (for tube axial), louvered shutter (exhaust fans) & supporting arrangement.
- 4.27.02 Fan impeller with variable pitch, aerofoil section of cast aluminium alloy & casing/short duct as required, static & dynamic balancing of impeller.
- 4.27.03 The fan casing shall be of heavy gauge steel sheet construction.
- 4.27.04 The speed of fans shall not exceed 960 rpm for fan with impeller diameter above 450 mm and 1400 rpm for fan with impeller diameter 450 mm or less. However for fans having static pressure of 30 mm WC or above the speed of the fan shall not exceed 1500 rpm for fan with impeller diameter of above 450mm and 2800 rpm for with impeller diameter of 450 mm or less.
- 4.27.05 The first critical speed of rotating assembly shall be at least 25% above the operating speed.
- 4.27.06 Electric drive motor with coupling if any, including motor brackets.
- 4.27.07 All other accessories like supporting structure, inlet cone and grouting framework, etc, as required shall be provided.
- 4.27.08 Rain protection cowl with bird-screen adjustable damper, vibration isolators, back draft dampers, Filters, supporting arrangement etc. shall be provided.
- 4.27.09 Fans of capacity up to 1000m³/hr shall be propeller exhaust type.



4.29.00 Piping and Valves

4.29.01 Unless otherwise specified herein the specification. Piping for sizes smaller than 150 mm NB shall be continuous welded Galvanized steel pipes to IS: 1239 heavy class. Piping for sizes 150 mm and larger shall conform to IS: 3589 with minimum 6 mm thickness.

4.29.02 Fabricated elbows from pipe (5 piece mitre) shall be furnished for pipe fittings of sizes 200 mm & larger. Locally available long radius ($R=1.5D$) hot bends with thickness same as that of the pipe having butt welding ends as per ASA B-16.9 shall be furnished for pipe fittings of sizes 150 mm up to 65 mm NB. 3000 # ASA standard forged carbon steel pipe fittings to A-105 Gr. II or IS:1875 Class-2 or approved equal with socket welding ends as per ASA-B-16.11 shall be furnished for pipe fittings of sizes 50 mm NB and smaller.

4.29.03 Unless otherwise specified, all flanges shall be ASA # 150 standard (as applicable) forged carbon steel slip-on flanges to A-105 Gr. II or approved equal, faced and drilled to ASA-B-16.5. The pipe work flanges shall match with the valves and equipment connections. Hexagonal head machined carbon steel bolts to IS:1367 Class 4.6 or approved equal shall be furnished with hot forged carbon steel hexagonal head nuts to IS:1367 class 4.6. The gaskets shall be 3 mm thick wire inserted red rubber full face gaskets, 150 # ASA standard and drilling details to match with the flanges as required.

4.29.04 In general, all the line joints for sizes 65 mm and larger shall be butt welded and the joints at valves shall be flanged unless otherwise specified. For pipe sizes 50 mm and smaller, the line joints shall be in general socket welded and the joints at valves shall be screwed unless otherwise specified. The joints at equipment and instruments shall be as per manufacturer's drawings.

4.29.05 All the pipe supports, guides, anchors, turn buckles, rods, hangers with secondary structural steel framing shall be furnished and installed by the Bidder.

4.29.06 The Bidder shall ensure that the location of hangers and supports shall not increase the force and moments on equipment beyond the permissible limits. The anchors shall be designed for rigid fastening to the structure directly or through brackets. As far as possible, attachments of supports brackets to brick walls shall be avoided. All concrete inserts shall be galvanized and shall be



installed on the concrete structure where required for fastening supporting devices.

4.29.07 Bolted pipe clamps used for rod hangers shall be of minimum 6 mm thick. Hanger rods shall be 10 mm dia. All hanger components shall be given a shop primer coat.

4.29.08 Upon completion of the installation of all pipe work as per approved drawings, the pipe lines section shall be subjected to hydrostatic testing at 1.5 times the design pressure. All joints shall be carefully examined for sweating or leakage and repairs conducted as necessary and the hydrostatic test repeated till its satisfactory completion to the Engineer's satisfaction. After completing the hydrostatic test, the pipe lines shall be drained and flushed several times to ensure complete cleanliness inside the pipes.

4.29.09 All the drain piping between the drain connection of each equipment up to the nearest drain shall be provided by the Bidder. Necessary seal loops as required shall be incorporated in the drain piping.

4.29.10 VALVES

- i) All valves for sizes 65 mm and larger shall be 150 # ASA standard, double flanged, cast iron body to IS:210 Gr.260, stainless steel trim, bolted bonnet, bolted gland, rising stem outside screw and yoke, back seated, ends flanged (PF) faced and drilled to ASA-B-16.5.
- ii) All valves for sizes 50 mm and smaller shall be 800 class standard forged carbon steel body construction to ASTM A 105 stainless steel trim, union bonnets, rising stem inside screw, renewable seats ends female screwed to IS:554.
- iii) The butterfly valves shall be designed as per AWWA C 504 and designed to fit between flanges. The butterfly valves shall be provided with flow control lever, black nitrile rubber integrally moulded seating, disc of aluminium bronze to BS 1400 Gr. AB2/AB1, shafts of stainless steel AISI 410. The butterfly valve shall be rated for 8 bar; body/disc tested at 12 bar and seat at 7 bar (air test).
- iv) Valves shall have full size port and suitable for horizontal as well as vertical installation.
- v) Valve for regulating duty shall be of globe type suitable for controlling throughout its lift.
- vi) Gate, globe and stop check valves shall have bonnet back seat to facilitate easy replacement of packing with the valves in service.
- vii) All safety/relief valves shall be so constructed that the failure of any part does not obstruct the free discharge.
- viii) Manual gear operation shall be provided for valves of size 250 NB and above.
- ix) All valves with rising stem shall have position indicators.



- x) All valves shall be provided with locking arrangement.
- xi) All water line valves shall be cast iron body for sizes 65 NB and above confirming to IS 780 and of Gun metal construction for sizes less than 65 NB confirming to IS 778. Cast iron parts shall confirm to IS 210 Gr. FG 220.

4.30.00 Layout Considerations

- 4.30.01 All AC equipment including ducting shall be installed inside the buildings except cooling tower, makeup water tank, expansion tank, and outdoor units of split AC etc.
- 4.30.02 Adequate access and space shall be provided for maintenance of all equipment.
- 4.30.03 The outdoor units of the package/ducted/split AC plants shall be located either on the roof of the building or at a suitable location at ground, considering the piping requirements. Outdoor units can also be wall mounted, but proper access platforms with approach and hand railings shall be provided in such cases for ease of maintenance.
- 4.30.06 AC plant shall preferably be located at the ground floor of control building.
- 4.30.07 Cooling tower and softening plant shall preferably be at the roof of control building.
- 4.30.08 Clear access should be provided to all equipments.
- 4.30.09 Clear gap of 800mm shall be provided between equipments, taking into consideration all piping, ducts and structures, for easy access.
- 4.30.10 Adequate space for handing of tubes shall be provided for the chillers.
- 4.30.11 Ducting layout shall be such that there is no hindrance to walkways and access to various areas. Minimum 100mm clear space shall be provided from all equipment, piping, supports, structures etc.
- 4.30.12 Drains from all split and ducted ACs shall be routed in such a way that there should not be any chance for blockage in it and condensed water should smoothly flow out of the building. Seal loops as required shall be provided.
- 4.30.13 Adequate lay down area and maintenance space shall be considered in the maintenance bay.
- 4.30.14 Layout should be such that equipments can be easily handled and shifted for maintenance. Necessary maintenance access will be provided in the layout.



- 4.30.15 Easy approach for vehicles to handle the equipments near maintenance bay shall be provided.
- 4.30.16 Easy access to shift material and equipments to and from the building should be provided
- 4.30.17 Cranes and hoist arrangements as required, shall be provided, so that the heaviest component can be handled during maintenance.

5.00.00 PERFORMANCE GUARANTEE REQUIREMENT

Description/Parameter	Unit	Values
Inside conditions of the air conditioned area	°C & RH	As per system requirement and approved by owner/consultant during detailed engineering
Plant Capacity Test for chiller plants and AHUs	TR	As per system requirement and approved by owner/consultant during detailed engineering
Ventilated spaces	°C	As per system requirement and approved by owner/consultant during detailed engineering
Power Consumption	kW	As per system requirement and approved by owner/consultant during detailed engineering
Vibration & noise level of rotating equipments		As per approved standards
AC & ventilation plant performance shall be demonstrated during peak summer & monsoon conditions		

6.00.00 OPERATION AND CONTROL PHILOSOPHY

6.01.00 Air Conditioning and Ventilation System

- 6.01.01 Operation and control of the complete HVAC system shall be through a dedicated PLC, with hot redundant CPU, redundant power supply and redundant communication card I/O panels (as required), which shall be placed at different locations for remote RIO.
- 6.01.02 Complete operation of the main AC plants to be carried through OWS in remote mode. Auto or semi-auto mode to be selected from the OWS.
- 6.01.03 Status of all equipment to be monitored from the OWS.
- 6.01.04 2 nos. OWS/EWS comprising 24" monitors, PC, A4 colour laser Printer, ethernet switches etc, as specified elsewhere in the specification.
- 6.01.05 Basic Function of the system shall be as follows:
- To closely control and monitor inside temperature and humidity condition inside the air-conditioned spaces.
 - To optimise / minimize energy consumption by automated operations



- iii) To provide remote centralised monitoring and control for various mechanical facilities including sequential start/stop of the whole AC system
- iv) To provide remote centralised monitoring and control for various mechanical facilities including sequential start/stop of the air washer system.
- v) To generate maintenance data & alarms.
- vi) To maintain records of plant operation
- vii) Duty cycling to operate all the equipment including standby equipment for equal duration
- viii) Automatic start of stand by equipment in cases of failure of operating unit and displaying fault alarm status of the tripped unit.
- ix) Activating / deactivating water valves to start up/ stop water flow through chiller / condenser circuit for sequential operation/duty cycling.
- x) Programmed start-up/ stop of individual AHU as per operating requirements and for maintain the room temperature/ RH by controlling the 3 way mixing valves at chilled water line, humidified system and duct heater.
- 6.01.06 Local start/stop push button station for AC plant auxiliaries linked with central PLC panel would be provided; the stop push button shall be lockable.
- 6.01.07 Fire damper controls shall be implemented in AHU local control panel. Fire damper position shall be indicated on LCP with the help of limit switches.
- 6.01.08 One collective fault signal from each AC plant control system shall be hardwired to DDCMIS for annunciation.
- 6.01.09 The control system shall consist of necessary operating and safety controls, pushbuttons, indicating lamps, annunciator for annunciating trip of each auxiliary in AC plant etc.
- 6.01.10 The control of Package AC shall be microprocessor based programmable with PID controller. The controller shall have a LCD/LED display screen, which shall be visible prominently without removing any covers/external panels.
 - i) The screen should show the equipment status including the following:
 - a) Mode of operation (Cooling, heating, humidification, dehumidification etc.)
 - b) Display of Set and Actual values of temperature and humidity
 - c) Data time and unit identification display
 - d) Auto/manual status
 - e) Back-up battery charge status
 - f) Alarm indication along with mutable audio alarm
 - ii) There should be a feature to enable operator to program the start-up and shut-off of the system components (blower fan start/stop delay, first compressor start/stop delay, second compressor start/stop delay, etc.). Access to the controller settings shall be protected with passwords to prevent against unauthorised access.
 - iii) The unit shall also have the following protections:
 - a) High pressure trip – Manual reset for each compressor
 - b) Low pressure trip – Manual reset for each compressor
 - c) Single phasing preventers



- d) Reverse phasing
- e) Phase misbalancing
- f) Phase failure
- g) Overload tripping of all components
- iv) Following safety interlocks shall be provided:
 - a) Operation of heaters and humidifiers shall be possible only when blower fan is in operation.
 - b) Fire detection signal from the fire detector system shall be able to switch off the package unit
- 6.01.11 Control of Ventilation System
- 6.02.00 Common PLC system shall cover the controls of following ventilation equipment:
 - i) Air Washers comprising 1x100% duty centrifugal fan and 2x100% duty centrifugal pumps for TG hall ventilation of each unit.
 - ii) UAF comprising 1x100% duty centrifugal fan and 2x100% duty pumps for each ESP Building.
 - iii) Supply air fans, exhaust air fans / roof extractor units of each area shall be provided with their local starter panel
- 6.02.02 Connectivity to DDCIMS
 - i) The connectivity between DDCMIS & PLC system shall be OPC compliant over fibre optic cable and shall be used for monitoring purpose only.
- 7.00.00 DRAWINGS AND DOCUMENTS TO BE SUBMITTED**
- 7.01.00 Drawings and Documents to be Submitted with the bid**
- 7.01.01 Write-up on Air Conditioning and Ventilation system
- 7.01.02 Filled-in Data Sheet-B
- 7.02.00 Drawings and Documents to be Submitted after Award of Contract**
- 7.02.01 Design basis report/Design Memorandum of Air Condition System
- 7.02.02 Heat load Calculations of Air Conditioning System for various areas.
- 7.02.03 Sizing calculation of ventilation system for various areas.
- 7.02.04 Pressure drop and sizing calculations for condenser and chilled water system.
- 7.02.05 Operation and Control Philosophy of Air conditioning
- 7.02.06 Bill of quantities for Air Conditioning
- 7.02.07 GA and Technical Data Sheets of VAM unit
- 7.02.08 GA and Technical Data Sheets of Chiller unit
- 7.02.09 GA and Technical Data Sheets of Package AC units
- 7.02.10 GA and Technical Data Sheets of Ductable Split AC units
- 7.02.11 GA and Technical Data Sheets of Split AC units



- 7.02.14 GA and Technical Data Sheets of Water Softening Plant
- 7.02.15 GA and Technical Data Sheets of Pumps
- 7.02.16 GA and Technical Data Sheets of AHUs
- 7.02.17 GA and Technical Data Sheets of Fans
- 7.02.18 GA and Technical Data Sheets of other equipment like Cooling towers, ductwork, insulation, Filters, dampers, diffusers, pan humidifiers, strip heaters, valves, fitting, etc
- 7.02.19 Performance curves of Pumps
- 7.02.20 P&I Diagram for condensate and chilled water AC System
- 7.02.21 Schematic diagram of package AC system
- 7.02.22 Schematic diagram of ductable split AC system

- 7.02.25 Layout and General Arrangement of AC plant
- 7.02.26 Electrical equipment and cabling layout in AC plant

- 7.02.28 Piping layouts
- 7.02.29 Ducting layouts for various areas.
- 7.02.30 Valves and Specialities Schedule
- 7.02.31 Piping Schedule
- 7.02.32 Manufacturing Quality and Inspection Categorisation Plan of AC and ventilation system equipment
- 7.02.33 Field Quality Plan for Air Conditioning
- 7.02.34 PG test procedure for Airconditioning
- 7.02.35 Associated Electrical Equipment and System Drawings
- 7.02.36 Associated C&I Equipment and System Drawings
- 7.02.37 Associated Civil Design and Drawings



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RFx No. 3000046202 (BTG Package)

SECTION - 7

TECHNICAL SPECIFICATION AC & VENTILATION SYSTEM

REV. - 0

8.00.00 DATA SHEET – A (FILLED DATA SHEETS)

8.01.00 Vacuum Absorption Machine (VAM)

Sr. No.	Item	Unit	Requirement
8.01.01	Type of VAM		Steam fired
8.01.02	Quantity	Nos.	1x100%
8.01.03	Capacity	TR	As per system requirement and approved by owner/consultant during detailed engineering
8.01.04	Location		Indoor/AC plant room
8.01.05	Service		Power House Building AC areas as required and mentioned in the specifications
8.01.06	Chilled water flow	m ³ /hr	As per system requirement and approved by owner/consultant during detailed engineering
8.01.07	Chilled water inlet temperature to evaporator	°C	12
8.01.08	Chilled water inlet temperature from evaporator	°C	7
8.01.09	Evaporator passes	No.	1+1
8.01.10	Chilled water fouling factor	m ² hr °C/kcal	0.0001
8.01.11	Chilled water working pressure	Kg/cm ²	8
8.01.12	Cooling water flow	m ³ /hr	As per system requirement and approved by owner/consultant during detailed engineering
8.01.13	Cooling water fouling factor	m ² hr °C/kcal	0.0001
8.01.14	Working pressure	Kg/cm ²	8
8.01.15	Design pressure	Kg/cm ²	12
8.01.16	Tube Metallurgy		
i)	Evaporator tube material		Copper/Cu-Ni 70/30
ii)	Absorber tube material		Copper/Cu-Ni 70/30
iii)	Condenser tube material		Copper/Cu-Ni 70/30
iv)	High Temperature Generator		Stainless Steel 316L
v)	Low Temperature Generator		CS
8.01.17	Capacity control range		10 - 100%
8.01.18	Vibration pads		Yes


8.02.00 Chiller Package

Sr. No.	Item	Unit	Requirement
8.02.01	Type of Chiller		Water cooled
8.02.02	Design code		IS 16590
8.02.03	Quantity	Nos.	1x100%
8.02.04	Capacity	TR	As per system requirement and approved by owner/consultant during detailed engineering
8.02.05	Location		Indoor/AC plant room
8.02.06	Service		Power House Building AC areas as required and mentioned in the specifications
8.02.07	Chilled water flow	m ³ /hr	As per system requirement and approved by owner/consultant during detailed engineering
8.02.08	Chilled water inlet temperature to evaporator	°C	12
8.02.09	Chilled water inlet temperature from evaporator	°C	7
8.02.10	Evaporator		DX type, 1 no. per unit
8.02.11	Refrigerant		R134a/410a
8.02.12	Compressor		Semi hermetic screw compressor
8.02.13	Chilled water fouling factor	m ² hr °C/kcal	0.0001
8.02.14	Cooling water flow	m ³ /hr	As per system requirement and approved by owner/consultant during detailed engineering
8.02.15	Cooling water fouling factor	m ² hr °C/kcal	0.0002
8.02.16	Tube Metallurgy		
i)	Evaporator tube material		Copper
ii)	Condenser tube material		Copper
8.02.17	Capacity control		25% - 100%, Stepless automatic
8.02.18	Vibration pads		Yes

8.03.00 Package AC / Ducted AC

Sr. No.	Item	Requirement
8.03.01	Design Code	IS 8148 / 1391
8.03.02	Quantity	As per system requirement and approved by


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		owner/consultant during detailed engineering
8.03.03	Capacity	As per system requirement and approved by owner/consultant during detailed engineering
8.03.04	Location	Indoor/Respective building
8.03.05	Service	Various areas as mentioned in the specification
8.03.06	Compressor	Inverter or (Inverter + fixed) scroll/rotary compressor
8.03.07	Capacity control	Stepless
8.03.08	Control panel	Digital micro control / Inbuild or pendant type
8.03.09	Controller	Intelligent microprocessor controller
8.03.10	Refrigerant	R410a/32
8.03.11	Humidifier	Steam electrode type (as required)
8.03.12	Heater	Electric strip type (as required)
8.03.13	Vibration pads	Yes
8.03.14	Noise	Less than 68db @1m
8.03.15	Cabinet material and Finish	Powder coated on GI sheet, with insulation as required
8.03.16	Indoor Unit	
i)	Filters	Washable with HDPE filter media
ii)	Filter efficiency	95% down to 3 microns
iii)	Blower	Centrifugal fan, double inlet
8.03.17	Outdoor unit	
i)	Fan	Propeller type
ii)	MOC of fan	ABS/AL/GI
iii)	Condenser coil	Copper
iv)	Fins	Non-corrosive

8.04.00 Split AC

Sr. No.	Item	Requirement
8.04.01	Design Code	IS 1391-2
8.04.02	Quantity	As per system requirement and approved by owner/consultant during detailed engineering
8.04.03	Capacity	As per system requirement and approved by owner/consultant during detailed engineering
8.04.04	Location/service	Various areas as mentioned in the specification
8.04.05	Compressor	Inverter rotary compressor



8.04.06	Control	Hand held cordless remote
8.04.07	Refrigerant	R410a/32
8.04.08	BEE rating	5 star
8.04.09	ISEER	4.5 w/w (min.)
8.04.10	Noise level indoor/outdoor	46/58 db (Max.)
8.04.11	Filter	PM 2.5 micron filter
8.04.12	Supports/stand with vibration pads	Yes
8.04.13	Automatic voltage stabiliser	Yes (Suitable for Inverter ACs)
8.04.14	Refrigerant piping	Insulated Copper
8.04.15	Maximum piping capability	To suit installation

8.05.00 Centrifugal Pumps

Sr. No.	Item	Requirement
8.05.01	Type	Horizontal centrifugal, Axially split type casing / back pull out type pump
8.05.02	Quantity	As per system requirement and approved by owner/consultant during detailed engineering
8.05.03	Capacity & head	As per system requirement and approved by owner/consultant during detailed engineering
8.05.04	Location	Various areas as mentioned in the specification
8.05.05	Service	Cooling water / Chilled Water / Air washer
8.05.06	RPM	1500
8.05.07	Drive motor	TEFC, Squirrel Cage, Eff-1, IP-55, 3-Pahse / 415V $\pm 10\%$, 50Hz $\pm 5\%$, Combined $\pm 10\%$ (abs.), Insulation Class-F, Temp. rise limited to Class-B
8.05.08	Impeller	Closed, Bronze LTB2, IS 318
8.05.09	Casing	2% Ni, CI, IS 210 Gr. FG 260
8.05.10	Shaft	SS 410
8.05.11	Shaft sleeve	SS 410
8.05.12	Wear rings & Lantern rings	Bronze LTB2/LTB5, IS 318
8.05.13	Seal	Mechanical seal/non-asbestos gland packing
8.05.14	Base plate	Epoxy coated, CS, IS 2062

8.06.00 Cooling Tower

Sr. No.	Item	Requirement


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8.06.01	Type	Induced draft, cross or counter flow
8.06.02	Quantity	As per system requirement and approved by owner/consultant during detailed engineering
8.06.03	Capacity	110% of rated cooling water requirement
8.06.04	Recirculation allowance	0.5 °C
8.06.05	Design approach to WBT	5°C
8.06.06	Casing and Sump tank	FRP
8.06.07	Fan stack	FRP
8.06.08	Fan	Cast aluminium / FRP propeller type of multi blade aerofoil construction with adjustable pitch.
8.06.09	Motor	TEFC, Squirrel Cage, Eff-1, IP-55, 3-Phase / 415V $\pm 10\%$, 50Hz $\pm 5\%$, Combined $\pm 10\%$ (abs.), Insulation Class-F, Temp. rise limited to Class-B
8.06.10	Louvers	FRP / PVC / Aluminium
8.06.11	Fills	PVC, 0.25mm thick
8.06.12	Nozzles	Polypropylene / Brass with chrome plating
8.06.13	Drift eliminators	Removable sections to reduce the drift loss to 0.005%
8.06.14	Supporting structure	MS with HDG or Epoxy painted
8.06.15	Strainer at water outlet	Plate strainer made of GI/SS wire mesh of 16 gauge
8.06.16	Bird screen	25mm square made of GI/SS wire mesh of 16 gauge
8.06.17	Ladder	MS HDG for each tower
8.06.18	Distribution pipe	MS HDG
8.06.19	Fasteners	HDG steel
8.06.20	Accessories	Drain connection with isolation valve, make-up connection with ball – float valve, back-up gate valve and a parallel gate valve for manual operation. Overflow connection, equalising connection to connect sump of all the towers as applicable. Access doors in louvers/fan deck

8.07.00 Air Filters

Sr. No.	Item	Requirement
8.07.01	PRE-FILTER	



i)	Filter medium	Fibrous material (extruded polyethylene) or felt filter fabric; Dry type with element of 5 ply construction for fabric type
		V-fold galvanised wire mesh inter-spaced with flat layer of galvanised wire mesh for metallic type pre-filters
ii)	Frame	GI sheet (minimum 18SWG thick) or Aluminium alloy of (minimum 16SWG thick) supported by galvanised steel wire mesh 10mm square with handles.
iii)	Frame finish	Enamel painted
iv)	Sealing	Neoprene sponge rubber / Felt
v)	Suitable of being cleaned by water flushing	Yes
vi)	Minimum thickness	50mm for fabric type
vii)	Efficiency	90% down to 20 microns
viii)	Inspection & testing code	BS 6540 / ASHRAE 52 76
ix)	Face velocity	2.4 m/s (max.)
x)	Initial pressure drop	2-5 mm WC
xi)	Maximum pressure drop	10-12 mm WC
xii)	Other requirements	Suitable aluminium spacers to be provided for uniform air flow
		Density of filter medium shall increase in the direction of air flow, in case of metallic filter
8.07.02	FINE-FILTER	
i)	Filter medium	High efficiency synthetic non-woven media
ii)	Frame	GI sheet (minimum 18SWG thick) or Aluminium alloy of (minimum 16SWG thick) supported by galvanised steel wire mesh 10mm square with handles.
iii)	Frame finish	Enamel painted
iv)	Sealing	Neoprene sponge rubber / Felt
v)	Suitable of being cleaned by water flushing	Yes
vi)	Minimum thickness	150mm or 300mm
vii)	Efficiency	99% down to 5 microns
viii)	Inspection & testing code	BS 6540 / ASHRAE 52 76
ix)	Face velocity	2.4 m/s (max.) for 300mm & 1.2 m/s (max.) for 150mm


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x)	Initial pressure drop	4-7 mm WC
xi)	Maximum pressure drop	15-20 mm WC
xii)	Other requirements	Suitable aluminium spacers to be provided for uniform air flow

8.08.00 Centrifugal fan

Sr. No.	Item	Requirement
8.08.01	Type	DIDW / SISW
8.08.02	Fan scroll	3mm thick MS plate for fan dia. up to 750mm & 5mm thick MS plate for fan dia. above 750mm as per IS 1079 / 2062 Gr. B
8.08.03	Fan casing (Side plates & stiffeners)	MS plate to IS 2062 / 1079 Minimum thickness shall be 3.15mm
8.08.04	Impeller	MS sheet/plate (IS 2062 Gr. B) with spray galvanisation zinc deposit confirm to class 370 of IS 277
8.08.05	Impeller hub	Cast aluminium alloy (LM-6)
8.08.06	Impeller back plate blade & shroud	MS to IS 2062, Gr. B
8.08.07	Shaft	EN-8
8.08.08	Shaft sleeve	EN-8
8.08.09	Critical speed	1 st critical speed of rotting assembly shall be at least 25% above rate speed.
8.08.10	Drive motor	TEFC, Squirrel Cage, Eff-1, IP-55, 3-Pahse / 415V $\pm 10\%$, 50Hz $\pm 5\%$, Combined $\pm 10\%$ (abs.), Insulation Class-F, Temp. rise limited to Class-B
8.08.11	Fan supports, frames & structures	MS to IS 2062, Gr. B
8.08.12	Flexible connection at outlet/inlet	Fire resistant type plastic impregnated canvas with MS flange and cleats (3mm thick)
8.08.13	V-belt (matched sets)	ISI marked, reinforced rubber section to IS 4776
8.08.14	V pulley	CI multi groove to IS 210, Gr. 20
8.08.15	Belt guard	Yes, removable
8.08.16	Slide rails	MS/CI
8.08.17	Connection pieces	GI
8.08.18	Fasteners	Galvanised MS


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**KORADI THERMAL POWER STATION
2X660 MW UNITS - 11 & 12 PROJECT**

PART - A

RFx No. 3000046202 (BTG Package)

SECTION - 7

TECHNICAL SPECIFICATION AC & VENTILATION SYSTEM

REV. - 0

8.08.19	Vibration isolation pads, washers & spring if any	Hard synthetic rubber of hardness 40°C shore
8.08.20	Dampers	Heavy grade MS IS 2062, Gr. B
8.08.21	Noise	Less than 85 db (a) at 1m away
8.08.22	Painting	All MS part shall be galvanised or protected with one primer coat and two coats of synthetic enamel paint.

8.09.00 Axial fan / RE unit

Sr. No.	Item	Requirement
8.09.01	Type	Axial/Tube type
8.09.02	Design code	IS 3588
8.09.03	Casing	2mm thick MS plate for fan dia. up to 750mm 3mm thick MS plate for fan dia. above 750mm as per IS 1079/2062 Gr. B For RE unit (spray/HD galvanised) 3mm thick MS plate for fan dia. up to 750mm 5mm thick MS plate for fan dia. above 750mm as per IS 1079/2062 Gr. B
8.09.04	Impeller	Cast aluminium alloy (LM-6), BS 1490, Aerofoil
8.09.05	Hub	Cast aluminium alloy (LM-6)
8.09.06	Fan supports, frames & structures	MS to IS 2062, Gr. B (Galvanised/painted)
8.09.07	Speed	1450 rpm
8.09.08	Critical speed	1 st critical speed of rotting assembly shall be at least 25% above rate speed.
8.09.09	Drive	TEFC, Squirrel Cage, IP-55, 3-Phase / 415V ±10%, 50Hz ±5% , Combined ±10% (abs.), Insulation Class-F, Temp. rise limited to Class-B
8.09.10	Neoprene rubber pads	As required
8.09.11	Fan statically & dynamically balanced	Yes ISO 1940 Gr. 6.3
8.09.12	Coned inlet for wall exhausters / supply air fans	MS to IS 2062, Gr. B
8.09.13	Supporting frame for mounting	Required
8.09.14	Protective screen at inlet	Yes, Min. 14 SWG galvanised wire knitted in 1" square mesh
8.09.15	Rain protection Cowl	Suitably painted after fabrication from MS
8.09.16	Mounting flange on casing	At inlet & outlet



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8.09.17	Noise	Less than 85 db (a) at 1m away
8.09.18	Painting	All MS part shall be galvanised or protected with one primer coat and two coats of synthetic enamel paint.



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[Title] DATA SHEET - B (To be filled by Bidder)

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2.06.00 Air Conditioning and Ventillation System

2.06.01 Vacuum Absorption Machine (VAM)

Sl. No.	Item	Unit	Requirement
1.01.01	Type of VAM		
1.01.02	Quantity	Nos.	
1.01.03	Capacity	TR	
1.01.04	Location		
1.01.05	Service		
1.01.06	Chilled water flow	m ³ /hr	
1.01.07	Chilled water inlet temperature to evaporator	°C	
1.01.08	Chilled water inlet temperature from evaporator	°C	
1.01.09	Evaporator passes	No.	
1.01.10	Chilled water fouling factor	m ² hr °C/kcal	
1.01.11	Chilled water working pressure	Kg/cm ²	
1.01.12	Cooling water flow	m ³ /hr	
1.01.13	Cooling water fouling factor	m ² hr °C/kcal	
1.01.14	Working pressure	Kg/cm ²	
1.01.15	Design pressure	Kg/cm ²	
1.01.16	Tube Metallurgy		
i)	Evaporator tube material		
ii)	Absorber tube material		
iii)	Condenser tube material		
iv)	High Temperature Generator		
v)	Low Temperature Generator		
1.01.17	Capacity control range		
1.01.18	Vibration pads		

2.06.02 Chiller Package

Sl. No.	Item	Unit	Requirement
1.01.01	Type of Chiller		



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Sl. No.	Item	Unit	Requirement
1.01.02	Design code		
1.01.03	Quantity	Nos.	
1.01.04	Capacity	TR	
1.01.05	Location		
1.01.06	Service		
1.01.07	Chilled water flow	m ³ /hr	
1.01.08	Chilled water inlet temperature to evaporator	°C	
1.01.09	Chilled water inlet temperature from evaporator	°C	
1.01.10	Evaporator		
1.01.11	Refrigerant		
1.01.12	Compressor		
1.01.13	Chilled water fouling factor	m ² hr °C/kcal	
1.01.14	Cooling water flow	m ³ /hr	
1.01.15	Cooling water fouling factor	m ² hr °C/kcal	
1.01.16	Tube Metallurgy		
i)	Evaporator tube material		
ii)	Condenser tube material		
1.01.17	Capacity control		
1.01.18	Vibration pads		

2.06.03 Package AC / Ducted AC

Sl. No.	Item	Requirement
1.01.01	Design Code	
1.01.02	Quantity	
1.01.03	Capacity	
1.01.04	Location	
1.01.05	Service	
1.01.06	Compressor	
1.01.07	Capacity control	
1.01.08	Control panel	
1.01.09	Controller	
1.01.10	Refrigerant	



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Sl. No.	Item	Requirement
1.01.11	Humidifier	
1.01.12	Heater	
1.01.13	Vibration pads	
1.01.14	Noise	
1.01.15	Cabinet material and Finish	
1.01.16	Indoor Unit	
i)	Filters	
ii)	Filter efficiency	
iii)	Blower	
1.01.17	Outdoor unit	
i)	Fan	
ii)	MOC of fan	
iii)	Condenser coil	
iv)	Fins	

2.06.04 Split AC

Sl. No.	Item	Requirement
1.01.01	Design Code	
1.01.02	Quantity	
1.01.03	Capacity	
1.01.04	Location/service	
1.01.05	Compressor	
1.01.06	Control	
1.01.07	Refrigerant	
1.01.08	BEE rating	
1.01.09	ISEER	
1.01.10	Noise level indoor/outdoor	
1.01.11	Filter	
1.01.12	Supports/stand with vibration pads	
1.01.13	Automatic voltage stabiliser	
1.01.14	Refrigerant piping	
1.01.15	Maximum piping capability	

2.06.05 Centrifugal Pumps



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REV. - 0

Sl. No.	Item	Requirement
1.01.01	Type	
1.01.02	Quantity	
1.01.03	Capacity & head	
1.01.04	Location	
1.01.05	Service	
1.01.06	RPM	
1.01.07	Drive motor	
1.01.08	Impeller	
1.01.09	Casing	
1.01.10	Shaft	
1.01.11	Shaft sleeve	
1.01.12	Wear rings & Lantern rings	
1.01.13	Seal	
1.01.14	Base plate	

2.06.06 Cooling Tower

Sl. No.	Item	Requirement
1.01.01	Type	
1.01.02	Quantity	
1.01.03	Capacity	
1.01.04	Recirculation allowance	
1.01.05	Design approach to WBT	
1.01.06	Casing and Sump tank	
1.01.07	Fan stack	
1.01.08	Fan	
1.01.09	Motor	
1.01.10	Louvers	
1.01.11	Fills	
1.01.12	Nozzles	
1.01.13	Drift eliminators	
1.01.14	Supporting structure	
1.01.15	Strainer at water outlet	
1.01.16	Bird screen	
1.01.17	Ladder	
1.01.18	Distribution pipe	



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Sl. No.	Item	Requirement
1.01.19	Fasteners	
1.01.20	Accessories	

2.06.07 Air Filters

Sl. No.	Item	Requirement
1.01.01	PRE-FILTER	
i)	Filter medium	
ii)	Frame	
iii)	Frame finish	
iv)	Sealing	
v)	Suitable of being cleaned by water flushing	
vi)	Minimum thickness	
vii)	Efficiency	
viii)	Inspection & testing code	
ix)	Face velocity	
x)	Initial pressure drop	
xi)	Maximum pressure drop	
xii)	Other requirements	
1.01.02	FINE-FILTER	
i)	Filter medium	
ii)	Frame	
iii)	Frame finish	
iv)	Sealing	
v)	Suitable of being cleaned by water flushing	
vi)	Minimum thickness	
vii)	Efficiency	
viii)	Inspection & testing code	
ix)	Face velocity	
x)	Initial pressure drop	
xi)	Maximum pressure drop	
xii)	Other requirements	



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2.06.08 Centrifugal fan

Sl. No.	Item	Requirement
1.01.01	Type	
1.01.02	Fan scroll	
1.01.03	Fan casing (Side plates & stiffeners)	
1.01.04	Impeller	
1.01.05	Impeller hub	
1.01.06	Impeller back plate blade & shroud	
1.01.07	Shaft	
1.01.08	Shaft sleeve	
1.01.09	Critical speed	
1.01.10	Drive motor	
1.01.11	Fan supports, frames & structures	
1.01.12	Flexible connection at outlet/inlet	
1.01.13	V-belt (matched sets)	
1.01.14	V pulley	
1.01.15	Belt guard	
1.01.16	Slide rails	
1.01.17	Connection pieces	
1.01.18	Fasteners	
1.01.19	Vibration isolation pads, washers & spring if any	
1.01.20	Dampers	
1.01.21	Noise	
1.01.22	Painting	

2.06.09 Axial fan / RE unit

Sl. No.	Item	Requirement
1.01.01	Type	
1.01.02	Design code	
1.01.03	Casing	
1.01.04	Impeller	
1.01.05	Hub	
1.01.06	Fan supports, frames & structures	



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Sl. No.	Item	Requirement
1.01.07	Speed	
1.01.08	Critical speed	
1.01.09	Drive	
1.01.10	Neoprene rubber pads	
1.01.11	Fan statically & dynamically balanced	
1.01.12	Coned inlet for wall exhausters / supply air fans	
1.01.13	Supporting frame for mounting	
1.01.14	Protective screen at inlet	
1.01.15	Rain protection Cowl	
1.01.16	Mounting flange on casing	
1.01.17	Noise	
1.01.18	Painting	



TITLE:
2X660 MW KORADI STP (UNITS-11&12)
AIRCONDITIONING SYSTEM
PROJECT SPECIFIC GENERAL
REQUIREMENTS

SPECIFICATION No: PE-TS-527-553-A001

SECTION: I

SUB-SECTION: C-2B

REV. 00

DATE: AUGUST 2026

SECTION: I

SUB-SECTION: C 2B

CUSTOMER SPECIFICATIONS **PROJECT SPECIFIC GENERAL REQUIREMENTS**



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SECTION - 2

LEAD TECHNICAL SPECIFICATION

REV. - 0

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1.00.00 INTENT OF SPECIFICATION

- 1.01.00 Maharashtra State Power Generation Corporation Limited (MSPGCL /MAHAGENCO) has decided to install two 660MW pulverised coal fired units, based on state of the art supercritical technology at Koradi Thermal Power Station, near Koradi village, which is situated at about 11km from Nagpur city, in Maharashtra state, India.
- 1.02.00 Mahagenco intends to install the plant through Engineering, Procurement and Construction (EPC) route through two turnkey contractors; one for Main Plant (BTG) package and the other for Balance of Plant (BoP) package.
- 1.03.00 This set of bid specification documents (hereinafter referred to as 'bid specification' or just 'specification'), including all its associated volumes, annexure, attachments, clarifications and amendments, is intended for the execution of Main Plant (BTG) package (hereinafter referred to as 'package' or 'plant').
- 1.04.00 Mahagenco now intends to appoint a contractor for the design, engineering, manufacture/procurement, assembly, inspection and testing at manufacturer's works, packaging into properly sized units and shipping, transport, delivery to site, receipt, unloading, handling, storage, preservation, construction of civil and architectural works, structural fabrication, erection, painting, testing, commissioning, putting into operation; doing performance, reliability (trial operation) and guarantee testing and handing over of the completed main plant (BTG) package, comprising all items as mentioned in the scope of works and services; including specified mandatory spares, tools and tackles, 3 year O&M spares and defect liability, for the proposed 2x660MW units – 11 & 12 project of Koradi Thermal Power Station.
- 1.05.00 The EPC turnkey contractor (hereinafter referred to as "Bidder" in the bid specifications) would be responsible for all major aspects of installation; from detailed engineering, scheduling, procurement, project management, site management, construction, erection, supervision and quality control, performance testing and handing over of the plant as per the requirements of the bid specification. After award of the contract to the "Successful Bidder"; all references to "Bidder" in the bid specifications shall be read and interpreted as "Contractor" i.e. the EPC turnkey contractor who shall be completely responsible for execution of the comprehensive contract for the package. Owner/Employer/Engineer/Client refers to MAHAGENCO/MSPGCL. 'Owner's Engineer' refers to Owner's Engineering Consultant.
- 1.06.00 The bidder will control the work of all his subcontractors and will be responsible for all their work.
- 1.07.00 This technical specification is intended to specify the minimum requirement for the main plant (BTG) package. However the bidder can offer better configuration or technology to improve the plant performance or optimise the overall project cost (including capital or working/O&M cost). But any deviation has to be brought during the pre-bid stage and it has to be approved by the owner and owner's consultant by issue of relevant clarifications / amendment to the specification. No deviations will be allowed at a later stage.



1.08.00 This section also covers the general scope of supply and services, terminal points, general plant design and layout requirements, general quality and testing requirements, erection requirements, performance requirements, painting requirements, etc. Detailed technical requirements are indicated in other respective parts/sections of the specification.

1.09.00 The intent of the specification is to ensure that the plant & equipment under this package shall conform in all aspects, to high standards of engineering, design and workmanship and meet the intended performance of the plant, even if all details of design and construction are not specifically mentioned herein. It is the owner's intent that the specifications describe a functionally complete project/plant to be constructed in accordance with this specification. However, literal adherence to elements of this specification shall not relieve the bidder of ultimate responsibility for accomplishing the intent of the specification.

1.10.00 The intent of this specification is also to relieve the owner from any responsibility for completion of the package in all aspects, as per the requirements specified herein, except the works to be performed by the owner, which is specifically mentioned as owner's responsibilities.

2.00.00 BROAD SCOPE OF SUPPLY AND SERVICES

2.01.00 The scope of supply and services covered under this bid specification include all activities within the specified battery limits/terminal/tie-in points for completion of the main plant (BTG) package as specified herein, right from site preparation to takeover of the entire package by the owner; unless any item is specifically excluded from the scope of this specification. The plant/package shall be deemed complete, only when it has been taken over by the owner, without any further conditions; till then the complete plant is bidder's responsibility. And the owner will not delay the takeover, without valid reason.

2.02.00 Although all efforts are made to make the scope as clear as possible, it may not be possible to specify each and every item herein. Bidder's scope & responsibility for this package shall comprise every equipment, material, items, structures and necessary auxiliaries and systems as a whole, including complete mechanical, electrical C&I and civil works.

2.03.00 The information in this specification is not intended to be a complete, exhaustive listing, but is provided for convenience of the package bidder in developing an understanding of the overall scope.

2.04.00 Bidder's responsibility under this specification shall include everything which is required and necessary to complete the package. The bidder's scope under this package shall be deemed to include all such items which although may not be specifically mentioned in this specification, but are needed to make the system complete in all aspects, in accordance with good engineering practice, for safe, reliable, efficient, trouble free operation and coordinated operation of the plant.

2.05.00 The bidder will provide all necessary fixtures, components, accessories, electrical and C&I accessories and appurtenances for efficient and reliable erection, operation and maintenance whether mentioned in this specification or not.

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- 2.06.00 The extent of work under this contract includes all items shown in the appropriate sketches and drawings notwithstanding the fact that such items may have been omitted from the specifications or schedules. Similarly, the extent of work also includes all items mentioned in the specification and/or schedule, notwithstanding the fact that such items may have been omitted in the sketches and drawings.
- 2.07.00 The bidder shall provide all the relevant inputs, drawings and data in proper format to other package bidders, which is required for their detail engineering, to complete the project.
- 2.08.00 All necessary coordination and interfacing with sub-contractors shall be done by the bidder. The bidder will be responsible for all acts and omissions of any subcontractor and the owner will communicate only with the bidder regarding all matters pertaining to the contract.
- 2.09.00 All necessary coordination regarding interfacing with other package contractors shall be done by the bidder during detail engineering; with the approval of owner and owner's consultant.
- 2.10.00 Before preparation of the bids, the bidder may visit the project site and make himself familiar with the site/location conditions and understand all circumstances affecting the execution of the contract, including the extent and of work to be completed by him under this specification, means of transportation and access to site, facilities for accommodation of staff and labour (including those of sub-contractor's), storage and fabrication facilities available, availability of manpower, availability of construction material, labour and political issues, climatic conditions etc. Ignorance of site conditions shall not be accepted as basis for any claim for any type of compensation or extension of time.
- 2.11.00 The successful bidder upon signing of the Contract shall establish his office at the work site and in addition to a Project Co-ordinator/Manager stationed at his head quarters, nominate another responsible officer as his resident representative/Site in-charge, suitably designated for the purpose of overall responsibility and co-ordination of the works to be performed at Site. Such person shall function from the site office to be established by the bidder and in close coordination with the Engineer.
- 2.12.00 The scope of supply and services shall include but not be limited to the following:**
- 2.12.01 Basic & detailed design and engineering of the complete the package, including all systems, equipment and items.
- 2.12.02 Preparing and submitting engineering drawings and documents for owner's and owner's consultant's approval in agreed format and getting it approved after incorporating necessary changes. Submission of supporting drawings/documents/information sought by owner/owner's consultant, for this purpose.
- 2.12.03 Carrying out site investigation studies including, geo-technical investigation, topographic survey, area drainage study, water quality analysis etc for optimum design of the plant.

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- 2.12.04 Procurement, fabrication, manufacturing, assembly, shop painting, marking, inspection and testing at manufacturer's works, packaging into properly sized units and forwarding, insurance, shipping/transport, customs/port clearance, delivery to site of each and every item required to complete the package.
- 2.12.05 Receipt of all materials/equipment at site, unloading from carriers, handling for intermediate site storage, inspection at site for any shortage or damage and taking corrective action with the knowledge of owner / site in-charge, storage at site or other designated area near the site till the item is required for erection, security, protection and preservation at storage, handling from intermediate storage, transportation from storage area to location of erection.
- 2.12.06 Construction of civil and architectural works, structural fabrication, pre-assembly, erection, painting, pre-commissioning, testing, commissioning, putting into operation, performance, reliability (trial operation) and guarantee testing and handing over of the completed main plant (BTG) package, comprising all items as per the requirements of this specification.
- 2.12.07 All associated site services as mentioned elsewhere in the specification and as required to complete the plant.
- 2.12.08 Arranging and channelling all resources required to complete the package, as per the specification.
- 2.12.09 Deployment of additional resources as required to make-up for any delay in the project.
- 2.12.10 Installing latest and established ambient air quality monitoring system at strategic locations of the plant to monitor and comply with pollution norms as specified by statutory authorities.
- 2.12.11 Maintaining the complete project area clean and organised.
- 2.12.12 Obtaining necessary clearances/permits/licenses from statutory authorities for the completion of the project, as mentioned in Volume-I (Commercial).
- 2.12.13 Assisting owner and furnishing all relevant technical data for obtaining statutory clearances in owner's scope.
- 2.12.14 Preparation and submission of commissioning procedures and check lists for all equipment and systems.
- 2.12.15 All specialised equipment/services necessary for the package and all calibrated instruments and services required for performance testing of all items of the plant shall be made available for the purpose, by the bidder.
- 2.12.16 Provision for preservation of individual equipment after initial operation and commissioning, for example nitrogen blanketing etc. as necessary.
- 2.12.17 All structures which would be required by the bidder for supporting the piping and cables/cable racks. This includes complete pipe and cable racks/trenches/bridges.
- 2.12.18 All weld neck counter flanges, gaskets & fasteners shall be supplied by bidder wherever nozzle ends on any equipment such as strainer, flow nozzles etc. are flanged.



- 2.12.19 All fixtures, embedded parts, steel embedment including fixing lugs and welding between them, foundation plates, nuts, bolts etc. for fixing all the equipments, piping on civil works.
- 2.12.20 Chemical cleaning of equipment and systems as required, after their erection.
- 2.12.21 Thermal insulation and removable metal cladding shall be provided, for all the equipments, piping and piping support frames, as required.
- 2.12.22 Complete platforms with handrails, for operation and maintenance of equipment and valves. Toe-guards should be provided for all handrails.
- 2.12.23 Complete piping (integral and interconnecting), fittings, couplings, expansion joints, valves, gates, gaskets, fasteners, instrument stubs and supports/hangers, as required for the plant.
- 2.12.24 All pumps, filters/strainers, storage/intermediate/day tanks, agitators, air receivers, specialities etc, as required.
- 2.12.25 Complete potable water and service water distribution to all buildings in the package.
- 2.12.26 Individual overhead tanks at all locations for potable and service water as required.
- 2.12.27 Complete distribution of instrument air and service air piping for the package.
- 2.12.28 All equipment complete with drive motors, coupling, coupling guard, base plates, anchor bolts, fasteners, gaskets, etc as required.
- 2.12.29 Complete electrical works for the plant including transformers, bus-ducts, switchgears, cables, motors, local control panels, LPBS, illumination, battery, DC system etc.
- 2.12.30 Complete instrumentation required for both local and remote monitoring, process control and performance evaluation for all process parameters, including instruments, cables, control stations, PLCs, DCS etc.
- 2.12.31 Complete painting of all items of the plant. cleaning, surface preparation and painting/corrosion protection including shop painting, before erection, during erection, after erection and application of final touch-up painting as required.
- 2.12.32 Complete consumables required for the plant till successful completion of trial operation, like grease, lubricating oils, chemicals, resins, filters, gases, etc.
- 2.12.33 Supply of HSD for emergency DG set till 'take over' by the owner, will be in bidder's scope.
- 2.12.34 All the erection materials and consumables like shims, welding rods, soldering and brazing alloys, insulating tapes, compounds, chemicals etc. required for the erection and commissioning work shall be included in the Bidder's scope of work.
- 2.12.35 One set of all special tools and tackles required for the maintenance of equipments/system have to be supplied by the Bidder. These tools and tackles shall be separately packed and brought to site. These shall not be used for erection/ commissioning purposes and shall be in an unused and new condition, when they are handed over to the Employer. A list of all such special tools and tackles shall be submitted along with the offer.



- 2.12.36 Adequate maintenance and repair tools required for inspection, testing, calibration and rectification during maintenance of equipments/system of the plant.
- 2.12.37 Complete set of spares as mentioned in the specification.
- 2.12.38 Carrying out flow model tests, as required, on models prepared by him and witnessed/reviewed by owner/owners consultant as the case may be and submitting the test reports for owners and consultants approval.
- 2.12.39 Installation and removal of temporary items for commissioning, like piping, structures, equipment and other arrangements any, with the approval of Owner/Engineer; if such item is not required for normal operation and maintenance of the plant.
- 2.12.40 Completion and rectification/modification of all items as per punch list, before final takeover by owner.
- 2.12.41 Preparation and submission of all operation and maintenance manuals for all equipment and systems for owner's approval and getting it approved after incorporating necessary changes.
- 2.12.42 Submission of adequate copies as specified, of all approved drawings and documents in desired format, for owner's record.
- 2.12.43 Final submission of all approved 'as built drawings' in desired format.
- 2.12.44 Training of owners personnel as mentioned in relevant sections of the specification.
- 2.12.45 Defect liability of each part of the plant supplied, for a period of 12 months from the date of acceptance of PG tests; unless specified otherwise. Some of the specific requirements are mentioned in the specification.
- 2.12.46 Latent defect liability for the plant equipment under the specification after expiry of defect liability.



4.38.00 General Mechanical Requirements

4.38.01 HORIZONTAL AND ~~VERTICAL~~ PUMP

- i) The maximum efficiency of pumps shall be preferably within +10% of the rated design flow.
- ii) The head capacity curve shall be continuously rising from the operating point towards shut-off without any zone of instability and with a minimum shut-off without any zone of instability and with a minimum shut-off head of 15% more than design head.
- iii) Pumps of a particular category shall be identical and shall be suitable for parallel operation with equal load division.
- iv) The head vs capacity and BHP vs capacity characteristics should match to ensure even load sharing and trouble free operation throughout the range. Components of identical shall be interchangeable.
- v) Pumps shall run smoothly over the entire range of NPSH conditions without undue cavitation, noise & vibration. Peak to peak vibration limits shall be restricted to the following values during operation.

Speed	Antifriction bearing	Sleeve Bearing
1500 rpm & below	75.0 microns	75.0 microns
3000 rpm	50.0 microns	65.0 microns



- vi) The noise level shall not exceed 85dBA. Overall sound pressure level reference 0.0002 microbar (the standard pressure reference for air sound measurement) at a distance of 1m from the equipment surface.
- vii) The pumps shall be capable of starting with discharge valves open & close condition.
- viii) Selection of pumps shall be such that the design point shall be met even with negative manufacturing tolerance.
- ix) The pump shall be of stiff shaft design. The maximum internal clearances should be sufficiently more than the maximum static deflection of the shaft. Shaft size selected must take into consideration the critical speed as specified in API-610.
- x) Following codes shall be referred to:
 - a) IS 1520
 - b) IS 5120
 - c) API 610
 - d) IS 5639
 - e) IS 5659
 - f) HIS
 - g) IS 1710
 - h) And as specified.
- xi) *Horizontal Pumps*
 - a) Pump casing shall have radially/axially split type construction. The casing shall be designed to withstand maximum shut-off pressure developed by the pump at the pumping temperature.
 - b) The pumps may be single or multistage.
 - c) Pump casing shall be provided with a vent connection and piping with fittings & valves, casing drain as required shall be provided complete with drain valves, piping & plugs. It shall be provided with a connection for suction & discharge pressure gauge as standard feature.
 - d) Impeller – Impeller shall be closed or semi-closed as specified and designed in conformance with the detailed analysis of the liquid being handled.
 - e) Impeller/casing wear rings – Replaceable type wear rings shall be provided at suitable locations with suitable method of locking.
 - f) Shaft – The critical speed of shaft shall be well away from the operating speed and in no case less than 130% of the rated speed.
 - g) Shaft sleeves – Shaft sleeves shall be fastened to the shaft to prevent any leakage or loosening and shaft sleeve assembly should ensure concentric rotation.
 - h) Bearings



- 1) Heavy duty bearings, adequately designed for the type of service specified and for long trouble free operation.
- 2) The bearings offered shall be capable of taking both radial and axial thrust coming into play during operation. In case, sleeve bearing are offered, additional thrust bearings shall be provided
- 3) Bearing life shall be minimum 40,000 hrs (L-10) of continuous operation at rated load and speed.
- 4) Proper lubricating arrangement for the bearings shall be provided such that lubricating element does not contaminate the fluid pumped. Where there is possibility of liquid entering the bearings, suitable arrangement in the form of deflectors or any other suitable arrangement must be provided ahead of bearing assembly.
- 5) Bearings shall be easily accessible without distributing the pump assembly. A drain plug shall be provided at the bottom of each bearing housing.
- i) Stuffing Boxes – Stuffing boxes of packed ring construction type shall be provided wherever specified. Packed ring stuffing boxes shall be properly lubricated and sealed as per service requirements and manufacturer's standard. If external gland sealing is required, it shall be done from the pump connection. Gland packing shall be non-asbestos type.
- j) Mechanical seals – Wherever specified in pump data sheet, mechanical seals shall be provided. The sealing face shall be highly lapped surfaces of material known for their low frictional co-efficient and resistance to corrosion against the liquid being pumped.
- k) Pump shaft-motor shaft coupling – The pump and motor shaft shall be connected with a adequately sized flexible coupling of proved design with a spacer to facilitate dismantling of the pump without disturbing the motor.
- l) Base plate
 - 1) A common base plate mounting, both for the pump and motor shall be furnished. The base plate shall be of fabricated steel and of rigid construction, suitably ribbed and reinforced.
 - 2) Assembly and dismantling of each pump with drive motor shall be possible without dismantling the grouting base plate or alignment.
- xii) Vertical Pumps (Turbine type, mixed/axial flow)
 - a) Pumps shall be of vertical shaft, complete with bowl, column pipe, discharge head and base plate with all accessories, as applicable.
 - b) Bowl assembly
 - 1) Shall be either single stage or multi stage vertical turbine type, mixed flow or axial flow type with discharge co-axial with shaft. Type of impeller shall be chosen on the basis of the pump specific speed and the characteristics of the handling fluid.
 - 2) Pumps shall have provision for adjustment of impellers in vertical direction from an accessible location, preferably at the housing



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xiii) *Drive motor*

- a) The kW rating of the drive shall be based on continuously driving the connected equipment for the conditions specified.
- b) In case of parallel operation of the pumps is specified, the actual motor rating is to be selected considering overloading of the pump in the event of tripping of operating pump.
- c) Continuous motor rating (at 50°C ambient temperature) for the pump shall be at least 10% above the maximum load demand of the pump in the complete range or 15% over the duty point, whichever is higher.



7.00.00 QUALITY ASSURANCE AND CONTROL

7.01.00 All materials, components, structures and equipments covered under this specification shall be tested/checked at all stages of procurement, manufacturing, construction, erection, commissioning as per a comprehensive quality assurance programme.

7.02.00 The bidder including his suppliers and sub-contractors shall prepare their quality plans in line with the requirements of the specification and standard practices and implement it after approval by the owner and owner's consultant. This will include both Manufacturer's Quality Plans (MQPs) and Field Quality Plans (FQPs). MQPs and FQPs shall be submitted well in advance so that the same can be reviewed and approved by owner/owner's consultant well in advance before start of works.

7.03.00 Manufacturing quality plan shall detail out, for all the components, equipments & items various tests/inspection to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by bidder's quality control organization, the relevant reference document and standards, acceptance norms and inspection documents raised etc. during all stages of material procurement, manufacture, assembly and final testing/performance testing.

7.04.00 Field quality plans shall be submitted and shall detail out for all the items, the quality practices and procedure etc. to be followed by the bidder's site quality control organization during various stages of site activities including receipt of materials/equipments at site, preservation and storage, pre-assembly, fabrication, construction, erection, pre-commissioning and commissioning. The bidder shall provide all necessary means for execution of inspection and testing, according to the requirements including specialised instruments if any.

7.05.00 The bidder has primary responsibility for ensuring the quality of items of equipment supplied under the contract and remains accountable when manufacture or erection is subcontracted.

7.06.00 It is therefore a requirement of the specification that work is only subcontracted to companies with effective quality control organizations and that the bidder monitors the performance of these by the attendance at tests of experienced


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inspectors employed by the bidder. The bidder shall, at the appropriate time, prove that his material and/or equipment comply with all the requirements of this specification, such proof being the successful completion of tests and inspections.

- 7.07.00 Routine test and type test certificates shall be submitted for each item of equipment, wherever applicable.
- 7.08.00 All materials, components and equipment supplied under the contract shall be subject to inspection by the owner, his authorised representative or any statutory authority like IBR inspector, should they so require during manufacture, construction, erection and after completion.
- 7.09.00 No materials/equipment shall be dispatched from the manufacturer's works before the same is either accepted subsequent to pre-dispatch final inspection including verification of records of all previous tests/inspections by the owner/owner's authorized representatives, or such pre-dispatch final inspection is waived by the Owner and dispatch is authorized after review of test reports.
- 7.10.00 All materials used or supplied shall be accompanied by valid and approved material certificates and test and inspection reports and dispatch clearance duly approved by the Owner. These certificates and reports shall indicate the acceptable identification number of the material they proposed to certify. The material certified shall also have the identification details stamped on it.
- 7.11.00 All material used for equipment construction including castings and forgings etc. shall be of tested quality as per relevant codes/standards. Details of results of the test conducted to determine the mechanical properties, chemical analysis and details of heat treatment procedures recommended and actually followed shall be recorded on certificates and time temperature chart. Tests shall be carried out as per applicable material standards and/or agreed details.
- 7.12.00 All the sub-vendors proposed by the bidder for procurement of major bought out items including castings, forgings, pumps, heat exchangers, semi finished and finished components/equipment - (list of which shall be drawn up by the bidder and finalized with the owner) shall be subject to owner's approval.
- 7.13.00 All welding shall be carried out as per welding procedure drawn and qualified in accordance with requirements of ASME Section IX. Welding procedures shall be submitted to the Owner for approval prior to carrying out qualification test in the presence of Owner's representative.
- 7.14.00 All welders/welding operators employed on any part of the contract either in the Supplier's works or at site or elsewhere shall be qualified as per ASME Section-IX.
- 7.15.00 Test results of qualification tests and specimen testing shall be furnished to the Owner/owner's authorized representative for approval. However, wherever required by the Owner, tests shall be conducted in presence of Owner's/owner's authorized representative.
- 7.16.00 All the heat treatment results shall be recorded on time temperature charts and verified with recommended regimes.

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- 7.17.00 The type and extent of inspection of items shall be in accordance with the relevant International/Indian Standards/Indian Boiler Regulations and other standards approved by the owner/owner's representative, supplemented or amended by the requirements of this section of the specification or as specified elsewhere in the Specification.
- 7.18.00 Wherever owner's/owner's representative's (inspector) witness is required as per approved quality plans or inspection categorisation plans, the owner and owner's representative shall be notified (inspection call) along with all required details including details of item to be inspected, approved MQPs, address/place of inspection, inspection date etc, at least 21 days in advance, prior to the planned inspection date at manufacturer's works. All test reports and supporting documents shall be made available to owner's inspector at the time of inspection; irrespective of whether it has been furnished earlier.
- 7.19.00 All site inspections as per approved FQP shall be notified along with all details including details of item to be inspected, location, inspection protocols etc., at least 5 working days in advance.
- 7.20.00 The owner/owner's representative, within fifteen days from the date of receipt of such notice/inspection call, shall intimate the bidder, the probable date of visit for the inspection. All efforts shall be taken by the owner to ensure that such date shall not be later than eight days from the date of inspection as intimated by the bidder.
- 7.21.00 If the owner or his representative does not attend on the notified date or in the event the owner grants waiver for such inspection, the test may be proceed as per approved quality plan, unless an alternative date has been requested by the Owner.
- 7.22.00 Participation by owner/owner's representative in or their absence from or failure to participate in any Tests (other than the Performance Tests) shall not relieve or absolve the Bidder from any Guarantee or Warranty or obligations of services under or in pursuance of the contract.
- 7.23.00 In the event, the inspector could not witness the inspection on the scheduled date for the reasons attributable to the bidder/subcontractor; all the costs of deputing the inspector shall be borne by the bidder.
- 7.24.00 With respect to site inspections, the bidder shall, wherever required, give due notice to the owner/owner's representative whenever work is ready before covering up or putting out of view. The inspector shall then either carry out the inspection, examination, measurement or testing or notify the bidder that it is waived.
- 7.25.00 If the inspector is not satisfied with any test and requires a re-test, the tests shall be repeated under the same terms and conditions. If such retesting demonstrate that the work, equipment or material being so tested conforms to the requirements of Contract, then the owner shall bear the cost of such additional Test and the cost of any required uncovering and covering the goods and shall grant the extension of time for completion, if necessary. If however such retesting confirms inspector's conclusion and cause the owner to incur additional costs, such costs shall be recoverable from the bidder.

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- 7.26.00 If, as a result of inspection, examination or testing, the inspector decides that any equipment, system, materials, design or workmanship has failed in such inspection, examination or tests or is defective or otherwise not in accordance with the contract, the inspector may reject such equipment, system, materials, design or workmanship and shall notify the bidder promptly, stating his reasons. The bidder shall then promptly correct or replace, such item or portion so as to pass retesting and otherwise meet and conform to such requirements. No changes to project schedule or increase in the price shall be granted with respect to such additional testing. Bidder shall bear any cost resulting due to such rejections.
- 7.27.00 Notwithstanding anything contained hereinabove, the pressure parts of the boiler coming under the ambit of statutory inspection (IBR), shall be carried out by the owner's personnel only.
- 7.28.00 Reference to special codes and standards, where designated either directly or as "relevant", is intended to provide a measure of performance, safety, in-shop and on-site testing, and methods of construction and/or installation which must be equal or superior in order to be considered acceptable for use under this specification. If more than a single degree of quality or accuracy is permitted within the scope of particular code or standard, the highest quality shall be applicable and the degree of accuracy commensurate with the intended function shall be selected, but with the understanding that the final decision will be made by the Owner.
- 7.29.00 The bidder shall include in its proposal a comprehensive Quality Assurance Programme containing the overall quality management and procedures which it proposes to follow in the performance of the works to maintain the quality of product during various phases.
- 7.30.00 At the time of award of Contract, the detailed Quality Assurance Programme to be followed for the execution of the Contract will be mutually discussed and agreed to and such agreed programme should form a part of the Contract.
- 7.31.00 Test Certificate and Documentation**
- 7.31.01 The results of all tests shall be certified by the manufacturer, bidder or independent agency as appropriate.
- 7.31.02 On completion of the inspection/tests, the bidder shall furnish the inspection report and test certificates as per the approved quality plans to the owner for approval and despatch clearance. The test reports shall invariably indicate identification data, including Model No., Sr. No., Billing Break-up reference etc. of the equipment, method of application and duration of test along with test results.
- 7.31.03 Document files containing material certificates, welding procedures, test report etc. shall be compiled for each item of plant and shall be suitably identified (including equipment classification reference) and bound.
- 7.31.04 Four copies of each document file containing inspection reports and certificates of site erection testing activities of a particular item of plant or system shall be supplied to the Owner prior to commissioning.
- 7.31.05 Copies of the performance and acceptance test reports shall be prepared and distributed as specified in Clause 'Performance and acceptance test data and



reports' of this Section. All documentation as required by IBR shall also be prepared and submitted.

7.31.06 Soft copies of above shall also be submitted.

8.00.00 PROJECT MANAGEMENT

8.01.00 The bidder shall be responsible for the overall management of the project.

8.02.00 The bidder shall submit a project management plan, within 30 days from the date of award.

8.02.01 The main objective of the document is to indicate how the various elements of the project like engineering, procurement; sub-contracting, transportation, site execution, quality control, commissioning and performance testing are planned and integrated.

8.02.02 The plan shall be in line with the project milestone schedule.

8.02.03 This plan shall contain the following:

- i) *Project Management Organisation Structure* – Indicating the responsibility centres at both home office and site office, for engineering, procurement, sub-contracting and transportation. System/area wise and discipline wise responsibilities.
- ii) *Site Organisation Structure* – Indicating system/area wise and discipline wise responsibilities, for site management, planning, site execution, administration, quality control, safety, commissioning and performance testing including material management and Billing.
- iii) *Transportation Logistics* – Planning logistics and identification of ODC consignments and its transportation strategy.
- iv) *Construction Methodology, Erection Strategy and Deployment of T&P and resources* – A detailed erection strategy showing delivery plans, sequential erection activities supported by T&P and manpower deployment plan, indicating quantities and time period. This shall also indicate time schedule for finalisation of erection agencies/sub-contractors. Considering time gap between the units, unit wise deployment program shall also be indicated.
- v) Any other information reasonably requested by owner.

8.02.04 Curricula Vitae of key personnel, who will be part of project during various stages, shall be submitted to the owner and make suitable changes if suggested by owner. Any change of the key personnel or organisation structure shall promptly be communicated to the owner.

8.02.05 This plan shall be mutually agreed between the owner and the bidder.

8.03.00 Project Schedule, Planning and Monitoring

8.03.01 The Bidder shall prepare a Master Network Schedule in the form of PERT network. The network shall be prepared on a Work Breakdown Structure.

8.03.02 The master network shall identify milestones of key events of each system in the areas of engineering, procurement, manufacture and despatch, erection and commissioning. The master network shall represent the Level I (L1) Schedule

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and will form the basis for development of detailed second and third tier execution plans i.e. L2 and L3 network schedules.

- 8.03.03 The master network shall be submitted along with the bid and shall be mutually discussed and finalised before the award of Contract. The master network shall identify a complete list of inputs to be furnished by the Owner which may be required for proper interfacing and tie up. Scheduled dates for providing such inputs shall also be indicated and the same will be mutually discussed and finalised.
- 8.03.04 The Bidder shall not change the Master network without the prior approval of the Owner in accordance with the Conditions of Contract. In the event that the Owner approves a revision to the Master Network in accordance with the Conditions of Contract, the Bidder shall submit a revised Master Network within two weeks thereafter. This programme shall fully comply with the requirements of the specification and where necessary, reflect changes to the sequence or progress of the Works as indicated by the Owner or as proposed by the Bidder and accepted by the Owner. Such an agreed revised programme shall become the overall schedule for the outstanding works.
- 8.03.05 The Bidder, within 30 days after the date of award of contract shall submit to the Owner the detailed L2 schedule and within 90 days from the date of award of contract shall submit the detailed L3 schedule for the package, which shall be consistent with the Project Schedule given above.
- 8.03.06 The schedule shall show the sequence, timing and duration of the Work and the planned commencement and completion dates of all separable portions of the Work, including each Milestone, in form, content and level of detail satisfactory to Owner. The Bidder shall fix the major milestones to check / review progress on the life cycle curves so that the time gap between 2 milestones should not be more than 10% of the total time duration.
- 8.03.07 Along with the L2, detailed sequential supply schedule shall also be submitted and shall be mutually agreed between the Bidder and Owner. All supplies shall be purely sequential based on its requirement at site.
- 8.03.08 The Bidder shall at all times perform the scope of supply in accordance with Project Schedule and the programme.
- 8.03.09 No material alteration to the Programme shall be made without the approval of the Engineer. However, Bidder may make minor alterations to the Programme without the prior approval of the Engineer being required where such alterations are consistent with the key milestone dates set out in the Project Schedule.
- 8.03.10 The Bidder shall submit the coding procedure being adopted for computerisation along with the logic and the Work Breakdown Schedule with their respective weightages used for generating the life cycle curves and shall submit the Work Intensity Chart based on weightages conforming to their overall schedule.
- 8.03.11 If the progress of the Scope of Supply or any other part of the Works does not conform to the Programme, the Owner may instruct the Bidder to revise the programme.
- 8.03.12 If for any reason which does not entitle the Bidder to an extension of time the rate of progress of the Scope of Supply or part thereof is at any time in the

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reasonable opinion of the Owner or the Engineer too slow to secure completion of the works within the Time for Completion or any extended date the Employer may so notify the Bidder in writing and the Bidder shall thereupon take such steps as are necessary and the Employer may approve an order to accelerate (whether by re-programming the order or sequence of work or by increasing the personnel or other resources of the Bidder or its sub-contractors employed on the Scope of Supply) the progress of the Scope of Supply or part thereof so as to achieve completion of each section by the Time for Completion as may be extended. The Bidder shall not be entitled to any additional payment or extension of time for taking such steps.

8.03.13 During the performance of the Work, Bidder shall submit monthly updates comparing the Work completed against the milestone schedule or if Bidder's performance is not in compliance therewith, more frequently as requested by Owner. If Bidder's performance of the work is not in compliance with the Milestone Schedule, without restricting any other rights or remedies of Owner hereunder, Bidder shall

- i) Submit its plan for schedule recovery and
- ii) Specify in writing the steps to be taken to achieve ongoing compliance with such revised schedule.
- iii) Bidder shall submit the overall life cycle curve for progress curve. The Bidder shall adopt a milestone approach and shall identify several milestones to be achieved so that they could be measured physically. Computation of progress of the Bidder shall use weighted value concept and submit detailed computerised linked bar chart. Bidder shall submit work breakdown structure in detail along with the weightage and the milestone to be achieved every week preferably in a graphical / tabular format.

8.03.14 Bidder shall comply with the Schedule and to attend and participate in progress, site co-ordination or special purpose meetings. Progress, site and co-ordination meeting will be held at Bidder's engineering office or the Site on a weekly basis, unless otherwise requested by Owner. Bidder shall have in attendance at any such meeting the Project Manager and other management workers authorised to commit additional manpower to the Work and shall for any progress meeting bring a forecast showing the last period's progress versus the last period's scheduled work plan and the work plan for the next one month period. Unless otherwise stated in writing by Owner the forecast shall describe the Work by task, by site location, by area or building and by bay for a one month period. The commencement and completion of each task to be performed shall be clearly designated. If requested by Employer, representatives of Vendors of major materials shall be present at each such meeting. Employer may on reasonable notice to Bidder call a special purpose meeting whether at Bidder's engineering office or the site to review any portion of the Work, the performance of which is of substantial concern to Employer.

8.03.15 The Bidder shall use the latest version of a project management software preferably like MS project/Primavera to generate and submit the following (both hard copies and soft copies) to the Owner to facilitate monitoring the project progress:



- i) Overall Schedule (on Monthly basis) hard copy and soft copies.
- ii) Performance / Forecast look ahead schedule i.e., three weeks work ahead and previous week's performance. This shall be submitted and monitored every week.
- iii) Milestone slippage report, if any.

9.00.00 SITE AND LAYOUT REQUIREMENTS
9.01.00 Plant Area
9.01.01 SITE AND SOIL PROFILE

- i) A preliminary soil investigation and topographical survey has been carried out by owner. The details are furnished in Annexure 5 and 6 of Volume – V.
- ii) The detailed geotechnical investigation, topography and setting out survey for the area covered under this package will be performed by the bidder, and will be the basis for the detailed engineering for the project. The geotechnical report shall contain recommendations for foundation design during detailed engineering.

9.01.02 LAYOUT OF SITE

- i) A suggestive plot plan indicating available area is enclosed as Dwg. No ETG061-COM-GEN-PP-001 considering the existing plant facility, fuel receipt and electrical system hook-up. However, the bidder shall further elaborate and prepare a detailed layout arrangement which will be subjected to approval of the owner.
- ii) In developing the site layout, a systematic approach shall be adopted with a view to ensure that all the subsystems comprising the package are optimally laid out both from the view point of capital cost as well as running/operating costs.
- iii) Ease of operation and maintenance of the plant will be the most important aspect to be considered while developing the layout.
- iv) The detailed layout shall be prepared by the bidder taking into consideration the most economical option, considering the requirements of the specification, functional requirements, optimum space utilisation and transportation/storage/construction/erection strategies.
- v) While preparing the detailed layout, planning the facilities in the bidder's scope and deciding upon the functional requirements, transportation and construction/erection strategies,
- vi) Bidder should take into consideration the aspects like economical layout of the plant and ease of integration of systems with existing units and considering the ease of construction, operation and maintenance.
- vii) The area for construction/erection facilities like lay-down, pre-assembly, offices and stores is to be managed by the bidder within the overall area available and allocated within plant boundary. In case bidder requires additional area, he shall make his own arrangement at his own cost outside the plant boundary. Development of the same including security etc. for the intended use will also be his responsibility.



- viii) The spacing between various buildings and facilities shall be suitably decided so as to avoid interference between the foundations.
- ix) Face of the buildings and facilities shall be located in such a way so as to have an offset of minimum 15 m with respect to centre line of double lane road and 12 meter with respect to centre line of single lane road.
- x) In case of rail track minimum 3m horizontal clearance between face of adjacent structure to centre line of rail and 8.5m vertical clearance between bottom of structure to top of rail shall be maintained. Further as per the practice adopted in railways, any crossing below the rail track, minimum opening size of culvert shall be 2.0m wide X 1.8m deep. A walkway of min 600mm width shall also be made available in the culvert.
- xi) The development work consists primarily of clearing the site, grading the site to appropriate levels keeping in view the planning for storm water drainage and green belt.
- xii) Global Coordinate system shall be followed or as mutually agreed. Elevation shall be in meters.
- xiii) All statutory requirements including safe distances between various facilities as per applicable rules/acts/laws including local bye-laws are met.

9.01.03 SITE LEVELLING AND GRADING

- i) Finished grade level (FGL) of the site shall be RL (+) 304.75 m above MSL; which is more or less the existing grade level of the site.
- ii) Finished Floor Level (FFL) of Power House Building shall be 500 mm above FGL.
- iii) Finished Ground Floor (FFL) Level of Power House building taken as EL 0.00m.
- iv) Paved level (top) in boiler & ESP area shall be at EL (-) 0.20m.
- v) Paved level (top) in transformer yard shall be at EL (-) 0.10m.
- vi) FFL of ESP/FGD control building and other buildings in boiler/Mill bunker building/chimney area shall be EL 0.00m.
- vii) Top of road shall be 0.20mm above from ground level.
- viii) Drains shall be provided both sides of roads except patrolling road. Drain shall be provided on one side of patrolling road.
- ix) FFL of offsite buildings shall be 500mm above FGL of respective areas.
- x) Site shall be cleared as required for construction. Trees if any may be retained if it will not obstruct the plant construction.
- xi) Site shall be excavated and all underground structures and unwanted debris as mentioned in the specification shall be removed.
- xii) Earthwork in excavation including quarrying/blasting as required, identifying borrow pits, transportation of soil from borrow pits, backfilling and disposal of excavated material.
- xiii) Backfilling after removal of all debris and further compaction to maintain the FGL shall be done, as required.



- xiv) Necessary grading/levelling required for the construction shall be done by the bidder. The area shall be suitably cut and filled to suit the layout requirement as required.

9.01.04 ROADS, BOUNDARY WALL AND FENCING

- i) Water bound macadam (WBM) roads shall be constructed after levelling and grading of the site, for easy movement of plant men and material including cranes and other construction equipments. Preferably all road crossings shall be planned, designed and completed before laying of WBM road.
- ii) Roads as required inside the plant for easy access of men and material to various locations shall be provided.
- iii) Drains shall be provided both sides of roads except patrolling road. Drain shall be provided one side of patrolling road.
- iv) Plant Main road to the power house building from the main gate shall be considering turning radius required for heavy multi axle trucks.
- v) All roads in & around the power block (BTG island) area (Area from Transformer yard to chimney & FGD area) shall be rigid pavement with RCC.
- vi) All roads around the BTG Island except the road on East side of BTG Island shall be 10m wide and 1.5m wide shoulder on both sides. Road on the East side of BTG Island road shall be 15m wide four lane road and 1.5m shoulder on both sides.
- vii) All roads inside the BTG area providing access to buildings / structures / systems requiring maintenance by vehicles shall be 7 m wide and 1.5m wide shoulder on both sides.
- viii) All other roads for access to the BoP plants shall be 7.0m wide and 1.5m wide shoulder on both sides.

9.02.00 Layout of the plant area

9.02.01 The package shall comprise mainly of power block/main plant area and other non-plant areas covered under the specification like, cooling water pump house, FGD area, fuel oil transfer system, fire system, compressor house etc. (together called as 'Plant Area', for this package).

9.02.02 The following factors shall be considered in developing the plant layout for all area:

- i) Safety of personnel and plant is the most important criteria for plant layout.
- ii) Optimisation of resources and ease of operation and maintenance are the other important criteria.
- iii) Easy and safe access to all areas shall be provided for smooth operation of the plant. Especially, adequate access shall be provided to all valves.
- iv) Similarly adequate provision shall be provided for convenient maintenance of the all items of the plant. This is very important in order to reduce the equipment/plant downtime and increase the equipment/plant availability.



- v) The layout of this plant shall be compact so as to optimize use of land, materials and minimize system losses. Special care shall be taken to optimise the total piping and cabling lengths.
- 9.02.03 As the part of layout optimization, the Bidder shall keep the following in to consideration:
- i) Unit pitch : Shall be minimum 130 m for 3 cylinder steam turbines and 140 m for 4 cylinder steam turbine.
- 9.02.04 Due consideration shall be given for the wind direction while deciding on the relative location of Cooling tower and switchyard to minimize the moisture drift towards the switchyard.
- 9.02.05 Control Room / Control equipment room {for placing control and power system panels, including remote I/O (RIO)} for all areas shall be provided as near as possible near to their respective area MCC/Switchgear. Control Rooms / Control Equipment Rooms / RIO rooms shall be air-conditioned. Batteries for power supply systems as required shall be placed in separate suitably ventilated Battery rooms.
- 9.02.06 Ground level FFL 0.00m shall be used as cable vault. All MCC / Switchgear / control equipment / panels will be placed above the cable vault floor. Minimum floor height of the cable spreader floor shall be 3.5 m.
- 9.02.07 Adequate space shall be provided for unloading and maintenance purposes in Turbine - Generator (TG) area. Requisite lay down area shall be provided for each unit on TG floor and same shall be approachable with electric overhead travelling (EOT) crane.
- 9.02.08 Each unit shall be provided with its own laydown area on operating floor level, thus enabling simultaneous maintenance and overhauling of all units, if required. In case any special arrangement for rotor maintenance is required, the same should be provided.
- 9.02.09 The bidder shall furnish GA drawings indicating the equipment laydown area with details such as blocks indicating orientation of dismantled items, travel path etc.
- 9.02.10 The bidder shall also furnish GA drawings indicating the laydown arrangement of major assemblies (provided as spares) in the TG hall, with access from EOT crane. If the area provided inside TG building is not sufficient to accommodate these unit assemblies then a separate buildings shall be provided. The layout and arrangement shall be furnished along with the bids submitted by the bidder.
- 9.02.11 Adequate provision shall be made at all areas, in regard to space and access, in order to carry out the maintenance of various equipments. Adequate maintenance facilities & access shall be provided as required, for assembly, disassembly, handling during maintenance and alignment work of all important equipment and auxiliaries viz: dampers, actuators, field instruments, steam turbine casing (inner and outer), diaphragm glands, steam valves, journal/thrust bearings, turbine rotors, generator rotor, end rings, shaft seals, generator bearings, hydrogen coolers, condenser water box, condenser cooling water line inlet and outlet motor operate butter fly valves, vacuum pumps, CEPs and BFP cartridges, BFP drive motor, turbine oil coolers, pumps, fans, air pre heaters, boiler circulation pumps, regenerative heater, coal mill, coal feeder etc.

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- 9.02.12 Cut-outs as required and lay down space for all the equipments shall be considered and lifting and handling equipments shall be extended up to the lay down space
- 9.02.13 Adequate fire escape staircases shall be provided in power house building with fire doors at each landing.
- 9.02.14 Adequate no. of staircases and access through elevator shall be provided as required and specified for various buildings.
- 9.02.15 Adequate number of permanent stores and open paved yard shall be provided as per requirement of the Station for storage of spares and materials etc.
- 9.02.16 The safety requirements as per the Factories Act, Indian Electricity Rules and other applicable codes/standards etc. shall be observed while developing the layout.
- 9.02.17 Steel storage yard and pre-assembly yard required for storing and assembling of plant equipments during construction phase and later this space will converted into open storage/green belt during the operational phase.
- 9.02.18 Crisis Management scheme and Emergency Management scheme shall be provided. This is related to plant and personnel safety during construction and operation in relation to layout features, operational features and accidents. The details shall be discussed and finalized during engineering stage.
- 9.02.19 Sufficient clear head room of minimum 2.1m shall be provided in all plant area.
- 9.02.20 Valves shall be located in accessible positions. All piping shall be routed at a clear height of minimum 2.5 m from the nearest access level for clear man movement. Best engineering practices shall be adopted for keeping the minimum clear working space around equipment and clear headroom within main structures and cable trays etc.
- 9.02.21 Space for pipe racks and pipe pedestals shall be considered while planning the layout.
- 9.02.22 Major external functional system shall be so oriented that any maintenance work as well as subsequent construction work can be carried out without any interference and/or hindrance to the operational units.
- 9.02.23 All facilities of the units are to be laid out in close proximity to each other to the extent practicable so as to accommodate all facilities efficiently within the plant boundary.
- 9.02.24 The layout shall also facilitate communication of men and materials between the various facilities both during initial construction and also during subsequent operation and maintenance.
- 9.02.25 Cross over ladders shall be provided at all suitable places wherever pipe/cable (laid over pedestals and floor level) has to be crossed.
- 9.02.26 Hand rails of suitable height and toe guards shall be provided for all platforms/walkways/ladders.
- 9.02.27 Minimum clear gap of 1000mm shall be provided between equipment foundations/columns/pipes/cable racks/pedestals/walls/trenches etc.



- 9.02.28 Minimum clear width of all staircases shall be 1000mm.
- 9.02.29 Easy access to shift material and equipments to and from buildings should be provided.
- 9.02.30 Easy approach for vehicles to handle the equipments near maintenance bay shall be provided.
- 9.02.31 Each equipment room shall be provided with alternate exits in case of fire/accidents as per requirements of factory act and TAC. Further minimum two number fireproof double doors shall be provided in Cable vaults and HT/LT switch gear room.
- 9.02.32 One set of washroom/toilet to be provided in the control room floor of respective buildings. Separate washrooms/toilets at suitable locations shall be provided for male, female and transgender.
- 9.02.33 Pantry with suitable ventilation, sink and power supply points and platforms for induction stove and microwave oven to be provided adjacent to control rooms in respective buildings.
- 9.02.34 Below ground basement rooms shall not be considered.
- 9.02.35 All equipment shall be installed above ground. Below ground installation will not be allowed, but if a below ground installation is unavoidable, then proper maintenance space and dewatering arrangement has to be provided. Collection of oil and dirt in that area has to be avoided and it should be easy to clean such a place.
- 9.02.36 Layout and Landscaping should be aesthetically planned for the project.



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10.00.00 ERECTION, SITE TESTING, COMMISSIONING AND RELIABILITY TEST

- 10.01.00 This section generally covers the minimum requirements of installation, testing and commissioning of various equipments, to be adhered to during the execution of the mechanical, electrical & instrumentation works.
- 10.02.00 Works shall be performed in accordance with this technical specification and various other drawings and schedules submitted and approved by the Owner during the execution and the instructions from Engineer-in-charge or his authorized representatives during the progress of the work.
- 10.03.00 All consumables required for the job shall be ensured by the bidder.
- 10.04.00 Electrical power for testing, commissioning, reliability test and performance guarantee test shall be provided by owner, on the terms and conditions as mentioned in the commercial portion, i.e. Volume-1.



- 10.05.00 All necessary equipments & instruments required to carry out the works, recalibration of the instruments required during loop checking and commissioning shall be done by the bidder.
- 10.06.00 Field quality plans shall be submitted and shall detail out for all the equipments, the quality practices and procedure etc. to be followed by the bidder's site quality control organization during various stages of site activities including receipt of materials/equipments at site, preservation and storage, pre-assembly, erection, pre-commissioning and commissioning.
- 10.07.00 All inspections and tests shall be done as per approved field quality plans and protocols.
- 10.08.00 The Bidder shall provide all necessary means for execution of inspection and testing, according to the requirements.
- 10.09.00 Erection**
- 10.09.01 Erection work shall be carried out in the manner and sequence as agreed with bidder's site in-charge/resident engineer and the Owner/Engineer.
- 10.09.02 Construction and erection shall be planned such that all below ground construction & erection shall be completed first, preferably before rainy season.
- 10.09.03 All existing structures, piping, conduits, equipment and facilities, if any, shall be protected by the Bidder against damage during erection. Any damage caused by Bidder shall be rectified at his cost to the satisfaction of the Owner.
- 10.09.04 As erection proceeds each assembled part before being boxed up with a view to erecting it finally, shall be inspected and approved by the concerned supervisor. If any defect is found out during such inspection, the bidder shall make it good as per directives from owner.
- 10.09.05 All materials such as electrodes, gaskets, bolts, nuts etc., shall be of reputed make and conforming to relevant Indian Standards. Prior approval of Owner will have to be obtained before commencement of work. Manufacturer's test certificate shall have to be provided when called for.
- 10.09.06 Bidder shall furnish all instruments, isotopes, films etc. for conducting radiography and equip himself fully. Necessary operators of all testing equipment shall be provided by the Bidder. Dark room facilities with air conditioners for storing and processing radiography films and equipment, as necessary, shall have to be arranged by the Bidder. The radiography shall be done on any weld (including welds for repair) only after final heat treatment.
- 10.09.07 The equipment shall be placed on respective support, levelled and aligned with precision measuring instruments, checked for proper clearance between moving and stationary parts wherever applicable.
- 10.09.08 The installation of motors shall be carried out along with driven equipment in accordance with manufacturer's instructions and/or as directed by the Owner.
- 10.09.09 Wherever the scope includes control panels, all connections in control panels shall be completed, checked and adjusted to ensure safety and satisfactory operation of the equipment.



- 10.09.10 Particular attention shall be given towards removal of buckles and other forms of distortion. Holes in plate work to assist in erection should be avoided.
- 10.09.11 Misalignment in vertical joints shall not exceed 10% of plate thickness or 1.0 mm, or whichever is larger.
- 10.09.12 Misalignment in horizontal joints shall not exceed 15% of upper plate thickness with a maximum of 2 mm for plate thickness above 8 mm and a maximum of 1.0 mm for plate thickness less than 8 mm.
- 10.09.13 Welding sequence shall be adopted in such a way so as to minimise distortion due to weld shrinkage and shall be got approved from the Owner prior to commencement of work.
- 10.09.14 Welding shall not be carried out on wet surfaces and shall be protected from high winds.
- 10.09.15 **ERECTION PROGRAM AND NOTIFICATION**
- i) The Bidder shall furnish a detailed erection programme taking into consideration the constraints likely to be encountered during various phases of work including interfacing with the existing plant. This erection programme shall be strictly adhered to. The Bidder shall take appropriate steps as directed by the Owner to make up for any slippage from this erection programme and no additional compensation shall be allowed on this account.
 - ii) Before erection commences and not later than three months before start of erection, the Bidder shall submit the proposed erection test program and the commissioning test program with all proposed erection and commissioning tests and checks. Together with the test programs the proposed test procedures have to be submitted.
 - iii) The test programs should consider:
 - a) that the sequence and duration of the proposed activities are logical, realistic and in accordance with safety and permit regulations in force
 - b) that the commissioning of any item of plant would not interrupt the normal operation of the existing plant.
 - c) that allowance for training the Owner's operation personnel during this period has been made.
 - iv) The Bidder has to take care that the test programs are maintained by the erection organization during erection and commissioning.
 - v) The Bidder has to mark all stages, which are subject to the Owner's acceptance and has to notify at least one (1) week in advance when such inspection for acceptance becomes due.
- 10.09.16 **SUPERVISION DURING ERECTION**
- i) The Bidder shall provide at proper time the necessary supervisory engineers, supervisors and other supervisory personnel duly qualified and in sufficient number for transportation, handling, unloading, storage, erection, pre-commissioning and post commissioning etc., start-up, testing and trial operation of plants and equipment.



- ii) The Bidder shall keep a competent representative, who shall be approved by owner, who will be resident Engineer-in- charge and shall remain as In-charge of Bidder's work site and also remain answerable to the Owner for all activities of the Bidder at site. Before his placement at site, the Bidder shall submit his bio-data to the Owner for his approval.
- iii) The resident Engineer-in-charge shall supervise the work of all men of the Bidder working at site. He shall work in complete harmony and co-operation with Owner.
- iv) All statutory rules and labour laws prevailing in the area must be followed by the Bidder.
- v) All the areas shall be maintained clean and organised, both during execution and handover.
- vi) All safety measures against occurrence of accidents must be taken effectively.
- vii) Resident Engineer-in-charge shall not be withdrawn without written permission of the Owner.
- viii) If any of the Bidder's personnel was found unsuitable for the job, the Bidder shall remove him forthwith and a suitable replacement shall be posted to site within a reasonable time. No compensation for withdrawing of unsuitable or unqualified person(s) from site or for posting suitable person(s) to site at any stage of the project shall be allowed by the Owner.

10.09.17 SEQUENCE OF ERECTION WORK

- i) All packing cases and packages shall be opened in presence of the Owner or his authorized representative.
- ii) Each material after stripping from boxes or received loose, shall be carefully inspected, checked with shipping list and identified with erection drawing if necessary. Any short supply and/or damaged part shall be reported forthwith to the Owner in writing. The Bidder shall be completely responsible to make all necessary arrangements, application and follow procedure to process claim on underwriters, obtain replacement repair/rectify and modify as required on all such damaged/defective/lost equipment and material at no extra cost to the Owner in order to execute the work to satisfaction of the Owner within the stipulated contract time. Once the materials are inspected, the same shall be preserved properly and adequately protected from theft and deterioration or damage by rain, storm, dust, water, tampering by casual visitors or workers. The Bidder shall prepare and maintain stores, ledgers and bin cards for all materials in his custody.
- iii) Carrying out all repairs to damages that might have suffered during transit and in subsequent storage and modifications and rectification work and replacement of all lost parts, are under the Bidder's scope.
- iv) Nails and packing strips should be pulled out with suitable appliances and kept separately in container and not thrown away at random. All timber of packing cases shall have to be sorted out and stored properly at a suitable place as directed by the Owner. From time to time packing materials, timber, nails and strips shall be delivered back to the Owner or otherwise disposed of as directed by the Owner.



- v) All timber and packing materials shall remain the property of the Owner.

10.09.18 INSPECTION

- i) After completion of erection and/or installations and before start-up the equipment and all its appurtenances shall be thoroughly cleaned and then, inspected in the presence of the Owner for correctness, soundness and completeness of installation and acceptability for start-up.
- ii) All works to be carried out by the Bidder shall be subject to inspection by the Owner as applicable. The work shall be carried out as per applicable specifications, codes of practice, drawings and instructions of Owner. The Bidder shall provide necessary facilities, instruments, personnel etc., for carrying out the inspection as above and shall comply with the instructions given.
- iii) A check list in triplicate will be furnished for the approval of Owner wherein all items to be checked and necessary instructions will be listed. Inspection and checking shall strictly follow this check list. On completion of the joint inspection and checking two (2) copies of the check list will have to be handed over to the Owner. The check lists after checking will have to be jointly signed by the Bidder's supervisor and the Owner to ensure that all inspection and checking have been properly carried out. However, such endorsement shall not relieve the Bidder from the responsibility in ensuring proper erection and cleaning.
- iv) During inspection all clearance, alignment and important measurements and adjustments as may be directed shall be noted by the Bidder for future reference and guidance. Two (2) copies of such notes shall be delivered to the Owner.
- v) All reports of radiographic examination in a format approved by the Owner shall be submitted to the Owner for his approval and records.

10.09.19 CLEANING

- i) The Bidder shall observe strict cleanliness throughout execution of the work till handover of the plant.
- ii) Bidder shall be in possession of vacuum cleaner for cleaning the internals of machinery under installation. They shall check that all the finished surfaces are greased and covered.
- iii) Before boxing up, the Bidder shall examine carefully to ensure that no foreign material, such as welding rod ends, welding beads, metal chips, rope, working tools, etc., has been left inside any equipment.
- iv) In the case of motors, the following procedure shall be observed:
 - a) Checking and cleaning of bearings and charging/filling of lubricants, wherever necessary.
 - b) Cleaning of core and winding, drying out and cornicing the winding and measurement of air gap for motor assembled at site.
- v) Wherever the scope includes control panels, all withdrawable components shall be taken out and internals shall be cleaned with vacuum cleaner.

10.10.00 Testing and commissioning

10.10.01 GENERAL



- i) The Bidder upon completion of installation of equipments and systems shall conduct pre-commissioning and commissioning activities, to make the facilities ready for sustained safe, reliable and efficient operation.
- ii) The pre-commissioning and commissioning activities including checks, initial operation, trial run and Guarantee tests of the equipment furnished and installed by the Bidder, shall be responsibility of the Bidder.
- iii) All pre-commissioning/commissioning activities considered essential for such readiness of the facilities, including those mutually agreed and included in the Bidder's quality assurance program, as well as those indicated in clauses elsewhere in the technical specifications shall be performed by the Bidder.
- iv) It shall be the responsibility of the Bidder to provide all necessary temporary arrangements, connections, instrumentation and other devices required during start-up and initial operation of the equipment systems which are installed by him.
- v) The Bidder shall provide test instruments, calibrating devices, etc. and labour required for successful performance of these operations. If it is anticipated that the above test may prolong for a long time, the Bidder's workmen required for the above test shall always be present at Site during such operations.
- vi) The Bidder shall also be responsible for flushing & initial filling of all oils & lubricants required for the equipment furnished and installed by him, so as to make such equipment ready for operation. The Bidder shall be also be responsible for supplying such flushing oil and other lubricants unless specified otherwise, elsewhere in these specifications.
- vii) Bidder shall make all arrangements to conduct the commissioning and testing safely and all safety precautions shall be taken appropriately.
- viii) Wastes and effluents generated during these activities shall be suitably disposed off after neutralisation and meeting all statutory requirements, in a manner acceptable to owner and PCB.

10.10.02 TESTING & COMMISSIONING PROCEDURES

- i) Bidder shall prepare and submit equipment/system wise testing and commission procedures, for all equipment/system covered under the contract.
- ii) Commissioning and Testing procedures shall be submitted at least six (6) months prior to actual commissioning/testing; and bidder should ensure that all procedures should be approved by Owner, prior to actual commissioning/testing of the equipment/systems.
- iii) The Bidder shall furnish his recommendations regarding use of various test equipments and instruments and termination/acceptance criteria for testing & commissioning, which in any case shall meet the steam turbine-generator requirements.
- iv) Standard formats for Testing/commissioning procedure are expected to maintain consistency of presentation, content and reporting.
- v) The procedures should contain the following as a minimum:
 - a) Equipment/System details



- b) Design data
 - c) Objective
 - d) Pre-requisites and readiness of associated items
 - e) Proposal – Method and Sequence of Activities (SoA)
 - f) Time duration of each activity
 - g) Inputs & Consumables required – Quantity and quality
 - h) Specification of temporary arrangements, as required
 - i) Safety precautions
 - j) Emergency procedures
 - k) Schemes and drawings, wherever required.
 - l) Completion/Acceptance criteria
 - m) Reference drawings/documents
 - n) OEM approval/acceptance for certain items like valves / control-valves to be included in the commissioning activities, like Steam Blowing.
 - o) Activity Log and commissioning protocol.
 - vi) Commissioning procedures should include all pre-commissioning activities.
- 10.10.03 PRE-COMMISSIONING AND INITIAL TRIAL**
- i) On completion of erection of equipment, each item of the equipment shall be thoroughly cleaned by Bidder and inspected jointly by the Owner/Consultant and Bidder for correctness and completeness of installation and acceptability for initial trials of the equipment by the Bidder & Owner. During the above joint walk down, the list of equipment deficiency & defects shall be prepared and for such a punch list, action shall be initiated by the bidder in agreed time frame.
 - ii) The list of tests to be performed prior to initial trials shall be mutually agreed and included in the Field Quality Plan by Bidder.
 - iii) The purpose of these initial trials is to ensure integrity of all individual equipment for its operation in the system for initial operation.
 - iv) Following the satisfactory completion of inspection, checking and cleaning of a unit, the plant will be placed in test run. During this period, all adjustments and repairs as required shall be made by the Bidder. Protocol shall be made and signature has to be obtained from Owner/ Bidder. On completion of satisfactory test run, the plant will be placed under trial operation.
 - v) Prior to initial trial of any equipment the following shall be checked:
 - a) During erection all required erection tests as well as final erection checks of the mechanical completion of the systems and part thereof have to be performed.
 - b) After successful mechanical completion Mechanical Completion Certificates will be issued.



c) The activities necessary for mechanical completion shall include but not be limited to following testing, as applicable:

- 1) Visual inspection after unloading at site
- 2) Checking of completion of relevant systems
- 3) Proper installation of the equipment and drive where applicable (like for rotating equipment), on the foundation
- 4) Proper alignment of the equipment and drive where applicable (like for rotating equipment).
- 5) Freeness of the rotors of drive and rotating equipment.
- 6) Proper connection of supports, hangers, piping, valves, instruments and other fittings.
- 7) Healthiness of lube oil system, changing and filling as necessary.
- 8) Safety audit
- 9) Testing of site welds (non-destructive examinations)
- 10) Pressure/leak/tightness test
- 11) Pipe line and equipment flushing and cleaning
- 12) Chemical protection of piping systems
- 13) Checking of coating
- 14) Testing of cranes and hoists
- 15) Safety signs and warning signs
- 16) Completion of buildings and civil works
- 17) Test of ventilating and air-conditioning units

10.10.04 PRE-COMMISSIONING TESTING

- i) After installation of all equipment on foundation, alignment tests shall be carried out by the Bidder to check levelling, clearance, eccentricity etc. Measurements will be witnessed and acceptance will be certified by the Owner and/or owner's representative.
- ii) Preconditions for the commissioning are the issue of the Mechanical Completion Certificate and the availability of the accepted commissioning program and the bidder's commissioning procedures.
- iii) Hydro Test, Air & Gas Tightness Test and vacuum tightness test shall be conducted, as applicable, for the entire system/equipment after installation at required pressure. All necessary blanking and spool arrangements for hydro testing shall be furnished by the Bidder. All necessary test pump/temporary piping/temporary tanks etc shall be supplied by the Bidder. On completion of hydraulic test, bidder shall renew the gaskets, if instructed by the engineer.
- iv) Flushing of piping, including oil flushing of control oil system, lube oil system of all rotating equipment and oil flushing of fuel oil system.



- v) Steam blowing & chemical cleaning, as applicable of integral piping of the turbo-generator, piping of auxiliaries like BFP, CEP, Drip pump, interconnecting piping of feed water heating system, Low pressure piping, Power cycle piping & other piping in the scope of the Bidder shall be done.
- vi) The Pre-commissioning checks cover the functional tests of the individual items and their alarm and tripping systems.
- vii) Following general tests shall be included:
 - a) Mechanical equipment
 - 1) Individual pre-commissioning runs/initial trials of all rotating equipment such as pumps, compressors, dosing equipment etc.
 - 2) Functional tests of the mechanical equipment
 - 3) Testing and adjustment of safety devices.
 - 4) Fill test of tanks.
 - 5) All tests and activities pertaining to the heater exchangers as per OEM recommendations and this specification.
 - 6) All test and activities pertaining to auxiliaries like BFP, CEP, Drip Pumps,



11.00.00 PERFORMACE GUARANTEES AND ACCEPTANCE TESTS

- 11.01.00 The term "Performance Guarantees" wherever appears in the technical specification, shall have the same meaning and shall be synonymous to "Functional Guarantees". Similarly the term "Performance Tests" wherever appears in the technical specification, shall have the same meaning and shall be synonymous to "Guarantee/Acceptance Test(s)"; these terms may also have been used interchangeably.
- 11.02.00 After satisfactory completion of the trial operation, and is established, the performance test shall be conducted at site by the bidder.
- 11.03.00 The bidder shall guarantee that the equipment offered shall meet the ratings and performance requirements stipulated for various equipment covered in the specifications. The performance guarantee figures of the equipment/system shall be proved by the bidder during the performance guarantee test.
- 11.04.00 The bidder shall provide guaranteed performance for the complete package and the values guaranteed shall be binding on him.
- 11.05.00 The bidder shall conduct performance test as described in the contract document and prove the guarantees as per mutually agreed & approved procedures.
- 11.06.00 Performance guarantee shall be provided for operation at contract specific site reference conditions as specified and the guaranteed performance parameters of the plant shall be proved by the bidder during the test. Should the results of these tests show any deficiency from the guaranteed value, the Bidder shall modify the equipment as required at no extra cost, to enable it to meet the guarantee
- 11.07.00 The guaranteed performance parameters furnished by the bidder in his offer, shall be without any tolerance values whatsoever. All margins required for instrument inaccuracies and other uncertainties shall be deemed to have been included in the guaranteed figures.
- 11.08.00 The Bidder shall conduct performance tests and demonstrate all the guarantees covered herein during performance guarantee/acceptance test (PG test). The various tests which are to be carried out during the PG test are mentioned in the specification.
- 11.09.00 The tests shall be conducted at the specified load conditions or as near the specified conditions as practicable. The owner/bidder will apply agreed factors to

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compensate for deviation from the designed parameters. The suitable correction curves mutually agreed by the owner and the bidder shall be used.

- 11.10.00 The parameters indicated under 'Correction' shall be guaranteed by the bidder during the performance tests and if the parameters are not attained during the performance tests, bidder shall make all efforts to achieve the parameters.
- 11.11.00 These tests shall be binding on both the owner and the bidder to determine performance of the equipment/system with the performance guarantees data.
- 11.12.00 The Bidder should make the plant ready for the PG tests before start of Trial Operation.
- 11.13.00 Once the Trial Operation starts, No further shutdown is envisaged for preparation of PG test. But, in case of an unavoidable situation, owner will provide required shutdown, on mutually agreed basis.
- 11.14.00 All Category-I Performance Tests shall be conducted along with the Trial Operation; except the following:
- 11.14.01 Coal Mill Wear Parts Warranty
- 11.14.02 Auxiliary Power Consumption for Station Auxiliaries; PG test for Station Auxiliaries Power Consumption can be done along with Unit#2 Initial Operation)
- 11.14.03 PG test of AC System (especially for Auxiliary Power Consumption, under station auxiliaries) shall be carried out by the Bidder within One (1) year of successful completion of trial operation of the respective AC system during summer in the months of March to June. If Unit#2 initial operation falls in these months, then PG test of AC system can be clubbed with Unit#2 initial operation.
- 11.15.00 It shall be responsibility of owner to arrange for start-up power, primary & secondary fuel, water and load dispatch clearance (to export power) during PG tests.
- 11.16.00 The performance tests shall be performed using only the normal number of operating staff provided by the owner. Bidder, vendor or other subcontractor personnel shall only guide wherever required and collect necessary data for compiling the reports.
- 11.17.00 At all times during the performance tests the emissions and effluents from the plant shall not exceed the guaranteed emission and effluent limits.
- 11.18.00 The duration of the Performance Guarantee Test of the plant at the rated capacity shall be mutually agreed. However, a stability period of 2 hours before commencement of test and 2 hours test period followed by another 2 hours stable period shall be maintained.
- 11.19.00 All efforts shall be made for successful completion of the PG test along with Trial Operation of the unit on designated fuel or as per the time frame specified for a particular equipment/ plant/ system in the Technical specifications. Delay in conductance of the test beyond this period will not be normally permitted by the owner. In the event of owner agreeing to conductance of such tests after three months, for reasons not attributable to the owner, as assessed by the owner, no factor for ageing shall be considered for computing performance of the equipment.

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11.20.00 The guarantee tests shall be conducted by the bidder at site in presence of owner on each unit individually.

11.21.00 All costs associated with the tests including cost associated with the supply, calibration, installation and removal of the test instrumentation shall be included in the contract price.

11.22.00 Any special equipment, tools and tackles required for the successful completion of the performance tests shall be provided by the Bidder free of cost.

11.23.00 Performance Guarantee Tests on the equipments/systems not covered in this section shall be carried out as per the procedure/test codes specified in respective detailed section.

11.24.00 Measurements

11.24.01 All instruments including flow nozzles as necessary for conductance of PG tests shall be installed prior to the start of initial operation. No shutdown shall be allowed for installation of PG test instrument/ flow nozzle etc. Any advanced class instrument system such as those using electronic devices or mass flow technique shall be arranged by the Bidder, if required. However, same shall be installed before start of initial operation of unit.

11.24.02 All test instrumentation as required for the Performance Guarantee Test shall be provided by the Bidder free of cost. Special / Precision instruments required for Performance Guarantee Test shall, however, be arranged by him and shall be returned to him after successful completion of the tests. All test instrumentation shall be in accordance with the applicable code.

11.24.03 All the necessary instruments (in duplicate) required for the tests shall be furnished by the bidder so as to meet the accuracies specified in the codes.

11.24.04 Any advanced class instrument system such as those using electronic devices or mass flow technique shall be arranged by the bidder, if required.

11.24.05 The essential mandatory requirements for instruments, methods and precautions to be employed shall be in accordance with the requirements specified in the respective codes.

11.24.06 Instruments for PG test and instruments for process control of similar applications are envisaged to be of same make and model having same accuracy level. However, instruments for PG tests are also acceptable as per standard and proven practice of the Bidder/OEM and in such case; instruments for process control shall be as per requirements of the specification.

11.24.07 All the instruments shall be calibrated by a certified body (an accredited independent test institute) before and after the tests Instruments need to be calibrated before and after the test to identify the drift which is to be used for applying corrections to the calibration which is estimated based on the average of the pre-test and post-test calibrations

11.24.08 All the instruments including the flow nozzle shall be calibrated by the Bidder before initial operation in a reputed international institute. All calibrations reports shall be made available prior to the start of initial operation and calibration certificates in original submitted to Employer. All calibrations shall be made



available prior to the test and calibration certificates in original submitted to Owner at least 15 days before conductance of the test for Owner's approval.

- 11.24.09 The calibration certificates shall be considered valid for a period of not more than six (6) months from the date of its calibration or as per the guidelines of NABL accredited Calibration agency.
- 11.24.10 The instruments shall be sealed after calibration by calibrating lab. The percentage calibration error/deviation should not be more than accuracy class of the instrument. Calibration low beta ratio throat tap nozzle assembly including flow straightner, upstream and down stream machined straight lengths, for main condensate flow measurements shall be as per ASME PTC6.
- 11.24.11 All test instruments and calibration procedures shall be duly approved by the Owner. Batch calibration shall not be accepted. Calibration before and after test and installation of the test instrumentation for the test shall be the Bidder's responsibility.
- 11.24.12 Control system loop tuning required to limit the variation of parameters during performance guarantee testing shall be completed prior to Trial Operation / PG Test.
- 11.24.13 All PG test process parameters shall be made available in DDCMIS.
- 11.24.14 The protecting tubes, pressure connections and other test connections required for conducting guarantee test shall conform to the relevant codes.
- 11.24.15 Tools and tackles, thermowells (both screwed and welded) instruments/devices including flow devices, matching flanges, impulse piping & valves etc. and any special equipment, required for the successful completion of the tests, shall be provided by the bidder; with all costs included in the contract price.
- 11.24.16 For determination of primary flow to the turbine, a calibrated low Beta-ratio throat-tap nozzle assembly shall be installed permanently in condensate line prior to initial operation; same shall be also used for process control.
- 11.24.17 Secondary flow devices shall be calibrated flow nozzle / orifice plate as per ASME PTC 19.5.

11.25.00 Test Documents

11.25.01 TEST PROCEDURE

- i) Bidder shall submit all PG test procedures, as per latest codes / standards, meeting the specification requirements, along with sample calculations and detailed activity plan of preparation (including test instrumentation), conductance and evaluation of Guarantees.
- ii) The test procedure shall highlight the anticipated date for the test, list of instruments and their accuracies, arrangement and form of the tests.
- iii) The procedure shall include the following for each test or group of tests:
 - a) Objective of the test
 - b) Prerequisites and system readiness checklist.
 - c) Safety and emergency precautions and preparations required; and checklist.



- d) Various guaranteed parameters & tests as per contract.
- e) Method of conductance of test and test code.
- f) Duration of test, frequency of readings & number of test runs.
- g) Method of performance calculation and formulae.
- h) Correction calculations, curves and respective equations for graphs to be fed for the online computation.
- i) Instrument list consisting of range, accuracy, least count, and location of instruments.
- j) Scheme showing measuring points.
- k) Sample calculation
- l) Acceptance criteria.
- m) The sequence of the tests to be conducted.
- n) The time duration of each test
- o) The number of test runs
- p) A list of instruments that will be used for each test. The list shall define which instruments are:
 - 1) Special test instruments,
 - 2) Certified,
 - 3) To be calibrated before and after each test to identify the drift which is to be used for applying corrections to the calibration which is estimated based on the average of the pre-test and post-test calibrations,
 - 4) Check instruments,
 - 5) Station supply instruments
 - 6) Schematic diagram showing all test points and cross referenced to the instrument list and
 - 7) Method of data logging. Data logging thro' satellite communication is not permitted.
- q) All formulae, calculations, conversion factors, curves, correction curves etc., to be used in the conducting of the tests and the calculations of the test results. All such items shall be to a accuracy level of four decimals.
- r) Sample test reports to data sheets and all specific result sheet forms that will be used for the test.
- s) Special conditions if any.
- t) Any other information required for conducting the test and analysing the test results.



iv) The provisions outlined in the ASME performance test code or other International and Indian approved equivalents shall generally be used as a guide for all the above test procedures unless specified otherwise in the specification.

v) All tests shall be carried out and acceptance shall be according to mutually agreed procedures.

11.25.02 TEST REPORTS

i) After the conductance of PG test, the test results shall be calculated in Bidder's PG test program/software. The correction curves shall be fed/inbuilt in the PG test program/software. Provision of manual entry of offline data, which cannot be captured online (such as Relative Humidity, Atmospheric pressure, Coal Analysis, Un-burnt carbon in fly ash and bottom ash, Bottom ash / Fly ash collection in various hoppers, Flue gas analysis (grid result) etc.) shall be provided.

ii) The Bidder shall prepare test reports for each performance test in which the methods followed, instrument readings, graphs, observations, final results obtained etc., shall be recorded.

iii) Evidence of the test data shall be issued by Bidder after who shall also perform the necessary calculations. The basic information and figures to be used for the tests shall be compiled by Bidder.

iv) The details of all measuring/recording meters, test instrumentation such as class of accuracy, make etc. shall be covered in the trial operation and performance test reports.

v) The reports shall contain a summary of any tests and certifications as well as results, recorder charts, observations and comments derived from the testing and turnover procedure as applicable.

vi) For each of the Performance & Guarantee Tests, the Bidder shall evaluate the test figures and compile the Test Report containing a complete analysis of the test results.

vii) Bidder shall examine and sign the reports and certificates of all tests. The Owner shall review and comment on all test protocol and procedures, reports and certificates.

viii) After the conductance of Performance test, the Bidder shall submit the detailed test evaluation report of Performance test results to Owner promptly but not later than two (2) weeks from the date of conductance of Performance test. Preliminary test reports shall be submitted to the Owner after completing each test run. Six (6) hard copies and soft copies as desired by owner, of each test report of final conducted test on each equipment/plant/system shall be submitted to Owner for approval.

11.26.00 The Bidder shall conduct performance test and demonstrate all the guarantees covered herein under Category I, II & III.

11.27.00 Should the results of these tests are at adverse side from guaranteed values, the Bidder shall modify the equipment as required to bring it to meet the guarantees. In such cases, the performance tests shall be repeated within one month from the date on which the equipment is made ready again for tests. All costs of

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modifications including labour, material and the cost of additional testing to prove that equipment meets the guarantee shall be borne by the Bidder.

- 11.28.00 If, the PG test fails i.e. the Functional Guarantees are not met, either in whole or in part, the Owner may, at its sole discretion, provide the Bidder notice, setting forth particulars of such defects or failure. The Bidder shall, forthwith upon receipt of such notice, at his own cost and expense, within a reasonable period allowed by the owner, make such changes, modifications and/or additions to the Plant and Equipment or any component thereof, as may be necessary to meet the Functional Guarantees. The Bidder shall notify the Owner upon completion of the necessary replacement, changes, modifications and/or additions, shall request the Owner to facilitate the repetition of the Guarantee Tests until the Functional Guarantees have been met.
- 11.29.00 If, the PG test fails i.e. the level of tested functional/performance guarantee parameters is beyond the acceptable shortfall limits, either in the whole or in part, even after the expiry of any additional time granted by the Owner (i.e. after carrying out necessary changes, modifications, and/or additions), the Owner may, at its sole discretion, exercise anyone of the following options:
- 11.29.01 FOR CATEGORY-I GUARANTEES – PERFORMANCE GUARANTEES UNDER LIQUIDATED DAMAGES
- Reject the equipment/system/plant and recover from the Bidder the payments already made; Or
 - Accept the equipment/system/plant after levying liquidated damages as specified in Volume - I, The LD for shortfall in performance shall be levied separately for each unit. The penalty values and acceptable shortfall limits are applicable for per unit basis except for total auxiliary power consumption (as total auxiliary power consumption shall be guaranteed for the two units). The penalty shall be pro-rated for the fractional parts of the deficiencies. The performance guarantees coming under this category shall be called 'Category-I' Guarantees
- 11.29.02 FOR CATEGORY-II GUARANTEES – PERFORMANCE GUARANTEES UNDER REJECTION
- Reject the equipment/system/plant and recover from the Bidder the payments already made. Conformance to the performance requirements under Category-II is mandatory.
- 11.29.03 FOR CATEGORY-III GUARANTEES – PERFORMANCE GUARANTEES UNDER COMPULSORY CORRECTION.
- Reject the equipment/system/plant and recover from the bidder the payments already made; Or
 - Accept the equipment/system after assessing the deficiency in respect of the various ratings, performance parameters and capabilities and recover amount equivalent to the damages as determined by the owner, from the contract price. Such damages shall, however be limited to the cost of replacement of the equipment(s) / system(s), replacement of which shall remove the deficiency so as to achieve the guaranteed performance. These parameters/capacities shall be termed as 'Category-III' Guarantees

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11.30.00 GUARANTEES UNDER CATEGORY – I (PERFORMANCE GUARANTEES UNDER LIQUIDATED DAMAGES) ARE AS FOLLOWS:

11.30.01 UNIT HEAT RATE AT 100% TMCR LOAD

- i) This will be the Guaranteed Heat Rate in kcal/kWhr, at 660MW under rated steam conditions at 33 deg.C cooling water inlet temperature and minimum 10 deg.C temperature rise across the condenser (optimized condenser vacuum), with zero make-up.

11.30.02 TG OUTPUT AT VWO CONDITION

- i) Continuous TG output of 693 MW unit load (i.e. 105% of rated load) under rated steam conditions at 33 deg.C cooling water inlet temperature and minimum 10 deg.C temperature rise across the condenser (optimized condenser vacuum), with zero make-up.

11.30.03 AUXILIARY POWER CONSUMPTION

- i) Power consumption of all unit & station auxiliaries shall be taken for continuous unit operation at 660 MW (i.e. 100% rated load) under rated steam conditions and at guaranteed condenser pressure with 0% make-up with design coal.
- ii) Note: Power consumption of each of the pump/fan/compressors/ Conveyors etc. wherever mentioned shall be measured with its own drive at the switchgear end.

11.30.04 STEAM GENERATING CAPACITY

- i) Steam generating capacity in Tons/hr of steam at rated steam parameters at superheater outlet & rated steam temperature at reheater outlet (with any combination of mills working as per Owner's discretion) with the coal being fired from within the specified range in Volume – II, Section – 1, Project Information.

11.30.05 AVERAGE CONDENSER PRESSURE

- i) Average Condenser pressure in mm Hg (abs) measured at 300 mm above the top row of condenser tubes with 660 MW output, 0% make up, design CW temperature and design CW flow.

Note: The condenser pressure measurement while conducting the guarantee tests from (i) to (iv) above shall be measured at 300 mm above the top row of condenser tubes.

11.30.06 APH LEAKAGE

- i) APH leakage; not more than 8%.

11.30.07 LIMESTONE CONSUMPTION RATE

- i) Limestone consumption of FGD system in kg/hr, while firing worst coal under guarantee point conditions.

11.30.08 AMMONIA (ANHYDROUS) CONSUMPTION RATE

- i) Ammonia consumption of SCR system in kg/hr under guarantee point conditions.

11.30.09 FOR THE ABOVE PURPOSE, RESPECTIVE (CAT-I) PERFORMANCES / GUARANTEES WILL BE COMPUTED AND ESTABLISHED AS FOLLOWS:

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- 2) Cooling water inlet temperature of 33 °C, and minimum 10 deg.C temperature rise across the condenser.
- 3) Generator power factor of -0.85
- ix) *Steam generating capacity*
 - a) Steam generating capacity in T/hr of steam at rated steam parameters at superheater outlet & rated steam temperature at reheater outlet (with any combination of mills working as per Owner's discretion) with the coal being fired from within the range specified at the following conditions:
 - 1) BMCR/VWO condition
 - 2) TMCR conditions
 - x) *Auxiliary Power Consumption(APC)*
 - a) The respective Auxiliary Power Consumption for Unit and Station (2x660MW BTG Package) are to be calculated in isolation to calculate the respective guaranteed power consumption as is illustrated hereunder: The guaranteed auxiliary power consumption shall be sum of the calculated Unit and Station Auxiliary Power Consumption.
 - b) Unit Auxiliary Power Consumption
 - 1) The unit auxiliary power consumption shall be calculated using the following relationship, with design coal-

$$P_{AU} = P_U + T_L \text{ (Unit)}$$

Where,

P_{AU} = Guaranteed Unit Auxiliary Power Consumption

P_U = Power consumed by the auxiliaries of the unit under test

T_L = Losses of the Generator transformers and Unit Transformers supplied by bidder based on works test reports. While guaranteeing the auxiliary power consumption the bidder shall necessarily include all continuously operating unit auxiliaries.

- 2) The power consumption (P_U) of entire unit auxiliaries fed from unit transformers shall be measured at the incomers of respective unit boards. Suitable correction for auxiliaries not in service at the time of this measured power consumption like MDBFP etc, shall be done on as per the technical specification. If GCB scheme is adopted, suitable corrections for station auxiliaries shall be done.
- 3) All unit auxiliaries required to be operated to continuously the plant at the rated load of 100% TMCR have to be considered. The auxiliaries to be considered shall include but not be limited to the following:
 - Unit Auxiliaries to be considered for calculating P_U
 - ◆ Turbine generator and auxiliaries
 - ◇ Turbine unit oil purifier



- ◆ Balance of plant - Unitised systems
 - ◇ ACW (booster) pumps of the unit
 - ◇ DMCW pumps to supply cooling water on the primary (DM) side of the plate type heat exchangers in the closed loop Equipment cooling (Unit auxiliaries) water system.
 - ◇ Other Unit auxiliaries (Bidder to list all other continuously/intermittently running equipment)

- Electrical system
 - ◆ Losses in Bus ducts (at rated load conditions)
 - ◇ Isolated phase bus duct (IPBD)
 - ◇ Segregated phase bus duct (SPBD)
 - ◆ UPS power consumption (at rated load condition)
 - ◆ DC System power consumption (at rated load condition)
 - ◆ GCB Losses of Unit : Losses and fan power for Generator Circuit Breaker (if applicable)
 - ◆ Other Unit auxiliaries (Bidder to list all other continuously/intermittently running equipment)

4) Transformer losses (for Unit)

- Transformer losses (at rated capacity) shall include –
 - ◆ Iron loss
 - ◆ Copper loss
 - ◆ Cooler pump and fan loss
- Following transformers are included:
 - ◆ Generator Transformer losses (at rated Load Condition)
 - ◆ Unit auxiliary transformer losses (at rated load conditions)
 - ◆ Station transformer losses (at Unit rated load conditions)
 - ◆ Losses in all other service/auxiliary transformers (at rated load conditions)

- 5) The bidder shall furnish a list of equipment to be covered under Unit auxiliary power consumption, which shall be subject to Owner's approval.
- 6) The bidder shall ensure that power supply to all such equipment to be covered under unit auxiliary power consumption is fed from unit board of the respective unit.
- 7) The measurement for guaranteed auxiliary power consumption shall be carried out during ESP collection efficiency test. The method for computing the power shall be as described below:-



- Power consumption of ESP will be measured pass wise and for one pass/stream (Say ESP-A) at a time with the help of energy meter in ESP MCC.
 - Energy meter reading will be taken before starting the collection efficiency test and after completion of collection efficiency test.
 - Before starting collection efficiency test, note down energy meter readings for period t1 i.e. E1. The power consumption shall be $W1=E1/t1$.
 - During the collection efficiency test the total energy fed in to ESP MCC of one pass (say ESP-A) will be measured during entire period of collection efficiency test i.e. E2. Total time period (t2) of test shall be noted. The power consumption shall be $W2=E2/t2$. During the test all hopper heaters of all ESP passes will be in ON condition and set point temperature shall be kept 5 °C above the flue gas temperature.
 - Measured power consumption for one ESP pass (say ESP-A)= $(W2-W1)$
 - Measured Electrostatic Precipitator power of one unit= Power of (ESP-A + ESP-B + ESP-C + ESP-D + ESP-E + ESP-F)
 - Number of stream & fields shall be as per the PG test of ESP as detailed elsewhere.
- 8) Guaranteed Unit Auxiliary Power Consumption of FGD system shall be taken by considering the additional pressure drop in the FGD system during FGD SO₂ removal efficiency test at specified guarantee point conditions. For this purpose, difference of FGD system pressure drop during FGD SO₂ removal efficiency test and that at Unit Auxiliary Power Consumption test shall be loaded as additional Auxiliary Power Consumption.
- Generation from roof top solar during the test period shall be added to the total measured power consumption.
- c) Station Auxiliary Power Consumption
- 1) The station auxiliary power consumption shall be calculated using the following relationship, with design coal-

$$P_{AS} = P_S + T_L \text{ (Station)}$$

&

$$P_S = \text{SUM} (P_i \times D_i)$$

Where,

P_{AS} = Guaranteed Station Auxiliary Power Consumption

P_S = Total Power Consumption, while running the units at 100% design load for all auxiliaries of the (2x660MW) station, supplied by the Bidder under this Package.



P_I = Power consumed by each station auxiliary

D_I = Duty factor to be considered for each station auxiliary

T_L = In this case (Station) - Transformer Losses of the Station transformers and that of any other Transformers associated with station auxiliary power supply system (excluding those in Unit system like GT, UT, UAT, UST etc.) and shunt reactor supplied by bidder, for meeting station auxiliary power supply, based on works test reports.

- 2) Losses of transformers shall be considered based on the works test reports as per the criteria specified in subsequent clauses under the subheading Transformers.
- 3) While guaranteeing the station auxiliary power consumption the bidder shall necessarily include all the station auxiliaries running at full load with duty factors as have been defined herein.
- 4) Common auxiliaries/system for both units such as Fire Protection System, Illumination, and HVAC etc shall be apportioned for individual units during testing & calculation.
- 5) The station auxiliaries that shall be running during the guarantee test for calculating " P_s " shall include but not be limited to the following:
 - Plant Instrument and Service Air Compressors & Air Drying Plant
 - ◆ Instrument Air Compressors (All Normally Running (' N_{IA} ' Nos.)) – Duty Factor=0.6
 - ◆ Service Air Compressors (All Normally Running (' N_{SA} ' Nos.)) – Duty Factor=0.35
 - ◆ ADP Heaters (if applicable) (All Normally Running (' N_{IA} ' Nos.)) – Duty Factor=0.5
 - ◆ ADP Blowers (if applicable) (All Normally Running (' N_{IA} ' Nos.)) – Duty Factor=1.0
 - ◆ Power consumption at rated duty point for compressors to be arrived based on shop test and power consumption at rated duty point for Air Drying plant to be arrived based on site test.

- Air Conditioning System
 - ◆ Power consumption at motor input terminals of working units (i.e. excluding stand-by) at its rated duty point of Chilling machines / VAM machine, Chilled water Pumps, Condenser water Pumps, Air handling unit (AHU) fans, cooling tower fans and other auxiliaries for the Air conditioning system of main plant building, FGD control room, ESP control room of each units, service building. Power consumption at motor input terminals of working units (i.e. excluding stand-by) at its rated duty point of compressor and condenser fans of air cooled condensing unit, Air handling unit (AHU) fans for the Air



conditioning system of auxiliary plants like ESP control rooms, FGD control rooms, etc. Power consumption at motor input terminals of centrifugal fans of mechanical ventilation system.

- ◆ Power consumption at rated duty point for water cooled chillers & air cooled condensing units shall be based on site test and for other drives like chilled water pumps, Condenser water Pumps & AHU/centrifugal fans shall be based on shop test.
- Ventilation System
 - ◆ Power consumption at motor input terminals of working units (i.e. excluding stand-by) at its rated duty point of Ventilation Fans (including Air Washers), Air Washer Water Pumps,
- Auxiliary Water System Pumps (Working Pumps)
 - ◆ Service water pumps
 - ◆ Potable water pumps
 - ◆ DM water transfer pumps
 - ◆ Waste water transfer pumps
 - ◆ Any other pump/drive required for continuous operation of the plant.
- Fuel Oil System
 - ◆ LDO forwarding/pressuring pumps – Duty factor – 0.5
- Plant Illumination
 - ◆ Indoor Lighting
 - ◆ Outdoor Lighting – Duty factor – 0.4
- DMCW / ECW system for common auxiliaries
 - ◆ ECW system for common station auxiliaries (as provided). Total power consumption of all equipments (excluding envisaged standby ones) shall be included.
- Transformers
 - ◆ Transformer losses (TL) shall be considered as per following (as applicable)-
 - ◇ GT - 100% no load loss, 54% of Copper losses & 100% Cooler Loss.
 - ◇ ST– 100% no load loss, 8% of Copper losses & 9% Cooler Loss.
 - ◇ UT – 100% no load loss, 52% of Copper losses & 50% Cooler Loss.
 - ◇ Aux/ LT Outdoor/ LT Indoor Transformer: 100% no load loss & 25% of Copper losses

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- a) Guaranteed Ammonia consumption rate (in Kg/hr/unit, 99.5 wt %), at 100% TMCR, for firing design coal, shall be demonstrated. The ammonia consumption rate shall be measured during the test for SCR efficiency for control of NO_x emission.
- b) Maximum NO_x emission (thermal as well as fuel) measured as NO₂ from the Steam Generator unit shall not exceed 70 mg/Nm³ (at 6% O₂ dry at stack inlet) for design coal specified; at 100% TMCR continuous operation provided the minimum catalyst inlet temperature required for ammonia injection is maintained.

11.31.00 Guarantees under Category – II (Performance Guarantees under rejection) are as follows:

11.31.01 NO_x EMISSION

- i) It shall be guaranteed that, total NO_x emission from the unit shall be less than 70 mg/Nm³ (6% O₂ dry at stack inlet), at 100% TMCR, with design coal.
- ii) The emission shall be measured during steam generating capacity test. The bidder shall furnish the methodology of measurement and demonstration of variations w.r.t. load up to 50% of total load.

11.31.02 SO_x EMISSION

- i) It shall be guaranteed that total SO_x emission from the unit shall be less than 70 mg/Nm³ (6% O₂ dry at stack inlet), at 100% TMCR, with worst coal.

11.31.03 PARTICULATE MATTER EMISSION

- i) It shall be guaranteed that, with one field out of service in each stream/pass, the particulate emission from ESP at 100% TMCR load and worst coal firing shall be less than 27 mg/Nm³ (6% O₂ dry at stack inlet). The corresponding ESP efficiency shall be worked out.

11.31.04 NOISE LEVEL

- i) All the plant, equipment and systems covered under this specification shall perform continuously without exceeding the noise level over the entire range of output and operating frequency specified in the technical specifications.

11.31.05 FOR THE ABOVE PURPOSE, RESPECTIVE (CAT-II) PERFORMANCES / GUARANTEES WILL BE COMPUTED AND ESTABLISHED AS FOLLOWS:

- i) Particulate Matter Emission from Electrostatic Precipitator
 - a) The performance/acceptance tests shall be carried out in accordance with method-17 of EPA (Environmental Protection Agency of USA) code. The details of the test shall, however be mutually agreed upon between the Owner and the Bidder.
 - b) The particulate emission from ESP shall not be more than 27 mg/Nm³ (6% O₂ dry at stack inlet) under guarantee point condition at 100% TMCR load with worst coal firing. The corresponding ESP efficiency shall be worked out.

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- a) The performance tests shall be carried out in accordance with ASME PTC 40 (2017) code.
- b) The details of the test shall, however be mutually agreed upon between the Owner and the Bidder.
- iii) Noise Levels
 - a) 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 BS EN 61672-1, 2 & 3 / IS 15575.
 - b) 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.
 - c) A minimum of 6 points around each equipment, shall be covered for measurement. Additional measurement points shall be considered based on the applicable standards and the size of the equipment. The measurement shall be done with slow response on the A-weighting scale. The average of A-weighted sound pressure level measurements expressed in decibels to a reference of 0.0002 micro bar shall not exceed the guaranteed value. Corrections for background noise shall be considered in line with the applicable standards. All the necessary data for determining these corrections, in line with the applicable standards, shall be collected during the tests.

11.32.00 Guarantees under Category – III (Performance Guarantees under compulsory correction) are as follows:

11.32.01 START-UP

- i) Start-up time (upto full load), and loading capabilities for the complete unit (boiler, turbine and generator together) for cold start, warm start and hot start conditions as agreed shall be demonstrated, ensuring that the various turbine operational parameters like vibration, absolute and differential expansion, eccentricity and steam metal temperature mismatch etc. are within design limits.

11.32.02 UNIT LOAD RAMP RATE CAPABILITY

- i) Individual unit load ramp rate capability shall be demonstrated as per the requirements of the specification, ramp-up up to 100% load and ramp down up to minimum continuous operating load; while maintaining the parameters within prescribed limits.

11.32.03 MINIMUM CONTINUOUS LOW LOAD OPERATION

- i) Minimum continuous low load operation, without oil support, when firing with the coals from the range identified. The Bidder shall demonstrate that with any combination of mills/adjacent mills in service (to Owner's choice) the Steam Generator does not require oil firing for stable boiler operation at the minimum specified load.

11.32.04 STEAM GENERATOR AND AUXILIARIES



- Hoisting
- Long travel

vii) *Air conditioning system in each area*

- a) Capacity and discharge pressure of chilled water pumps, condenser water pumps at its rated duty point. Parallel operation of pumps
- b) Capacity and static pressure of AHU fans at its rated duty point.
 - 1) Capacity (TR) of A/C system of Main Plant Area (TG Building), A/C system of Service and A/C system of ESP/FGD control rooms.
- c) Auxiliary power consumption
- d) Inside room conditions during summer, for all air conditioned areas.
- e) Vibration and noise level of equipment.

viii) *Ventilation system in each area*

- a) Capacity and static pressure of centrifugal fans, roof exhausters at its rated duty point of Ventilation system.
- b) Auxiliary power consumption
- c) Inside room conditions
- d) Capacity and discharge pressure of pumps of air washer units and UAF units at its rated duty point of Ventilation system.
- e) Vibration and noise level of equipment.

ix) *CW Chemical Treatment*

- a) The bidder shall guarantee that the program offered shall meet the performance requirements stipulated for CW System. Also, the bidder shall demonstrate the guaranteed chemical consumption proposed in the bid, during the contract period.
- b) For the purpose of verifying the guarantees on scale, a deposit monitor/test heat exchanger/fouling monitor shall be provided by the bidder stimulating the condenser operating conditions. The deposit monitor shall be weighed in new and clean condition and then weighed again on monthly basis and after completion of the test period. Prior to commencement of treatment program and after chemical cleaning of condenser tubes, the fouling factor shall be calculated for each condenser of 2 x 660 MW units.
- c) The fouling factor shall also demonstrate the cleanliness of condenser tubes by visual examination of the same.
- d) Corrosion coupons reflecting the metallurgy of the system components shall be supplied and installed by the Bidder to measure guaranteed corrosion value and corrosion rate shall be determined based on observations on monthly basis after completion of six months.
- e) Guarantee Values of Scale, Corrosion, Fouling & Bio Fouling
 - 1) Cumulative Corrosion Rate on Mild Steel < 3 mils/year

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2) Cumulative Corrosion Rate on Stainless Steel < 0.1mils/year 3) Cumulative Corrosion Rate on Cu/Ni < 0.3 mils/year. 4) Cumulative Scaling Rate of Internal Tube Surface Area of Condenser <15mg/dm²/year 5) Fouling Factor: Deterioration in Heat Transfer Coefficient shall not be more than 5% of the original value just before commencement of the treatment program. 6) TVC (Total Viable Count) (Micro Biological Counts) < 1.2 x 100000 counts/ml of circulating water. 7) SRB (Sulphate Reducing Bacteria) <100 organisms/100 ml of circulating water. f) Dosing capacity of all dosing pumps shall be demonstrated. 11.32.11 ELECTRICAL SYSTEM i) As applicable and/or as specified in the technical specification in electrical Section 11.32.12 CONTROL AND INSTRUMENTATION i) Performance guarantee tests for closed loop control system shall be carried out at site to verify the integrated performance of the total plant C&I and to verify as to whether all the important parameters remain within stipulated permissible limits under all the operating conditions. In case during this tests or otherwise it is observed that the behaviour/response of Bidder's system (drives actuators/valves etc.) is not satisfactory/acts as a limitation/restriction in achieving the permissible limits, the bidder shall carry out all required modifications rectification etc., in his system whatsoever so that the permissible limits can be achieved. He shall also depute his experts for associating in the above tests and also for carrying out the necessary modifications, rectification etc. ii) Further the Performance guarantee tests shall be as applicable and/or as specified in the technical specification in Control & Instrumentation section. 11.32.13 AUTOMATIC ON-LINE TURBINE TESTING (ATT) SYSTEM On-load testing of turbine protective equipment without disturbing normal operation and keeping all protective functions operative during the test 11.32.14 MAKE-UP WATER Bidder shall specify the amount of make-up water required at TMCR and the conditions being the basis for his calculation. Bidder will be required to guarantee the amount. 11.32.15 VIBRATIONS Bidder shall guarantee that the vibration levels as stipulated elsewhere in this specification will not be exceeded under any operating condition. 11.32.16 PLANT AVAILABILITY GUARANTEE i) Bidder shall guarantee the availability of the plant as a whole (BTG Package) to be demonstrated during the Warranty period.		
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12.00.00 SITE HEALTH AND SAFETY MANAGEMENT

- 12.01.00 Safety is to be given utmost priority. Safety is one of the most important philosophies to be strictly followed, while execution of this project. All precautions shall be taken by the bidder to avoid any unsafe incidents, including injury to personnel involved in installation of this project, material damage and environmental damage. Bidder will be completely responsible for any consequential damage arising out of such unsafe acts/incidents by the bidder or bidder's sub-contractor.
- 12.02.00 Bidder should follow all the safety regulations / norms as imposed by the Law/Authority/factory inspectorate /owner.
- 12.03.00 Bidder shall require his employees to wear suitable personal protection equipments (PPEs) like hard hats, safety shoes/boots and safety reflective jacket at all times when they are inside the plant area. Hard hats, safety shoes and safety jackets with reflective stripes shall be mandatory for all site personnel. Safety gumboots shall be used while working in waterlogged or slushy area.
- 12.04.00 All workers, when going to or from place of work in the plant only the prescribed walkways, paths or cross-overs shall be used. Rail-road crossing warnings shall be followed.
- 12.05.00 The bidder shall be responsible for:
- 12.05.01 The management of safety organisation at site for implementation of health and safety at site
- 12.05.02 The identification of site hazards and assessment of risks and mitigating the same
- 12.05.03 The arrangement of emergency plans, safety inspections and audits.



- 12.05.04 The system of notifying all employees, of the site safety plan, method statements and site safety rules.
- 12.05.05 Imparting safety induction training to all workers involved in the project, directly or indirectly under him.
- 12.05.06 Conducting safety review meetings
- 12.06.00 The bidder shall ensure the safety of all workmen, materials and equipment either belonging to him or to others working at site under him. He shall observe safety rules & codes applied by the Owner at site without exception.
- 12.07.00 The bidder shall notify the Owner of his intention to bring to the site any equipment or material which may create hazard. The Owner shall have the right to prescribe the conditions under which such equipment or material may be handled or prohibit the use of the same for safety reasons. Bidder shall abide by Owner's decision in such cases. No claim for compensation due to such prohibition will be entertained by the Owner.
- 12.08.00 Storage of petroleum products & explosives for construction work shall be as per rules and regulations laid down in Petroleum Act, Explosive Act and Petroleum and Carbide of Calcium Manual. Approvals as necessary from Chief Inspector of Explosives or other statutory authorities shall be the responsibility of the Bidder.
- 12.09.00 All requisite tests and inspection of handling equipment, lifting tools & tackle shall be periodically done by the Bidder and all records shall be maintained. Defective equipment shall be removed from service. Any equipment shall not be loaded in excess of its recommended safe working load.
- 12.10.00 All combustible waste and rubbish shall be collected and removed from the work site at least once each day. Use of undercoated canvas, paper, corrugated paper, fabricated carton, plastic or other flammable materials shall be restricted to the minimum and promptly removed.
- 12.11.00 The bidder shall provide adequate number of fire protection equipment of the required types for his stores, office, temporary structures, labour colony, etc.
- 12.12.00 Personnel trained for fire fighting shall be made available by the Bidder at site during the entire period of the contract.
- 12.13.00 All electrical appliances used in the work shall be in good working condition and shall be properly earthed. No maintenance work shall be carried out on live equipment. The Bidder shall maintain adequate number of qualified electricians to maintain his temporary electrical installation safely.
- 12.14.00 All accidents resulting in injury shall be reported to the Owner promptly. Owner's safety rules, regulations and directives shall be followed and reports thereon shall be submitted as and when required.
- 12.15.00 Female workers shall not be allowed to work beyond 6 PM.
- 12.16.00 The Bidder shall provide necessary first aid facilities for all his employees, representatives and workmen working at the Site. Enough number of Bidder's personnel shall be trained in administering first aid.
- 12.17.00 First aid kits shall be available at bidder's site office and other suitable locations.



12.18.00 Bidder shall ensure that proper treatment of injuries is immediately available either as such or in the form of constantly available transportation to a source of such treatment.

12.19.00 Bidder shall ensure that stretchers are available near all areas in which their men are working and that the location of stretchers are well marked.

12.20.00 Bidder shall be solely responsible for the dissemination of all safety regulations including those written here, those promulgated by the Owner and those dictated by good practice, and shall ensure that all his employees and those of his Sub-Contractors are conversant with same.

12.21.00 Safety regulations during execution

12.21.01 Crawling on, over or under movable equipment shall generally be prohibited.

12.21.02 For overhead work, proper signs shall be placed below and shall be barricaded preferably, and, when conditions justify, a watchman shall be stationed to warn employees in the vicinity. Suitable safety nets shall also be used to avoid fall of men/material/tools.

12.21.03 Work on or about crane runways shall not be undertaken without the Owner's permission. Whenever it is necessary to do any work on or above the crane runways, the Bidder shall furnish a flag man stationed on the floor.

12.21.04 SCAFFOLDING:

i) Only scaffolds which meet the safety requirements and any governing laws shall be used in the project.

ii) All scaffoldings shall be certified by the safety inspector and shall be visibly tagged as per the status, whether it is UNSAFE or FIT for USE.

iii) Hand rails and toe guards shall be provided for all platforms unless unavoidable.

12.21.05 Work in area of electric wires and cables shall generally be avoided.

12.21.06 All burning and welding equipment shall conform to, and be used in accordance with, regulations governing such equipment. No burning or welding shall be done at any place on the site until location where such work is to be done is approved.

12.21.07 Adequate fire protection shall be made available before proceeding with such work.

12.21.08 Appropriate warning signs shall be placed at various locations and shall be observed.

12.21.09 Temporary guard rails/barricading shall be provided for all openings/pits during construction. And, safety belt, as required, depending on fall height, has to be used while working very near to such area.

12.21.10 Safety goggles shall be worn whenever there is a possibility of flying particles or splashing of corrosive fluid.

12.21.11 When working around corrosive environment workmen shall wear gloves, goggles and protective shoes.



12.21.12 When ladders are the means of access to a platform, they shall be firmly secured top and bottom and the ladder rails shall extend at least one meter above the top landing. When a ladder cannot be secured, a man shall be stationed at the base.

12.21.13 Safety belts shall be used by men working in high places above 6 feet, when no hand rails or other guards are in place. Fall arrester shall be used wherever required and as directed by owner's safety inspectors.

12.21.14 List of suggestive safety equipments is as below:

Sr. No.	Safety equipment
1.	Safety PPEs (Industrial Safety helmet & Industrial Safety Shoes) Industrial Safety Helmet (IS: 2925-1984 marked) Industrial Safety/Electrical Shoes (IS: 15298-2002 marked) Full body Safety Harness (conforming IS: 3521)
2.	Fall Arrester 'Rope grab fall arrester' & anchorage line. Anchorage Line: 14mm -16 mm diameter, three strand twisted Polyamide rope. Rope Grab fall arrester: Openable & Guided type Fall Arrestor (on flexible line) conforming EN 353-2 & works on 14-16 mm diameter polyamide rope. material: Nickel Chrome plated Steel Connector: Karbiner conforming to EN 362 (Minimum Strength 22 KN), material: Steel
3.	Horizontal life line Stainless Steel Wire rope of 8mm diameter. Minimum six nos. of steel U-bolt clips are required for clamping each wire rope to a rigid support (03 nos. of U-bolt clips at each end).
	Safety Net (Conforming IS 11057:1984) Safety Net (Net Size: 10m x 5m, Mesh Size: 25 mm, Mesh Rope: 2mm double cord, Border/Tie Cord: 12mm diameter polypropylene rope (tested as per IS: 5175). 2M length shall be provided at all four corners.

13.00.00 SPARE PARTS

13.01.00 All the spares shall be delivered in new and unused condition.

13.02.00 All spares shall be procured from their OEMs or from equally reputed vendors.

13.03.00 Equipment and components shall be standardised as much as possible for interchange-ability and to reduce spares inventory.

13.04.00 Spares shall be inter-changeable with the parts for which they are intended to be a replacement.

13.05.00 The quality plan and the inspection requirement finalized for the main equipment will also be applicable to the corresponding spares.

13.06.00 All spares shall be properly packed and protected for long storage at site under prevailing conditions, up to expiry of guarantee period of the spares.

13.07.00 Spare part identification number shall be clearly marked for all items.



13.08.00 Spares for the plant shall be divided into three categories as follows:

13.08.01 Commissioning and start-up spares

13.08.02 It shall be the responsibility of the bidder to maintain adequate items in sufficient number, as commissioning & start-up spares to ensure that commissioning & start-up activities and plant operation till end of Performance Guarantee Test and subsequent handover of the plant to owner, do not hamper for want of spares.

13.08.03 These used spares shall be the property of the owner. However, bidder will be allowed to take back all the left over unused erection and commissioning spares after the guarantee period is over.

13.08.04 All commissioning & start-up spares as required shall be provided by the Bidder without any additional cost to the Owner.

13.08.05 The list and details of start-up and commissioning spares shall be furnished by Bidder prior to award of Contract.

13.09.00 Mandatory spares

13.09.01 The mandatory spares required for the plant are identified and listed in Annexure-3, Volume-V of this specification. Bidder shall review the list of spares specified and finalise the same based on the equipment and system proposed by the Bidder, in consultation with Owner.

13.09.02 When a particular item of spares is indicated as 'percentage', it shall be considered as percentage of total number of that item for scope of work, unless specified otherwise. Fraction shall be rounded off to the next higher whole number. Wherever a particular item of spares is mention in 'Set' it is the set of items for one (1) equipment.

13.10.00 The Bidder shall specify the quantity in numbers/sets, unit cost and anticipated normal life of individual spares. Wherever sets are mentioned, the bidder shall furnish the item details and prices of each such sub-item.

13.11.00 Whenever the item of spares has been indicated as 'set' for the Unit or the station, the same shall include total supply of that item, as specified and where it is not specified, 'set' shall mean the supply for single equipment / system.

13.12.00 One set of spares for particular equipment shall mean the total quantities of that particular spares for the single equipment e.g., 'set' of bearings for a pump shall include the total number of bearings in a pump. The 'set' shall however, include all components required to replace the item of spares.

13.12.01 The owner reserves the right, to vary the quantity of any of the spares and /or to add/delete any item of spares, after evaluation/during award/detailed engineering stage limited to a period of six (6) months from date of award of contract, at the unit rates agreed to in the contract or to be mutually agreed at a later stage.

13.12.02 The deliveries of mandatory spares shall commence from the date of first synchronisation of the unit (first unit if more than one units awarded) and shall be completed on or before the date of taking over the unit (first unit if more than one units awarded) by the owner. However, imported spares may be supplied along with respective equipment.

13.13.00 Recommended operation and maintenance (O&M) spares



- 13.13.01 The bidder shall provide, based on his own experience of the performance of his equipment, in the form of a schedule given in bid documents, the complete list of recommended operation and maintenance spares for three (3) years operation of the equipment covered under the proposal.
- 13.13.02 In the list of operation and maintenance spares parts, the Bidder shall identify the unit-wise population of each of items recommended and anticipated normal life of the spares.
- 13.13.03 The spare parts must be able to replace the original part completely and have the same technical specifications in quality, material, inspection and mechanical aspects.
- 13.13.04 Bidders shall supply all measurement testing data (if applicable) of any spare part supplied.
- 13.13.05 All spare parts supplied shall be packed and stored for a 5 years preservation based on the local climatic conditions. Suitable preserving coating as required shall be applied. Small spare parts shall be packed and sealed by transparent plastic bags and drying agents will be used if necessary.
- 13.13.06 Every spare parts shall have operation instructions and design marks of the factory when it is supplied.
- 13.13.07 When multiple spare parts are packed in one packing box or container, the general indication to the spare parts outside the packing boxes or containers shall include a detailed list. All packing boxes, containers, and other such tanks shall be marked properly and numbered clearly. All electrical equipment including switches, fuse connection easy melting and other similar apparatus shall be protected and insulated.
- 13.13.08 The identification of all spare parts shall be in the English language.
- 13.13.09 Deliveries of these spares (if awarded under this contract) shall commence within 6 months from the date of taking over of the respective unit by the owner and shall be completed within 12 months from the date of such taking over.
- 13.13.10 Wear and tear parts, to be replaced by the Owner at his own cost, shall be marked separately.
- 13.13.11 Bidder shall identify in the spare parts list, the items having a delivery time of more than 3 months
- 13.13.12 Bidder shall enter into a long term spare supply agreement with the OEM, and agree to transfer the same faithfully to the owner upon COD. Bidder shall commit to facilitate further negotiations on the spares with the OEMs directly by the owner.
- 14.00.00 TOOLS AND TACKLES**
- 14.01.00 All tools and tackles required for repair and maintenance of the plant by the owner, after takeover shall be supplied by the bidder.
- 14.02.00 This shall also include special tools and tackles as required for the operation, maintenance, inspection and repair of the individual main equipment and auxiliary equipment shall be supplied by the Bidder in sufficient quantity to equip



the shift personnel, maintenance personnel and workshop craftsman for commissioning, testing, calibration, modification and maintenance of the unit.

- 14.03.00 List of such special tools, tackles and equipment shall be submitted in the EPC bid.
- 14.04.00 The tools, tackles and appliances supplied in general, shall not be used for erection purposes by the Bidder and shall be handed over in brand new condition. Damaged tools, tackles, and appliances shall be replaced before handing over.
- 14.05.00 The exception to this is the special lifting gear which may be used provided that when it is handed over to the Owner it has not been subjected to more than normal wear and is still fully suitable for its intended use.
- 14.06.00 The following tools and appliances shall be supplied under this Contract for use by the Owner:
- 14.06.01 Two sets of special tools and gauges required for the maintenance of the Plant
- 14.06.02 One set of special lifting and handling tackles / appliances required for the maintenance of the Plant.
- 14.07.00 Each set of tools, gauges and appliances under category (a) above shall be suitably arranged in fitted boxes of mild steel/aluminium/wooden construction, the number of boxes being determined in relation to the layout of the plant and equipment in question.
- 14.08.00 If the weight of any box and its contents should be such that it cannot conveniently be carried, it shall be supported on steerable rubber-tyred wheels.
- 14.09.00 Each cabinet and box shall be painted, fitted with a lock and clearly marked in white letters with the name of the item of equipment for which the tools and appliances contained are intended. Details of the tools/tackles and a list of items shall be maintained for each box and shall be marked on the box or a copy of list of items shall be maintained (tamper proof) in the box.
- 14.10.00 Suitable storage racks shall be provided for all portable tools and tackles supplied under this contract.
- 14.11.00 Suitable lifting lugs, ears or ring bolts, or tapped holes for lifting rings shall be provided on all equipment items where the weight exceeds 15 kg.
- 14.12.00 All lifting tackle shall be stamped with a unique identification number and safe working load. A test certificate from an approved Authority shall be supplied for each item of lifting tackle.
- 14.13.00 The Bidder shall provide a schedule of all lifting tackle and tools and appliances being supplied, for the approval of the Owner's Engineer.
- 14.14.00 The Bidder shall provide all runway beams, trolleys (manual as well as battery operated), mobile ladders, collapsible maintenance platforms, lifting blocks, special slings etc. necessary for the safe and efficient handling and maintenance of the works. Particular attention shall be paid to handling of equipment located at higher elevations



14.15.00 The tools and appliances with the appropriate storage racks, cabinets and boxes shall be handed over to the Owner at the time of Taking Over of the complete Plant.

15.00.00 CONSUMABLES

15.01.00 Lubricants and greases

15.01.01 All lubricants proposed for the Plant operation shall be suitable for all operating and environmental conditions that will be met on site.

15.01.02 All oils and greases shall as far as possible, be readily available in India.

15.01.03 The number of oils and greases shall be kept to a minimum. For each type and grade of lubricant recommended, the bidder shall list at least three equivalent lubricants manufactured by alternative companies.

15.01.04 In case of imported oils, lubricants and other consumables, the bidder shall indicate the indigenous equivalents to enable the Owner to arrange subsequent refills. Preference should be given to indigenous oils and lubricants during first filling itself.

15.01.05 Short shelf life items if any may be supplied in a phased manner keeping in view of their actual use.

15.01.06 The Bidder shall supply the first fill of lubricants for the Plant, and shall provide at the Completion Certificate sufficient lubricants and greases necessary for the efficient operation and maintenance of the Plant at full load 24 hours per day for a period as specified under scope of supply.

15.02.00 Chemicals and other consumables

15.02.01 Scope includes the supply (by the Bidder) of all chemicals, reagents, resins, and other consumables required for testing, commissioning and setting to work of each section of the Works.

15.02.02 The Bidder shall provide all chemicals and other consumables required for the efficient operation and maintenance of the plant at full load 24 hours per day for a period as specified under scope of supply and services.

15.02.03 The Bidder shall prepare a list of these consumables giving quantities necessary for each section of the works and the recommended suppliers.

16.00.00 SURFACE PREPARATION AND PAINTING

16.01.00 This section covers the general requirements related to the cleaning protective coating and painting of equipment, components and system. Painting and protective coatings shall comply with the requirement of this section as well as Volume-V, Annexure-8 Cleaning, Protective Coating and Painting.

16.02.00 Painting system for the complete 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.

16.03.00 All paint and associated materials shall be procured from approved vendors and should be delivered to project site, in manufacturer's sealed original packaging/container. Each container shall be labelled by the manufacturer, with



the manufacturer's name, type of paint, description of content, colour, batch number, date of manufacture, shelf life expiry date and pot life.

- 16.04.00 All coating materials and solvents shall be stored in the original container bearing the manufacturer's label and instructions.
- 16.05.00 The components and/or equipment shall be mechanically and /or chemically cleaned during the following stages-
 - 16.05.01 Cleaning before painting and/or corrosion protection (application of prime coat)
 - 16.05.02 Cleaning in workshop
 - 16.05.03 Cleaning before erection and during installation.
- 16.06.00 Cleaning of fabricated component items shall be carried out after fabrication and final heat treatment or welding at manufacturer's works or at site, as appropriate.
- 16.07.00 For cleaning in workshop and before painting, mechanical cleaning as opposed to alternative chemical cleaning is the preferred method for works cleaning except where this is precluded by design or access considerations.
- 16.08.00 Machined surfaces shall be protected during the cleaning operations.
- 16.09.00 In the event of the surfaces not being cleaned to the Owner's satisfaction, such parts of the cleaning procedures or agreed alternatives as are deemed necessary to overcome the deficiencies shall be carried out at the supplier's sole expense.
- 16.10.00 Austenitic stainless steels, copper and aluminium alloys, cast iron, bimetallic and metallic/plastic items, and components fabricated by spot welding or riveting shall not be chemically cleaned.
- 16.11.00 All weld areas shall be suitably stress relieved before chemical cleaning.
- 16.12.00 The paint manufacturer's instruction shall be followed as far as practicable at all times. Particular attention shall be paid to the following:
 - 16.12.01 Proper storage to avoid exposure as well as extremes of temperature
 - 16.12.02 Surface preparation prior to painting.
 - 16.12.03 Mixing and thinning
 - 16.12.04 Application of paints and the recommended limit on time intervals between coats.
 - 16.12.05 Shelf life for storage.
- 16.13.00 Any painting work (including surface preparation) on piping or equipment shall be commenced only after the system tests have been completed and clearance for taking up painting work is given by the Engineer, who may, however, at his discretion authorise in writing, the taking up of surface preparation or painting work in any specific location, even prior to completion of system test.
- 16.14.00 Mechanical mixing, as recommended by manufacturer, shall be used for paint mixing operations in case of two pack systems, except that the Engineer may allow the hand mixing of small quantities at his discretion.
- 16.15.00 All the surface preparation, protective coating, painting of steel, structures; equipments shall be suitable for prevailing site condition.

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- 16.16.00 The bidder has to check all painting work to be carried out according to the specification & recommendations of the paint supplier, further to all relevant prescriptions and regulations concerning the health and safety of work.
- 16.17.00 The type and number of protective coats for any item requiring painting are to be furnished by the bidder as per the paint manufacturer's recommendation for owner's approval; if it is different from the requirements of the specification.
- 16.18.00 The paint supplier has to present data sheets including at least the flash point of the paints, ventilation requirements, handling precautions such as inhalation, eye and skin protection, and first aid procedure, storage requirements, spill or leak procedure, fire precaution, waste disposal.
- 16.19.00 Bidder shall take all safety precautions and shall follow the entire EHS requirement as agreed with the owner/engineer during execution of work.
- 16.20.00 The paint shall comply with applicable laws, regulations, ordinances etc., of the local authority, state or the nation which pertains to the work.
- 16.21.00 Protection of the blast cleaner operator's eyes and respiratory system should be given prime consideration in any open blast cleaning operation. Airfed helmets, respiratory filters, air conditioned hoods etc. should be provided in sufficient number to the blast cleaning operators to avoid the harmful effect of blast cleaning abrasives. Also, an automatic shut-off device which will shut-off the air supply to the blasting machine should be installed which will prevent the dangerous whipping of an operating blast hose if an operator becomes disabled.
- 16.22.00 The colour code scheme is intended for identification of the individual group of the pipeline. The system of colour coding consists of a ground colour and colour bands superimposed on it.
- 16.23.00 Transport and erection of painted structures shall be carried out only after the drying time specified by the paint manufacturer has elapsed. Handling & packing of painted material shall be appropriate to avoid damage to painting, such as the use of non-metallic slings, etc for handling and by minimising handling after painting. All steel equipment shall be provided with priming or coating system to protect the steel surface during transport, storage, installation and construction.

17.00.00 APPROVED SUB-VENDOR / MAKES

- 17.01.00 Approved sub-vendor list is provided in Annexure – 4, Volume-V.
- 17.02.00 Any change in sub-vendor/contractor for all items under this package shall be subject to owner's approval. Bidder shall submit all necessary credentials and other details as sought by owner for the approval of such sub-vendors.
- 17.03.00 Owner reserves the right to accept/reject any sub-vendor for the project.
- 17.04.00 Approval, rejection or addition of makes shall not have any cost implication to the Owner after award of contract.

18.00.00 PLANT AND EQUIPMENT IDENTIFICATION, LABELLING

18.01.00 Plant and equipment identification

- 18.01.01 The Bidder shall propose and apply a common identification system preferably KKS numbering for the whole plant equipment, facilities and systems showing

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the name and number of each item and its respective drawing number etc. to fully identify the plant.

18.01.02 The structure of the designations shall be developed in such a way that the symbols used can be handled by electronic data processing equipment. The identification system must be used by all subcontractors, vendors, etc., and shall be a proven system for power plant application.

18.01.03 Each item of plant shall be separately designed with a reference number, which shall be used consistently on the drawings, in the documents and on the catalogues as well as on the equipment items themselves.

18.02.00 Labelling

18.02.01 Name plates which are to be firmly fixed on all the equipment, buildings and structures shall be provided. For equipment of small size, these are to be fixed on the skid or structure adjacent to the equipment. The contents of nameplate are to include the designation and principal parameters of the equipment.

18.02.02 The nameplate within the field shall be made of a high temperature - resistant metallic sheets, with designation permanently engraved on them.

18.02.03 Indoor installed equipments (e.g., panels, cabinets, switchgear, etc.) shall also be labelled by appropriate name plate.

18.02.04 The form, size, base colour and colour of contents of the name plates and prompting plates will be agreed between the Bidder and the Owner. It shall be possible for these to be readily seen by the operator. The designation of warning tags shall be different from that of other tags.

19.00.00 DRAWINGS AND DOCUMENTS

19.01.00 General

19.01.01 The bidder shall submit all design drawings and documents like, General Arrangement drawings, Mechanical, Electrical, C&I and Civil Design Basis/Criteria, Drawings, Data Sheets, Equipment and their Capacity Selection, Test Procedure etc. and other engineering documents stipulated in the specification for approval/information of the engineer along with the design calculations and general write up wherever involved. All design documents and drawings shall be properly coordinated.

19.01.02 The Owner reserves the right to ask the Bidder to submit copies of drawings and other documents for approval to his Head Office or to the Office of his Representatives. If the Owner/consultant are satisfied with the drawing, it will be returned to the Bidder marked with an 'Approved' stamp. If the Owner/consultant are not satisfied with the drawing, it will be returned to the Bidder with comments and the drawing shall be revised and re-submitted for approval.

19.01.03 The purpose of having drawings checked and approved by the Owner is to assist the Bidder in interpreting the Technical Specification so as to eliminate mistakes in the equipment or material actually shipped to the site of the work. The formal approval given to the Bidder is to be considered as in conformity with this purpose and in no manner shall be construed so as to release the Bidder from



any liability or responsibility for proper design, fabrication or compliance with the Contract Documents.

- 19.01.04 Equipment drawings shall clearly indicate the general arrangement of the equipment to be furnished, give principal dimensions, and show sufficient details required for a complete power station.
- 19.01.05 While submitting drawings for approval, including any prepared by a Sub-Contractor, the Bidder shall certify that he has fully examined such drawings and that they comply with the requirements of the Contract.
- 19.01.06 For the purpose of this Clause, the term "drawings or documents" shall imply all design drawings and documents associated with the project including GA drawings, P&IDs, design calculations, data sheets, equipment specifications, design basis, diagrams, schedules, performance curves etc.
- 19.01.07 Approval of a drawing by the Owner or his Representatives will imply that:
- i) Drawings and documents have been examined and appear to be in accordance with the basic design concept of the project and meet the requirements of the Specification.
 - ii) Drawings and documents of components and equipment have only been examined in relation to compatibility of the items and equipment with the Specification and in respect of interconnection with other items and equipment.
 - iii) Any approval given by the Owner or his Representatives shall in no way relieve the Bidder of his responsibility under the Contract.
- 19.01.08 The Owner will not normally require receiving copies of detailed manufacturing drawings but the Bidder shall make these available if requested to do so.
- 19.01.09 The Bidder shall ensure that drawings are submitted in due time to permit amendments to be made and the drawings re-submitted for approval without delaying the scheduled deliveries or the guaranteed competition dates according to the Contract. Execution of work shall be taken up after the drawings are cleared by the Owner.
- 19.01.10 Submission of drawings and documents for approval shall be strictly sequential, in accordance with the manufacturing and construction plan and sequence.
- 19.01.11 Master drawing list and submission sequence shall be submitted after approval of project schedule and supply schedule. Supply schedule shall include the lead time for manufacturing of all items.
- 19.01.12 It shall be noted that the tender drawings and data sheets submitted along with the specification is only for tender purpose and shows only the minimum requirements for the plant. Bidder's drawings and documents shall be more detailed and shall include all details as per the actual requirements during detailed engineering.
- 19.01.13 Requirements about the format of drawings and documents, the provision for documents and the Owner's responsibilities with regard to documentation are specified in relevant section of this volume.
- 19.01.14 Soft copies of all drawings and documents shall be submitted to owner and consultant via email and larger size files if any shall be transferred through Cloud



Storage Servers. Sufficient soft copies as mutually agreed during the term of the contract shall be submitted in USB flash drive or CD/DVDs, especially as-built drawings and O&M manuals. Hard copies shall be submitted as per the document distribution schedule defined herein or as mutually agreed during the term of the contract.

19.01.15 The Bidder shall be responsible for any discrepancies, errors or omissions in the drawings and other particulars supplied by him, whether such drawings and particulars have been approved by the Owner and his Representatives or not.

19.01.16 The stipulations and requirements specified elsewhere in the specification shall also be followed with respect to preparation and submission of drawings.

19.01.17 All Bidder's drawings which are found to be incorrect during the construction period or which require changes owing to site constraints, shall be corrected by the Bidder to an "as built" condition to reflect any necessary changes.

19.02.00 Drawings and documents to be submitted by bidder

The drawings and documents to be submitted by the Bidder for approval shall cover the complete Scope of Contract work as defined by the Contract Specification and shall generally include, but not be limited to, the following:

19.02.01 DRAWINGS AND DOCUMENTS TO BE SUBMITTED ALONG WITH THE BID:

i) General

- a) Completely filled in technical schedules & other schedules as required to be submitted with the bid documents.
- b) Completely filled in data sheet – B
- c) Project milestone schedule
- d) Project implementation schedule (Level-2) along with required readiness dates for owner inputs and readiness of systems to be covered under Balance of Plant package.
- e) Inputs required from client, with quantities and qualities required.
- f) Sequential supply schedule of all major items, along with lead time for manufacture and delivery to site.
- g) Master Document List (MDL) for Mechanical, Electrical, Civil and C&I with sequential schedule of submission
- h) Project execution methodology
- i) Flow Diagrams and P&ID (Process and Instrumentation drawings) indicating Instruments and the destination / functionality of the signals
- j) Space requirement for construction site and equipment
- k) Layout of temporary site facilities, buildings, structures, installations
- l) Plot plan
- m) A report on foundation proposed for various structures, buildings and facilities based on the data furnished by OWNER and further data collected by the BIDDER. Allowable safe bearing capacity for open foundation,



depth of foundation, need for pile foundations, soil improvement if any required, special precaution against aggressive soil etc., shall also be covered in the report.

- n) General arrangement drawings with sections for major building viz. Power house building, Boiler and auxiliaries, ESP & FGD control building, CW pump house, etc.
- o) Quality Assurance plan.
- p) Complete description of the plant offered including description of the process and the equipment
- q) General descriptions of individual systems and control philosophy including descriptions of operation including description of start-up, shutdown and emergency shutdown procedures, Also behaviour of boiler/steam generator and, turbine, etc. under transient conditions.
- r) Complete bill of materials of the plant with expected life of major items along with break up price
- s) Project specific Safety Plan shall be submitted for approval of owner.
- t) Training program and schedule for training of Owner's personnel
- u) List of spares
- v) List of Special tools and Tackles
- w) Maintenance proposal (for SG and STG)
- x) Inspection intervals (major/minor) for six years along with the spares to be replaced during the above inspections. Bidder shall provide the cost of such spares on yearly basis.
- y) For, steam turbine, steam generator, generator and the total scope of supply maintenance and overhaul charts should be submitted with this bid. Both major and minor plant outages for inspection and/or routine maintenance should be shown on the chart, together with the nature of the work to be undertaken and the expected duration of the outage. This information should also include all the auxiliary plant to be supplied under the Contract.
- z) Drawings and documents to be submitted with bid as mentioned elsewhere in the specification

ii) Mechanical

- a) Heat and Mass balance diagram same for 100% TMCR condition (0% and 1.0 % makeup), VVO condition (0% and 1.0 % makeup), 60% TMCR (Constant and Sliding pressure operation), All HP heaters out condition, Auxiliary steam condition and house load operation with HP-LP bypass in operation
- b) Start up curve for cold, warm and hot condition

iii) Electrical

- a) Technical description of electrical system



- b) Single line diagram of BTG package
- c) Ratings of all major equipment - load list
- d) Characteristic curves of Generator & motors
- e) Description of Generator Cooling System, Excitation System & AVR
- f) GA drawing for all the major equipment such as Generator, transformers, GCB, HT switchboards
- g) Type test certificates for Generator, Generator transformer, GCB, HT switchboard
- h) Description & Catalogues of all Electrical equipment
- i) Technical Data Sheets
- iv) Control and instrumentation
 - a) DCS / PLC architecture drawing (also indicating interconnection of different offsite C&I System) highlighting system features and capabilities
 - b) Plant Control and operational philosophy
 - c) Process description / functional write – up for all open loop and closed loop controls
 - d) GA diagram of the major equipments such control panel, control room console etc
 - e) Functional specification for Plant DCS, STG control system with technical catalogues
 - f) Write-up, scheme, technical details etc. of Continuous Emission Monitoring (CEM), Vibration monitoring and analysis system, Steam & Water Analysis System (SWAS), GPS /Master slave clock system etc
 - g) SER / Annunciation system configuration details including capacity, time stamping etc
 - h) Details on all C&I items including CCTV, AAQMS, lab Instruments, Flue gas analysers and Field Instruments
 - i) List of software (latest version) and hardware with confirmation certificate

19.02.02 DRAWINGS AND DOCUMENTS TO BE SUBMITTED AFTER AWARD OF CONTRACT:

The drawings and documents required for design, manufacture, construction, installation, operation and maintenance of the plant shall be submitted by the bidder in good time for approval/information, so as to permit the plant as a whole to be constructed in compliance with the specification and time schedule.

The below list is only indicative. The detailed list and approval category of the drawings/documents shall be submitted and agreed sufficiently in advance, so that corrections and amendments desired by the owner as well as resubmission of the documents will not result in any delay with respect to the guaranteed time table. The owner reserves the right to request from the bidder additional



drawings and documents as may be required for proper understanding and clarity on design and engineering of the plant.

- i) Re-Submission of all the technical data furnished during pre award contract stage.
- ii) Geotechnical investigation report
- iii) General arrangement drawings / Equipment layout of all equipments/buildings etc, along with coordinates, sections indicating the approach, unloading & maintenance area.
- iv) Bill of quantities/materials
- v) Part lists
- vi) Specifications
- vii) Design basis for all the systems and major equipment
- viii) Control philosophies
- ix) Design/Sizing calculation of all major equipment
- x) P&ID (Process and Instrumentation drawings) indicating Instruments and the interlocks for all the systems
- xi) Flow diagrams
- xii) Schematic diagrams
- xiii) System architectures
- xiv) Logic diagrams
- xv) I/O lists
- xvi) HMI configurations
- xvii) Data sheets of all items
- xviii) Load lists
- xix) Feeder lists
- xx) Drive lists
- xxi) Air requirement
- xxii) Water requirement
- xxiii) Ash collection data
- xxiv) Performance data
- xxv) Valve schedules
- xxvi) Pipe schedules
- xxvii) Pipe routing
- xxviii) Cable schedules



- xxix) Cable routing
- xxx) Cable connection diagrams
- xxxi) Settings
- xxxii) Instrument schedules
- xxxiii) Performance curves
- xxxiv) Single line diagrams
- xxxv) Key diagrams
- xxxvi) Circuit diagrams
- xxxvii) Protection schemes
- xxxviii) Load details
- xxxix) Forces, moments and movement diagrams
- xl) Design basis memorandum for all buildings, facilities, services and structures
- xli) Design calculations and drawings for foundations, substructure and superstructure of all buildings and other structures & facilities like drains, roads, crossings, tanks, sumps, trenches, ducts, sewers, tunnels etc.
- xl ii) Design calculations including dynamic analysis and drawings for all foundations subjected to dynamic loads like foundations for TG, BFP, Mill, Fans (PA, FD, ID), Crushers etc
- xl iii) Design calculations and drawings for all facilities and services like roads, culverts, bridges, paving, road/rail crossings, drainage pump house (if required), drains, sewers, sewage pump house, sewage treatment plant, water supply, water tank, sumps, tunnels, trenches, ducts etc
- xl iv) Architectural drawings including finishing schedules and colour schemes
- xl v) Foundation plans
- xl vi) Levelling and grading plan
- xl vii) Excavation details
- xl viii) Reinforcement details
- xl ix) Architecture details including schedule of doors and windows
- l) Plot plan of the site including all buildings and installations, roads, drains, pipe and cable rack/pedestal/trench routing, sewage and fire system pipe line layout, storage and fabrication area etc with coordinates of major points and elevations/FGLs.
- li) Manufacturing quality plans for all items
- lii) Painting and surface preparation procedure
- liii) Painting schedules
- liv) Storage and preservation procedures
- lv) All field quality plans


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**KORADI THERMAL POWER STATION
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- lvi) Welding procedures
- lvii) Equipment testing procedure
- lviii) Equipment and system wise commissioning procedures
- lix) Monthly progress reports
- lx) Master document list
- lxi) Manufacturing and supply/delivery schedule
- lxii) L2 network schedule
- lxiii) System wise L3 schedule
- lxiv) Testing reports
- lxv) Declaration of confirmation with statutory regulations
- lxvi) Operation and maintenance manuals
- lxvii) Lubrications list and schedule for all items
- lxviii) All as built drawings
- lxix) Training program
- lxx) Complete bill of materials of the plant with expected life of major items along with break up price
- lxxi) Drawings and documents as mentioned elsewhere in the specification and as required by the owner for better understanding or other reasonable purpose, even though not specifically mentioned.

19.03.00 Document distribution schedule (of Hard copies, after placement of order)

Document	Distribution		
	Owner		Consultant
	Head Quarter	Site	
L2 schedule & monthly progress reports	4	4	0
Drawings and documents for approval	3	0	0
Drawings and documents for information	3	0	0
Approved drawings and documents	2	2	0
Testing and commissioning procedures	2	2	0
O&M Manuals	2	4	0
As built drawings	2	4	0



Note: Only soft copies to be submitted to consultant. However, hardcopies should be submitted to consultant, whenever specifically sought.

19.04.00 Manuals

19.04.01 General

- i) The Bidder shall provide the manuals in a timely manner to enable the Owner / Engineer to review and comments and request changes as necessary.
- ii) Payments will be withheld for non-compliance or for late delivery of the drawings, procedures and manuals. In particular the Bidder shall be held responsible for consequential damage to the plant where such damage is due to late delivery of the O&M manual resulting in non-familiarity of the operating technique.
- iii) The Bidder shall also note that while all documents, procedures and manuals shall be in the English language including that of the sub vender of the bidder, it is particularly important that the O&M manuals be in clear concise English.
- iv) All manuals shall be divided by systems or sections and cross-indexed as necessary.

19.04.02 Certification Manuals

- i) This manual shall contain the approved works certification documentation for all plant equipment and services as specified in the relevant codes and standards and in this specification and the Bidders Quality Manual.
- ii) This manual shall also include all material tests certificates. Certificates and test procedures shall be specific to the plant supplied.

19.04.03 Construction Manual

- i) This manual shall include a comprehensive record of as built site construction tests and records.
- ii) The manuals shall be compiled in separate parts system wise for the complete plant offered.

19.04.04 Commissioning Manual

- i) This manual shall include all the records, certificates and test results arising from the agreed pre-commissioning and commissioning procedures carried out on site.
- ii) The performance tests and guarantee test results shall also be included. There is a particular requirement that all commissioned plant/equipment values be recorded in this manual and subsequently incorporated into the O&M manuals.

19.04.05 Operating and Maintenance (O&M) Manual

- i) The Bidder shall provide the O&M Manual properly bound, within the time required/specified, to enable the Owner's staff to become fully acquainted with the operation, adjustment and maintenance of the entire plant.
- ii) The manuals shall contain full and explicit instructions in respect of the operation of the plant under all operating conditions and the maintenance routines and requirements to be established to maintain the plant in optimum performance.



- iii) These instructions shall be as comprehensive as possible and the form in which they are to be set out shall be agreed with the Owner / Engineer.
- iv) The instructions shall be tailored to suit the specific requirements of the Operations and Maintenance functions and personnel, taking into account the staffing philosophy for the thermal power project.
- v) The instructions for the related parts shall be accurate and easy to understand and shall contain the necessary sequence of individual activities.
- vi) The diagram and drawings associated with the instruction shall be clear and unambiguous.
- vii) It is an essential requirement that all information and plant data contained in the manual must be project specific and derived from the design, manufacturers / suppliers and commissioning data of the as-built plant.
- viii) Where the Bidder includes standard brochures the installed item of plant or equipment shall be clearly identified.
- ix) All sections shall contain an introductory description of the particular item/system including its function and operating criteria and any special features.
- x) On the basis of the commissioning and running experience of the Plant, the instructions shall be amended to a final form within three months of the end of commissioning and, for this purpose; the Bidder shall supply the required number of printed copies of all approved amendments for insertion in the bound set of instructions.
- xi) The Bidder shall prepare manuals integrating all equipments supplied by the sub vendors.
- xii) The entire O&M manuals including that of the sub vendors shall all adopt the same format paper size etc.
- xiii) Contents of the Manual (equipment or system wise)
 - a) Safety precautions
 - b) Write-up/specification of the equipment/system
 - c) Control philosophy
 - d) Installation instructions
 - e) Commissioning instructions
 - f) Operation instructions
 - g) Maintenance instructions
 - h) Data Sheets
 - i) General arrangement drawings, P&IDs, schematics, wiring diagrams, logics, functional diagrams, performance curves etc.
- xiv) Manuals may be common or separate for-
 - a) Erection/installation
 - b) Operation &



- c) Maintenance
- xv) Operating Instructions

The instructions shall include at least the following specific procedures/items:

 - a) Pre-start-up
 - b) Start-up
 - c) Normal operation and parameters to be monitored and limiting values
 - d) Shut-down
 - e) Interlocks and protections
 - f) Operation procedures during fault conditions
 - g) Trouble shooting
 - h) Isolation procedures
 - i) Stand-by mode and preservation
 - j) Operation Logs/running records to be maintained including parameters and intervals
 - k) Items requiring special attention (if any)
- xvi) Maintenance instructions
 - a) Maintenance instructions shall include the required inputs for-
 - 1) Mechanical
 - 2) Electrical
 - 3) Control and instrumentation
 - b) The instructions shall include at least the following specific procedures/items:
 - 1) Safety instructions
 - 2) Inspection
 - 3) Handling and lifting
 - 4) Routine maintenance and intervals
 - 5) Lubrication schedules and lubricants
 - 6) Assembly and disassembly
 - 7) Part lists including part identification number and blow-up diagrams
 - 8) Drawings detailing tolerances
 - 9) Set-up and calibration
 - 10) Test-run
 - 11) Special maintenance/repair including welding (if any)
 - 12) Maintenance log and history to be maintained


13) Items requiring special attention (if any)
19.04.06 Plant Technical Diary

- i) A plant technical diary including technical details of all plant systems and equipment shall be prepared and submitted.
- ii) The technical diary shall include following details as a minimum:
 - a) Major specifications
 - b) Location
 - c) Make
 - d) Quantities
 - e) Weight
 - f) Material of construction
 - g) Bearing details
 - h) Major dimensions
 - i) Design and working pressures
 - j) Efficiency
- iii) All major technical parameters including limiting values shall be specified therein.

19.05.00 Format

- 19.05.01 All drawings and documents shall be prepared in international 'A' series i.e. A4, A3, A2, A1 & A0
- 19.05.02 Soft copy of all documents shall be submitted in PDF format. AutoCAD or other original formats may be sought by owner/consultant in some cases like plot plan for better clarity/understanding.
- 19.05.03 Grouped documents shall be provided by size A4, with the inclusion of bigger size drawings which, however, have to be folded as Size A4.

19.06.00 Numbering and Identification of Documents

- 19.06.01 All the drawings shall be identified through a common way of numbering in accordance with the requirement of contracting.
- 19.06.02 The numbering system of drawings and documents proposed by the Bidder shall be in compliance with the plant identification system and to be agreed with the Owner.
- 19.06.03 Apart from this, some drawings may also be numbered in the way which the bidder or subcontractors are used to do. But, there shall be a common title block on all published drawings which include the following contents:
 - i) Project
 - ii) Owner
 - iii) Owner's Engineer
 - iv) Contractor



v) Description

vi) Drawing No.

vii) Sheet No.

viii) Revision No.

19.06.04 The measuring units and dimensions marked on the project engineering drawings shall be of SI system conforming to ISO 80000-1.

19.06.05 In case dimensions are not marked in conformity with the scale of drawings and any dimension on the drawing does not conform to those dimensions and sizes measured through certain scale, the actual marked dimensions shall be applicable.

19.06.06 For revision of drawings, the revised part shall be clearly and definitely shown on the drawing.

19.07.00 Others

19.07.01 The Owner and bidder agree that the Contract will be concluded in accordance with the EPC method of building the power project.

19.07.02 It is the Bidder's duty to ensure that design standards and conditions meet the requirements and that the power project shall operate safely, reliably and with high efficiency, having the same performance as stipulated and guaranteed.

19.07.03 The Owner may examine, check and approve the drawings and documents at his discretion with the aim of ascertaining that all these drawings and documents meet the requirements specified in the contract documents. The Bidder shall have an active and cooperative working relationship with the Owner. If there is a disagreement over any issue, Owner and Bidder shall work together to reach some conclusion through mutual consultations.

19.07.04 The drawings and documents of the Bidder shall be approved or returned with observations, within fourteen working days by the owner.

19.07.05 To enable smooth review of drawings and documents in time, bidder shall strictly follow the agreed document submission schedule and dumping/bunching of documents will not be entertained.

19.07.06 The Bidder shall clarify the observations raised by the owner and shall attempt to correct the drawing or document subsequently only.

19.07.07 Generally, copies of drawings or documents containing trade secret and drawings with patented nature need not be provided. However, to know whether the Bidder has performed its obligations, the Owner/consultant will have the right to examine those drawings and may seek them if required.

20.00.00 ENVIRONMENTAL PROTECTION

20.01.00 The Bidder shall offer a plant so as to meet the pollution control requirements of statutory authorities. Emissions and discharges of solid, liquid and gaseous effluents from the plant shall fully comply with all requirements and limits specified in Environmental (Protection) Act, 1986, along with all latest amendments to all of the above requirements, stipulations of the Central Pollution Control Board (CPCB), Ministry of Environment and Forests (MOEF)


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and State Pollution Control Board (SPCB) for the project, and any other central or local statutory requirements regarding environmental pollution and its abatement.

- 20.02.00 The discharge of pollutants in water and air as well as noise levels shall meet with the stipulations of Central Pollution Control Board (CPCB), Maharashtra Pollution Control Board (MPCB) as well as other Acts of the Government under the Ministry of Environment and Forestry (MoEF). If there should be a discrepancy between standards and this specification from the more stringent requirement will apply.
- 20.03.00 Bidder shall comply with the following clearances obtained for the project, as applicable for the scope of the package:
- 20.03.01 Environmental Clearance form MoEF
- 20.03.02 Consent to establish from MPCB
- 20.04.00 Environmental protection design for the power project will be based on the requirements of environmental impact report and relevant stipulations, and state of the art, proven technology will be adopted.
- 20.05.00 The air emissions of the plant will meet the Pollution control board norms and guidelines. The plant effluent shall also meet the stipulations laid down by Pollution control board. The general pollution control board (PCB) requirements shall be imposed. Any add-on requirements during public hearing and EC shall be imposed as amendment.
- 20.06.00 The plant should be designed to economize on water use and to set up a water management system featuring maximum reuse of effluents.
- 20.07.00 The Bidder shall take all necessary measures for noise attenuation in order to meet the specified noise levels. All equipment shall be designed to run without undue vibration and with the least amount of noise.
- 20.08.00 Environmental monitoring stations as per the requirement of the specification shall be provided by the EPC Bidder in accordance with "Environmental Protection Design Stipulation for Thermal Power Projects". It shall be provided with the instruments according to Environmental Monitoring norms to supervise and monitor the pollutants emitted during power generation so that it meets with the ambient air quality standards and also that environmental quality and trend can be known so as to provide scientific basis for pollution prevention and control. The environmental monitoring station will be designed in such a way as requiring no staff and Maharashtra Pollution Control Board should be consulted in deciding the location of the stations.
- 20.09.00 In order to meet the environmental quality requirements, the Bidder has to guarantee that at all loads and operating conditions of the Steam Generator the flue gas emission levels (Suspended Particulate Matter (SPM), Sulphur Di Oxide, and NO_x) for the range of fuel to be used in the plant, will strictly adhere to the norms and requirements of MoEF. No deviation/correction in this regard is acceptable.
- 20.10.00 The Bidder shall provide on-line automatic Continuous Stack Emission Monitoring (CEM) for monitoring the levels of SO_x, NO_x and SPM. The Bidder



shall also provide stack monitoring kits for monitoring SO_x, NO_x and SPM at plant boundaries.

20.11.00 The monitoring systems should incorporate the means to record various time averaged values as required by the performance requirements. Monitoring data should be displayed in the control room, with provision of alarms to notify the operator of any deviation from the specified values. The Bidder shall furnish a list of monitoring equipment he intends to provide with their location in the plant.

20.12.00 Soil can become contaminated by oil and chemical spillage during Operation and Maintenance of the Plant. The entire plant shall be designed, operated and maintained in such a way to prevent any soil contamination and adequate provisions shall be made in the design.

20.13.00 Dust emission to the air from the site, roadway, etc. shall be controlled by providing suitable dust control systems.

20.14.00 Noise Control

20.14.01 An integrated approach shall be taken by the Bidder to control noise emission which shall include but not be limited to:

- i) Design and layout of building to minimise transmission of noise, segregation of particular items of plant and to avoid reverberant areas
- ii) Specification of permissible noise levels for bought-out items
- iii) Choice of materials for civil construction
- iv) Acoustic design of buildings
- v) Use of acoustic lagging / enclosure with attenuation properties on plant components/installation of sound attenuation panels around the equipment.

20.14.02 Where the requirements stated above are not met within the basic design of the plant they shall be achieved by the supply under the Contract of suitable means of noise control, which shall conform to the following requirements:

- i) The noise control system shall, as far as possible, be designed to form an integral part of the plant
- ii) The abatement system shall, wherever practicable, be applied to the source of excessive noise rather than to the entire item or component
- iii) If above means are not adequate and enclosures are used for noise abatement, close fitting enclosures shall be provided

20.14.03 Noise control areas

- i) Control Rooms - The noise levels in control rooms must be such that intelligible speech communication is always possible and mental concentration is not hindered.
- ii) Other control areas - The noise levels in other control areas must be such that intelligible conversation (telephone and person-to-person) is possible and operator fatigue is minimised.
- iii) Station noise criterion - The criterion for environmental noise is that the design of the station and its components shall not exceed, in any continuous mode of



operation, the level stipulated by MOEF and/or Pollution Control Board at any point on the site boundary. Presently the norm is such that the noise level shall not exceed 85 dBA at 1.5 m from equipment surface and 70 dBA at plant boundary.

iv) Noise level shall not exceed 85 dBA at 1.5 m from equipment surface, except for the following:

- a) Turbine, generator and pulveriser – 90dBA
- b) Safety valves & associated vent pipes, HP/LP bypass valve, soot blower or wall blowers, regulation drain valves – 115 dBA

20.15.00 The rain water collected from the roof of buildings shall be channalised through the rain water down comers and routed to the garland drain around the buildings. These garland drains shall be connected to the plant storm water drainage network system all around the plant. Several recharge wells shall be located at strategic locations within the plant and shall be interconnected to the storm water drain network system to ensure recharging of the ground water table.

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	GENERAL TERMS & CONDITIONS OF THE CONTRACT		
25.0 Submission & Approval of Design Documents: 25.1 The contractor shall submit all the General Arrangement drawings, Mechanical, Electrical and Civil Design Basis/Criteria, Drawings, Data Sheets, Documents, Equipment and their Capacity Selection, Test Procedure etc. and other engineering documents stipulated elsewhere in the contract (hereinafter referred to and called as ‘design document’) for approval of the Engineer and Owner’s Consultant, if any, along with the design calculations and general write up wherever involved. All electrical and mechanical drawings shall be properly coordinated. 25.2 The Design document so submitted shall be approved/commented upon generally within 10 working days from the date of its submission at the office of the respective Engineer and Owner’s Consultant. Both the parties shall put their efforts together to complete the activity of design document approval in good faith in order to complete the same within stipulated period as above. However, the contractor acknowledges that the duration of approval/ commenting largely depends upon quality of the submission and also bunching of submission and hence agrees with the owner that neither any specific period for approval can be ascertained			
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nor the delay if any in the same (unless the delay is due to sheer negligence on the part of the engineer/his authorised personnel/owner’s consultant in which case onus of proof of negligence shall rest with the contractor) can be considered as the reason for extension of work completion period. 25.3 In the event of any discrepancy observed in the design document submitted during its scrutiny, the same shall be communicated to the contractor promptly. The contractor shall either arrange to correct the design document or shall justify the correctness of his submission. 25.4 On approval of the design document by the engineer, the contractor shall furnish at least six hard copies and soft copy in AUTOCAD form (*.dwg)/PDF form, as applicable of these approved drawings to the recipients as per the distribution to be intimated by the engineer during the first co-ordination meeting (kick-off meeting). As the drawings shall be approved based on the basic information furnished by the contractor, approval by the Engineer shall not absolve the contractor of his responsibilities towards correctness of design & performance of the equipment. 25.5 If the Owner/Engineer is of opinion that any design document submitted and the approval thereof were erroneous, the Owner/Engineer reserves right to ask the contractor to revise/ modify approved design document and submit the same for approval of the Engineer without any financial liability to the owner. 25.6 During the currency of the contract, if any approved design document are required to be modified, such details of the modifications required to be carried out shall be separately maintained. 25.7 On completion of all the works, the contractor shall incorporate all the changes necessitated in the drawings and submit at least 6 (six) hard copies and soft copy in AUTOCAD form (*.dwg)/PDF form, as applicable of all the "As built" drawing for the records of the Owner/engineer.			
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2.0 Quality Plan: 2.1 Critical/Vital/Major Equipment or Materials: 2.1.1 The list of major equipment/materials for which the quality plan shall be submitted by the contractor shall be finalised during the kick off meeting or a meeting specially organised for this purpose. The owner reserves the right to add/delete any item in/from such list during the period of currency of the contract but before the pre-despatch inspection of such equipment or material. 2.1.2 Immediately after finalisation of the source but before taking up the equipment for manufacturing, the contractor shall submit the quality plan of the equipment to be manufactured which shall indicate the special characteristics of the equipment/components/input materials to be used for manufacturing the same, quality checks proposed, nature and frequency of the same,		
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acceptance norms, records to be maintained, customer hold points etc. However, the owner reserves the right to modify the Quality Plan including customer hold points before the respective manufacturing stage is completed. The contractor shall maintain the record of the quality plans till expiry of the Latent Defect Liability Period. 2.2 Non-Critical/Non-Vital Equipment/Materials: 2.2.1 All the equipment/material not classified as Critical/Vital/Major as mentioned in Clause No. 2.1 above, shall deem to be classified as Non-Critical/Non-Vital Equipment/Materials. 2.2.2 The contractor shall prepare and approve the quality plan for such equipment/material and maintain the record of the same till expiry of the Defect Liability Period. 2.3 The contractor shall ensure that the approved quality plan is followed scrupulously by him/his subcontractors. All the records of checks during manufacturing shall be made available for verification to the owner's representative during the stage inspection/pre-despatch inspection. 3.0 Stage Inspection/Pre-Despatch Inspection by the Owner/his Authorised Representative: 3.1 The inspection of goods to be supplied by the owner/owner's authorised representative shall be generally carried out as stipulated hereunder at pre-identified customer hold points as per the approved Quality Plan. However, the owner or his authorised representative shall have unrestricted access to the area of the plant of contractor/subcontractor where goods to be supplied against this contract are being manufactured during the process of manufacturing of goods. 3.2 Indigenous Supplies: 3.2.1 The authorised representative of the owner/Independent Inspection Agency (IIA) appointed by the owner shall carry out inspection at customer hold points. All the costs of deputing owner's representative/IIA for such inspection shall be borne by the owner. 3.2.2 The contractor, at-least twenty one (21) days prior to expected date of attaining the respective stage of manufacturing/readiness of the goods, shall submit the inspection call indicating the date of		
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inspection to the Controller of the Quality appointed by the owner/IIA under intimation to the Controller of Quality. 3.2.3 The Controller of the Quality appointed by the owner/IIA, within fifteen (15) days from the date of receipt of such notice, shall intimate the contractor, the probable date of visit for the inspection. Such date shall not be later than eight days from the date of inspection as intimated by the contractor. 3.2.4 The inspection shall be carried out by the authorised representative of the owner/Independent Inspection Agency (IIA) strictly as per the approved quality plan. However, in the event the owner grants waiver for such inspection or the owner's representative /IIA is not able to attend the inspection on the date confirmed as per Clause No 3.2.3 above, the contractor shall carryout the inspection as per the approved Quality Plan and submit the report of the same to the Controller of the Quality. 3.2.5 In the event the inspection is not be carried out on the date confirmed as per Clause No 3.2.3 above and inspection call is required to be cancelled for the reasons attributable to the Contractor/his Sub-contractor/Vendor all the costs of deputing owner's representative /IIA shall be recovered from the contractor's invoices. 3.3 Offshore Supplies: 3.3.1 Inspection at customer hold points shall be carried out by the Independent Inspection Agency (IIA) of international repute and having presence in the country where inspection is to be carried at the offshore works of contractor/subcontractor. Such agency shall be appointed by the contractor on prior approval of the owner. All the costs of appointing such agency shall be borne by the contractor. 3.3.2 Apart from the inspection by IIA, the owner reserves right to witness such inspection by deputing his representative, the cost of which shall be borne by the owner. However, the local conveyance abroad shall be arranged by the contractor at his own costs. 3.3.3 The contractor, immediately after approval of the quality plan shall forward the details of the Independent Inspection Agency (ies) he wishes to appoint for such inspection along with their credentials such as experience, financial strength. The owner reserves the right		
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to approve any agency proposed by the contractor or to reject all the agencies proposed by the contractor and ask him to submit the fresh list of such agencies. 3.3.4 The contractor, at least forty five (45) days before the expected date of attaining such stage of manufacturing/readiness of goods, shall intimate the Chief Engineer (P&P). The Chief Engineer (P&P), within twenty one (21) days from the date of receipt of such intimation, shall revert confirming owner's intentions of the owner to witness such tests or otherwise. In the event, the owner intends witnessing such tests, the contractor shall extend all his co-operation for arrangement of visa etc. 3.3.5 The scheduled date of witnessing the test shall be the date practically possible and mutually agreed but not later than fifteen (15) days from the date as intimated by the contractor. 3.3.6 However, if the owner does not intimate its intension to witness within the stipulated period or the owner's representative does not attend the inspection/testing on the date scheduled as per Clause No. 3.3.5 above, the contractor may go ahead with the inspection by the IIA and submit the report of the same to the owner for approval. 3.3.7 In the event, the owner's representative could not witness the testing on the scheduled date for the reasons attributable to the contractor/subcontractor, all the costs of deputing the owner's representative shall be borne by the contractor. 3.4 Notwithstanding anything contained hereinabove, the pressure parts of the boiler coming under the ambit of statutory inspection (IBR) whether manufactured in India or abroad, shall be carried out by the owner's personnel only. 3.5 If the Owner/Owner's Representative requires such equipment, materials, design or workmanship to be re-tested, the tests shall be repeated under the same terms and conditions. The contractor shall undertake an additional testing of any material, equipment or the work, if the Owner/Owner's Representative believes the results of earlier tests are not accurate or do not establish the true condition to specification of equipment, material or work being tested. If such retesting demonstrate that the work, equipment or material being so tested conforms to the requirements of Contract, then the owner shall bear the cost of such		
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additional Test and the cost of any required uncovering and covering the Goods and shall grant the extension of time for completion, if necessary. If however such retesting confirms owner's conclusion and cause the Owner to incur additional costs, such costs shall be recoverable from the Contractor. 4.0 Despatch Clearance: 4.1 On completion of tests of equipment/material enlisted in the list as mentioned under Clause No. 2.1 above, at manufacturer's works, the Contractor shall furnish 4 copies of test certificate(s) as required as per the approved quality plan to the Controller of Quality for approval under intimation to the Project Manager. The test report shall invariably indicate identification data, including Model No., Sr. No. etc. of the equipment, method of application and duration of test along with test results. 4.2 For the purpose of transmission of the test reports and speedy approvals, the owner may utilise the provisions of the c-Folders module of ERP system being operated by the owner. The contractor shall have access to the respective folder of the system to enable him to upload/transmit the soft copies of the inspection report (in *.pdf form). Decision in this regard, shall be taken during the execution of the contract by mutual agreement. However, the report in physical form shall also be invariably submitted. 4.3 The approval of Test Reports shall be generally granted within 10 working days from the date of receipt of documents complete in all respects by the Controller of the Quality. Only on approval of these test results by the Controller of Quality and the despatch clearance thereafter by the Controller of Quality, the material shall be despatched to site. The despatch clearance shall be notified by way of e-mail/letters as may be mutually agreed during execution of the contract. 4.4 For Non-critical/Non-vital/Minor items, the despatch clearance shall not be required. However, the Test Certificates/Inspection Report of the Pre-despatch Inspection/Tests carried out by the Contractor/Sub-vendor shall invariably accompany the consignment. 5.0 Packing, Forwarding and Shipping the Goods: 5.1 The Contractor, after proper surface treatment shall pack and crate all equipment/goods in such manner so as to protect it from damage and		
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deterioration in transit and during storage at site till the time of erection. 5.2 The shipments to be made by sea or air shall be packed in sea worthy/airworthy packing in a manner suitable for export to a tropical humid climate region in accordance with the internationally accepted export practices and standards in this regard. 5.3 The Contractor shall ensure that the dimensions of the packages conform to the requirements of the carriers viz. Railways or any other mode of transport. Packing case size and weights shall also take into consideration, where appropriate, the remoteness of the good's final destination and the absence of heavy handling facilities at all points in transit. 5.4 On receipt of the despatch clearance from the owner, the Contractor shall arrange to despatch the goods by suitable mode of transport and notify the owner the date of each shipment from the works or port of embarkation as well as the expected date of arrival of such shipment at the designated port and/or the expected date of arrival at site. 5.5 The Contractor shall prepare detailed packing list of the packages, containers, bundles and loose materials forming each and every consignment despatched to site. The packing, marking and documentation within and accompanying the packages shall comply strictly with such special requirements as shall be expressly provided for in the contract and/or in any subsequent instructions by the owner. Copy of the packing list should be sent to the Project Manager. 5.6 The ocean shipment shall be effected preferably with vessels carrying Indian Flag. 5.7 In case of OVERSIZED shipments by road, obtaining all statutory clearances from various authorities shall be responsibility of the contractor. Immediately upon shipping of such shipments, the contractor shall give fifteen days/one week/forty eight hours/twenty four hours notice to the Project Manager intimating the expected arrival of the shipment. 6.0 Demurrage/Wharfage/Warehousing Charges: 6.1 All demurrage, wharfage and other expenses incurred due to delayed loading or clearance of the materials, for any reason shall be to the account of the Contractor.		
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7.0 Replacement of Defective Parts and Materials:

- 7.1 If on receipt of the goods or any time during the progress of the works, the Engineer observes and inform in writing to the contractor that the any plant or part of the plant supplied by the contractor is unsound or imperfect or inferior than the quality specified, the contractor, on receiving details of such defects or deficiencies, shall at his own expense within fifteen (15) days of his receiving the notice, or otherwise within such time as may be reasonably necessary for making it good, replace such parts or materials at his own expenses.
- 7.2 In the event such defective plants or parts thereof are already erected, the contractor at his own costs shall proceed to alter, reconstruct or remove such work and furnish the fresh equipment up to the standard of the specifications.
- 7.3 In case the contractor fails to do so, the Engineer may, on giving the contractor 15 (fifteen) days written notice his intention to do so, proceed to remove the portion of the works so complained of and at the cost of the contractor perform all such work or furnish all such equipment.
- 7.4 Notwithstanding anything contained hereinabove, nothing in this clause shall be deemed to deprive the owner of or affect any rights under the contract which the owner may otherwise have in respect of such defects and deficiencies.


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SR. NO.	ITEM		Koradi 2x660 MW
		2	HD FIRE PROTECT PVT. LTD., THANE
34.26	HYDRANT VALVES	1	WINCO VALVES PVT. LTD., AHMEDABAD
34.27	PIPE STRAINERS	1	GRAD PRIX
		2	CHEMPHRAM
		3	GUJARAT AUTO FILT
		4	MULTIPLEX ENGINEERS
		5	SUPER FLOW
		6	JAY-EESH ENGINEERING COMPANY
		7	NISAN SCIENTIFIC PROCESS EQUIPMENTS PVT LTD
		8	ACME FLUID SYSTEMS
34.28	BW FITTINGS	1	ENGINEERING SERVICE ENTERPRISE
		2	N.L.HAZRA & SON
		3	SIDDHARTHA & GAUTAM ENGINEERS PVT.LTD.
		4	GUJRAT INFRAPIPES PVT. LTD
		5	SUPER FORGE PVT LTD
		6	TESHI ENGINEERS & SALES PROMOTERS (P) LTD
		7	TRUE FORGE PVT LTD
34.29	FORGED FITTINGS	1	ENGINEERING SERVICE ENTERPRISE
		2	N L HAZRA
		3	PAUL INDUSTRIES
		4	SUPER FORGE PVT LTD
		5	TESHI ENGINEERS & SALES PVT LTD
		6	TRUE FORGE PVT LTD
		7	LEADER VALVES
34.30	WATER MONITORS SYSTEM	1	AVON
		2	H. D. FIRE
		3	New Age Fire Fighting Co. Ltd.
35.00	VENTILATION EQUIPMENT		
35.01	VENTILATION SYSTEM	1	BLUE STAR Ltd.
		2	Hyderabad Pollution Controls Ltd.
		3	VOLTAS LIMITED
		4	AEROVENT PROJECTS LIMITED
		5	WRC ENGINEERING COMPANY PVT LIMITED
		6	Advance Ventilation Pvt.Ltd.
		7	Wollaque Ventilation & Conditioning Pvt. Ltd.
		8	M/s DV Equipments Pvt. Ltd. Haryana-131 028.


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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	KAITAN
		2	FLAKT
35.04	V.BELTS & PULLEY	1	DUNLOP
		2	FENNER
35.05	FIRE DAMPAR	1	TSC
		2	AIR TECH
		3	GEORGE RAO
		4	RAVISTAR INDIA PVT LIMITED.
35.06	BEARINGS	1	SKF
		2	NORMAN
		3	NBC
		4	FAG
36.00	AIR CONDITIONING		
36.01	REFRIGERATION RECIPROCATING COMPRESSOR	1	ACCL,KOLKATA
		2	KIRLOSKAR,PUNE
		3	VOLTAS,MUMBAI
		4	CARRIER,MUMBAI
		5	TRANE (INDIA) PVT.LTD.,MUMBAI
36.02	CONDENSER & CHILLER	1	NMW (I) PVT. LTD., HOWRAH (W.B)
		2	PATEL AIR TEMP, AHMEDABAD
		3	JAYPEE ENGG. WORKS,KOLKATA
		4	BLUE STAR,MUMBAI
		5	CARRIER,MUMBAI
		6	VOLTAS,MUMBAI
36.03	COOLING COILS	1	JAYPEE , AHMEDABAD
		2	BLUE STAR , MUMBAI
		3	CARRIER,MUMBAI
		4	COOL TECH,MUMBAI
		5	V.M. ENGG., PUNE
36.04	AIR HANDLING UNITS	1	FLAKT (ABB)


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SR. NO.	ITEM		Koradi 2x660 MW
		2	BLUE STAR,MUMBAI
		3	CARRIER, MUMBAI
		4	COOL TECH, MUMBAI
		5	V.M. ENGG.,PUNE
		6	HYDERABAD POLLUTION CONTROLS PVT. LTD
		7	ADVANCE VENTILATION PVT.LTD.
36.05	CONDENSER CHILLED WATER PUMPS	1	KIRLOSKAR
		2	BEACONWEIR
		3	GREAVES LTD.
		4	JYOTI
		5	KSB
		6	CROMPTON GREAVES
		7	FLOWMORE LTD.
36.06	FRESH AIR FANS	1	GEC
		2	KHAITAN
		3	FLAKT(ABB)
		4	ADVANCE VENTILATION PVT.LTD.
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	BEORDESEL
		2	FGP
		3	LLOYD
		4	UP TWIGA
		5	BASF
36.09	FAN COIL UNITS	1	BLUE STAR
		2	FLAKT
		3	ACCO
		4	TEXCHEM
36.10	BEARINGS	1	SKF
		2	NORMAN
		3	FAG
		4	NBC

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SR. NO.	ITEM		Koradi 2x660 MW
36.11	V BELTS & PULLEY	1	DUNLOP
		2	FENNER
36.12	FALSE CEILING MATERIAL	1	LUXALON 84 C & BIGGER WIDTH 124 C
36.13	MOTORISED DAMPERS	1	HIN
		2	LEHMAN
		3	TECHNOMECH
		4	BACHMANN
		5	TEE INSTRUMENT
36.14	COOLING TOWERS	1	PAHARPUR
		2	ADVANCE COOLING TOWER PVT.LTD.
36.15	FIRE DAMPER	1	TSC
		2	AIR TECH
		3	GEORGE RAO
36.16	MIXING VALVES	1	HONEYWELL
		2	TSC
		3	AVCON
		4	SIEMENS PVT. LTD
36.17	MODULATING MOTORS	1	HONEYWELL
		2	TSC
		3	AVCON
36.18	MODULATING THERMOSTAT	1	PROTO-TECH
36.19	AIR CONDITIONING SYSTEM	1	Advance Ventilation Pvt. Ltd.
		2	COMFORT SYSTEMS
		3	THERMAL ENGINEERS & INSULATORS PVT LTD.
		4	Roots Cooling Systems Pvt. Ltd.
		5	FRICK INDIA LIMITED
		6	TRAC FUJICO AIR SYSTEMS LLP.
40.00	ELEVATOR		
		1	OTIS ELEVATORS
		2	KONE ELEVATORS INDIA PVT. LTD.
		3	CITY LIFTS
		4	MEKASTER ENGG.LTD., HALOL(GUJARAT)
		5	ECE INDUSTRIES LTD.,KOLKATA
		6	Omega Elevators
		7	ECE Industries Ltd.
		8	Orbis Elevator Co.Ltd.



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ANNEXURE - 8

- PAINTING REQUIREMENTS

REV. - 0

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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 PREPARATION 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 / hastelloy / 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.



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.



- 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/m². 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



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 °C. The blasting activity shall be performed at ambient temperatures above 5°C and relative humidity less than 85%. Steel temperature shall be 3°C 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 3°C 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:
- When the surface temperature is greater than 60 °C, unless a higher temperature is agreed by the paint manufacturer.
 - When the air temperature is less than approximately 5°C, depending on local conditions.
 - When there is the likelihood of an unfavourable change in weather conditions within two hours after painting.
 - When there is a deposition of moisture in the form of rain, condensation, frost, etc., on the surface.
 - 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



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.



- 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:
- Wherever, paint manufacturer recommends brush application.
 - When areas cannot be properly coated by spraying for reasons such as material or environmental considerations
 - For the initial coat of paint to corners, edges, crevices, holes, welds or irregular surface prior to spray application
 - For 'touch up' or repairs to localize damaged paint or areas of incorrectly applied paint
 - 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 an 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-
- Corrosion protective properties
 - Health, safety and environment requirements
 - Properties related to application conditions, equipment and personnel
 - 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.

- v) Performance standard as listed below shall be established by paint manufacturer and the quality records shall be submitted for review –
- Adhesion test (pull off test)
 - Flexibility test
 - Salt spray test (min 1000 Hrs)
 - UV resistance test (external coating)
 - Cathodic dis bonding test (internal coating)
 - Abrasion test (internal coating)
 - 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, 180° 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

- 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% $\pm 2\%$) 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.
- 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% $\pm 2\%$) 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.
- 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% $\pm 2\%$) 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



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/m².
- 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/m² 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/m² 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 TiO₂ 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.



- 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)	
1.	Boiler & Auxiliaries								
a.	All insulated surfaces with temperature <95 °C	SP3/SP4 Sa 2	HB Zn Phosphate (Alkyd base)	2	60				100
b.	All insulated surfaces with temperature >95 °C	SP3/SP4 Sa 2	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				40
b.	All un-insulated Piping, fittings/ components, Pipe clamps, Vessels/Tanks, Equipment etc.								
i.	Design temperature < or equal to 60°C	SP3/SP4 Sa 2	HB Zn Phosphate (Alkyd base)	2	50				155

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ii.	Design temperature from 60°C to 200°C	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 >200°C	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 polyuretha ne, 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 60°C	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 >60°C	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 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	50	150 μ
6.	ESP											
a.	All surfaces with temperature <95 °C	SP3/SP4 Sa 2	Zinc Chrome (Alkyd base)	1	25				Zinc Chrome (epoxy base)	1	30	55
b.	All insulated surfaces with temperature >95 °C	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 > 120°C	Sa 2 ½	In organic Zn silicate	2	60							60 μ
16.	For insulated piping <125 °C	Sa 2 ½	Polyamide cured epoxy coating	2	250							250 μ

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7.	Un insulated silencer, steel stacks >120 °C	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 polyurethane	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		DFT (μ)	Intermediate Coat		Finish Coat		Total DFT (min.)		
			Primer	No. of Coats		Primer	No. of Coats	Primer	No. of Coats			
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 °C, 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.



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ANNEXURE - 8

TECHNICAL SPECIFICATION PAINTING REQUIREMENTS

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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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PART - A

RFx No. 3000046202 (BTG Package)

SECTION - 3

TECHNICAL SPECIFICATION PIPING, VALVES & SPECIALITIES
AND INSULATION

REV. - 0

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1.00.00 GENERAL

1.01.00 This section covers minimum requirements for design, engineering, manufacture & assembly, inspection, supply, erection, testing commissioning and performance testing of complete PIPING, VALVES & SPECIALITIES AND INSULATION for 2 x 660 MW pulverized fuel based thermal power plant; to meet well established engineering practices, safety codes and other relevant codes and standards. This section will cover the following:

1.01.01 High Pressure Piping

1.01.02 Low Pressure Piping

1.01.03 Large Diameter Pipes and Fabricated Tanks

1.01.04 Thermal Insulation

2.00.00 HIGH PRESSURE PIPING

2.01.00 General

2.01.01 This section covers all the piping, valves and specialties which connect the different equipment like the boiler, turbine, condenser, pumps, heaters etc. to make the power cycle.

2.01.02 The piping system acts as the pressure boundary for the fluid in circulation; water and steam in this case, which is subject to high pressure, temperature, change of phase and various types of transient and steady state operation. The piping system shall be designed and constructed for integrity, long life, high reliability, acceptable pressure drops, smooth and good operation and control from start-up to the maximum load.

2.01.03 Piping under this sub-section shall include all piping, valves and specialties as indicated in Annexure-1 of this sub-section and not limited to the following:

- i) All power cycle 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 specification.
- 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 as required.
- iii) Machining work of flanges, pipe spools and matching pipes to connect flow measuring orifices/nozzles with the main pipe work. The pipe spools shall be supplied along with necessary test certificates of the pipes, after necessary machining to the required bore, for assembly of flow nozzle element. The assembled flow nozzle shall be installed in the piping system. Additional length of pipes equal to length of all fully assembled flow nozzle & orifice plates pipe piece shall be supplied and the same shall also be erected prior to cleaning of the pipes by flushing or steam blowing or chemical cleaning or both. After completion of cleaning of piping the assembled flow nozzles shall be erected replacing the temporary pipe spools.



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 specialties 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.



- 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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SECTION - 3

**TECHNICAL SPECIFICATION PIPING, VALVES & SPECIALITIES
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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.


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



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.



- 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.



- 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.



- 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.

ANNEXURE – I
Specification for Low Pressure Piping

Services	A		B	C	D
	Filter/Clarified Water piping, DMCW piping				
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.		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
	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		

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TECHNICAL SPECIFICATION PIPING & SPECIALITIES

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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-351-CF8
Construction	Welded/ Seamless	Forged	Welded/ Seamless	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	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-	Slip - on flanges

Services	A		B		C	D
	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
				16.11 All 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 - galvanized-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)	Service Water (Clarified/Filtered)	For sizes 65mm NB and above.
		ii)	Filtered Water	
		iii)	Drinking Water	
		iv)	Inhibited Demineralised Water	
B.	Stainless steel body/ Gate/Globe /Check/Ball Valve	i)	For Demineralised water	For all sizes
		ii)	Drinking Water	For sizes less than and equal to 50 mm NB
		iii)	Service and Instrument Air	For all sizes. Ball valves to be used in air line.
C.	Steel Body valves	i)	Clarified/Filtered Water	For sizes less than and equal to 50 mm NB
		ii)	Inhibited Demineralised Water for DMCW system	
D.	Cast Iron body butterfly valve	i)	For Demineralised Water	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
		ii)	Clarified Water	
		iii)	Filtered Water	
		iv)	Inhibited Demineralised Water for DMCW system	

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

	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		b) BS-1873/ANSI-B-16.34
c)	IS-5312/MSS - SP -71	d) BS-5351	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 Body Gate/ Globe/Check Valve/ Ball Valve
7.00.00	Testing			
	a) Gate	i) As per IS - 780 for 50 mm - 300 mm NB		API-598
	b) Globe	ii) IS-2906 for sizes equal to and above 350 mm NB Hydrostatic Test as per MSS-SP- 85	As per ANSI B-16.34	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 Body Gate/ Globe/Check Valve/ Ball Valve
c) Check	IS-5312/MSS-SP-71		BS--1868

	TITLE: 2X660 MW KORADI STP (UNITS-11&12) AIRCONDITIONING SYSTEM TECHNICAL SPECIFICATION (ELECTRICAL PORTION)	SPECIFICATION No: PE-TS-527-553-A001	
		SECTION: I	
		SUB-SECTION: C-3	
		REV. 00	DATE: AUGUST 2026

SECTION: I

SUB-SECTION: C-3

TECHNICAL SPECIFICATION (ELECTRICAL PORTION)



**TECHNICAL SPECIFICATION FOR
HVAC SYSTEM
(ELECTRICAL PORTION)
PROJECT: 2X660MW KORADI THERMAL POWER
PROJECT (UNIT# 11 & 12)**

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SPECIFIC TECHNICAL REQUIREMENTS: ELECTRICAL

- 1.0 Scope for supply, and erection & commissioning of various equipment forming part of electrical system for this package shall be as per Annexure-I [Scope of Work (Electrical)].
- 2.0 Make of all electrical equipment/ items supplied shall be reputed make. Same shall be subject to approval of BHEL/customer after award of contract without any commercial implications. Tentative make list of various Electrical items (Motors/ lugs/glands) is attached.
- 3.0 All QPs shall be subject to approval of BHEL/customer after award of contract without any commercial implication.

4.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID

- 4.1 Bidder shall confirm total compliance to the electrical specification without any deviation from the technical/ quality assurance requirements stipulated.
- 4.2 No technical submittal such as copies of data sheets, drawings, write-up, quality plans, type test certificates, technical literature, etc, is required during tender stage. Any such submission even if made, shall not be considered as part of offer.

5.0 LIST OF ENCLOSURES

- 5.1 Electrical scope between BHEL & vendor (Annexure-I).
- 5.2 Technical specification - Motors (Annexure-II).
- 5.3 Datasheet –Motor (Annexure-III)
- 5.4 Quality Plan for motors. (Annexure-IV)
- 5.5 Technical Specification for Misc. Items (Annexure-V)
- 5.6 Load data format (Annexure-VI).
- 5.7 Explanatory note for Cable routing & Cable schedule format (Annexure-VII)
- 5.8 Tentative make list for electrical items (Annexure-VIII)



**TECHNICAL SPECIFICATION FOR
HVAC SYSTEM
(ELECTRICAL PORTION)
PROJECT: 2X660MW KORADI THERMAL POWER
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Electrical scope between BHEL & vendor
Annexure-I

STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGE: HVAC SYSTEM

SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT

PROJECT: 2X660MW KORADI THERMAL POWER PROJECT (UNIT# 11 & 12)

<u>S.NO</u>	<u>DETAILS</u>	<u>SCOPE SUPPLY</u>	<u>SCOPE E&C</u>	<u>REMARKS</u>
1	415V MCC	BHEL	BHEL	a) 240 V AC (supply feeder)/415 V AC (3 PHASE 4 WIRE) supply shall be provided by BHEL as per load data provided by vendor at contract stage for all equipment supplied by vendor as part of contract. b) Emergency supply feeder provided (if required) shall be 3 phase 3 wire only. Any other voltage level (AC/DC/Single ph emergency AC) required will be derived by the vendor. c) 230 V AC UPS Power supply (if required) shall be provided by BHEL at a single point, all necessary hardware for deriving other power supply from given feeder shall be in Vendor's scope.
2	Local control panel	Vendor	Vendor	Refer C & I specification for details
3	Local Push Button Station (for motors)	BHEL	BHEL	Located near the motors.
4	Power cables, control cables and screened control cables for a) both end equipment in BHEL's scope b) both end equipment in vendor's scope c) one end equipment in vendor's scope	BHEL BHEL BHEL	BHEL Vendor BHEL	1. For 4.b) & c): Sizes of cables required shall be informed by vendor at contract stage (based on inputs provided by BHEL) in the form of cable listing. Finalisation of cable sizes shall be done by BHEL. Vendor shall provide lugs & glands accordingly. 2. Termination at BHEL equipment terminals by BHEL. 3. Termination at Vendor equipment terminals by Vendor.

STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGE: HVAC SYSTEM

SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT

PROJECT: 2X660MW KORADI THERMAL POWER PROJECT (UNIT# 11 & 12)

5	Junction box for control & instrumentation cable (if applicable)	Vendor	Vendor	Number of Junction Boxes shall be sufficient and positioned in the field to minimize local cabling (max 10-12 mtrs) and trunk cable.
6	Cable trays, accessories & cable trays supporting system. 100/50 mm cable trays/Galvanised steel cable troughs for local cabling	BHEL BHEL	BHEL Vendor	Local cabling from nearby main route cable tray (BHEL scope) to equipment terminal (vendor's scope) shall be through 100/ 50 mm. cable trays/ conduits/ Galvanised steel cable troughs as per approved layout drawing during contract stage.
7	Any special type of cable like compensating, co-axial, prefab, MICC & fibre optical	Vendor	Vendor	Refer C&I portion of specification for scope of fibre Optical cables if used between PLC/ microprocessor & DCS.
8	Equipment grounding (including electronic earthing) & lightning protection	BHEL	BHEL	Vendor shall indicate location of Electronic Earth pit in their Civil assignment drawing
9	Motors with base frame and fixing hardware for motors.	Vendor	Vendor	Makes shall be subject to customer/ BHEL approval at contract stage.
10	Cable glands, lugs and bimetallic strip for equipment supplied by Vendor	Vendor	Vendor	1. Double compression Ni-Cr plated brass cable glands 2. Solder less crimping type heavy duty tinned copper lugs for power and control cables.
11	Conduit and conduit accessories for cabling between equipment supplied by vendor.	Vendor	Vendor	Conduits shall be medium duty, hot dip galvanised cold rolled mild steel rigid conduit as per IS: 9537.
12	Lighting	BHEL	BHEL	--
13	Below grade grounding	BHEL	BHEL	--
14	a) Input cable schedules (C & I) b) Cable interconnection details for above c) Cable block diagram	Vendor Vendor Vendor	- - -	Cable listing for Control and Instrumentation Cable in enclosed excel format shall be submitted by vendor during detailed engineering stage.
15	Any other equipment/material/service required for completeness of system based on the system offered by vendor (to ensure trouble free and efficient operation of the	Vendor	Vendor	--

STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGE: HVAC SYSTEM
SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT
PROJECT: 2X660MW KORADI THERMAL POWER PROJECT (UNIT# 11 & 12)

	system).	Vendor	-	For necessary interface review.
16	Electrical Equipment GA drawing	Vendor	-	For ensuring cabling requirements are met, vendor shall furnish Electrical equipment layout & cable tray layout drawings (both in print form as well as in AUTOCAD) of the complete plant (including electrical area) indicating location and identification of all equipment requiring cabling, and shall incorporate cable trays routing details marked on the drawing as per PEM interface comments. Cabling arrangement of the same (wherever overhead cable trays, trenches, cable ducts, conduits etc.) shall be decided during contract stage. Electrical equipment layout & cable tray layout drawing shall be subjected to BHEL/ customer approval without any commercial implications to BHEL.

NOTES:

1. Make of all electrical equipment/ items supplied shall be reputed make & shall be subject to approval of BHEL/customer after award of contract.
2. All QPs shall be subject to approval of BHEL/customer after award of contract without any commercial implication.
3. In case the requirement of Junction Box arises on account of Power Cable size mis-match due to vendor engineering at later stage, vendor shall supply the Junction Box for suitable termination.



**TECHNICAL SPECIFICATION FOR
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(ELECTRICAL PORTION)
PROJECT: 2X660MW KORADI THERMAL POWER
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Technical specification – Motors
Annexure-II



14.00.00 AC & DC MOTORS

14.01.00 SCOPE

This specification is intended to cover design, manufacture, assembly and testing of AC Squirrel Cage Induction Motors – HT, LT and DC Motors for use in Thermal Power Plants and is supplement to the driven equipment specifications under which these motors are being procured for the project.

14.01.01 Site Conditions

Site conditions are covered in 'Project Data', contained in specification of the driven equipment.

14.01.02 Gases, Fumes & Dust Particles

General - Sulphur dioxide and/or trioxide fumes mildly present. Climate is tropical, conducive to fungus growth.

14.01.03 Dust Particles

- i) Outdoor locations - Heavily dusty with abrasive dust and coal particles of size five (5) to hundred (100) microns present in atmosphere in large quantity.
- ii) Indoor Locations.
- iii) Other locations - Lightly dusty with abrasive dust and coal particles of size five (5) to twenty (20) microns present in atmosphere.

14.01.04 Special Fumes

- i) Acid cleaning room - Acid and alkali fumes present.
- ii) Fuel oil pumping areas & Hydrogen generation plant - Explosive fumes (flameproof motors required).
- iii) For the purpose of design of equipment/systems, an ambient temperature of 50 deg. Centigrade and relative humidity of 95% (at 40 deg C) shall be considered. The equipment shall operate in a highly polluted environment.

14.02.00 LOCATION OF MOTOR - As Required

14.03.00 CODES STANDARDS

All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) / IEC as given below except where modified and/or supplemented by this specification.

Code	Name of standard
IS : 325	Specification for three phase induction motor.
IS : 900	Code of Practice for installation and maintenance of induction motors


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Code	Name of standard
IS : 996	Single phase AC motors
IS : 1231	Dimensions of three-phase foot-mounted induction motors
IS : 1271	Thermal evaluation and classification of electrical insulation.
IS : 2223	Dimensions of flange mounted ac induction motors.
IS : 2254	Dimensions of vertical shaft motors for pumps
IS : 3043	Code of practice for earthing.
IS : 3177	Crane duty motors
IS : 4029	Guide for testing three phase induction motors.
IS : 4691	Degree of protection for enclosures of rotating electrical machinery.
IS : 4722	Specification for rotating electrical machinery.
IS : 4728	Terminal marking and direction of rotation for rotating electrical machinery.
IS : 4889	Methods of determination of efficiency of rotating electrical machines.
IS : 5571	Guide for selection of electrical equipment for hazardous areas.
IS : 6362	Designation of Method of Cooling of Rotating electrical machines.
IS : 8223	Dimensions and output ratings for foot mounted rotating electrical machines with frame numbers 355 to 1000.
IS : 8789	Values of performance characteristics for three phase induction motors.
IS : 12065	Noise level of motors.
IS : 12075	Measurement and evaluation of vibration of rotating electrical machines.
IS : 12615	Induction motors - Energy efficient, three-phase, squirrel cage – Specification
IS : 12802	Temperature rise measurement of rotating electrical machines.
IS : 12824	Temperature rise measurement of rotating electrical machines
IS : 12824	Type of duty and classes of rating assigned.
IS : 14222	Requirements and method of Impulse withstand test
IEC: 60034-1	Rotating electrical machines.
ISO : 1940-1	Mechanical vibration – Determination of permissible residual unbalance
NEMA, MG-1	Motors and Generators
DIN/IEC/IS	RTD
BS 5308 part II	RTD triad Cable

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Equipment and material conforming to any other standard, which ensures equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be furnished during detail engineering.

The electrical installation shall meet the requirements of Indian Electricity Rules as amended up to date and relevant IS Code of Practice. In addition, other rules and regulations applicable to the work shall be followed.

14.04.00 TYPE

14.04.01 AC Motors:

- i) Squirrel cage induction motor suitable for direct-on-line starting.
- ii) Crane duty motors shall be squirrel cage Induction motor of S4 duty and 40% CDF.

14.04.02 DC Motors shall generally be of shunt wound type rated for 220V DC.

14.05.00 VOLTAGE (NOMINAL)

14.05.01 LV Motors

For motors upto and including 200 KW - Four hundred fifteen (415) V.

14.05.02 MV Motors

For motors above 200 kW and including 1500kW. Three point three (3.3) kV.

14.05.03 HV Motors

- i) For motors above 1500kW - Eleven (11) KV

14.06.00 FREQUENCY (NOMINAL) - Fifty (50) Hertz

14.07.00 NUMBER OF PHASES - Three (3)

14.08.00 SPEED - As required by the driven equipment

14.09.00 TYPE OF STARTING

Direct on-line where variable voltage and variable frequency (VVFD) operation is envisaged through VVFD drives, motors shall be specially designed for such application

14.10.00 DUTY

14.10.01 Continuous motor rating shall be arrived at considering 15% margin over the duty point input or 10% over the maximum demand of the driven equipment, whichever is higher, considering highest system frequency and voltage

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variation. Crane motors shall be rated for S4 duty, 40% cyclic duration factor. If however, a higher margin is stipulated in the accompanying driven equipment specification, the higher stipulated margin shall prevail.

- 14.10.02 Motor rating shall be such that it is not overloaded at any operating point of driven equipment from zero to full load.
- 14.10.03 The break-away torque, pull-up torque and pull-out torque of the motors shall be properly co-ordinated with the requirements of driven equipment to ensure smooth and rapid starting and steady operation. The torque-speed characteristic of motor super imposed thereon driven equipment torque-speed characteristics at 100%, 90%, 80% shall be furnished.
- 14.10.04 Maximum torque shall not be less than 200% of full load torque.
- 14.10.05 All HV & MV motors shall be provided with vibration pads for mounting vibration detectors.
- 14.10.06 All motors shall be designed to withstand hundred twenty (120) percent of rated speed without any mechanical damage for two (2) minutes.
- 14.10.07 Motors shall be designed to keep torsional and rotational natural frequencies of vibration of the motor and driven equipment atleast twenty five (25) percent above or below, preferably above the motor operating speed (to avoid resonance in vibration over the operating speed) range.
- 14.10.08 All the duty motors shall be energy efficient type. For LT motors, the efficiency class shall be IE3 class as per IS 12615. For VFD controlled HT and LT motors, it shall be IE2 class as per IS 12615.

14.11.00 SUPPLY VARIATIONS

Motors shall be capable of running continuously at full load under following variations in power supply.

- 14.11.01 **Voltage (percent of nominal voltage)** Plus minus (+) ten (10%) for LT motors and Plus minus (+) six (6) for HT motors.
- 14.11.02 **Frequency (percent of minimal frequency)**..... Plus minus (+) five (5%)
- 14.11.03 **Combined voltage & frequency (percent)** Ten (10%) (sum of absolute percentage value of voltage and frequency variation)

14.12.00 ABNORMAL CONDITIONS CAPABILITY

Motor shall have following capabilities as specified design ambient temperature:

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14.12.01 The motors shall also be capable of running up again after voltage collapse to about 40% for approximate duration of 0.5 sec. Subsequent rise in voltage to 70% and further to 80% and 100%, the total duration not exceeding 20 sec.

14.12.02 Pump motor subject to reverse rotation shall be designed to withstand the stresses encountered when starting with non-energized shaft rotating at 125% rated speed in reverse direction.

14.12.03 Low Voltage Running:-

14.12.04 Motor shall be capable of running satisfactorily at seventy five (75) percent of nominal voltage for five (5) minutes.

14.12.05 Momentary Low Voltage Withstanding:

14.12.06 Motor, when running at full load, shall not stall when voltage drops down to seventy (70) percent nominal voltage for one (1) minute.

14.13.00 STARTING CAPABILITY

14.13.01 Low Voltage Starting

Motor shall be capable of starting and accelerating to full speed at full load (including loaded equipment e.g. mills and conveyors etc) at eighty (80) percent nominal voltage at motor terminals. Mill motors may be permitted to start with terminal voltage not below 90%.

14.13.02 Cold Motor Starting

Under specified voltage variations two (2) starts in quick succession and third start five (5) minutes thereafter, all with full load (including loaded equipment eg mills and conveyors etc) of driven equipment. No additional start shall be made till lapse of further thirty (30) minutes.

14.13.03 Hot Motor Starting

Under specified voltage variations, one (1) immediate and two (2) fifteen (15) minutes interval starts all with full load (including loaded equipment e.g. mills and conveyors etc) of driven equipment. No additional start shall be made till lapse of further thirty (30) minutes.

14.13.04 Motor shall also be suitable for three (3) equally spread starts per hour when the motor is under normal service condition.

14.13.05 Break-away Starting Current

Breakaway starting current as percent of full load current for various motor ratings shall not exceed the values given below:-

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- i) Motors upto 1000 KW 600% subject to IS Tolerance of plus 20%
- ii) Motors (above 1000 KW upto 3000 KW) 600%. Not subject to any positive tolerance.
- iii) Motors above 3000 KW.....450%. Not subject to any positive tolerance.
- iv) For energy efficient LT motors, locked rotor current shall be as per IS: 12615 **without any further positive tolerance.**
- v) Locked rotor current of the VFD controlled AC motors shall be limited to 300% of the full load current, and is subject to IS tolerance.

14.14.00 STARTING VOLTAGE REQUIREMENT

14.14.01 All Motors (except Mill Motors)

- i) 80% of rated voltage for Motors upto 4000 kW
- ii) 75% of rated voltage for Motors above 4000 kW

14.14.02 For Mill Motors:

- i) 85% of rated voltage for Motors above 1000 kW
- ii) 90% of rated voltage for Motors below 1000 kW

14.15.00 TORQUE REQUIREMENTS

14.15.01 Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor full load torque.

 14.15.02 **Pull** out torque at rated voltage shall not be less than 205% of full load torque. It shall be 275% for crane duty Motors.

14.16.00 STARTING TIME

14.16.01 For motors with starting time upto 20 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be atleast 2.5 secs. more than starting time.

14.16.02 For motors with starting time more than 20 secs. and upto 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be atleast 5 secs. more than starting time.

14.16.03 For motors with starting time more than 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be more than starting time by atleast 10% of the starting time.

14.16.04 Speed switches mounted on the motor shaft shall be provided in cases where above requirements are not met.



14.17.00 CLASS OF INSULATION

14.17.01 LV Motors Class F.

14.17.02 HV & MV Motors Class F

14.17.03 However temperature rise shall be restricted to limits corresponding to Class 'B' insulation for both MV, HV & LT motors. The temperature under abnormal running conditions shall be limited to 50C above class 'B' limits.

14.17.04 The value of the polarization index for motors above 160kW should not be less than 2 when determined according to IS: 78114.0

14.18.00 TEMPERATURE RISE UNDER NORMAL CONDITIONS

14.18.01 Temperature rise over specified design ambient temperature when motor is running with full load at nominal supply voltage & frequency shall not exceed the values given below:

S.No.	Specified Design Ambient Temperature	Thermometer Method	Resistance Method
i)	50°C	60°C	70°C

14.18.02 For Water Cooled Motors, temperature rise of insulation should be limited to 80 deg. C over inlet cooling water temperature mentioned elsewhere, by resistance method.

14.19.00 BUS TRANSFER WITHSTAND CAPABILITY

14.19.01 Motors shall be connected to an automatic bus transfer system and hence may be subjected to one hundred and fifty (150) percent of the nominal voltage during changeover of buses due to the vector difference between the residual voltage and incoming supply voltage and the duration of this condition may be one second. Motors shall be capable of withstanding the voltage and torque stresses developed under such conditions without damage. The motor shall not puncture its insulation during its lifetime.

14.19.02 The motor shall be capable of withstanding heavy inrush transient current caused by such bus transfers without damage.

14.19.03 The motor windings shall be adequately braced to satisfactorily withstand mechanical stresses under these conditions.

14.19.04 The motor and driven equipment shafts shall be adequately sized to satisfactorily withstand transient torques under these conditions.



14.20.00 TYPE OF ENCLOSURE

- 14.20.01 Outdoor Motors.....IPW 55 (Additional canopy to be provided by Bidder).
- 14.20.02 Indoor Motors IP 55
- 14.20.03 IP-55 degree of protection shall be achieved without application of any compound, putty etc.

14.21.00 METHOD OF COOLING

- 14.21.01 Method of cooling shall be IC 411 (TEFC), IC 511 (TETV) or IC 611 (CACA). However, motors rated 3000kW or above can be closed air circuit water cooled (CACW).
- 14.21.02 Large capacity motors not available with above types of cooling may be accepted with IC 81 W for IC 91 W (CACW) cooling subject to the approval of the Purchaser.

14.22.00 TYPE OF MOUNTING As required for the driven equipment.

14.23.00 MAXIMUM MECHANICAL VIBRATIONS

Vibration shall be limited within the limits prescribed in IS: 12075 / IEC 60034-14. Motors shall withstand vibrations produced by driven equipment. HV & MV motor bearing housings shall have flat surfaces, in both X and Y directions, suitable for mounting 80mmX80mm vibration pads. Vibration pads with screwed holes along with vibration probes shall be provided at both DE and NDE.

14.24.00 NOISE LEVEL

- 14.24.01 Noise level for all the motors shall be limited to 85 dB(A) except for BFP motor for which the maximum limit shall be 90dB(A) at 1m from operating motor measured in accordance with IS: 10265.
- 14.24.02 Motor body shall have two earthing points on opposite sides.
- 14.24.03 The spacing between gland plate & centre of terminal stud shall be as per Table-I.

TABLE – I		
DIMENSIONS OF TERMINAL BOXES FOR LV MOTORS		
Motor MCR in KW	:	Minimum distance between centre of stud and gland plate in mm
UP to 3 KW	:	As per manufacturer's practice.
Above 3 KW - upto 7 KW	:	85
Above 7 KW - upto 13 KW	:	115

TABLE – I
DIMENSIONS OF TERMINAL BOXES FOR LV MOTORS

Above 13 KW - upto 24 KW	:	167
Above 24 KW - upto 37 KW	:	196
Above 37 KW - upto 55 KW	:	249
Above 55 KW - upto 90 KW	:	277
Above 90 KW - upto 125 KW	:	331
Above 125 KW-upto 160 KW	:	203

14.24.04 For HV & MV motors the distance between gland plate and the terminal studs shall not be less than 500 mm.

14.24.05 All motors shall be so designed that maximum inrush currents and locked rotor and pullout torque developed by them at extreme voltage and frequency variations do not endanger the motor and driven equipment.

14.24.06 For motors rated 1000 KW & above, neutral current transformers of PS class shall be provided on each phase in a separate neutral terminal box for differential protection.

14.25.00 WINDING & INSULATION

14.25.01 Type: Non-hygroscopic, oil resistant, flame resistant

14.25.02 11kV & 3.3 kV AC motors: Thermal class 155 (F) insulation and the temperature rise shall be limited to Class B. Winding material shall be of copper. The winding insulation process shall be total Vacuum Pressure Impregnated(VPI). The lightning Impulse & interturn insulation surge withstand level shall be as per IEC-60034 part-15.

14.25.03 240VAC, 415V AC & 220V DC motors : Thermal Class(F)

14.26.00 DIRECTION OF ROTATION

14.26.01 As needed by driven equipment.

14.26.02 The 3 phase motor shall, however, be suitable for operation in both directions of rotation. A plate showing direction of rotation as determined by the phase sequence on the terminals marking shall be screwed at non-driving end of the body of the motor.

14.26.03 If, in the case of HV & MV motors, fan is suitable for only one direction of rotation, the fan shall be so designed that with the slight modification work, it can be made suitable for other direction of rotation also. No extra material shall be required for doing above modification work.

14.27.00 WINDING



- i) Winding shall be class F insulation with temperature limited to class B. Insulation shall be Non-hygroscopic, oil resistant, and flame resistant. Winding, fittings and hardware shall be corrosion resistant. Winding shall be tropicalized and suitably varnished, baked and treated for operating satisfactorily in humid and corrosive atmosphere.
- ii) For the VFD operated drives, insulation shall be designed to take care of stresses due to high DV/DT. Motors shall be wound with dual coated winding wires and impregnated with VPI process. Further for such application, insulated bearings shall be provided to avoid circulating current caused by shaft induced voltages.
- iii) Space heaters rated for 240 V AC, 50 Hz supply shall be provided for motors rated 30 kW and above to maintain windings in dry condition when motor is standstill.
- iv) For HT motors, insulation shall be Vacuum Impregnated (VPI).
- v) HT motors shall withstand one minute power frequency voltage test or 1.2/50 micro sec lightning impulse Voltage wave of 4U+5 kV (U=Line voltage in kV) test on main insulation as per IEC 600034-15. The coil inter-turn insulation shall withstand steep front impulse withstand voltage as per IEC 600034-15.
- vi) For HT motors, 12 nos. simplex or 6 nos. duplex RTDs (two per phase), each having D.C. resistance of 100 ohms at 0°C, embedded in the stator winding at locations where highest temperatures may be expected, shall be provided. The material of the ETD's shall be platinum.
- vii) For LT motors of rating more than 90KW, shall be provided with 2 nos of RTD's on each phase of the stator winding for its temperature measurement.

14.28.00 BEARINGS

- 14.28.01 Furnishing of all labour, skilled and unskilled, supervisory and administrative personnel, erection tools and tackles, testing equipment implements, supplies, consumables & hardware for timely efficient execution of complete work.
- 14.28.02 Greased ball, roller and/or sleeve bearing shall be rated for minimum standard life of 40000 hours taking bearing and driven equipment loads into account. Loss of grease shall be scarce and it shall not creep along shaft into motor housing.
- 14.28.03 Bearing shall be effectively sealed against dust ingress and shall be pressure grease gun lubricated.
- 14.28.04 If the bearings are oil lubricated, a drain plug shall be provided for draining residual oil and oil level gauge shall be provided to show precisely oil level required under standstill and running conditions.
- 14.28.05 Unless otherwise approved, bearing lubricating system shall be such that no external forced oil or water is necessary to maintain required oil supply to keep bearing temperature within design limits.

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- 14.28.06 For MV & HV motors rated 1000 KW and above, the bearings shall be insulated wherever necessary to prevent damage to motor bearings from shaft current.
- 14.28.07 When pressure oiling is required for horizontal motors, bearings shall be sleeve type arranged for pressure oiling supplied from lubrication system of driven machine, with ring oiling for starting and emergency duty. Ring oiling system shall be adequate for starting and continuous operation of motor for at least half an hour, without pressure oiling system in operation. Oil sight flow gauges shall be provided to indicate oil flow through each bearing.
- 14.28.08 Lubricants shall be selected for prolonged storage and normal use of motors in tropical climate and shall contain corrosion and oxidation inhibitors. Greases shall have suitable bleeding characteristics to minimize setting. The selected lubricants shall be indigenously available.
- 14.28.09 Sleeve bearings for use with motors having flexible coupling with limited end play, shall have adequate axial end play to prevent transmission of thrust from driven equipment to motor bearings.
- 14.28.10 All VFD operated motors shall have insulated bearings to prevent flow of shaft currents.
- 14.28.11 Bearings shall be of reputed make subject to the approval of the Purchaser/Consulting Engineer.
- 14.28.12 Large motors shall preferably have spherically seated babitted, ring forced, feed lubricated, water-cooled bearings. If anti-friction bearings are provided, these shall be roller bearings rated for a minimum standard life of 30000 hours taking all bearing and driven equipment loads into account.
- 14.29.00 SHAFT EXTENSION** Key slotted bare shaft extension of required length with key on driving end.
- 14.30.00 DRAIN HOLES** Two (2) drain holes with plugs, one (1) on either end of motor at the bottom most point.
- 14.31.00 LIFTING DEVICES** Motors shall be provided with eyebolts, lugs or other means to facilitate safe lifting.
- 14.32.00 DOWEL PINS.....** It shall be possible to drill holes vertically inclined through motor feet or mounting flange for installing dowel pins after assembling motor and driven equipment, before despatch (for completed driving + driven equipment assembly) or at site after erection (for separate supplies of above equipment).
- 14.33.00 CENTERING SPIGOT.....** Flange mounted motor shall have centering spigot to match driven equipment socket.

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14.34.00 EASE OF MAINTENANCE..... Motor shall be so constructed that it can be de-assembled and reassembled with ease.

14.35.00 NAMEPLATES..... Motor shall have nameplate(s) showing diagram of connections, all particulars as per IS: 325 and following additional information:-

14.35.01 In addition, an arrow block shall be screwed on to the body of motor on the non-driving end to indicate direction of rotation of motor.

14.35.02 Temperature rise under normal/abnormal conditions.

14.35.03 Type of bearing and recommended lubricants.

14.36.00 FINISH

14.36.01 Motor shall have synthetic enamel paint shade.

14.36.02 All sharp edges and scales shall be removed from the surface, which shall then be thoroughly degreased, de-rusted and given two (2) coats of primer and two (2) coats of finish paint. It is preferred that a phosphate coat is given to motor prior to application of primer coat. Motors for water treatment plant shall have Zinc Chromate base with acid resistant Epilex 4 paint.

14.37.00 TERMINAL BOXES

14.37.01 General

- i) Motors shall be provided with separate terminal boxes for main, space heaters, embedded temperature detectors, bearing temperature indicators and moisture detectors terminals, Neutral CT terminals. When it is not possible to provide LT motors with separate terminal box for space heater terminals, space heater terminals shall be adequately segregated from the main terminals in the single box. Terminal boxes shall be weatherproof and water-tight confirming to minimum IP-55 degree of protection with removable front cover for making connections. IP-55 degree of protection shall be achieved without application of compound. Space between and around terminals shall be adequate for easily connecting aluminium conductor cables. Terminal box arrangement shall be to the approval of the Purchaser /Consulting Engineer. All terminal boxes shall be suitable for proper termination cable to be finalized during detailed engineering.
- ii) The terminal boxes shall be complete with cable glands and termination accessories as required. Suitable non-magnetic material construction shall be adopted for terminal boxes where single core cables are to be terminated. All HV & MV motors shall be provided with phase segregated terminal box.
- iii) Terminal bushings and clamps shall be non-absorbent, non- inflammable,

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insulated material for connecting with cable.

14.37.02 Main Terminal Box

- i) HV Motors.....Terminal box shall be capable of being turned through 360 degrees in steps of 180 degrees. LV Motors Main terminal box shall be capable of being turned through 360 degree steps of 90 degrees.
- ii) MV & HV Motors shall be provided with two (2) terminal boxes for stator terminals. One (1) terminal box shall be for phase terminals while other one for forming star connection. For motors rated below 1000 KW should be interchangeable to facilitate cable routing.
- iii) Neutral terminal box for HV motors rated 1000 KW and above shall be suitable for mounting of three (3) Nos. wound/bar primary/ring type cast resin insulated current transformers for differential protection. These CTs shall be mounted in the motor neutral terminal box. Stator phase terminal box shall be phase segregated terminal box suitable for both top or bottom entry of cables (i.e. they should be capable of being turned through 180 Degrees). The terminal box shall be designed for termination of XLPE cables using heat shrinkable terminating Kit. Terminal leading shall be stud type or leading wire type.
- iv) Terminal Boxes shall be provided with cable end boxes having cable lugs and cable glands for cables.
- v) The terminal boxes shall be capable of withstanding at the terminals the system fault level (as indicated below) without rupture for a duration of atleast 0.25 seconds.

- a) Min. fault level for 11kV Motors - 840 MVA
- b) Min. fault level for 3.3 kV Motors - 250 MVA
- c) Min. fault level for 415V Motors - 50 KA

vi) Phase to Phase/ Phase to Earth Air Clearance:-

- a) Minimum inter-phase and phase-earth air clearances for LT motors with lugs installed shall be as follows:-

• Motor MCR in KW	-	Clearance
• UP to 110 KW	-	10mm
• Above 110 KW and upto 150 KW	-	12.5mm
• Above 150 KW	-	19mm

- vii) Terminal Accessories.....Each terminal end shall be furnished with bimetallic washers, spring washers, nuts and crimp type aluminium (preferably tinned) lugs suitable for cables of sizes.

14.38.00 TYPE AND SIZE OF CABLES

14.38.01 Space Heaters

- i) For LV Motors: Two point five (2.5) mm², two (2) core copper conductor



PVC insulated, armoured and FRLS PVC sheathed heavy duty 650/1100 V grade cable to IS: 1554 (Part-I).

- ii) For MV & HV Motors: Six (6) mm² two core aluminium conductor XLPE insulated armoured and FRLS PVC sheathed heavy duty 650/1100V grade cable to IS: 1554 (Part-I).
- iii) For Embedded Temperature Detectors two sets of six (6) Twisted triad 0.5 mm² ATC copper conductor armoured, shielded cable, 650/1100 V Grade IS: 1554 (Part-I). For bearing temperature, RTDS, two (2) sets of four (4) twisted triad 0.5 mm², ATC copper conductor armoured shielded 650/1100 V Grade, IS: 1554 (Part-I).
- iv) Bearing Temperature Indicators - For each indicator, 0.5 mm² six (6) tarnished triad ATC copper conductor, PVC insulated, shielded armoured and FRLS PVC sheathed heavy duty 650/1100 V grade cable as per IS: 1554 Part-I. Two (2) cables one (1) for each bearing temperature indicator.
- v) For Moisture Detectors.....As per space heaters

14.38.02 For Main Terminals:-

- i) LT Motors
 - a) Three (3) core cables Stranded aluminium conductor, XLPE insulated, colour coded, laid up, FRLS PVC type ST2 sheathed, GI wire / strip armoured, FRLS PVC type-ST2 jacketed overall, 650 / 1100V grade, heavy-duty cables as per IS: 1554 (Part-I).
 - b) Single core cables Stranded aluminium conductor, XLPE insulated, hard drawn aluminium wire/ strip armoured FRLS PVC type ST2 jacketed overall, 1100V grade, heavy duty cable as per IS: 1554 (Part-I).
- ii) HV & MV Motors
 - a) Three (3) core cables stranded aluminium conductor, XLPE insulated, screened colour coded, laid up, FRLS PVC type ST2 sheathed, GI wire/strip armoured FRLS PVC type ST2 jacketed overall, 3.3 KV / 11 KV un earthed grade, heavy duty cables as per requirement for unearthed system as per IS: 7098 (Part-II).

14.39.00 GROUNDING

14.39.01 General..... Two (2) grounding terminals one (1) on either side at the bottom suitable for connecting mild steel/GI flat/GI wire grounding conductor, size of grounding conductor shall be decided during detailed engineering.

14.39.02 LV Motors.....At each earthing point, two (2) drilled and tapped holes with hexagonal head bolts, plain washers, spring washers and tinned lugs (for motors upto 5.5 KW) for size of conductor specified shall be provided.

14.39.03 HV & MV Motors.....Non-corrodible metallic grounding pad shall be

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welded or brazed at each earthing point. The size of grounding pad shall be 75x65x25 mm. Grounding pad shall have 40 mm apart two (2) drilled and tapped holes with hexagonal head bolts, plain washers and spring washers for size of conductor specified. In addition, one suitable earthing terminal shall be provided inside the stator phase terminal box for earthing metallic shield of XLPE cables.

14.40.00 EMBEDDED TEMPERATURE DETECTORS

HV & MV motor shall be provided with four (4) Nos. simplex or two (2) Nos. duplex platinum resistance temperature detectors (RTDs) in each phase embedded in stator winding at locations where high temperatures are expected. In addition one (1) duplex type RTD shall be provided in each bearing. The RTDs shall be 3 wire duplex platinum resistance type having a value of 100 ohms at 0 Deg.C.

14.41.00 BEARINGS TEMPERATURE INDICATORS

HV & MV motors shall be provided with dial type two (2) bearing temperature indicators and shall have two (2) sets of contacts, each set having 2 NO + 2 NC contacts rated for 5A at 240V AC and 0.5A at 220V DC. One set shall be set to operate at lower value to give alarm and other set at a higher value to trip the motor.

14.42.00 SPACE HEATERS

14.42.01 Valve / Damper actuator motors; and Motors 30 KW and above shall be provided with one (1) or two (2) space heaters suitable for 240V, 50 Hertz single phase AC supply and of adequate capacity to maintain motor internal temperature above dew point to prevent moisture condensation or deterioration of insulation during shut down. Heaters shall be mounted inside the motor in accessible locations so that their removal and replacement is simple.

14.42.02 The terminals of space heaters shall be brought out to a separate totally enclosed dust proof and weatherproof terminal box.

14.42.03 The space heater shall be wired to maintain the motor internal temperature above dew point when the motor is in idle condition.

14.43.00 HOT AIR TEMPERATURE DETECTOR

If the motor is of CACA or CACW enclosure, dial type temperature indicator shall be provided (one each for hot and cold air temperature monitoring for CACA and CACW and one each for inlet and outlet water temperature monitoring for CACW). If alarm and trip are required for cooling air temperature, temperature switch shall be provided.

14.44.00 WATER FLOW INDICATOR

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If the motor is of CACW enclosure a provision shall be made for visual indication of water flow and flow switch shall also be provided with alarm contacts. Thermometers shall be provided in water inlet and outlet circuits.

14.45.00 MOISTURE DETECTORS

Motors with type of cooling 1C 81W or 1C 91 W shall be provided with moisture detectors for raising alarm in the event of water tube failure.

14.46.00 BED PLATE

Whenever motor is supplied with driven equipment the Supplier shall ensure that bed plate suits both motor and driven equipment and is adequately braced to keep vibration and misalignment within allowable limits to the approval of driven equipment and motor manufacturers.

14.47.00 OTHER ACCESSORIES

Motor shall be supplied with all accessories and parts other than those, specified above which are necessary and/or useful for efficient operation.

14.48.00 DC MOTOR

DC motors shall be provided where specified/required. DC Motors shall be sized for operation with fixed resistance starting for reliability. DC motors shall be shunt wound type. Motors shall be capable of delivering the rated output at 220 V DC with (+) 10% and (-) 15% variations without exceeding its guaranteed temperature limits. 220 V DC system shall be unearthed. Starting current of the DC motors shall be limited to 200% of the full load current of the motor, and is subject to IS tolerance. DC Motors shall be similar to AC Motors with respect to other features like enclosure type, cooling and class of insulation.

14.49.00 TESTS

14.49.01 HV & MV Motors

i) Routine Tests

All equipment shall be completely assembled, wired, adjusted and all acceptance and routine tests as per the specification and relevant standards shall be carried out. These tests shall be carried out in presence of the Purchaser's representative, for which a minimum 7 days notice shall be given by the Bidder. Charges for these shall be deemed to be included in the equipment price.

ii) Type Tests

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- a) For each type & rating of HV & MV motors the Bidder shall conduct all the type test as per relevant IEC and IS standards for all the proposed motors to be supplied under this contract and the test(s) should be conducted at an independent laboratory.

iii) List of minimum type tests to be conducted

The following Minimum type tests shall be conducted on each type and rating of HV & MV motor:-

- a) No load saturation and loss curves upto approximately 115% of rated voltage.
- b) Measurement of noise at no load.
- c) Momentary excess torque test (subject to test bed constraint).
- d) Full load test(subject to test bed constraint)
- e) Temperature rise test at rated conditions. During heat run test, bearing temp., winding temp., coolant flow and its temp. shall also be measured. In case the temperature rise test is carried at load other than rated load, specific approval for the test method and procedure is required to be obtained. Wherever ETD's are provided, the temperature shall be measured by ETD's also for the record purpose.
- f) High voltage test
- g) Test for vibration severity of motor
- h) Degree of protection (Test for suitability of IP55/ IPW- 55 as per IS 4691 as type test. Type test certificate for first numeral (IP5X) shall be acceptable in lieu to test, provided the test motor is identical to motor being supplied. Second numeral (IPX5) test shall be carried out on one motor of each type and rating.)
- i) Overspeed test.
- j) All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.

14.49.02 LT Motors

i) Routine Test

All equipment shall be completely assembled, wired, adjusted and routine tested as per relevant IS/IEC Standards at manufacturer's works in the presence of consultant /purchaser or his representative.

ii) List of minimum tests for which type test are to be conducted

	MAHARASHTRA STATE POWER GENERATION CO. LTD.	VOLUME – III
	KORADI THERMAL POWER STATION 2X660 MW UNITS - 11 & 12 PROJECT	PART – B
	RFx No. 3000046202 (BTG Package)	
	TECHNICAL SPECIFICATION ELECTRICAL	REV. - 0

The following minimum type test reports shall be submitted for each type and rating of LT motor of above 50 KW only

- a) Measurement of resistance of windings of stator and wound rotor.
- b) No load test at rated voltage to determine input current power and speed.
- c) Open circuit voltage ratio of wound rotor motors (in case of Slip ring motors)
- d) Full load test to determine efficiency power factor and slip .
- e) Temperature rise test.
- f) Momentary excess torque test.
- g) High voltage test.
- h) Test for vibration severity of motor.
- i) Test for noise levels of motor
- j) Test for degree of protection and
- k) Over speed test.
- l) Type test reports for motors located in fuel oil area having flame proof enclosures as per IS 2148 / IEC 60079-1

iii) For all other LT motors less than 50KW, Type test reports shall be submitted. In case the Bidder is not able to submit report of the type test(s) conducted,, or in case the type test report(s) are not found to be meeting the specification requirements and the type test reports are not withing 5 years prior to 24.07.2024 , the Bidder shall conduct all such tests under this contract free of cost to the Purchaser and submit the reports for approval,for which a minimum 7 days notice shall be given by the Bidder. Charges for these shall be deemed to be included in the equipment price

iv) All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.

14.50.00 INFORMATION WITH PROPOSAL

- 14.50.01 AC Motor Data Sheet.
- 14.50.02 Dimension Drawing/Foundation load details of motor and driven equipment.
- 14.50.03 Manufacturer's catalogue showing constructional details.

14.51.00 INFORMATION ON AWARD OF CONTRACT

- 14.51.01 Motor Data Sheet
Certified binding dimension drawing of motor complete with all accessories and fittings specifically showing terminal boxes, terminal spacing and sizes, earthing connections and sizes thereof, mounting details, lifting lugs, final foundation loads and dimensions with tolerances of centering spigot (where needed), shaft extension and key.

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14.51.02 Following characteristics curves:-

- i) Torque-speed curves for motor at eighty (80), hundred (100) and hundred ten (110) percent rated voltage as well as torque-speed curve for driven equipment.
- ii) Current-speed curves at eight (80), hundred (100) and hundred ten (110) percent rated voltage.
- iii) Current-time curves at eighty (80), hundred (100) and hundred ten (110) percent rated voltage.
- iv) Thermal withstand curves for hot and cold at eighty (80), hundred (100) and hundred ten (110) percent rated voltage.
- v) Efficiency, power factor, current and speed versus power output curves.
- vi) Speed-time curves at eight (80), hundred (100) and hundred ten (110) percent rated voltage.
- vii) Negative phase sequence current withstand characteristics.

14.52.00 DRAWINGS, DATA & MANUALS
14.52.01 Minimum Drawings, data & manuals for the motors to be submitted

- i) Dimensional General Arrangement drawing
- ii) Foundation Plan & Loading
- iii) Terminal box details
- iv) Space requirement for rotor removal
- v) Thermal withstand curves hot & cold
- vi) Starting and speed torque characteristics at 80% & 100% voltage
- vii) Complete motor Data sheet
- viii) Motor sizing calculation
- ix) Erection & Maintenance Manual
- x) Test reports
- xi) QAP

DATA SHEET

1	Auxiliary power supply	
1.1	HV supply	
	11kV, 3Φ, 3W, 50 Hz non effectively earthed	Motors rated above 1500 kW
	Fault level	44 /50kA for 1 second
1.2	MV supply	
	3.3kV, 3Φ, 3W, 50 Hz non effectively earthed	Motors above 200kW upto and including 1500kW
	Fault level	40 kA for 1 second
1.3	LV supply	
	415V, 3Φ, 3W, 50 Hz effectively earthed	Motors below and including 200kW
	Fault level	50kA for 1 second
	110V, 1Φ, 2W, 50 Hz effectively earthed	Lighting, space heating, AC control



		and protective devices
1.4	DC supply	
	220V, 2W, unearthed	DC alarm, control and protective devices.
	Fault level	25 kA for 1 second
2	Range of variation	As indicated in the specification
2.1	AC supply	
	voltage	-----
	Frequency	-----
	Combined voltage & frequency	-----
2.2	DC supply	198 to 240 V

Note: During starting of largest motor, the voltage may drop to 80% of the rated voltage for a period of 60 seconds. All electrical equipment while running shall successfully ride over such period without affecting system performance.

NOTE:

All electrical equipment mounted outdoor shall have RAL 5012 paint shade. All electrical equipment mounted indoor (non-air conditioned areas) shall have RAL 7042 paint shade while those located in air-conditioned areas shall have RAL 7035 paint shade. Panel interior shall be RAL 9010.



**TECHNICAL SPECIFICATION FOR
HVAC SYSTEM
(ELECTRICAL PORTION)
PROJECT: 2X660MW KORADI THERMAL POWER
PROJECT (UNIT# 11 & 12)**

SPECIFICATION NO. PE-TS-XXX-XXX-AXXX
VOLUME II B
REV 00 DATE 31.03.2026
PAGE 1 OF 1

Datasheet –Motor
Annexure-III

	TECHNICAL SPECIFICATION FOR HVAC SYSTEM (ELECTRICAL PORTION) 2X660MW KORADI THERMAL POWER PROJECT (UNIT# 11 & 12)	PE-TS-XXX-527-XXX	
		Issue No: 00	
		Rev. No. 00	
		DATE: 31.03.2026	
ANNEXURE-III DATA SHEETS-MOTOR (SUPPLIER DATA TO BE FURNISHED AFTER AWARD OF CONTRACT FOR EACH TYPE OF MOTOR)			
SL.NO		UOM	DETAIL
1.0	GENERAL		
i)	Manufacturer & Country of origin.		
ii)	Equipment driven by motor)		
iii)	Motor type		
iv)	Country of origin		
v)	Quantity	nos.	
2.0	DESIGN AND PERFORMANCE DATA		
i)	Frame size		
ii)	Type of duty		
iii)	Type of enclosure and method of cooling		
vi)	Type of mounting		
vii)	Direction of rotation as viewed from DE END		
viii)	Standard continuous rating at 40 deg.C. ambient temp. as per Indian Standard	(KW)	
ix)	(A) Derated rating for specified normal condition i.e. 50 deg. C ambient temperature	(KW)	
	(B) Rating as specified in load list	(KW)	
xi)	Rated speed at rated voltage and frequency	rpm	
xii)	At rated Voltage and frequency		
	a) Full load current	A	
	b) No load current	A	
xiii)	Power Factor at		
	a) 100% load		
	b) At duty point		
	c) 75% load		
	d) 50% load		
	e) NO load		
	f) Starting.		
xiv)	Efficiency at rated voltage and frequency		
	a) 100% load		
	b) At duty point		
	c) 75% load		
	d) 50% load		
xv)	Starting current(inclusive of IS tolerance) at		
	a. 100 % voltage	A	
	b. Minimum starting voltage	A	
xvi)	Starting time with minimum permissible voltage		
	a. Without driven equipment coupled	sec	
	b. With driven equipment coupled	sec	
xvii)	Safe stall time with 110% of rated voltage		
	a. From hot condition	sec	
	b. From cold condition	sec	
xviii)	Torques :		

	TECHNICAL SPECIFICATION FOR HVAC SYSTEM (ELECTRICAL PORTION) 2X660MW KORADI THERMAL POWER PROJECT (UNIT# 11 & 12)		PE-TS-XXX-527-XXX
			Issue No: 00
			Rev. No. 00
			DATE: 31.03.2026
	a. Starting torque at min. permissible voltage	(kg-mtr.)	
	b. Pull up torque at rated voltage.	(kg-mtr.)	
	c. Pull out torque	(kg-mtr.)	
	d. Min accelerating torque available	(kg-mtr.)	
	e. Rated torque	(kg-mtr.)	
xix)	Stator winding resistance per phase (at 20 Deg.C.)	Ohm	
xx)	GD ² value of motors		
xxi)	Locked rotor KVA input (at rated voltage)		
xxii)	Locked rotor KVA/KW.		
xxiii)	Bearings		
	a. Type		
	b. Manufacturer		
	c. Self Lubricated or forced Lubricated		
	d. Recommended Lubricants		
	e. Guaranteed Life in Hours		
	f. Whether Dial Type thermometer provided		
	g. Oil pressure Gauge/switch		
	i. Range		
	ii. Contact Nos. & ratings		
	iii. Accuracy		
xxiv)	Vibration		
	a) Velocity	mm/s	
	b) Displacement	microns	
xxv)	Noise level	db	
3	CONSTRUCTIONAL FEATURES		
i	Stator winding insulation		
	a. Class & Type		
	b. Tropicalised (Yes/No)		
	c. Temperature rise over specified max.		
	i. Cold water temperature of 38 DEG. C.		
	ii. Ambient Air 50 DEG. C.		
	d. Method of temperature measurement		
	e. Stator winding connection		
	f. Number of terminals brought out		
ii	Type of terminal box for		
	a. stator leads		
	b. space heater		
	c. Temperature detectors		
	d. Instrument switch etc.		
iii)	For main terminal box		
	a. Location		
	b. Entry of cables		
	c. Recommended cable size		
	d. Fault level	MVA	

	TECHNICAL SPECIFICATION FOR HVAC SYSTEM (ELECTRICAL PORTION) 2X660MW KORADI THERMAL POWER PROJECT (UNIT# 11 & 12)		PE-TS-XXX-527-XXX
			Issue No: 00
			Rev. No. 00
			DATE: 31.03.2026
iv)	Temperature detector for stator winding		
	a. Type		
	b. Nos. provided		
	c. Location		
	d. Make		
	e. Resistance value at 0 deg. C	ohms	
vi)	Paint shade		
vii).	Weight of(approx)		
	a. Motor stator (KG)		
	b. Motor Rotor (KG)		
	c. Total weight (KG)		
4	Relevant motor curves		
5	Any additional relevant data		



**TECHNICAL SPECIFICATION FOR
HVAC SYSTEM
(ELECTRICAL PORTION)
PROJECT: 2X660MW KORADI THERMAL POWER
PROJECT (UNIT# 11 & 12)**

SPECIFICATION NO. PE-TS-XXX-XXX-XXXX
VOLUME II B
REV 00 DATE 31.03.2026
PAGE 1 OF 1

Quality Plan for motors
Annexure-IV

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS		STANDARD QUALITY PLAN		SPEC. NO :	DATE:
	CUSTOMER :		PE-OP-999-Q-006, REV-02		DATE: 17.04.2020	
	PROJECT:		PO NO.:		DATE:	
	ITEM: AC ELECT. MOTORS UPTO 50 KW 415V		SYSTEM: II		SECTION: II	SHEET 1 of 2

S. NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY	REMARKS
1	2	3	4	5	6	7	8	9	10	
		1.WORKMANSHIP	MA	VISUAL	100%	MFG. SPEC.	MFG. SPEC.	LOG BOOK	P	
		2.DIMENSIONS	MA	VISUAL	100%	MFG. DRG./ MFG. SPEC.	MFG. DRG./ MFG. SPEC.	LOG BOOK	P	
1.0	ASSEMBLY	3.CORRECTNESS COMPLETENESS/ TERMINATIONS/ MARKING/ COLOUR CODE	MA	VISUAL	100%	MFG.SPEC./	MFG.SPEC.	LOG BOOK	P	
2.0	PAINTING	1.SHADE	MA	VISUAL	SAMPLE	MFG. SPEC/ APPROVED DATASHEET	MFG. SPEC/ APPROVED DATASHEET	LOG BOOK	P	
3.0	TESTS	1.ROUTINE TEST INCLUDING SPECIAL TEST	MA	VISUAL	100%	IS-325 / IS-12615/ APPROVED DATA SHEET	IS-325 / IS-12615/ APPROVED DATA SHEET	TEST/ INSPN. REPORT	P	* NOTE -1
		2.OVERALL DIMENSIONS & ORIENTATION	MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/ DATA SHEET	APPROVED DRG/ DATA SHEET	TEST/ INSPN. REPORT	P	* NOTE -1 & NOTE-2

BHEL				BIDDER/ SUPPLIER				FOR CUSTOMER REVIEW & APPROVAL			
ENGINEERING		QUALITY		Sign & Date		Sign & Date		Doc No:		Sign & Date	
Prepared by:	HEMA KUSHWAHA	Checked by:	KUNAL GANDHI	Seal		Reviewed by:		Seal			
Reviewed by:	PRAVEEN DUTTA	Reviewed by:	RITESH KUMAR JAISWAL			Approved by:					

	MANUFACTURER/ SUPPLIER NAME & ADDRESS		BIDDER/ BIDDER ADDRESS		STANDARD QUALITY PLAN		SPEC. NO :	DATE:
	CUSTOMER :		PROJECT:		SYSTEM:		QP NO.: PE-QP-999-Q-006, REV-02	DATE: 17.04.2020
							PO NO.:	DATE:
	ITEM: AC ELECT. MOTORS UPTO 50 KW 415V				SECTION: II			SHEET 2 of 2

		3.NAMEPLATE DETAILS	MA	VISUAL	100%	-	IS-325 / IS-12615 / APPROVED DATA SHEET	SAME AS COL. 7	TEST/ INSPN. REPORT	✓	P	V	-
4.0	PACKING	SURFACE FINISH & COMPLETENESS	MA	VISUAL	100%	100%	AS PER MFG. STANDARD / (#)	AS PER MFG. STANDARD / (#).	INSPC. REPORT	✓	P	W	- (#) REFER NOTE-8

NOTES:

1. Routine tests on 100% motors shall be done by the vendor. However, BHEL/ Customer shall witness routine tests on random samples. The sampling plan shall be mutually agreed upon.
2. For exhaust/ventilation fan motors of rating up to 1.5 KW, only routine test certificates shall be furnished for scrutiny.
3. In case test certificates for these tests on similar type, size and design of motor from independent laboratory are available, the same is valid for 5 years.
4. BHEL reserves the right to perform repeat test, if required.
5. After packing and prior to issue MDCc, photographs of items to be despatched shall be sent to BHEL for review.
6. In case of any changes in QP commented by customer at contract stage, same shall be carried out by bidder without any implication to BHEL/ Customer.
7. Project specific QP to be developed based on customer requirement.
8. For export job, BHEL technical specification for seaworthy packing to be followed.
9. Packing shall be suitable for storage at site in tropical climate conditions.
10. Latest revision/ year of issue of all the standards (IS/ ASME/ IEC etc.) indicated in QP shall be referred.

LEGENDS:

*RECORDS, IDENTIFIED WITH "TICK"(✓) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION,
 ** M: SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER, B: MAIN SUPPLIER/ BHEL/ THIRD PARTY INSPECTION AGENCY, C: CUSTOMER,
 P: PERFORM, W: WITNESS, V: VERIFICATION, AS APPROPRIATE
 MA: MAJOR, MI: MINOR, CR: CRITICAL
 D: DOCUMENTATION

BHEL			
ENGINEERING		QUALITY	
Prepared by:	Sign & Date	Checked by:	Sign & Date
HEMA KUSHWAHA		HEMA KUSHWAHA	
Reviewed by:	Sign & Date	Reviewed by:	Sign & Date
PRAVEEN DUTTA		RITESH KUMAR JAISWAL	

BIDDER/ SUPPLIER			
Sign & Date	Seal		

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

QAP FOR MOTORS 50KW AND ABOVE

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS		STANDARD QUALITY PLAN		SPEC. NO :	
			CUSTOMER :		OP NO: PE-QP-899-Q-007, REV-04	
			PROJECT:		DATE:17.04.2020	
			ITEM: AC ELECT. MOTORS 50 KW & ABOVE (LV (415V))		SECTION: II	
			SYSTEM:		SHEET 1 OF 9	

SI No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD	AGENCY		
					M	C/N				D	M	N
1	1.0 1.1	1.0 1.1	MA	VISUAL	100%	-	-	FREE FROM BLINKS, CRACKS, WARPNESS ETC	LOG BOOK		P	-
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	LOG BOOK		P	-
		3.PROOF LOAD TEST (ETE BOLT)	MA	MECH. TEST	SAMPLE	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	TEST REPORT		P/V	-
1.2	HARDWARES	1.SURFACE CONDITION	MA	VISUAL	100%	-	-	FREE FROM CRACKS, UN-EVENNESS ETC.	TEST REPORT		P	-
		2.PROPERTY CLASS	MA	VISUAL	SAMPLES	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	TC		P/V	-
1.3	CASTING	1.SURFACE CONDITION	MA	VISUAL	100%	-	MANUFACTURER'S DRG./SPEC	FREE FROM CRACKS, BLOW HOLES ETC.	LOG BOOK		P/V	-
		2.CHEM. & PHY. PROP.	MA	CHEM & MECH TEST	1*HEAT NO.	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	TC		P/V	-
		3.DIMENSIONS	MA	MEASUREMENT	100%	-	MANUFACTURER'S DRG.	MANUFACTURER'S DRG./SPEC	LOG BOOK		P/V	-
1.4	PAINT & VARNISH	1.MAKE SHADE, SHELF LIFE & TYPE	MA	VISUAL	100% CONTINUOUS	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	LOG BOOK		P/V	-
												PROPERTY CLASS MARKING SHALL BE CHECKED BY THE VENDOR
												HEAT NO. SHALL BE VERIFIED

ENGINEERING		BHEL		QUALITY	
Sign & Date	Name	Sign & Date	Name	Sign & Date	Name
 Prepared by: HEMA KUSHWAHA	HEMA KHUSHWAHA	 Checked by: PRAVEEN	HEMA KHUSHWAHA	 Reviewed by: R K JAISWAL	KUNAL GANDHI

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

FOR CUSTOMER REVIEW & APPROVAL	
Doc No:	
Sign & Date	Seal
Reviewed by:	
Approved by:	

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS		STANDARD QUALITY PLAN			SPEC. NO. :	
			CUSTOMER :			QP NO.: PE-QP-999-Q-007, REV-04	
			PROJECT:			PO NO.:	
			ITEM: AC ELECT. MOTORS 50 KW & ABOVE (LV (415V))			SYSTEM: II	
						DATE: 17.04.2020	
						SHEET 2 OF 9	

SI No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY		
1	2	3	4	5	6		7	8	9		10		
					M	C/N					M	C	N
1.5	SHAFT (FORGED OR ROLLED)	1. SURFACE COND. 2. CHEM. & PHYSICAL PROPERTIES 3. DIMENSIONS	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		P	-	-
				CHEM. & PHYSICAL TESTS	1/HEAT NO. OR HEAT TREATMENT BATCH NO	-	MANUFACTURER'S DRG/ SPEC.	MANUFACTURER'S DRG/ STD.	TC		P/V	-	VENDOR'S APPROVAL IDENTIFICATION SHALL BE MAINTAINED
				MEASUREMENT	100%	-	MANUFACTURER'S DRG/ SPEC.	MANUFACTURER'S DRG.	LOG BOOK		P/V	-	
				ULTRASONIC TEST	100%	-	ASTM-A388	MANUFACTURER'S STD.	INSPECTION REPORT	✓	P/W	V	FOR DIA OF 55 MM & ABOVE
1.6	SPACE HEATERS, CONNECTORS, TERMINAL BLOCKS, CABLES, CABLE LUGS, CARBON BRUSH TEMP. DETECTORS, RTD, BTD'S	1. MAKE & RATING 2. PHYSICAL COND. 3. DIMENSIONS (WHEREVER APPLICABLE) 4. PERFORMANCE/ CALIBRATION	MA	VISUAL	100%	-	MANUFACTURER'S DRG./ STD.	MANUFACTURER'S DRG./ STD.	INSPECTION REPORT		P/V	-	
				MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG./ STD.	MANUFACTURER'S DRG./ STD.	INSPECTION REPORT		P/V	-	
				TEST	100%	-	MANUFACTURER'S DRG./ STD.	MANUFACTURER'S DRG./ STD.	TEST REPORT		P/V	-	

BHEL			
ENGINEERING		QUALITY	
Sign & Date	Name	Sign & Date	Name
HEMA KUSHWAHA	HEMA KHUSHWAHA		KUNAL GANDHI
Prepared by:		Checked by:	
Reviewed by: PRAVEEN DUTTA		Reviewed by: R K JAISWAL	

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

FOR CUSTOMER REVIEW & APPROVAL		
Doc No:	Sign & Date	Seal
Reviewed by:		
Approved by:		

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS		STANDARD QUALITY PLAN		SPEC. NO. :		DATE: 17.04.2020
			CUSTOMER :		QP NO.: PE-QP-699-3-007, REV-04		
			PROJECT:		PO NO.:		
			ITEM: AC ELECT. MOTORS 50 KW & ABOVE (LV (415V))		SYSTEM: II		
SHEET 3 OF 9							

Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD	AGENCY			
1	2	3	4	5	M	C/N	7	8	9	D	M	C	N
1.7	OTHER INSULATING MATERIALS LIKE SLEEVES, BINDINGS CORDS, PAPERS, PRESS BOARDS ETC.	1. SURFACE COND. ETC. 2. DIMENSION (BORE DIA, WALL THICKNESS, BDV AS RECEIVED, BDV AFTER FOLDING AT 180°)	MA	VISUAL	100%	-	-	NO VISUAL DEFECTS	TEST REPORT	P/V	-	-	-
1.8	SHEET STAMPING (PUNCHED)	1. SURFACE COND. 2. DIMENSIONS INCLUDING BURS HEIGHT 3. ACCEPTANCE TESTS	MA	TEST	SAMPLE	-	MANUFACTURER'S STD.	MANUFACTURER'S STD.	LOG BOOK AND/OR SUPPLIER'S TC	P/V	-	-	-
1.9	CONDUCTORS	1. SURFACE FINISH 2. ELECT. PROP. & MECH. PROP.	MA	VISUAL	100%	-	-	NO VISUAL DEFECTS (FREE FROM BURS)	LOG BOOK	P	-	-	-
							MANUFACTURER'S DRG.	MANUFACTURER'S DRG.	LOG BOOK	P/V	-	-	-
							MANUFACTURER'S DRG./ STD.	MANUFACTURER'S DRG./ STD.	TC	P/V	-	-	-
							-	FREE FROM VISUAL DEFECTS	LOG BOOK	*P/V	-	-	-
							MANUFACTURER'S DRG./ SPEC.	MANUFACTURER'S / SPEC.	TC & VENDOR'S TEST REPORTS	P/V	-	-	-

ENGINEERING				BHEL				QUALITY			
Prepared by:	HEMA KUSHWAHA	Name	HEMA KHUSHWAHA	Checked by:	HEMA KHUSHWAHA	Sign & Date		Sign & Date		Name	HEMA KHUSHWAHA
Reviewed by:	PRAVEEN DUTTA	Name	PRAVEEN DUTTA	Reviewed by:	PRAVEEN DUTTA	Sign & Date		Sign & Date		Name	PRAVEEN DUTTA

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

FOR CUSTOMER REVIEW & APPROVAL	
Doc No:	
Sign & Date	
Reviewed by:	
Approved by:	

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS		STANDARD QUALITY PLAN		SPEC. NO. :	
			CUSTOMER :		QP NO.: PE-QP-999-Q-007, REV.04	
			PROJECT:		DATE:17.04.2020	
			ITEM: AC ELECT. MOTORS 50 KW & ABOVE (LV (415V))		SECTION: II	
					SHEET 4 OF 9	

Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD	AGENCY			
1	2	3	4	5	M	C/N	7	8	9	D	M	C	N
1.10	BEARINGS	3.DIMENSIONS	MA	MEASUREMENT	SAMPLES	-	MANUFACTURER'S DRG./ SPEC.	MANUFACTURERS / SPEC.	LOG BOOK		P/V	-	-
		1.MAKE & TYPE	MA	VISUAL	100%	-	MANUFACTURER'S DRG./ APPROVED DATASHEET	MANUFACTURER'S DRG./ APPROVED DATASHEET	LOG BOOK		P/V	-	-
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	-	APPROVED DATASHEET	APPROVED DATASHEET/ MANUFACTURER'S CATALOGUES	LOG BOOK		P/V	-	-
		3.SURFACE FINISH	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		P/V	-	-
1.11	SIP RING (WHEREVER APPLICABLE)	1.SURFACE COND.	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		P	-	-
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG	MANUFACTURER'S DRG	LOG BOOK		P	-	-
		3.TEMP.WITH- STAND CAPACITY	MA	ELECT.TEST	SAMPLE	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURERS STD./APPROVED DATASHEET	LOG BOOK		P/V	-	-
		4.HVIR	MA	-D-O-	100%	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURERS STD./APPROVED DATASHEET	LOG BOOK		P/V	-	-
1.12	OIL SEALS & GASKETS	1.MATERIAL OF GASKET	MA	VISUAL	100%	-	MANUFACTURER'S DRG/SPEC	MANUFACTURERS DRG/ SPEC.	LOG BOOK		P	-	-
		2.SURFACE COND.	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		P	-	-
		3.DIMENSIONS	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG	MANUFACTURERS DRG	LOG BOOK		P	-	-

ENGINEERING				QUALITY			
Sign & Date		Name		Sign & Date		Name	
HEMA KUSHWAHA Asst. Engineer (Mechanical)		HEMA KHUSHWAHA		 R K JAISWAL Asst. Engineer (Mechanical)		KUNAL GANDHI	
Prepared by:		Checked by:		Reviewed by:		Reviewed by:	
PRAVEEN DUTTA Asst. Engineer (Mechanical)		PRAVEEN DUTTA		R K JAISWAL Asst. Engineer (Mechanical)		R K JAISWAL	

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:		Sign & Date	Seal
Reviewed by:			
Approved by:			

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS		STANDARD QUALITY PLAN			SPEC. NO. :		
			CUSTOMER :			QP NO.: PE-QIP-999-Q-007, REV-04		DATE: 17.04.2020
			PROJECT:			PO NO.:		
			ITEM: AC ELECT. MOTORS 50 KW & ABOVE (LV (415V))			SYSTEM:		SECTION: II
						SHEET 5 OF 9		

Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD	AGENCY			
1	2	3	4	5	6		7	8	9	10			
					M	C/N				D	M	C	N
2.0	IN PROCESS (IN CASE OF FABRICATED STATOR)	1.WORKMANSHIP & CLEANNESS	MA	VISUAL	100%	-	MANUFACTURER'S DRG	GOOD FINISH	LOG BOOK		P/W	-	-
2.1		2.DIMENSIONS	MA	MEASUREMENT	100%	-	MANUFACTURER'S DRG	MANUFACTURER'S DRG	LOG BOOK		P	-	-
2.2	MACHINING	1.FINISH	MA	VISUAL	100%	-	-DOL-	GOOD FINISH	LOG BOOK		P	-	-
		2.DIMENSIONS	MA	MEASUREMENT	100%	-	MANUFACTURER'S DRG	MANUFACTURER'S DRG	LOG BOOK		P	-	-
2.3	PAINTING	3.SHAFT SURFACE FLOWS	MA	PT	100%	-	MANUFACTURER'S STD./APPROVED DATASHEET. ASTM E165	MANUFACTURER'S STD./APPROVED DATASHEET.	LOG BOOK	✓	P	V	-
		1.SURFACE PREPARATION	MA	VISUAL	100%	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-
		2.PAINT THICKNESS (BOTH PRIMER & FINISH COAT)	MA	MEASUREMENT BY ELCOMETER	SAMPLE	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-
		3.SHADE	MA	VISUAL	SAMPLE	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-
		4.ADHESION	MA	CROSS CUTTING &	SAMPLE	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-
				TAPE TEST		-			LOG BOOK		P	-	-

ENGINEERING				BHEL				QUALITY			
Sign & Date	Name	Sign & Date	Name	Sign & Date	Name	Sign & Date	Name				
 Prepared by: HEMA KUSHWAHA	HEMA KHUSHWAHA	 Checked by: RITESH KUMAR	KUNAL GANDHI	 Reviewed by: PRAVEEN DUTTA	R K JAISWAL	 Reviewed by: R K JAISWAL					

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

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Doc No.	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS		STANDARD QUALITY PLAN		SPEC. NO. :	
			CUSTOMER :		QP NO.: PE-QP-989-Q-007, REV/04	
			PROJECT:		PO NO.:	
			ITEM: AC ELECT. MOTORS 50 KW & ABOVE (LV (415V))		SYSTEM:	
					SECTION: II	
					SHEET 6 OF 9	

Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD	AGENCY			
1	2	3	4	5	6		7	8	9	10			
					M	C/N				D	M	C	N
2.4	SHEET STACKING	1.COMPLETENESS 2.COMPRESSION & TIGHTENING	MA	MEASUREMENT	-	-	MANUFACTURER'S STD.	MANUFACTURER'S STD.	LOG BOOK		P	-	-
			MA	MEASUREMENT	100%	-	MANUFACTURER'S STD.	MANUFACTURER'S STD.	LOG BOOK		P	-	-
2.5	WINDING	1.COMPLETENESS	CR	VISUAL	100%	-	MANUFACTURER'S STD/APPROVED DATASHEET	MANUFACTURER'S STD/APPROVED DATASHEET	LOG BOOK		P	-	-
		2.CLEANLINESS	CR	VISUAL	100%	-	MANUFACTURER'S STD/APPROVED DATASHEET	MANUFACTURER'S STD/APPROVED DATASHEET	LOG BOOK		P	-	-
		3.IR-HVR	CR	ELECT. TEST	100%	-	IS-325/IS-12615/IEC-60034 PART-1	IS-325/IS-12615/IEC-60034 PART-1	TEST/INSPC. REPORT	✓	P	V	-
		4.RESISTANCE	CR	ELECT. TEST	100%	-	IS-325/IS-12615/IEC-60034 PART-1	IS-325/IS-12615/IEC-60034 PART-1	TEST/INSPC. REPORT	✓	P	V	-
		5.INTERTURN INSULATION	CR	ELECT. TEST	100%	-	IS-325/IS-12615/IEC-60034 PART-1	IS-325/IS-12615/IEC-60034 PART-1	TEST/INSPC. REPORT		P	-	-
2.6	IMPREGNATION	1.VISCOSITY	MA	PHY. TEST	-	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK		P	-	-
		2.TEMP. PRESSURE VACUUM	MA	PROCESS CHECK	-	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK		P	-	-
		3.NO. OF DIPS	MA	PROCESS CHECK	-	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK	✓	P	V	-
													THREE DIPS TO BE GIVEN

ENGINEERING				BHEL				QUALITY			
Sign & Date		Name		Sign & Date		Name					
Prepared by: HEMA KUSHWAHA		HEMA KUSHWAHA		Checked by:		KUNAL GANDHI					
Reviewed by: PRAVEEN DUTTA		PRAVEEN DUTTA		Reviewed by:		R K JAISWAL					


 PRAVEEN DUTTA


 R K JAISWAL

BIDDER/ SUPPLIER	
Sign & Date	Seal

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Doc No.	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS		STANDARD QUALITY PLAN		SPEC. NO. :	
			CUSTOMER :		QP NO.: PE-QP-999-Q-007, REV-04	
			PROJECT:		PO NO.:	
			ITEM: AC ELECT. MOTORS 50 KW & ABOVE (LV (415V))		SYSTEM: II	
					DATE: 17.04.2020	
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Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD	AGENCY		
1	2	3	4	5	6		7	8	9	10		
					M	C/N				D	M	C N
2.7	COMPLETE STATOR ASSEMBLY	4.DURATION 1.COMPACTNESS & CLEANLINESS	MA	PROCESS CHECK VISUAL	CONTINUOUS	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK	✓	P	V -
2.8	BRAZING/COMPRESSION JOINT	1.COMPLETENESS 2.SOUNDNESS	CR	VISUAL	100%	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK		P	-
			CR	WALLET TEST & UT	100%	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK		P	-
			CR		100%	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	TEST/INSPC. REPORT	✓	P	V -
2.9	COMPLETE ROTOR ASSEMBLY	3.HV 1.RESIDUAL UNBALANCE	MA	ELECT. TEST	100%	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	TEST/INSPC. REPORT	✓	P	V -
			CR	DYN.BALANCE	100%	-	MANUFACTURER'S SPEC./ ISO 1840	MANUFACTURER'S DWG.	LOG BOOK		P	-
			CR	ELECT. (BROUWLER TEST)	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	TEST/INSPC. REPORT	✓	P	V -
2.10	ASSEMBLY	1.ALIGNMENT	MA	MEAS.	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	LOG BOOK		P	-
		2.WORKMANSHIP	MA	VISUAL	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	LOG BOOK		P	-
		3.AXIAL PLAY	MA	MEAS.	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	LOG BOOK	✓	P	V -
		4.DIMENSIONS	MA	MEAS.	100%	-	MANUFACTURER'S DRG./ MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	LOG BOOK		P	-
		5.CORRECTNESS, COMPLETENESS, TERMINATIONS/ COLOUR CODE	MA	VISUAL	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	LOG BOOK		P	-
		6. RTD, 8TD & SPACE HEATER MOUNTING.	MA	VISUAL	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	LOG BOOK	✓	P	V -

ENGINEERING			QUALITY		
Sign & Date	Name	Sign & Date	Sign & Date	Name	
HEMA KUSHWAHA	HEMA KHUSHWAHA	Checked by:		KUNAL GANDHI	
Reviewed by: PRAVEEN DUTTA	PRAVEEN DUTTA	Reviewed by:		R K JAISWAL	

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

FOR CUSTOMER REVIEW & APPROVAL		
Doc No:	Sign & Date	Seal
Reviewed by:		
Approved by:		

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS		STANDARD QUALITY PLAN		SPEC. NO. :	
			CUSTOMER :		QP NO.: PE-QP-999-Q-007, REV-04	
			PROJECT:		DATE:17.04.2020	
			ITEM: AC ELECT. MOTORS 50 KW & ABOVE (LV (415V))		SECTION: II	
SYSTEM:			SHEET 8 OF 9			

Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY		
1	2	3	4	5	M	C/N	7	8	9	*	D	M	N
3.0	TESTS	1.TYPE TESTS INCLUDING SPECIAL TESTS 2.ROUTINE TESTS INCLUDING SPECIAL TEST 3.VIBRATION & NOISE LEVEL 4.OVERALL DIMENSIONS AND ORIENTATION 5.DEGREE OF PROTECTION 6. MEASUREMENT OF RESISTANCE OF RTD & RTD 7. MEASUREMENT OF RESISTANCE I/R OF SPACE HEATER 8. NAME PLATE DETAILS 9.EXPLOSION FLAME PROOF NESS (IF SPECIFIED) 10. PAINT SHADE, THICKNESS & FINISH	MA	ELECT.TEST	1/TYPE/SIZE	1/TYPE/SIZE	IS-225/IS-12615/APPROVED DATASHEET	IS-325/IS-12615/APPROVED DATASHEET	TEST REPORT	✓	P	W*	-
			MA	ELECT.TEST	100%	-	IS-325/IS-12615/APPROVED DATASHEET	IS-325/IS-12615/APPROVED DATASHEET	TEST REPORT	✓	P	V [§]	-
			MA	ELECT.TEST	100%	-	IS: 12075 /IEC 60034-14 & IS-12065	IS: 12075 /IEC 60034-14 & IS-12065	TEST REPORT	✓	P	V [§]	-
			MA	MEASUREMENT & VISUAL	100%	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET &	TEST/INSPC. REPORT	✓	P	W	-
			MA	ELECT. & MECH. TEST	1/TYPE/ SIZE	-	IEC 60034-5/IS-12615	APPROVED DATASHEET	TC	✓	P	V	-
			MA	ELECT. & MECH. TEST	100%	-	IS-325/IS-12615/IEC-60034 PART-1/IS-12602	IS-325/IS-12615/IEC-40034 PART-1/IS-12602	TC	✓	P	V [§]	-
			MA	ELECT. & MECH. TEST	100%	-	IS-325/IS-12615/IEC-60034 PART-1	IS-325/IS-12615/IEC-60034 PART-1	TC	✓	P	V [§]	-
			MA	VISUAL	100%	-	IS-325/IS-12615& DATA SHEET	IS-325/IS-12615 & DATA SHEET	TEST/INSPC. REPORT	✓	P	V [§]	-
			MA	EXPLOSION FLAME PROOF TEST	1/TYPE	-	IS 2148 /IEC 60079-1	IS 2148 /IEC 60079-1	TC	✓	P	V	-
			MA	VISUAL & MEASUREMENT BY ELKOMETER	SAMPLE	SAMPLE	APPROVED DATASHEET	APPROVED DATASHEET	TC	✓	P	W§	-

BHEL				QUALITY			
ENGINEERING		BIDDER/ SUPPLIER		FOR CUSTOMER REVIEW & APPROVAL			
Sign & Date	Name	Sign & Date	Name	Doc No:	Sign & Date	Name	Seal
Prepared by: HEMA KUSHWAHA Reviewed by: PRAVEEN DUTTA	Checked by: HEMA KHUSHWAHA Reviewed by: PRAVEEN DUTTA	 R K JAISWAL	 R K JAISWAL				

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS				STANDARD QUALITY PLAN				SPEC. NO. :	
					CUSTOMER :				QP NO.: PE-QP-899-Q-007, REV-04	
	PROJECT:				PROJECT:				PO NO.:	
	ITEM: AC ELECT. MOTORS 50 KW & ABOVE (LV (415V))				SYSTEM:				SECTION: II	

SI No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check	Reference Document	Acceptance NORMS	FORMAT OF RECORD	AGENCY
1		3	4	5	6	7	8	9	
					M	C/N			M C N
4.0	PACKING	SURFACE FINISH & COMPLETENESS	MA	VISUAL	100%	100%	AS PER MANUFACT. STANDARD / (#)	INSPEC. REPORT	P W -

NOTES:

1. DEPENDING UPON THE SIZE AND CRITICALLY, WITNESSING BY BHEL SHALL BE DECIDED.
2. ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR, HOWEVER, BHEL/CUSTOMER SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON.
3. IN CASE TEST CERTIFICATES FOR THESE TESTS ON SIMILAR TYPE, SIZE AND DESIGN OF MOTOR FROM INDEPENDENT LABORATORY ARE AVAILABLE, THE SAME IS VALID FOR 5 YEARS.
4. BHEL RESERVES THE RIGHT TO PERFORM REPEAT TEST, IF REQUIRED.
5. AFTER PACKING AND PRIOR TO ISSUE MDCC, PHOTOGRAPHS OF ITEMS TO BE DESPATCHED SHALL BE SENT TO BHEL PURCHASE GROUP FOR REVIEW.
6. IN CASE, ANY CHANGES IN QP COMMENTED BY CUSTOMER AT CONTRACT STAGE SHALL BE CARRIED OUT BY BIDDER WITHOUT ANY IMPLICATION TO BHEL/ CUSTOMER.
7. PROJECT SPECIFIC QP TO BE DEVELOPED BASED ON CUSTOMER REQUIREMENT.
8. FOR EXPORT JOB, BHEL TECHNICAL SPECIFICATION FOR SEAWORTHY PACKING TO BE FOLLOWED.
9. PACKING SHALL BE SUITABLE FOR STORAGE AT SITE IN TROPICAL CLIMATE CONDITIONS.
10. LATEST REVISION/ YEAR OF ISSUE OF ALL THE STANDARDS (IS/ ASME/ IEC ETC.) INDICATED IN QP SHALL BE REFERRED.

LEGENDS:

*RECORDS, IDENTIFIED WITH "TICK(✓)" SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION.
 ** M: SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER, B: MAIN SUPPLIER/ BHEL/ THIRD PARTY INSPECTION AGENCY, C: CUSTOMER,
 P: PERFORM, W: WITNESS, V: VERIFICATION, AS APPROPRIATE
 MA: MAJOR, MI: MINOR, CR: CRITICAL
 D: DOCUMENT

BHEL			
ENGINEERING		QUALITY	
Sign & Date	Name	Sign & Date	Name
 HEMA KHUSHWAHA	HEMA KHUSHWAHA	 RITESH KUMAR	KUNAL GANDHI
Prepared by:		Checked by:	
Reviewed by: PRAVEEN DUTTA	PRAVEEN DUTTA	Reviewed by:	R K JAISWAL

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:		Sign & Date	Seal
Reviewed by:			
Approved by:			



**TECHNICAL SPECIFICATION FOR
HVAC SYSTEM
(ELECTRICAL PORTION)
PROJECT: 2X660MW KORADI THERMAL POWER
PROJECT (UNIT# 11 & 12)**

SPECIFICATION NO. PE-TS-XXX-XXX-AXXX
VOLUME II B
REV 00 DATE 31.03.2026
PAGE 1 OF 1

Technical Specification for Misc. Items
Annexure-V

	TECHNICAL SPECIFICATION FOR HVAC SYSTEM (ELECTRICAL PORTION) PROJECT: 2X660MW KORADI THERMAL POWER PROJECT (UNIT# 11 & 12)	SPECIFICATION NO. PE-TS-XXX-XXX-XXX VOLUME II B REV 00 DATE 31.03.2026 PAGE 1 OF 1

TECHNICAL SPECIFICATION FOR MISC. ITEMS:

TECHNICAL SPECIFICATION OF CABLE GLANDS AND LUGS

Cable glands shall conform to BS:6121. Cable glands shall be made of heavy-duty brass machine finished and nickel chrome plated. Thickness of plating shall not be less than 10 microns. All washers and Hardware shall also be made of brass with nickel chrome plating. Rubber components shall be of neoprene or better synthetic material and of tested quality.

Cable lugs/ferrules shall be solderless crimping type suitable for power and control cables as per the DIN 46239. Aluminium solderless crimping lugs/ ferrules shall be used for Aluminium cables and Copper lugs/ferrules shall be used for Copper cables. Bimetallic washers or bimetallic type lugs shall be used for bimetallic connections

TECHNICAL SPECIFICATION OF JUNCTION BOX

Junction box shall be made of Fire-retardant material. Material of JB shall be Thermoplastic or thermosetting or FRP type. The box shall be provided with the terminal blocks, mounting bracket and screws etc. The cable entry shall be through galvanized steel conduits of suitable diameter. The JB shall have suitable for installing glands of suitable size on the bottom of the box. The JB shall be suitable for surface mounting on ceiling/structures. The JB shall be of grey color RAL 7035. All the metal parts shall be corrosion protected. Junction box surface should be such that it is free from crazings, blisterings, wrinkling, colour blots/striations. There should not be any mending or repair of surface. JB's will be provided with captive screws so that screws don't fall off when cover is opened. JB's mounting brackets should be of powder coated MS. Type test reports for the following tests shall be furnished:

- a) Impact resistance for impact energy of 2 Joules (IK07) as per BS EN50102
- b) Thermal ageing at 70deg C for 96 hours as per IEC60068-2-2Bb
- c) Class of protection shall be IP 55
- d) HV test

Terminal blocks shall be 1100V grade, of suitable current rating, made up of unbreakable polyamide 6.6 grade. The terminals shall be screw type or screw-less (spring loaded) / cage clamp type with lugs. Marking on terminal strips shall correspond to the terminal numbering in wiring diagrams. All metal parts shall be of non-ferrous material. In case of screw type terminals, the screw shall be captive, preferably with screw locking design. All terminal blocks shall be suitable for terminating on each side the required cables/wire size. All internal wiring shall be of cu. Conductor PVC wire.

TECHNICAL SPECIFICATION OF FLEXIBLE CONDUITS

Flexible Steel Conduits shall be water proof and rust proof made of heat resistant steel with temperature rating of 150 Deg.C. Conduit diameter shall be uniform throughout its length. Internal surface of the conduit shall be free from burrs and sharp edges. Conduits shall be complete with necessary accessories for proper termination of the conduit with junction boxes.



**TECHNICAL SPECIFICATION FOR
HVAC SYSTEM
(ELECTRICAL PORTION)
PROJECT: 2X660MW KORADI THERMAL POWER
PROJECT (UNIT# 11 & 12)**

SPECIFICATION NO. PE-TS-XXX-XXX-XXXX
VOLUME II B
REV 00 DATE 31.03.2026
PAGE 1 OF 1

Load data format
Annexure-VI



**TECHNICAL SPECIFICATION FOR
HVAC SYSTEM
(ELECTRICAL PORTION)
PROJECT: 2X660MW KORADI THERMAL POWER
PROJECT (UNIT# 11 & 12)**

SPECIFICATION NO. PE-TS-XXX-XXX-XXXX
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PAGE 1 OF 1

Explanatory note for Cable routing & Cable schedule format
Annexure-VII

[illegible]

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in BHEL

1. For the purpose of clarity, it may please be noted that the information given in regard to the cables to be routed through WinPath as per the system elaborated below is called "Cable List", while the term "Cable Schedule" applies to the cable list with routing information added after routing has been carried out.
2. The cable list shall be entered as an MS Excel file in the format as per enclosed template EXT_CAB_SCH_FORMAT.XLS. No blank lines, special characters, header, footer, lines, etc. shall be introduced in the file. No changes shall be made in the title line (first line) of the template.
3. The field properties shall be as under:
 - a. UNITCABLENO: A/N, up to sixteen (16) characters; each cable shall have its own unique, unduplicated cable number. In case this rule is violated, the cable cannot be taken up for routing.
 - b. FROM: A/N, up to sixty (60) characters; the "From" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
 - c. TO: A/N, up to sixty (60) characters; the "To" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
 - d. PURPOSE: A/N, up to sixty (60) characters; the purpose (i.e. power cable/ indication/ measurement, etc.) to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
 - e. REMARKS: A/N, up to forty (40) characters; Any information pertinent to routing to be specified here (e.g., cable number of the cable redundant to the cable number being entered). Information in excess of 40 characters will be truncated after 40 characters.
 - f. CABLESIZE: A/N, 7 characters exactly as per the codes indicated below shall be specified here. The program cannot route cables described in any other way/ format.
 - g. PATHCABLENO: Field reserved for utilization by the program. User shall not enter any information here.
4. One list shall be prepared for each system/ equipment (i.e., separate and unique cable lists shall be prepared for each system).
5. The cables shall be described as per the scheme listed below:

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in BHEL

A	NIN	A	NIN
Cable	No. of cores	Cable code	Cable size
Voltage	(e.g. 01,03,3H, 07)	(See C below)	(e.g. 035,185,2.5, 0.5)
Code (see B below)			

please refer below examples:

- i) 3C x 120 sq. mm. (1.1kV) PVC FRLS, Unarmoured Aluminium cable, the voltage code shall be D03G120
- ii) 3C x 2.5 sq. mm. (1.1kV) PVC FRLS, Unarmoured Copper cable, the voltage code shall be D03C2.5
- iii) 3.5C x 120 sq. mm. (1.1kV) PVC non-FRLS, Armoured Aluminium cable, the voltage code shall be D3HF120

(A) SYSTEM VOLTAGE CODES:

- (ac) A = 11KV, B = 6.6KV, C = 3.3KV, D = 415V, E = 240V, F = 110V
- (dc) G = 220V, H = 110V, J = 48V, K = +24V, L = -24V

(B) CABLE VOLTAGE CODES:

- A = 11KV (Power cables)
- B = 6.6KV (Power cables)
- C = 3.3KV (Power cables)
- D = 1.1KV (LV & DC system power & control cables)
- E = 0.6KV (0.5 sq. mm. Control cables)

(C) CABLE CODES

PVC Copper

- A = Armoured FRLS
- C = unarmoured FRLS
- B = Armoured Non-FRLS
- D = Unarmoured Non-FRLS

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in BHEL

<u>PVC Aluminium</u>	
E = Armoured FRLS	F = Armoured Non-FRLS
G = unarmoured FRLS	H = Unarmoured Non-FRLS
<u>XLPE Copper</u>	
J = Armoured FRLS	K = Armoured Non-FRLS
L = unarmoured FRLS	M = Unarmoured Non-FRLS
<u>XLPE Aluminium</u>	
N = Armoured FRLS	P = Armoured Non-FRLS
Q = unarmoured FRLS	R = Unarmoured Non-FRLS
S = FIRE SURVIVAL CABLES	
T = TOUGH RUBBER SHEATH	
U = OVERALL SCREENED	
V = PAIRED OVERALL SCREENED	
W = PAIRED INDIVIDUAL SCREENED	
Y = COMPENSATING CABLES	
I = PRE-FABRICATED CABLES	
Z = JELLY FILLED CABLES	

6. Once a cable list has been given to BHEL for routing, any subsequent changes required in the cable list (which may be in the form of addition of cables, deletion of cables, change of type or size of cable, etc.) must be informed as specific changes (as a separate file MS Excel of the same format as the original file) to the cable list given earlier if the cable list has been routed and cable schedule generated. The routing status of the cable list shall be got confirmed from BHEL by the agency that has prepared the cable list before the changes are intimated. In case BHEL confirms that the cable list in question has not been taken up for routing, and the revised cable list is acceptable,

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in BHEL

the same may be sent. Since cable routing through the program involves adding each cable list to the project cable schedule database, the original cable schedule shall not be furnished to BHEL with revisions incorporated within.



**TECHNICAL SPECIFICATION FOR
HVAC SYSTEM
(ELECTRICAL PORTION)
PROJECT: 2X660MW KORADI THERMAL POWER
PROJECT (UNIT# 11 & 12)**

SPECIFICATION NO. PE-TS-XXX-XXX-XXXX
VOLUME II B
REV 00 DATE 31.03.2026
PAGE 1 OF 1

Tentative make list for electrical items
Annexure-VIII

	MAHARASHTRA STATE POWER GENERATION CO. LTD.	VOLUME-V
	KORADI THERMAL POWER STATION 2x660 MW UNITS - 11 & 12 PROJECT	
	RFx No. 3000046202 (BTG Package)	ANNEXURE - 4
	SUB-VENDOR LIST	REV. - 0

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

8.00	CONTROL CABLES ONLY	(a)	CORDS CABLE INDUSTRIES LTD.

	MAHARASHTRA STATE POWER GENERATION CO. LTD.	VOLUME-V
	KORADI THERMAL POWER STATION 2x660 MW UNITS - 11 & 12 PROJECT	
	RFx No. 3000046202 (BTG Package)	ANNEXURE - 4
	SUB-VENDOR LIST	REV. - 0

21.00	POWER CONTACTOR/AUXILIARY CONTACTOR	(a)	SIEMENS
		(b)	L&T
		(c)	ABB
		(d)	SCHNEIDER
		(e)	GE

28.00	CT(LT)	(a)	KAPPA
		(b)	SILCON

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	MAHARASHTRA STATE POWER GENERATION CO. LTD.	VOLUME-V
	KORADI THERMAL POWER STATION 2x660 MW UNITS - 11 & 12 PROJECT	
	RFx No. 3000046202 (BTG Package)	ANNEXURE - 4
	SUB-VENDOR LIST	REV. - 0

30.00	CONTROL TRANSFORMERS	(a)	KAPPA
		(b)	SILCON
		(c)	POWER PACK
		(d)	PRAGATI
		(e)	CANDS
		(f)	PRECISE

32.00	SELECTOR SWITCHES AND	(a)	KAYCEE
	CONTROL SWITCHES	(b)	SIEMENS
		(c)	L&T
		(d)	RECON
		(e)	SWITRON
33.00	TIMERS	(a)	GE
		(b)	ABB
		(c)	SCHNEIDER
		(d)	L&T
		(e)	EAPL (ELECTRONIC AUTOMATION PVT.LTD.)
		(f)	MINILEC (INDIA) PVT. LTD.
34.00	FUSES FOR LT	(a)	GEC ALSTHOM
		(b)	SIEMENS
		(c)	L&T
		(d)	STANDARD

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	MAHARASHTRA STATE POWER GENERATION CO. LTD.		VOLUME-V
	KORADI THERMAL POWER STATION 2x660 MW UNITS - 11 & 12 PROJECT		
	RFx No. 3000046202 (BTG Package)		ANNEXURE - 4
	SUB-VENDOR LIST		REV. - 0

SR. NO.	ITEM		Koradi 2x660 MW

37.00	TERMINAL BLOCK &	(a)	ELMEX
	ACCESSORIES SIDE CLAMP	(b)	CONNECT WELL IND
		(c)	WAGO AND CONTROLS
38.00	DOUBLE COMPRESSION	(a)	COMET CABLE GLANDS AND TERMINALS
	CABLE GLAND	(b)	ELECTRO MAG
		(c)	COSMOS
		(d)	POWER ENGG
39.00	CRIMPING LUGS	(a)	DOWELL

43.00	CONDUIT	(a)	SENCO
		(b)	M. CHANDRA
		(c)	NAGARJUNA
		(d)	K.K. INDUSTRIES KOLKATA

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	MAHARASHTRA STATE POWER GENERATION CO. LTD.	VOLUME-V
	KORADI THERMAL POWER STATION 2x660 MW UNITS - 11 & 12 PROJECT	
	RFx No. 3000046202 (BTG Package)	ANNEXURE - 4
	SUB-VENDOR LIST	REV. - 0

SR. NO.	ITEM		Koradi 2x660 MW
44.00	CABLE LUGS	(a)	DOWELL
		(b)	CROWN
		(c)	NIKO
		(d)	FORWARD ENGG.

50.00	ABOVE GROUND EARTHING MATERIALS	(a)	INAR PROFILES PVT.LTD.,ANKAPALLE
		(b)	INDUSTRIAL PERFORATION (I) PVT. LTD.KOLKATA
		(c)	PREMIER POWER PRODUCTS (CAL) PVT.LTD.,KOLKATA
		(d)	RABI ENGINEERING WORKS PVT.LTD, KOLKATA.
		(e)	UNITECH FABRICATORS AND ENGINEERS PVT. LTD.,KOLKATA
		(f)	ASSOCIATED POWER STRUCTURES PVT. LTD.,GUJRAT

	MAHARASHTRA STATE POWER GENERATION CO. LTD.	VOLUME-V
	KORADI THERMAL POWER STATION 2x660 MW UNITS - 11 & 12 PROJECT	
	RFx No. 3000046202 (BTG Package)	ANNEXURE - 4
	SUB-VENDOR LIST	REV. - 0

SR. NO.	ITEM		Koradi 2x660 MW

57.00	LT MOTORS (415V)	(a)	ALSTOM
		(b)	BHEL
		(c)	CROMPTON GREAVES LTD
		(d)	KIRLOSKAR ELECTRIC CO. LTD

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	MAHARASHTRA STATE POWER GENERATION CO. LTD.	VOLUME-V
	KORADI THERMAL POWER STATION 2x660 MW UNITS - 11 & 12 PROJECT	
	RFx No. 3000046202 (BTG Package)	ANNEXURE - 4
	SUB-VENDOR LIST	REV. - 0

SR. NO.	ITEM		Koradi 2x660 MW
		(e)	SIEMENS
		(f)	MARATHON ELECTRIC
		(g)	ABB
		(h)	BHARAT BIJLEE
		(i)	LAXMI HYDRAULIC LTD

	MAHARASHTRA STATE POWER GENERATION CO. LTD.	VOLUME-V
	KORADI THERMAL POWER STATION 2x660 MW UNITS - 11 & 12 PROJECT	
	RFx No. 3000046202 (BTG Package)	ANNEXURE - 4
	SUB-VENDOR LIST	REV. - 0

4.00	Selector Switches and Control Switches	1	Kaycee
		2	Alstom
		3	L&T
		4	Siemens
		5	Recon
		6	Switron

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	MAHARASHTRA STATE POWER GENERATION CO. LTD.	VOLUME-V
	KORADI THERMAL POWER STATION 2x660 MW UNITS - 11 & 12 PROJECT	
	RFx No. 3000046202 (BTG Package)	ANNEXURE - 4
	SUB-VENDOR LIST	REV. - 0

H	Cables		
1.00	Control Cables	1	Delton Cables, Faridabad
		2	Universal Cables, Satna
		3	Nicco Cable, Kolkata
		4	Polycab, Daman
		5	Reliance Engrs, Bangalore
		6	Cords Cables, Rajasthan
		7	Paramount Cables, Alwar
		8	Thermocables, Hyderabad
		9	KEI Industries Ltd., Chennai
		10	Special Cables Pvt. Ltd.
		11	Suyog Electrical Pvt. Ltd.
2.00	Instrumentation Cable	1	Delton Cables, Faridabad
		2	Universal Cables, Satna
		3	Nicco Cable, Kolkata
		4	Polycab,Daman
		5	Gayolene, Mumbai
		6	Reliance Engrs, Bangalore
		7	Cords Cables, Rajasthan
		8	Paramount Cables, Alwar
		9	Thermocables, Hyderabad

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	MAHARASHTRA STATE POWER GENERATION CO. LTD.	VOLUME-V
	KORADI THERMAL POWER STATION 2x660 MW UNITS - 11 & 12 PROJECT	
	RFx No. 3000046202 (BTG Package)	ANNEXURE - 4
	SUB-VENDOR LIST	REV. - 0

SR. NO.	ITEM		Koradi 2x660 MW
		10	KEI Industries Ltd., Chennai
		11	Cable Corprn of (I) Ltd., Chennai
		12	RPG Cables Ltd., Chennai
		13	Fort Gloster Industries Ltd. Kolkata
		14	Deco Cables, Delhi
		15	Krishna Cables, Gwalior
		16	Thermopads (P) Ltd
		17	Elkay Telelinks Ltd.
		18	Incab Industries Ltd
		19	Torrent Cable Ltd.
		20	Special Cables Pvt. Ltd.
		21	Suyog Electrical Pvt. Ltd.
3.00	Compensating Cables	1	Delton Cable
		2	Toshniwal, Mumbai
		3	Reliance, Bangalore
		4	Lapp India, Mumbai/ Bangalore
		5	Cords Cables, Rajasthan
		6	Paramount Cable
		7	Suyog Electrical Pvt. Ltd.
4.00	Special cables (PTFE /FEP Insulated Cables)	1	Toshniwal cable
		2	Reliance Cables
		3	Lapp India, Mumbai
		4	Paramount Cables
		5	Finolex, Pune
		6	Tempsens Instruments India Pvt. Ltd.
		7	Thermo Cables Limited
5.00	Thermocouple extension Cable	1	Tempsens Instruments India Pvt. Ltd.
		2	Thermo Cables Limited
		3	Suyog Electrical Pvt. Ltd.
6.00	Optical Fiber Cable	1	Birla Cable Limited
		2	Aksh Optifibre Limited

ITEM CODE	ITEM/SERVICE DESCRIPTION	SL NO.	VENDOR CODE	VENDOR NAME	ADDRESS	PHONE	REMARKS

ES33	IND.POWER & WLDG SOCKETS	1	C02	CROMPTON GREAVES	3RD FLOOR, EXPRESS BUILDING,9-10, BAHADUR SHAH ZAFAR MARG, NEAR ITO CROSSING,NEW DELHI-110002, INDIA	91 11 23460700 - 999 'Sunil.Das@cgglobal.com	
	IND.POWER & WLDG SOCKETS	2	E1207	CYCLO ELECTRIC DEVICE & SERV.CO.	: A-3, NEAR ANTHEM BIOSCIENCE, KSSIDC INDUSTRIAL AREA, BOMMASANDRA, BOMMASANDRA INDUSTRIAL AREA, BANGALORE, KARNATAKA 560099	Mr. H.Jaishanker +919845039081, 080 - 27833102 , 080 - 27833103 : +91 80 41460985 'cycloelectric@gmail.com	
	IND.POWER & WLDG SOCKETS	3	B04	BCH	20/4, MATHURA ROAD, FARIDABAD - 121006, HARYANA, INDIA	0(129)-4063000, 9015800189(Ramesh Giri) 'ramesh.giri@bchindia.com	
	IND.POWER & WLDG SOCKETS	4	B02	BEST & CROMPTON	Best & Crompton Engineering Ltd	DGM Mr. VI Raj:- 9840593411	BEST & CROMPTON
	IND.POWER & WLDG SOCKETS	5	A03	AJMER INDUSTRIES & ENGG. WORKS	AJMER INDL. AND ENGG. WORKS. AJMER HOUSE, A-61 / KHAIRANE MIDC. , TTC INDL. AREA, NAVI MUMBAI – 400705.	Tel : 022 27620299 / 97 / 96 'mail@ajmera.net	
ES35	INDICATING LAMPS	1	B04	BCH	20/4, MATHURA ROAD, FARIDABAD, HARYANA-121006	0129-4293000	
	INDICATING LAMPS	2	C01	C&S ELECTRIC LTD.	222, OKHLA IND. ESTATE, PH-III, NEW DELHI-110020	6832259,6918834-37	
	INDICATING LAMPS	3	E1050	ESSEN DEINKI	FLAT NO. 502, SKYLINE HOUSE 85, NEHRU PLACE NEW DELHI	011-26217060	
	INDICATING LAMPS	4	E1153	VAISHNO(HOTLINE SWGR.& CONTROL)	G-19, SECTOR - 11, NOIDA - 201301, UTTAR PRADESH, INDIA	8377805157 9818338922	
	INDICATING LAMPS	5	A35	GE-POWER	KAMAK TOWER, 3RD FLOOR, PLOT NO. 12-A, TVK INDUSTRIAL ESTATE, EKKADUTHANGAL, GUINDY, CHENNAI-600032	9818338922	
	INDICATING LAMPS	6	S01	SIEMENS	RC-IV I S NR DEL AREA, JIL BUILDING, TOWER-B, PLOT NO. 78, SECTOR 18, GURGAON-122015, INDIA	0124-2842000, 9873424331 amit.bhadauria@siemens.com	
	INDICATING LAMPS	7	S03	SCHNEIDER ELECTRIC INDIA PVT. LTD.	9TH FLOOR, BLDG. NO. 10, TOWER-C, DLF CYBER CITY, PH-II, GURGAON-122002	0124-3940400	
ES36	JUNCTION BOXES (NON FLAME PROOF)	1	J01	JASPER ENGINEERS PVT. LTD.	A-23, SECTOR - 8, NOIDA-201301	0120-4033520/533	
	JUNCTION BOXES (NON FLAME PROOF)	2	EC05	Electro Controls & Devices	M/S ELECTRO CONTROLS & DEVICES, F-41, SITE-C, SURAJPUR INDUSTRIAL AREA GREATER NOIDA, UTTAR PRADESH :201308	Mr. Sanjay Sharma (Chief Promoter) 0120-2569487, 2560100,2560300	
	JUNCTION BOXES (NON FLAME PROOF)	3	SRC01	M/s Shrenik & Co.	39A/3, PANCHRATNA INDUSTRIAL ESTATE, SARKHEJ-BAVLA ROAD, CHANGODAR, AHMEDABAD – 382 213	020-026708100	
	JUNCTION BOXES (NON FLAME PROOF)	4	PME-01	M/s PHOENIX MECANO LTD.,	388 BHARE, TALUKA MULSHI, POST GHOTAWADE, PIRANGOOT, INDUSTRIAL AREA, PUNE-412115	Awasthi(09971119006) Tel: ++91 20 6674 5103, Mobile: +91 90499 95985, Fax: ++91 20 6674 5126	
	JUNCTION BOXES (NON FLAME PROOF)	5	ACE01	Adroit Control Engineers Pvt.Ltd.	M/S ADROIT CONTROL ENGINEERS PVT.LTD. PLOT-3, KRISHNA INDL. AREA, SECTOR-25 FARIDABAD – 121004	011-47600700, 0129-4251400	
	JUNCTION BOXES (NON FLAME PROOF)	6	PME-01	M/s PHOENIX MECANO LTD.,	388 BHARE, TALUKA MULSHI, POST GHOTAWADE, PIRANGOOT, INDUSTRIAL AREA, PUNE-412115	Awasthi(09971119006) Tel: ++91 20 6674 5103, Mobile: +91 90499 95985, Fax: ++91 20 6674 5126 contact person : Vishwa bandhu E-mail:d.gupta@pmipl-online.com ;admin@pmipl-online.com	
	JUNCTION BOXES (NON FLAME PROOF)	7	MK01	MIKA ENGINEERS	BRANCH OFFICE : 'D'-101, DHEERAJ HERITAGE RESIDENCY II, SHASTRI NAGAR, SANTACRUZ (W), MUMBAI 400 054.	Director : Mr. Asgar Karimi Email: asgar@mikaengineers.com E-mail : mika@mtnl.net.inTelfax : 022-26610081/82/83/84Tel : 02527-249066/70 Cell : 099230 74373	TYPE-S ONLY

ITEM CODE	ITEM/SERVICE DESCRIPTION	SL NO.	VENDOR CODE	VENDOR NAME	ADDRESS	PHONE	REMARKS
	JUNCTION BOXES (NON FLAME PROOF)	8	PME-01	M/s PHOENIX MECANO LTD.,	388 BHARE, TALUKA MULSHI POST GHOTAWADE, PIRANGOOT, INDUSTRIAL AREA, PUNE-412115	TEL. : +912066745000 Awasthi(09971119006) Tel: ++91 20 6674 5103, Mobile: +91 90499 95985, Fax: ++91 20 6674 5126 contact person : Vishwa bandhu E-mail:d.gupta@pmpl-online.com ;admin@pmpl-online.com	
	JUNCTION BOXES (NON FLAME PROOF)	9	B05	BAJAJ ELECTRICALS	BAJAJ ELECTRICALS LTD. ENGINEERING & PROJECTS BU (NORTH) 3rd FLOOR, GULMOHARHOUSE, COMMUNITY CENTRE 161/B-4, GAUTAM NAGAR, YUSUF SARAI NEW DELHI – 110049	CONTACT PERSON : Mr. S. SREEMANY. SR. MANAGER (PROJECTS) CONTACT DETAILS : (+91) 9871025705. MAIL ID : srabans@bajajelectricals.com;	
	JUNCTION BOXES (NON FLAME PROOF)	10	A03	AJMERIA INDUSTRIES & ENGG. WORKS	AJMERIA INDL. AND ENGG. WORKS. AJMERIA HOUSE, A-61 / KHAIRANE MIDC. , TTC INDL. AREA, NAVI MUMBAI – 400705.	Tel : 022 27620299 / 97 / 96 'mail@ajmera.net	
	JUNCTION BOXES (NON FLAME PROOF)	11	SB02	S.B. ELECTRICAL ENGINEERING CORPORATION	03, SARDAR GRIHA BUILDING, LOHAR CHAWAL, MUMBAI-400002	022- 22069831; 022-66637259	
	JUNCTION BOXES (NON FLAME PROOF)	12	RT13	RITTAL INDIA PVT. LTD.	Espire Building ,Level -1 A-41, Mohan Co- Operative Industrial Estate ,Mathura Road, New Delhi -110044	Amit Bansal Phone: 011-42004000, D: 011-42004033 · Mobile: +91 9717772245 · mailto:amit.b@rittal- india.com www.rittal-india.com	
	JUNCTION BOXES (NON FLAME PROOF)	13	HP08	HPL ELECTRIC AND POWER LTD.	Works Address: Village Shavella, PO:Jabil, Teh- Kasauli, Dist-Solan, Himachal Pradesh-173209	Mr. Ashwani Kumar mailto:'ashwani@hplindia.com' M:9971127370	

ITEM CODE	ITEM/SERVICE DESCRIPTION	SL NO.	VENDOR CODE	VENDOR NAME	ADDRESS	PHONE	REMARKS
ES80	PVC WIRES				BIS APPROVED MAKE		

Note:

Make of all the equipment/instrument under this specification shall be subjected to Owner (End Customer)/BHEL approval in the event of order. The bidder may propose name of additional sub-vendors makes based on their experience, which will be subject to Owner (End Customer)/BHEL approval.

Owner (End Customer)/BHEL approval reserves the right to accept/reject any make or sub-vendor after award of contract. Approval and rejection of makes shall not have any price & time implication to the purchaser after award of contract.



TITLE:
2X660 MW KORADI STP (UNITS-11&12)
AIR CONDITIONING SYSTEM
TECHNICAL SPECIFICATION
(C&I PORTION)

SPECIFICATION No: PE-TS-527-553-A001

SECTION: I

SUB-SECTION: C-4

REV. 00

DATE: AUGUST 2026

SECTION: I

SUB-SECTION: C-4
TECHNICAL SPECIFICATION (C&I PORTION)

**KORADI THERMAL POWER STATION
2 x 660 MW UNITS - 11 & 12 PROJECT**

C&I TECHNICAL SPECIFICATION

**FOR
HVAC SYSTEM**



**SYSTEM & CONTROL ENGINEERING DEPARTMENT
PROJECT ENGINEERING MANAGEMENT
BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
NOIDA**

PREPARED BY	CHECKED BY	APPROVED BY
ANJALI RAMAN	MAYANK KESHARWANI	MAYANK KESHARWANI
SR. MGR. (S&CE)	DGM (SH-I03, S&CE)	DGM (SH-I03, S&CE)



**KORADI THERMAL POWER STATION
2 x 660 MW UNITS - 11 & 12 PROJECT**

SECTION: C
SUB SECTION: C&I

**C&I SPECIFICATION FOR
HVAC SYSTEM**

INDEX

S. No.	DESCRIPTION
1	TITLE SHEET
2	INDEX SHEET
3	C&I SPECIFIC TECHNICAL REQUIREMENTS
4	LIST OF DOCUMENTS/DELIVERABLES
5	MOTORISED VALVE ACTUATORS
6	SPECIFICATION FOR FIELD INSTRUMENTS & CONTROL PANEL
7	SIGNAL EXCHANGE BETWEEN DRIVES & DCS
8	PROCESS CONNECTION AND PIPING
9	ERECTION HARDWARE
10	QUALITY ASSURANCE
11	TYPE TEST REQUIREMENT
12	APPLICABLE CODES AND STANDARDS
13	INSTRUMENT INSTALLATION DRAWING
14	PROVENNESS CRITERIA
15	SUB VENDOR LIST



**KORADI THERMAL POWER STATION
2 x 660 MW UNITS - 11 & 12 PROJECT**

SECTION: C
SUB SECTION : C&I

**C&I SPECIFICATION FOR
HVAC SYSTEM**

C&I SPECIFIC TECHNICAL REQUIREMENT

|



**KORADI THERMAL POWER STATION
2 x 660 MW UNITS - 11 & 12 PROJECT**

SECTION: C
SUB SECTION: C&I

**C&I SPECIFICATION FOR
HVAC SYSTEM**

C&I Specific Technical Requirement

1. Complete C&I system for Air Conditioning & Ventilation system (HVAC) is in bidder scope of supply. Items not specifically mentioned however required for the completeness of the system shall be supplied by bidder.
2. The control system of HVAC System shall be as per C&I Annexure-I (enclosed with this specification). The operation and control philosophy of HVAC System has been elaborated in separate section in the specification.
3. Bidder shall provide complete Instrumentation for control, monitoring and operation of entire HVAC System. The requirements given below are to be read in conjunction with detailed Technical specification enclosed in the specification. Further In case of any discrepancy, ambiguity or conflict in the requirements specified in the tender documents, the Bidder shall bring the same to the notice of BHEL through a pre-bid clarification. In the absence of any such pre-bid clarification, the more stringent requirement, as determined by BHEL/Customer, shall prevail, and the Bidder shall comply with the same without any additional commercial implication.
4. Bidder shall provide instrumentation for the HVAC System in accordance with the technical specification document / drawings wherever provided for the respective systems, as a bare minimum requirement. In addition, for completeness of the system and its associated equipment, the Bidder shall also provide all the necessary instruments required to meet the process requirements even if such instruments are not specifically indicated in the technical specification documents/drawings. During detail engineering if any additional instruments are required for safe & reliable operation of plant, bidder shall supply the same without any technical, commercial and delivery implication to BHEL.
5. The make/model of various instruments/items/systems shall be subject to approval of owner/purchaser during detailed engineering stage. No commercial and delivery implication in this regard shall be acceptable. In case of any conflict and repetition of clauses in the specification, the more stringent requirements among them are to be complied with, BHEL discretion will prevail.
6. All local gauges as well as transmitters and sensors for parameters like pressure, temperature, flow etc. as required for the safe and efficient operation and maintenance under the scope of specification shall be provided by bidder. The necessary root valves, impulse piping, drain cock, gauge zeroing cocks, valve manifolds, instrument racks and all the other accessories required for mounting / erection of these local instruments, transmitters and sensors shall be supplied by bidder even if not specifically asked for. Also, the proposal shall include the necessary cables, flexible conduits, instrument racks, junction boxes and accessories for the above purpose. Double root valves shall be provided for



**KORADI THERMAL POWER STATION
2 x 660 MW UNITS - 11 & 12 PROJECT**

SECTION: C
SUB SECTION: C&I

**C&I SPECIFICATION FOR
HVAC SYSTEM**

all pressure tapping where the pressure is 40kg/cm² and above. Single root valve for below 40Kg / Cm². The contacts of equipment mounted instruments; sensors, switches etc. for external connection including spare contacts shall be wired out to suitably located junction boxes.

7. All field instruments/analyzers/actuators/sov/control valves etc. shall be hooked with DDCMIS based control system as per requirement mentioned elsewhere in the specification.
8. Instruments used for PG test: All test instrumentation as required for the Performance Guarantee Test shall be provided by the Bidder free of cost. Special / Precision instruments required for Performance Guarantee Test shall, however, be arranged by him and shall be returned to him after successful completion of the tests. All test instrumentation shall be in accordance with the applicable code. The instruments for PG test shall meet the minimum requirements specified in ASME PTC or subsequent clauses in this chapter whichever is better.
9. All transmitters shall be smart type and shall have 4-20mA DC signal with superimposed digital communication having proven HART protocol to facilitate configuration, zero adjustment, calibration and diagnostic from remote location. The calibrated range shall be so selected that the normal parameter shall generally be between 50 to 75 % of the range, depending on expected excursion. All microprocessor-based transmitters shall have the same type of protocol.
10. All local gauges, transmitters and switches shall be mounted on suitable enclosures, racks (closed for outdoor area/ open for indoor areas) subject to owner's approval. The racks/enclosure shall be in Bidder's scope of supply.
11. All the instruments/drives/control elements shall be terminated on JB's/Panels in field. JB's/Panels and other erection hardware shall also be in Bidder's scope. Number of Junction Boxes shall be sufficient and positioned in the field to minimize local cabling (max 12-15 mtrs) and trunk cable. Junction boxes shall be IP-65 enclosures with knock-out holes and cage-clamp type terminals
12. All electric actuators, pneumatic control valves, Junction Boxes, Solenoid boxes and Local control panels which are not installed inside building, suitable canopy shall be provided by bidder and design of canopy shall be approved by Employer during detailed engineering.
13. Transmitters shall be normally used for switching application as well by setting limit values in DCS. Direct acting switches shall be used only if recommended by equipment manufacturers. Temperature switches shall be avoided altogether.



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SECTION: C
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**C&I SPECIFICATION FOR
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14. RTD's shall be of duplex type. Both the elements of duplex temperature sensors shall be terminated to junction boxes.
15. Bidder to provide Local Control Panel for AC and Ventilation system given elsewhere in the specification.
16. Bidder to keep the provision for accepting fire signals from Fire Alarm & Protection System (supplied by others) and the closure of relevant fire dampers in Air Conditioning and Ventilation System. The no of IO & other specifications in this regard shall be finalized during detail engineering.
17. Provision for redundant soft interfacing and Hardwired interfacing shall be included for signal exchange between HVAC DDCMIS and chiller's Microprocessor based control panel. Bidder shall include required hardware at MP end.
18. Time synchronization of MP with DCS is to be carried out. Necessary hardware/software for same at MP end to be provided by Bidder.
19. VFD panels for applicable drives are in Bidders scope. Typical signal exchange with DCS has been indicated in the specification elsewhere.
20. Bidder to provide flow measuring device suitable for service condition, which shall be decided by BHEL/Customer during detailed engineering. Bidder to comply the requirement without any commercial implication.
21. Electronics located outside control room areas shall be tropicalized and enclosed in dust & weather proof cabinets suitable for the environment.
22. Scope of Instrumentation cables (Screened Control Cables), Fibre Optic cable & Control cables shall be as per Electrical Cable scope matrix in Electrical portion of specification. Any cable in Bidder's scope shall be as per specification.
23. All Electrical Actuators shall be of the non-integral starter type and shall be provided by bidder for all on/off and inching type valves, along with necessary interface units for linking to corresponding Control System, as applicable. A typical Hook-up diagram for the drives is included in the specification. Non-contact type electronic 2-wire (HART Compatible) position transmitters shall be provided by bidder for all inching type motorised valves. The detailed specification is attached elsewhere in the specification.
24. The solenoid operated valves/Dampers/Gate shall have a limit switch for open/close feedback. Solenoid Valve shall be rated for 24V DC only.



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25. The Bidder shall provide all regulating-duty control valves, equipped with smart positioners having integral I/P converters and valve position transmitters. The smart positioner shall accept 4-20 mA signal from the control system as input and provide a compatible signal for driving the pneumatic actuator. In addition to electrical to pneumatic signal conversion & positioning functions, it shall also perform detailed diagnostics & make available the actuator/control valve faults via a HART interface. The HART signal for the detailed faults shall be superimposed on the 4-20 mA control signal itself. The detailed specification is attached elsewhere in the specification.
26. Interface of MCC, HT SWGR, Solenoid valves, field instruments, Actuators etc. with DDCMIS based control system shall be as per Drive Control Philosophy enclosed in specification.
27. The specifications for instruments mentioned in the specification are minimum requirements. Any item/ equipment not indicated above however required for the completeness of the system is to be supplied by bidder without any technical, commercial and delivery implication to BHEL.
28. Instruments for which specification are not attached, vendor's data sheet for such items will also be subject to customer/BHEL's approval during detail engineering without any commercial and delivery implication.
29. The bidders shall specifically mention any deviation they would like to take on the C&I specification. In absence of only deviation, a No deviation certificate is to be furnished.
30. Bidder to provide input/output list, drives list, junction box schedule and termination details, recommended control logics, write-up etc. the list of documents to be submitted after award of contract is to be referred by bidder.
31. Bidder to perform tests of C&I items/instruments/systems as per Quality plans/type test attached in the specification. However, if any test not specified in the quality plan but specified in specification Tests for I&C equipment included elsewhere in specification will have to perform by Bidder without any cost implication. In case of any conflict and repetition of clauses in the specification, the more stringent requirements among them are to be complied with.
32. Instrument installation and accessories required for the same shall be in Bidder's scope and shall be submitted after award of contract. However, any instrument/ analyser installation not covered in the same shall be subject to Customer and BHEL approval during detailed engineering.
33. Instruments and control equipment shall be guaranteed to meet the performance, functional and accuracy requirements enumerated in the specification. All field wiring should be through conduits. All fittings, cable glands etc. shall be strictly as per NEC recommendation article, 500 to 503.



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34. Instruments must have separate tapping lines. Sharing of the same tapping pipe for redundant instruments or various different instruments is not acceptable.
35. Instruments, devices and equipment for location in outdoors/indoor/airconditioned areas shall be designed to suit the environmental conditions for the proposed plant location for continuous operation.
36. All equipment / instruments envisaged for sea water applications, shall be provided with wetted parts made of Monel/ Hastelloy C or any other material (if provenness experience of the proposed material for such applications is established by contractor).
37. For coastal areas, all equipment / instruments/ accessories shall be provided with durable epoxy coating for housings and all exposed surfaces of the equipment / instruments/accessories.
38. For coastal areas, all impulse piping / air supply piping / local instrument enclosures and racks/ accessories shall be provided with durable epoxy coating for all exposed surfaces.
39. For coastal areas, all conduits / cable sub trays / cabling accessories shall be provided with durable epoxy coating for all exposed surfaces.
40. All the instruments having contact with the process fluids which are corrosive, viscous, solid bearing or slurry type, shall be provided with diaphragm seals. 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.
41. Bidder to provide at least 20% spare unused terminals in Junction boxes, LIE/LIRs, termination/marshalling cabinets etc.
42. 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.
43. Level transmitters for applications where transmitter location is not accessible, the transmitter shall have separate sensor unit and electronic unit for such applications. It shall be possible to mount the electronic unit at accessible location.



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- 44.** Redundancy of instruments to be provided by bidder shall be as follows:
- 1) Triple redundancy for all analog and binary inputs required for protection of system/drives.
 - 2) For all other control functions dual redundancy of the sensors shall be provided by the bidder.
- 45.** Bidder to comply with codes and standards as mentioned in the specification.
- 46.** Instrument installation shall be as per the attached "Standard Hook-up diagram of instrument." However, any instrument/ analyser installation not covered in the same shall be subject to Customer and BHEL approval during detailed engineering.
- 47.** Bidder shall provide erection hardware as per installation drawings.
- 48.** Bidder must offer general tools and tackles and special calibration instruments required during start-up, trial run, operation and maintenance of the system.
- 49.** Number of pairs to be selected for Screen /Control cable
- a) F-Type: 2P/4P/8P/12P (Size: 0.5sqmm2)
 - b) G-Type: 2P/4P/8P/12P (Size: 0.5sqmm2)
 - c) Core Cable: 3CX2.5sqmm2/ 10CX2.5sqmm2/ 12CX2.5sqmm2/ 16CX2.5sqmm2/ 19CX2.5sqmm2
- 50.** All equipment shall be installed above ground. Below ground installation will not be allowed, but if a below ground installation is unavoidable, then proper maintenance space and dewatering arrangement has to be provided. Collection of oil and dirt in that area has to be avoided and it should be easy to clean such a place.
- 51.** 230 V AC UPS Power supply shall be provided by BHEL at a single point, further distribution to various instruments/equipment of the system shall be in bidder scope. Bidder to include necessary power distribution board, change over circuit in his scope. Any power supply other than the above, if required by any instrument/equipment has to be derived by the bidder from the above supply & all necessary hardware for the same shall be in bidder scope. Further, Bidder to furnish electrical load/ UPS load data during detailed engineering in BHEL format.
- 52.** In addition to requirements specified here, all C&I systems/ sub-systems/ equipment/ devices shall also meet other requirements stipulated under other Sub-sections/ parts/ sections of specification. The above given scope is indicative & minimum. Any item/ equipment not indicated above however required for the completeness of the system is to be supplied by bidder without any technical, commercial and delivery implication to BHEL.



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- 53.** Standardisation and Uniformity of hardware:
Bidder shall ensure that various C&I instruments /equipment like 4-20mA electronic transmitters / transducers, Temperature elements and other instruments/ local devices etc. that are being furnished by the Bidder, are of the same make, series and family of hardware so as to ensure smooth and optimal maintenance, easy interchangeability and efficient spare parts management. For the instruments that are proposed to be connected to Bidder's Steam Turbine Generator integral controls and other Skid Mounted instruments, Bidder's standard and proven instruments are acceptable.
- 54.** Bidder shall furnish Instrument Schedule, I/O list, Drive list, Cable Schedule, Cable interconnection (DCS end terminal details shall be provided to vendor during detail engineering to incorporate in cable interconnection), JB grouping, Control Scheme, Annunciation list, SOE list, List of Instruments/devices for HART in BHEL approved format. Also reusable database format like MS Excel, MS Access etc. of these documents shall also be provided by Contractor in BHEL approved format. Soft copy of the formats shall be provided to the successful bidder.
- 55.** Bidder's presence is required for 3 Man days (excluding travel time) at EDN Bangalore during FAT of DDCMIS for certifying correctness & completeness of implementation of Control logic. Intimation regarding FAT shall be given 2 days in advance. All the expenses like boarding, lodging and travel, air fare etc. shall be in bidder's scope.
- 56.** Bidder's presence is required for 6 Man days (in two visits 3 days each excluding travel time) at site during commissioning of DDCMIS for assistance related to process correctness. All the expenses like boarding, lodging and travel, air fare etc. shall be in bidder's scope.
- 57.** Bidder shall provide the proper user license for all kind of software and hardware (where applicable), used in the project. All the hardware and software items shall be the latest updated version with minimum 3 years proven running records under the same capability of this project.
- 58.** All software and firmware user licenses shall be valid for entire life of power plant. User should not have to pay any recurring license fee during the usage period of the system. License will be provided on permanent basis and for any upgradation of software (for operating system & Firmware) for minimum fifteen years without any financial implication to the owner.
- 59.** Further, Bidder to meet the provenness criteria for all the supplied C&I items mentioned elsewhere in the specification.
- 60.** In case of any conflict and repetition of clauses in the specification, BHEL discretion will prevail.

2X660 MW KORADI TPP UNIT 11&12 - BTG

C&I Annexure-I

Sl. No.	System / Package	Scope of supply (Control system)	Common/ per unit	Control System		Operation from		Type of interface with main plant DDCMIS		Communication			Time Sync Format	Remarks	Rev
				Type	Location of Control cabinet	Local	Remote (CCR)	Link	Purpose	Cable Type	Redundant (Y/N)	Protocol			
1	Air Conditioning & Ventilation System for Main Plant	EDN	Common	DDCMIS	CER	N	Y			NA			NA		00
2	Air Conditioning & Ventilation System for ESP & FGD Area	EDN	Common	DDCMIS *	CER	N	Y			NA			NA	* RIO panel in utilised ESP Cum FGD Control Room	00
3	Air Conditioning System for Service building	--	--	--	--	--	--			--**			--	The operation of Ducted Split ACs of service building shall be from local MCB.	04
4	Air Conditioning System for other offsite control room	--	--	--	--	--	--			--			--	The operation of ACs of other offsite building shall be as per Mechanical spec	04

LEGEND:

- 1 HW - Hard Wired
- 2 FO - Armoured Fibre Optic
- 3 RIO - Remote Input/Output
- 4 TP- Twisted Pair
- 5 MP- Microprocessor

NOTES:

1. ** Soft link interface shall be provided with DDCMIS for ductable split ACs.
2. TP/FO cable along with required accessories (at DDCMIS end) for interfacing of PLC/MP based system with DDCMIS shall be in BHEL-EDN scope of supply.
3. Required accessories at PLC/MP end for interfacing of PLC/MP based system with DDCMIS shall be in package supplier's scope.



3.32.00 Air conditioning and Ventilation System

- 3.32.01 The operation of each Air Conditioning system shall be possible through Microprocessor based Distributed Digital Control Monitoring and Information System (DCS) as defined in standalone DCS. Dedicated controllers to be provided by Contractor for each Screw /centrifugal Chiller units with local start / stop & indication for plant A/C system for all BTG & FGD areas including "Service Building".
- 3.32.02 All the functional requirements specified here and general control logic specified under this section shall be implemented in the respective control system.
- 3.32.03 The basic function of the system shall be to closely control and monitor temperature and humidity conditions inside the air-conditioned spaces, to optimize / minimize energy consumption by automated operation, to provide remote centralized monitoring & control for various mechanical facilities including sequential start/stop of the whole Air conditioning System, automatically calculate record and cooling load for each hour /day/season, to generate maintenance data & alarms, to maintain records of plant operation & energy consumption for varying loads, duty cycling to operate all the equipment including standby equipment for equal duration, automatic startup of standby equipment in case of failure of operating unit and displaying fault alarm status of the tripped unit, activating /deactivating water valves to startup/stop water flow through chiller/condenser circuit.
- 3.32.04 For sequential operation /duty cycling, programmed start up/stop of individual AHU as per operating requirements and inside room temperature and humidity of all BTG control room, UPS and Battery Charger room shall be maintained by controlling the chilled water flow by means of motor operated three way modulating valve at chilled water line, humidified system and duct heater.
- 3.32.05 For Service building inside room temperature and humidity shall be maintained by varying the chilled water flow of secondary chilled water pumps through VFD driven motor and by varying the air flow of AHU through VFD driven motor, humidified system and duct heater. For sequential operation/duty cycling, programmed startup/stop of individual AHU's, pumps and cooling towers as per operating requirements and inside room temperature and humidity. Adequate no's of VAV box shall be provided for optimum use of VFD driven AHUs. Adequate nos. of occupancy sensor shall be provided. CO2 sensor shall be provided in each AHU room to regulate the fresh air.
- 3.32.06 Microprocessor-based control panels of Chiller units shall be suitably interfaced with BTG-DCS .
- 3.32.07 Water chilling unit control system shall be designed to have a constant chilled water outlet temperature from evaporator at all load condition by means of controlling ON-OFF thermostat (one for each compressor). The closure of liquid



line solenoid valve and tripping of compressor at lower water temperature and opening of solenoid valve and starting of compressor at high water temperature set point shall be automatic through the thermostat. Between the above set points the compressor capacity shall be controlled automatically through cylinder "load-unload" mechanism activated through the suction pressure or return chilled water temperature.

- 3.32.08 On-off type anti-freeze thermostats, one for each chiller shall be provided in addition to the controlling on-off thermostat for safety purpose and shall act in the event of failure of on-off thermostat to close the liquid line solenoid valve and also to simultaneously trip the compressor.
- 3.32.09 Compressor starting/running shall be interlocked with the low / adequate flow at the outlet of each chiller and each condenser and as well as with pressure in the inlet of the condensers. In addition, closure or open status of various valves shall be used for interlock, alarm and control of Air Conditioning System.
- 3.32.10 Operation of air conditioning system shall be interlocked with the required minimum pressure and temperature of cooling tower at inlet to the condenser. Status indication of condenser water pumps and associated cooling towers shall be provided in the control panel of air conditioning plant.
- 3.32.11 AHU shall be started either locally or from the main control room of AC system by means of Remote / Manual selection facility.
- 3.32.12 Miscellaneous Control Requirements
- a) Separate emergency local stop push button shall be provided for each pump, compressor, fans etc. of A/C system.
 - b) Status shall be provided of each pump, compressor, fans etc. of A/C system and Ventilation system on HMI system at control room.
 - c) All the annunciations related to failure of equipments, tripping of equipments, source of failure / reason due to which the equipment is stopped/tripped, low & high limits of parameters such as level, temperature, pressure drop, pressure etc. shall be provided for each pump, fan, compressor, AHU, PAC, etc. of A/C system.
 - d) The fans (both supply and exhaust fans) associated with mechanical ventilation system shall be operated locally.
 - e) Relative humidity and temperature measurement of all BTG control rooms, Service Building and all major air-conditioned areas shall be available in standalone DCS.
- 3.32.13 Plant Control of Ventilation System
- 3.32.14 Separate emergency local stop push button shall be provided for each pump, fans, etc. of Ventilation system.
- 3.32.15 The status of each pump, centrifugal fans, etc. of centralized ventilation system is available on OWS in control room locally.



MAHARASHTRA STATE POWER GENERATION CO. LTD.

VOLUME - III

**KORADI THERMAL POWER STATION
2x660 MW UNITS - 11 & 12 PROJECT**

PART - C

RFx No. 3000046202 (BTG Package)

TECHNICAL SPECIFICATION CONTROL & INSTRUMENTATION

REV. - 0

- 3.32.16 All the alarms related to failure of equipments, tripping of equipments, source of failure / reason due to which the equipment is stopped / tripped, low & high limits of parameters such as level, temperature, pressure drop, pressure etc shall be provided for each pump, fan, AWU etc. in the control system.
- 3.32.17 The fans (both supply and exhaust fans) associated with mechanical ventilation system shall be operated locally.



**KORADI THERMAL POWER STATION
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SECTION: C
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**C&I SPECIFICATION FOR
HVAC SYSTEM**

C&I DELIVERABLES LIST

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**KORADI THERMAL POWER STATION
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**C&I SPECIFICATION FOR
HVAC SYSTEM**

LIST OF VENDOR DELIVERABLES FOR C&I FOR HVAC SYSTEM

Sl.No.	DRAWING NO.	DRAWING/DOCUMENT TITLE	CATEGORY
1	PE-V4-527-553-H901	CONTROL & OPERATIONAL WRITE-UP FOR THE SYSTEM WITH SET POINTS	A
2	PE-V4-527-553-H902	CONTROL SCHEMES/LOGIC DIAGRAM (TO BE IMPLEMENTED IN DDCMIS)	A
3	PE-V4-527-553-H903	HMI PICTURES/PLANT SCHEMATICS	A
4	PE-V4-527-553-H904	INSTRUMENT SCHEDULE WITH SET POINTS	A
5	PE-V4-527-553-H905	INPUT / OUTPUT LIST (ANALOG & BINARY)	A
6	PE-V4-527-553-H906	DRIVE LIST/SOLENOID/ACTUATOR VALVE LIST WITH LOCATION DATA	A
7	PE-V4-527-553-H907	DATA SHEETS FOR LOCAL PANELS WITH OGA AND WIRING DETAILS	A
8	PE-V4-527-553-H908	DATA SHEETS INSTRUMENT, JB's etc.	A
9	PE-V4-527-553-H909	INSTRUMENT INSTALLATION/ HOOK UP DRAWINGS	A
10	PE-V4-527-553-H910	QUALITY PLANS (INSTRUMENTS, VMS, LCP etc.)	A
11	PE-V4-527-553-H911	FIELD JB/RACK TERMINATIONS /GROUPING DOCUMENT	A
12	PE-V4-527-553-H912	CABLE SCHEDULE & INTERCONNECTION	A
13	PE-V4-527-553-H913	ANNUNCIATION & SOE LIST	A
14	PE-V4-527-553-H914	LIST OF SIGNAL EXCHANGE WITH DDCMIS (BOTH HARDWIRED & SERIAL INTERFACE)	A

NOTES:

1. ANY OTHER DOCUMENT DECIDED DURING DETAILED ENGINEERING SHALL BE PROVIDED BY BIDDER WITHOUT ANY COMMERCIAL/TECHNICAL IMPLICATION.

2. CONTRACTOR TO SUBMIT REUSABLE DATABASE FORMATS IN BHEL/CUSTOMER APPROVED FORMATS LIKE MS EXCEL, MS ACCESS OF DOCUMENTS LIKE INSTRUMENT SCHEDULE, I/O LIST, DRIVE LIST, FIELD JB TERMINATIONS, CABLE SCHEDULE & INTERCONNECTION, etc. SOFT COPY OF FORMATS SHALL BE PROVIDED TO SUCCESSFUL BIDDERS.



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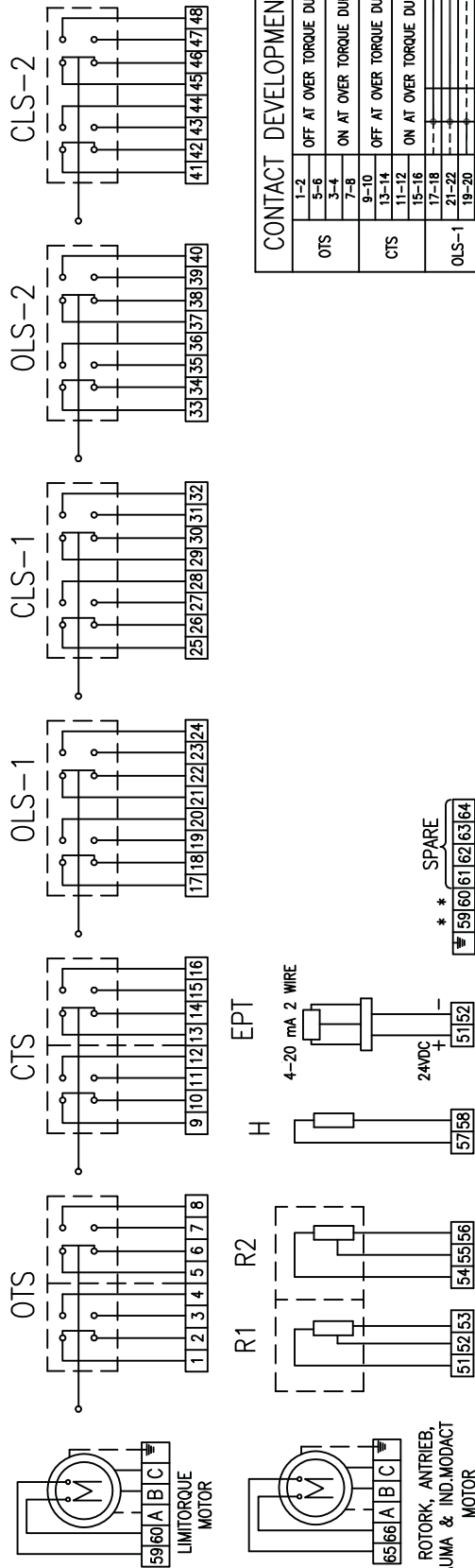
**SPECIFICATION FOR
MOTORISED VALVE ACTUATOR**

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR		SPECIFICATION NO.: PE-ID-527-145-H902	
			VOLUME II B	
			SECTION D	
			REV. NO. 00	DATE:30/07/2025
			SHEET 2	OF 6
Data Sheet A & B				
DATA SHEET-A (TO BE FILLED BY PURCHASER)			DATA SHEET-B (TO BE FILLED-UP BY BIDDER)	
GENERAL*	* PROJECT	2X660 MW KORADI TPP UNIT 11&12 - BTG		
	OFFER REFERENCE			
	* TAG NO. SERVICE			
	* DUTY	☐ ON / OFF ** ☐ INCHING		
	* LINE SIZE (inlet/outlet): MATERIAL			
	* VALVE TYPE	☐ GLOBE ☐ GATE ☐ REG. GLOBE ☐ BUTTERFLY		
	* OPENING / CLOSING TIME			
	* WORKING PRESSURE			
	AMBIENT CONDITION	SHALL BE SUITABLE FOR CONTINUOUS OPERATION UNDER AN AMBIENT TEMP. OF -20 to 70 DEG C AND RELATIVE HUMIDITY OF 0-95% IN HOT, HUMID AND TROPICAL ATMOSPHERE AND HIGHLY POLLUTED AT PLACES OF COAL DUST AND FLY DUST		
	VALVE SEAT TEST PRESS	BIDDER TO SPECIFY		
	REQUIRED VALVE TORQUE	BIDDER TO SPECIFY		
	ACTUATOR RATED TORQUE	BIDDER TO SPECIFY		
	CONSTRUCTION AND SIZING	CONSTRUCTION	TOTALLY ENCLOSED, WEATHER PROOF, DUST TIGHT SUITABLE FOR OUTDOOR USE WITHOUT CANOPY, NEMA6/IP:68	
MECHANICAL POSITION INDICATOR		TO BE PROVIDED FOR 0-100% TRAVEL		
BEARINGS		DOUBLE SHIELDED, GREASE LUBRICATED ANTI-FRICTION.		
GEAR TRAIN FOR LIMIT SWITCH/TORQUE SWITCH OPERATION		METAL (NOT FIBRE GEARS). SELF-LOCKING TO PREVENT DRIFT UNDER TORQUE SWITCH SPRING PRESSURE WHEN MOTOR IS DE-ENERGIZED.		
SIZING		OPEN/CLOSE AT RATED SPEED AGAINST DESIGNED DIFFERENTIAL PRESSURE AT 90% OF RATED VOLTAGE. FOR ISOLATING SERVICE THREE SUCCESSIVE OPEN-CLOSE OPERATIONS OR 15 MINS. WHICHEVER IS HIGHER. FOR INCHING SERVICE - 150 STARTS/HR MINIMUM & FOR REGULATING SERVICE - 600 STARTS/HR MINIMUM		
HANDWHEEL as per standard EN 12570:2000	* REQUIRED	☒ YES ☐ NO		
	* ORIENTATION	☐ TOP MOUNTED ☐ SIDE MOUNTED		
	*TO DISENGAGE AUTOMATICALLY DURING MOTOR OPERATION.			
ELECTRIC ACTUATOR	ACTUATOR MAKE/MODEL	BIDDER TO SPECIFY		
	MOTOR MAKE / MODEL / TYPE / RATING (KW) (REFER NOTE NO. 6 & 7)	BIDDER TO SPECIFY		
	@ MOTOR TYPE	SQUIRREL CAGE INDUCTION MOTOR, STARTING CURRENT LIMITED TO SIX TIMES THE RATED CURRENT-INCLUSIVE OF I.S. TOLERANCE		
	ACTUATOR APPLICABLE WIRING DIAGRAM	☒ ENCLOSED (BIDDER TO CONFIRM) A: ☐ DRG. NO. 3-V-MISC-24227 R00 B: ☐ DRG. NO. 3-V-MISC-24550 R00 C: ☐ DRG. NO. 3-V-MISC-24283 R00 D: ☒ DRG. NO. 4-V-MISC-90271 R11 E: ☐ For Thyristor based Integral starter, Bidder/Vendor to furnish wiring diagram		
	COLOUR SHADE	☐ BLUE (RAL 5012) ☒ TO BE DECIDED DURING DETAILED ENGINEERING		
	PAINT TYPE	☐ ENAMEL ☒ EPOXY CONFIRMING TO CORROSION CATEGORY C5-I		
	SHAFT RPM	BIDDER TO SPECIFY		
	OLR SET VALUE	BIDDER TO SPECIFY		
	@ STARTING / FULL LOAD CURRENT	BIDDER TO SPECIFY		
	NO. OF REV FOR FULL TRAVEL	BIDDER TO SPECIFY		
	@ PWR SUPP TO MTR / STARTER	415V, 3PH, AC		

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR		SPECIFICATION NO.: PE-ID-527-145-H902	
			VOLUME II B	
			SECTION D	
			REV. NO. 00	DATE:30/07/2025
			SHEET 3	OF 6
Data Sheet A & B				
DATA SHEET-A (TO BE FILLED BY PURCHASER)			DATA SHEET-B (TO BE FILLED-UP BY BIDDER)	
INTEGRAL STARTER	@ CONTROL VOLTAGE REQUIREMENT	TO BE DERIVED FROM THE POWER SUPPLY TO THE STARTER ☐ 230 V ☐ 110 V		
	@ ENCLOSURE CLASS OF MOTOR	☐ IP 67 ☒ IP 68 ☐ FLAME PROOF		
	@ INSULATION CLASS	CLASS-F TEMP. RISE LIMITED TO CLASS-B		
	@ WINDING TEMP PROTECTION	THERMOSTAT (3 Nos.,1 IN EACH PHASE)		
	SINGLE PHASE / WRONG PHASE SEQUENCE PROTECTION	REQUIRED (THERMISTOR PTC)		
	INTEGRAL STARTER	☐ REQUIRED ☒ NOT REQUIRED		
	TYPE OF SWITCHING DEVICE	☐ CONTACTORS ☐ THYRISTORS		
	TYPE	☐ CONVENTIONAL ☐ SMART (NON-INTRUSIVE)		
	IF SMART (REFER BELOW POINT a – h)			
	a) SERIAL LINK INTERFACE	☐ INTEGRAL ☐ FIELD MOUNTED		
	b) SERIAL LINK PROTOCOL	☐ FOUNDATION FIELD-BUS ☐ PROFI-BUS ☐ DEVICE NET ☐		
	c) SERIAL LINK MEDIA	☐ TWISTED PAIR Cu-CBL ☐ CO-AXIAL Cu-CBL ☐ OFC		
	d) HAND HELD PROGRAMMER	☐ REQUIRED ☐ NOT REQUIRED		
	e) TYPE OF HAND HELD PROGRAMMER	☐ BLUETOOTH ☐ INFRARED ☐		
	f) MASTER STATION	☐ REQUIRED ☐ NOT REQUIRED		
	g) MASTER STN INTRFACE WITH DCS	☐ MODBUS ☐ TCP/IP		
	h) DETAILS OF SPECIAL CABLE	☐ ENCLOSED ☐ NOT REQUIRED		
	STEP DOWN CONT. TRANSFORMER	☐ REQUIRED		
	OPEN / CLOSE PB	☐ REQUIRED ☐ NOT REQUIRED		
	STOP PB	☐ REQUIRED ☐ NOT REQUIRED		
INDICATING LAMPS	☐ REQUIRED ☐ NOT REQUIRED			
LOCAL REMOTE S/S	☐ REQUIRED ☐ NOT REQUIRED			
STATUS CONTACTS FOR MONITORING	☐ REQUIRED ☐ NOT REQUIRED			
INTEGRAL STARTER DISTURBED SIGNAL	☐ REQUIRED ☐ NOT REQUIRED			
ACTION ON LOSS OF EXTERNAL ELECTRIC POWER	☐ STAYPUT ☐ FAIL SAFE			
INTERPOSING RELAY/OPTO COUPLER (Applicable for integral Starter) DATASHEET & WIRING DIAGRAM OF ISOLATION DEVICE TO BE PROVIDED	TYPE OF ISOLATING DEVICE	☐ INTERPOSING RELAY ☐ OPTO COUPLER ☐ TO BE DECIDED DURING DETAILED ENGINEERING		
	QUANTITY	☐ 2 NOs. ☐ 3 NOs.		
	DRIVING VOLTAGE	☐ 20.5 – 24V DC ☐ _____ V DC		
	DRIVING CURRENT	☐ 125mA MAX ☐ _____ mA MAX		
	LOAD RESISTANCE	☐ > 192 ohms - <25 k ohms ☐ > _____ ohms - < _____ ohms		
TORQUE SWITCH (Not Applicable for Smart Actuator) (\$\$ Refer Notes)	MFR & MODEL NO.	BIDDER TO SPECIFY		
	OPEN / CLOSE	☒ 1 No. ☐ 2Nos. / ☒ 1 No. ☐ 2Nos		
	CONTACT TYPE	2 NO + 2 NC		
	RATING	5A 240V AC AND 0.5A 220V DC		
	CALIBRATED KNOBS (OPEN&CLOSE TS)	REQUIRED FOR SETTING DESIRED TORQUE		
	ACCURACY	+3% OF SET VALUE		

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR		SPECIFICATION NO.: PE-ID-527-145-H902				
			VOLUME		II B		
			SECTION		D		
			REV. NO.		00	DATE:30/07/2025	
			SHEET		4	OF	6
Data Sheet A & B							
DATA SHEET-A (TO BE FILLED BY PURCHASER)					DATA SHEET-B (TO BE FILLED-UP BY BIDDER)		
LIMIT SWITCH (Not Applicable for Smart Actuator) (\$\$ Refer Notes)	MFR & MODEL NO.	BIDDER TO SPECIFY					
	OPEN : INT : CLOSE	☐ 1 No ☒ 2 Nos.	2 Nos. (ADJ.)	☐ 1 No. ☒ 2Nos.			
	CONTACT TYPE	2 NO + 2 NC					
	RATING (AC / DC)	5A 240V AC AND 0.5A 220V DC					
	ACCURACY	2% OF SET VALUE					
POSITION TRANSMITTER	POSITION TRANSMITTER (For inching duty & other specific applications**)	☒ REQUIRED ☐ NOT REQUIRED					
	MFR & MODEL NO.	BIDDER TO SPECIFY					
	TYPE	☐ ELECTRONIC (2 WIRE) R/I CONVERTER ☒ ELECTRONIC (2 WIRE) CONTACTLESS					
	SUPPLY	☒ 24V DC ☐					
	OUTPUT	☒ 4-20mA					
	ACCURACY	± 1% FS					
SPACE HEATER	@SPACE HEATER	REQUIRED					
	@ POWER SUPPLY (NON INTEGRAL)	240V AC, 1 PH., 50 Hz					
	@ POWER SUPPLY (INTEGRAL)	BIDDER TO SPECIFY					
	@ RATING						
TERMINAL BOX	ACTUATOR/MOTOR TERMINAL BOX	REQUIRED					
	ENCL CLASS ACTUATOR/MOTOR T.B.	☒ IP 68 @ ☐					
	@ EARTHING TERMINAL	REQUIRED					
	PLUG & SOCKET	☐ REQUIRED ☒ NOT REQUIRED					
	NO. OF PINS REQUIRED (TO BE CHECKED AS PER SIGNALS IN DRIVE CONTROL PHILOSOPHY)						
	NOS. OF PLUG & SOCKET	☐ 1 Nos. for ON/OFF ☐ 2 NOS.(for inching duty) ☐ OTHER (TO BE SPECIFIED INLINE WITH DRIVE CONTROL PHILOSOPHY)					
CABLE GLANDS	@ POWER CABLE GLAND	SIZE:-----					
	@ SPACE HEATER CABLE GLAND	SIZE:-----					
	CONTROL CABLE GLANDS-1	QUANTITY & SIZE :- <u>1 no. & 4P x 0.5 sqmm. G type</u>					
	CONTROL CABLE GLANDS-2 (Additional for inching duty)	QUANTITY & SIZE : <u>1 no. & 2P x 0.5 sqmm. G type</u>					
	CONTROL CABLE GLANDS-3	QUANTITY & SIZE : <u>1 no & 5 C X 2.5 sqmm Cable</u>					
WEIGHT	TOTAL WEIGHT (ACTUATOR + ACCESSORIES)	BIDDER TO SPECIFY				_____ Kg.	

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR		SPECIFICATION NO.: PE-ID-527-145-H902	
			VOLUME II B	
			SECTION D	
			REV. NO. 00	DATE: 30/07/2025
			SHEET 5	OF 6
Data Sheet A & B				
DATA SHEET-A (TO BE FILLED BY PURCHASER)			DATA SHEET-B (TO BE FILLED-UP BY BIDDER)	
NOTES: 1. SCOPE: DESIGN, MANUFACTURE, INSPECTION, TESTING AND DELIVERY TO SITE OF ELECTRIC ACTUATOR FOR INCHING OR OPEN / CLOSE DUTY. 2. CODES & STANDARDS: DESIGN AND MATERIALS USED SHALL COMPLY WITH THE RELEVANT LATEST NATIONAL AND INTERNATIONAL STANDARD. AS A MINIMUM, THE FOLLOWING STANDARDS SHALL BE COMPLIED WITH: IS-9334, IS-2147, IS-2148, IS-325, IS-2959, IS-4691, IS-4722, IEC 60947-5-1 AND EN 15714-3 :2010 OR LATEST VERSION. 3. TEMPERATURE RISE SHALL BE RESTRICTED TO 70 DEG. C FOR AMBIENT TEMPERATURE OF 50 DEG C. 4. CABLE GLANDS OF DOUBLE COMPRESSION TYPE, BRASS MATERIAL SHALL BE PROVIDED. 5. THE TORQUE SWITCHES SHALL BE PROVIDED WITH MECHANICAL LATCHING DEVICE TO PREVENT OPERATION WHEN UNSEATING FROM THE END POSITIONS. THE LATCHING DEVICE SHALL UNLATCH AS SOON AS THE VALVE LEAVES THE END POSITION. IF SUCH PROVISION IS NOT POSSIBLE, THE TORQUE SWITCHES SHALL BE BYPASSED BY END-POSITION LIMIT SWITCHES WHICH OPENS ON VALVE LEAVING END POSITION. THESE LIMIT SWITCHES ARE ADDITIONAL TO THE NUMBER OF LIMIT SWITCHES SPECIFIED ELSEWHERE. 6. THE MOTOR SHALL BE SUITABLE FOR DIRECT ON LINE STARTING. IT SHALL BE RATED FOR S2-15 MINUTES DUTY FOR ON/OFF VALVE AND INTERMITTENT DUTY FOR INCHING DUTY. MAXIMUM CONTINUOUS MOTOR RATING SHALL BE ATLEAST 10% ABOVE THE MAXIMUM LOAD DERIVED OF THE DRIVEN EQUIPEMNT UNDER ENTIRE OPERATING RANGE INCLUDING VOLATGE AND FREQUENCY VARIATION. 7. MOTOR SHALL BE SUITABLE FOR OPERATION UNDER VOLTAGE VARIATION OF +/- 10%, FREQUENCY VARIATION OF +/- 5% AND COMBINED VOLTAGE & FREQUENCY VARIATION OF 10% ABSOLUTE. 8. THE MOTOR SHALL BE CAPABLE OF STARTING AT 85 PERCENT OF RATED VOLTAGE RUNNING AT 80 PERCENT OF RATED VOLTAGE AT RATED TORQUE AND 85 PERCENT RATED VOLTAGE AT 33 PERCENT EXCESS RATED TORQUE FOR A PERIOD OF 5 MINUTES EACH. 9. IN ADDITION TO ABOVE REQUIREMENTS FOR LIMIT/TORQUE SWITCH, MECHANICAL END STOP WITH ACCURACY OF 2% SHALL BE SUPPLIED. 10. IT SHOULD BE POSSIBLE TO OPERATE THE ACTUATOR LOCALLY. LOCKABLE LOCAL/REMOTE SELECTION SHALL BE PROVIDED ON THE MCC. 11. LOCAL POSITION INDICATOR SHALL BE PROVIDED FOR 0 TO 100 % TRAVEL. 12. CONTROL WIRING SHALL BE SUITABLE VOLTAGE GRADE COPPER WIRE 1.5 SQ. MM. 13. ENDURANCE: RATED TORQUE RANGE SHOULD BE BASED ON ISO 5211, ISO5210. 14. TAG PLATE SHALL BE CONFIRMING TO STANDARD BS-15714. 15. ACTUATOR SHALL ATTAIN FULL SPEED OPERATIONS BEFORE VALVE LOAD IS ENCOUNTERED AND IMPART AN UNSEATING BLOW TO START THE VALVE IN MOTION (HAMMER BLOW EFFECT). ** VALVES WITH 10 DEGREE/20DEGREE FEEDBACK REQUIREMENT FOR APPLICATIONS SUCH AS CW/ACW/PLANT WATER SYSTEM SHALL BE CONSIDERED AS INCHING DUTY VALVES. ACCORDINGLY, POSITION FEED BACK TRANSMITTER, PLUG & SOCKET REQUIREMENT SHALL BE CONSIDERED. \$\$ TORQUE SWITCH & LIMIT SWITCH SHALL ACT INDEPENDENT OF EACH OTHER. TANDEM OPERATION IS NOT ACCEPTABLE.				
NAME SIGNATURE DATE	PREPARED BY ANJALI RAMAN	CHECKED BY MAYANK KESHARWANI	APPROVED BY MAYANK KESHARWANI	VENDOR COMPANY SEAL NAME SIGNATURE DATE
	30.07.2025	30.07.2025	30.07.2025	
NOTES* = TO BE FILLED BY MPL (LEAD AGENCY). @ BE FILLED BY ES				



* - SPARE FOR ROTORK, AUMA, ANTRIEB & IND.MODACT

SWITCHES - ALL ARE POTENTIAL FREE AND TWO PAIR OF CONTACTS CAN BE USED FOR DIFFERENT SUPPLY THERMOSTAT - 65-66 (ROTORK, AUMA, ANTRIEB & IND.MODACT), 59-60 (LIMITORQUE).

EPT - ELECTRONIC POSITION TRANSMITTER (POTENTIOMETRIC TYPE, FOR INCHING DUTY)

THERMOSTAT TERMINALS - TERMINATED IN MOTOR TB IN ANTRIEB & IND.MODACT AND IN MAIN TB IN OTHER MAKES

CTS - TORQUE SWITCHES FOR CW ROTATION (CLOSE) - 2 NO+2 NC

OTS - TORQUE SWITCHES FOR CCW ROTATION (OPEN) - 2 NO+2 NC

OLS-1, OLS-2 - LIMITSWITCHES FOR POSITION OPEN - 2 NO+2 NC

CLS-1, CLS-2 - LIMITSWITCHES FOR POSITION CLOSE - 2 NO+2 NC

OTS, CTS - TWO INDEPENDENT SWITCHES IN ANTRIEB & LIMITORQUE

OLS-2 & CLS-2 - CAM DISC IN ROTORK & ANTRIEB

R1-R2- POTENTIOMETER 2 x 100 OHMS

H - SPACE HEATER 1 ϕ 240V AC SUPPLY

M - MOTOR 3 ϕ 415V 50 Hz AC SUPPLY

ILS-1, ILS-2 - INTERMEDIATE LIMIT SWITCH (ADJ.) - 2NO + 2NC

VALVES	OPEN		CLOSE	
	MAIN	BACK UP	MAIN	BACK UP
GATE VALVE OF 100 mm AND ABOVE IN 1500 CL AND ABOVE RATINGS	OLS	OTS	CLS	CTS
ALL OTHER GATE & GLOBE VALVES	OLS	OTS	CLS	CTS

● - CLS NOT TO BE CONNECTED IN TRIP CIRCUIT

NOTE:

1. BYPASS OTS FOR INITIAL 5% OF TRAVEL (FOR GATE VALVES ONLY)
2. CONNECT THERMOSTAT WITHOUT FAIL IN THE STARTER CIRCUIT

CONTACT DEVELOPMENT DIAGRAM										
OTS	1-2	OFF AT OVER TORQUE DURING OPENING TRAVEL								
	5-6	ON AT OVER TORQUE DURING OPENING TRAVEL								
	3-4	ON AT OVER TORQUE DURING CLOSING TRAVEL								
	7-8	ON AT OVER TORQUE DURING CLOSING TRAVEL								
CTS	9-10	OFF AT OVER TORQUE DURING OPENING TRAVEL								
	13-14	ON AT OVER TORQUE DURING OPENING TRAVEL								
	11-12	OFF AT OVER TORQUE DURING CLOSING TRAVEL								
	15-16	ON AT OVER TORQUE DURING CLOSING TRAVEL								
OLS-1	17-18	ON AT OVER TORQUE DURING OPENING TRAVEL								
	21-22	ON AT OVER TORQUE DURING OPENING TRAVEL								
	19-20	ON AT OVER TORQUE DURING CLOSING TRAVEL								
	23-24	ON AT OVER TORQUE DURING CLOSING TRAVEL								
CLS-1	25-26	ON AT OVER TORQUE DURING OPENING TRAVEL								
	29-30	ON AT OVER TORQUE DURING OPENING TRAVEL								
	27-28	ON AT OVER TORQUE DURING CLOSING TRAVEL								
	31-32	ON AT OVER TORQUE DURING CLOSING TRAVEL								
OLS-2	33-34	ON AT OVER TORQUE DURING OPENING TRAVEL								
	37-38	ON AT OVER TORQUE DURING OPENING TRAVEL								
	35-36	ON AT OVER TORQUE DURING CLOSING TRAVEL								
	39-40	ON AT OVER TORQUE DURING CLOSING TRAVEL								
CLS-2	41-42	ON AT OVER TORQUE DURING OPENING TRAVEL								
	45-46	ON AT OVER TORQUE DURING OPENING TRAVEL								
	43-44	ON AT OVER TORQUE DURING CLOSING TRAVEL								
	47-48	ON AT OVER TORQUE DURING CLOSING TRAVEL								
SWITCH	TERMINAL NO.	FULL OPEN		a		INTERMEDIATE		b		FULL CLOSE
	VALVE POSITION									
INDICATES CONTACT CLOSED										
INDICATES CONTACT OPEN										

CONTACT RATING: 5A AT 250V AC & 0.5A AT 220V DC

15.00.00 ELECTRICAL ACTUATORS – NON-INTEGRAL STARTER

15.01.00 SCOPE

15.01.01 This Specification covers the general requirements of Electric Motor Actuators for valves, dampers and gates.

15.01.02 All electric motor actuators shall be furnished in accordance with this general specification and the accompanying driven equipment specification.

15.02.00 CODES & STANDARDS

All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) / IEC as given below except where modified and/or supplemented by this specification.

Code	Name of Standard
IS: 325	Specification for three phase induction motor
IS: 900	Code of Practice for installation and maintenance of induction motors.
IS: 996	Single Phase AC Motor
IS: 1271	Thermal evaluation and classification of electrical insulation.
IS: 2223	Dimensions of flange mounted AC induction motors.
IS: 3043	Code of practice for earthing
IS: 4029	Guide for testing three phase induction motors.
IS: 4691	Degree of protection for enclosures of rotating electrical machinery.
IS: 4722	Specification for rotating electrical machinery.
IS: 4728	Terminal marking and direction of rotation for rotating electrical machinery.
IS: 4889	Methods of determination of efficiency of rotating electrical machines.
IS: 5571	Guide for selection of electrical equipment for hazardous areas.
IS: 6362	Designation of Method of Cooling of Rotating electrical machines.
IS: 8789	Values of performance characteristics for three phase induction motors.
IS: 9334	Electrical Motor Operated Actuators
IS: 12065	Noise level of motors.
IS: 12075	Measurement and evaluation of vibration of rotating electrical machines.
IS: 12615	Induction motors – Energy efficient, three-phase, squirrel cage – Specification
IS: 12802	Temperature rise measurement of rotating electrical machines.
IS: 12824	Type of duty and classes of rating assigned.
IEC: 60034-1	Rotating electrical machines
NEMA, MG-1	Motors and Generators

Equipment and material conforming to any other standard, which ensures equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be furnished during detail engineering. The electrical installation shall meet the requirements of Indian Electricity Rules as amended up to date and relevant IS Code of Practice. In addition, other rules and regulations applicable to the work shall be followed.

15.03.00 SERVICE CONDITIONS

- 15.03.01 The actuator shall be Non-integral type and suitable for operation in a hot, humid and tropical atmosphere, highly polluted at places with coal dust & fly ash and shall be suitable for an ambient temperature ranging from (-) 20 deg C to (+) 70 deg C.
- 15.03.02 Actuators for explosion-hazardous applications shall in addition be certified Flameproof for Zones 1 and 2 (Divisions 1 and 2 Group gases).

15.04.00 RATING

- 15.04.01 Supply Voltage & frequency: 415V $\pm 10\%$, 3 Phase, 3 Wire 50Hz $\pm 5\%$. It shall be equipped with 3 phase induction motor, rated for S2-15 minutes duty for ON/OFF valve and intermittent duty for inching duty.
- 15.04.02 Sizing:
- i. For Open/Close at rated speed against designed differential pressure at 90% of rated voltage.
 - ii. For isolating service: three successive open-close operations or 15 minutes, whichever is higher. For regulating service 150 starts per hour or required cycles, whichever is higher.
 - iii. Maximum continuous motor rating shall be at least 10% above the maximum load derived of the driven equipment under entire operating range including voltage & frequency variation.
- 15.04.03 Control voltage of the motor starter shall be 110V AC.

15.05.00 PERFORMANCES

- 15.05.01 The actuator shall meet the following performance requirements:
- 15.05.02 Open and close the valve completely and make leak-tight valve closure, without jamming.
- 15.05.03 Attain full speed operation before valve load is encountered and impart an unseating blow to start the valve in motion (hammer blow effect).
- 15.05.04 Operate the valve stem at standard stem speed and shall function against design differential pressure across the valve seat.
- 15.05.05 The motor reduction gearing shall be sufficient to lock the shaft when the motor is de energised and prevent drift from torque switch spring pressure.
- 15.05.06 The entire mechanism shall withstand any shock resulting from closing with improper setting of limit switches or from lodging of foreign matter under the valve seat.

15.06.00 SPECIFIC REQUIREMENT OF MOTOR OPERATED NON-INTEGRAL VALVE ACTUATORS

15.06.01 Construction

- i) The actuator shall essentially comprise the drive motor, torque/ Position limit switches, gear train, clutch, hand wheel, position indicator and transmitter, inbuilt thermostat for overload protection, space heater and internal wiring.
- ii) The actuator enclosure shall be totally enclosed, dust tight, weather proof (NEMA-6/IP-68) suitable for outdoor use without necessity of any canopy.
- iii) All electrical equipment, accessories and wiring shall be provided with tropical finish to prevent fungus growth.
- iv) The actuator shall be designed for mounting in any position without any lubricant leakage or operating difficulty.
- v) A lockable local/remote selector switch shall also be provided for selecting mode of operation.
- vi) Gear Train:-Metal (Fibre gears are not acceptable) self-locking to prevent drift under torque switch (where ever applicable) spring pressure when motor is de-energised.
- vii) Manual Wheel:- Shall disengage automatically during motor operation.
- viii) The actuators shall have MCC based starters along with over load relays. The actuator shall be designed for short time duty (S2) in accordance with IEC 34-1.
- ix) Actuators shall be non-integral type with starters located in separate MCCs/ separate Gate Valve damper control room in switchgear room/ control room.
- x) The control wiring runs from the control room to the MCC with feedback wires from the valve actuator position-indicating and torque-sensing switches. The power cables run from the MCC to the individual actuators.
- xi) The actuator with non integral starter shall be time rated for at least 15 minutes or twice the valve stroking time, whichever is higher at an average load of at least 33% of the maximum valve torque. For regulating service, the actuator with integral starter shall be suitably time rated for the duty cycle involved with necessary number of starts per hour, but in no case less than 150 starts per hour. It shall be capable of starting at 85% of rated voltage. Torque switch must trip at maximum driven equipment torque at 90% rated voltage.
- xii) Motor shall have minimum class 'F' (150 deg C) insulation with temperature rise restricted to 70 degC.
- xiii) Motor shall be suitable for operation under voltage variation of +/- 10%, frequency variation of +/- 5% and combined voltage & frequency variation of 10% absolute.
- xiv) The actuator with direct online start from module shall be complete with all accessories viz torque limit switch, end of-travel switch, adjustable position limit switch, hand-wheel etc shall be supplied.
- xv) Complete actuator shall be tested as per QA before dispatch.
- xvi) Actuator enclosures & internal wiring should be resistant to steam ingress and give maximum protection against steam leakages in surrounding area. Control & Power

Cables of actuators in the high heat zone area should be heat proof and shall be covered with Heat resistant tape for high heat zone to provide maximum protection against Steam leakages.

- xvii) Local controls with 'OPEN - STOP - CLOSE' pushbutton station. A lockable selector switch with 'LOCAL - OFF - REMOTE' function at MCC or Local. Local controls shall be supplied with indicating lights red for 'OPEN', yellow for 'FAULT' and green for 'CLOSED'.

15.06.02 Motor

- i) The squirrel cage induction motor shall be designed for full voltage direct-on-line start, with starting current limited to 6 times full-load current. The motor shall be capable of starting at 85% of rated voltage and running at 80% of rated voltage at rated torque and also at 85% of rated voltage at 33% excess rated torque for a period of 5 minutes each. The motors shall otherwise generally conform with technical specification for motors mentioned elsewhere in this specification.
- ii) The actuators shall be sized so as to open or close valves/ dampers at rated speed. Enclosure shall not be more than 70 degree 'C' over ambient temperature of 70°C as these are subjected to higher ambient conditions due to their vicinity to operate fluid on continuous load operation. The actuators shall be suitable for a relative humidity of 95%. Class of insulation shall be Class-F and type of enclosure shall be IP-65.
- iii) Motor shall be surface-cooled, designed for enclosure protection class of IP-67. Motor shall be suitable for starting direct-on-line.
 - a) Insulation: The motor winding shall be insulated with Class-F insulation having temperature rise limited to Class-B. Motor shall be of Class-H insulation with temperature limited to Class-B, used for high pressure and high temperature valves.
 - b) Performance: The motor shall be capable of –
 - Starting at 85% of rated voltage
 - Running at 80% of rated voltage at rated torque for 5 minutes
 - Running at 85% rated voltage at 33% excess rated torque for 5 minutes
- iv) Bearing: The motor bearing shall be double shielded, grease lubricated and antifriction type.
- v) Earthing
At least two earthing terminals shall be provided for the motor body. Separate earthing terminal should be provided for terminal box.
- vi) Protection: The following electrical protections should be provided for the motor:
 - a) Single Phasing Protection
 - b) Overload Protection
 - c) Overheating protection through thermostat
- vii) The actuators shall be designed to be self-locking upon loss of power. Motor shall be designed to close in 30 seconds (depending on valve size and process requirement) from full open position and shall have adequate capacity to open and close under full unbalanced design pressure.

- viii) The actuators shall be flange mounted to valve bonnets or with gearing and disengaging hand wheel for dampers.

15.06.03 Limit Switches

- i) Each motor actuator shall have six (6) rotary drum position limit switches with two for open each with 2 NO + 2 NC contacts and two for close each with 2 NO + 2 NC contacts positions, with adjustable setting between fully open and fully closed positions. Each rotary drum limit switch shall have two (2) limit switches for intermediate open position each with 2 NO + 2 NC contacts. The limit switches shall have a capacity of 5A at 240V AC or 0.5A at 220V DC.
- ii) Each motor actuator shall also have two (2) torque limit switches with two (2) normally opened and two (2) normally closed contacts each.
- iii) The torque switches shall have a minimum accuracy of 3% of set value. The torque switches shall be provided with calibrated knobs for setting desired torque and separate knobs shall be provided for open and close torque switches. The torque and position limit switches shall be housed in a separate enclosure with protection class as that of actuator. The torque switches with provision for adjusting the desired torque are must to avoid overrun and mechanical jamming of valves.
- iv) The motor operators/actuators shall be capable of meeting 150 percent of unseating torque at specified voltage.
- v) Deleted
- vi) Torque switches shall function to stop the motor on closing/opening. Upon actuation by the torque clutch it is restricted its attempt to open or close, thereby causing an overloading torque. Torque switches shall be self-resetting type only (i.e.) once a particular direction torque switch operates, it shall get resetted only when the equipment is operated in other direction.
- vii) All six (6) limit switches shall be changeover type and adjustable besides having the snap facility. All limit switches, contacts shall be wired up independently upto the terminal block.

15.06.04 Position Indicator/Transmitter

- i) Motor actuators shall be provided with clearly visible local position indicators mounted on the operator assembly itself. Suitable transducers shall be provided for remote indication of the position.
- ii) To be provided for 0 to 100% travel.
- iii) As required. Suitable for stabilized 4–20 mA signal, 2-wire inductive type, 24 volts DC operated.

15.06.05 Hand Wheel

Each actuator shall have a hand wheel fitted on it for emergency operation. The hand wheel shall be designed such that it is declutched automatically when the power supply to the motor is restored. The material of the hand wheel shall be either malleable iron or steel. The hand wheel shall have adequate clearance from housing for each gripping and operation. Actuators offered shall be with self-locking worm.

15.06.06 Space Heater

Provision of space heater, if necessary, shall also be made with servomotor limit switch compartments. The space heaters shall be suitable for operation at 240V AC and its rating shall be indicated by the tenderer. Space heater circuit shall be complete with thermostat.

15.06.07 Terminal Box

- i) The terminals, terminal boards, terminal boxes, winding coils, and associated equipments shall be suitable for connection to supply system having short-circuit capacity specified in the data sheet and clearance time determined by associated fuses. The terminal boxes shall be totally enclosed.
- ii) 1100V grade for power cables.

15.06.08 Wiring

- i) All wiring connections for various limit and torque switches, space heaters, position transmitters shall be brought out on separate terminal boards, having liberal space for wiring and making connections to Purchaser's external circuits. Plug-in type terminals shall be used suitable for analog/digital application. There shall be at least 5 terminal spare to terminate spare cores of cable. Size of each control terminal shall be such that two (2) nos. lugged 2.5 sq.mm cable can be terminated on each side. Power terminals shall be suitable for termination of 6 sq.mm lugged wire or as required depending on the motor capacity.
- ii) Motor terminal box and actuator terminal box shall be provided with double compression cable glands to suit cable type and size and copper lugs for cables.
- iii) Adequate earthing terminals preferably not less than 8 SWG GI wire shall be provided for suitable earthing system. Two earthing terminals shall be provided per motor, one No. on either side of the motor.

15.06.09 Interfaces:

- i) Open/Close command termination logic with position & torque Limit Switches, positioner circuit shall be suitably built in the PCB inside the power supply feeder or separate GVDC (Gate valve damper control room) panel shall be considered for all motor operated valves.
- ii) For Binary Drive (both ON-OFF and INCHING type):- Open/Close command & status thereof and disturbance monitoring signal (common contact for Overload, Thermostat, control supply failure, L/R selector switch at local & other protections operated) shall be provided.
- iii) Interface with the control system shall be through hardware signal only. Inter posing relays provided (with coil burden 2.5 VA) in the power supply feeder or separate GVDC (Gate valve damper control room) panel shall be energized to initiate opening and closing, by 24V DC signal from the external control system
- iv) For Modulating Drive:- the command to actuator shall be in form of 4- 20mA signal. The necessary positioning circuit and motor protection shall be provided.

- v) Open/close command termination logic shall be suitably built inside power supply feeder or separate GVDC (Gate valve damper control room) panel.
- vi) The following individual fault annunciation LED's (Colour-Red) shall be provided in power supply feeder or separate GVDC (Gate valve damper control room) panel locally.
 - a) Torque switch OPEN
 - b) Torque switch CLOSE
 - c) Thermo switch trip
 - d) Electronic overload relay trip
 - e) Motor single phasing
 - f) Common fault (Inclusive of any one or combination of above fault)
- vii) View port shall be provided on starter to monitor the above status annunciation and fault annunciation.
- viii) Electronic Overload relay shall be provided to trip actuator in case of overload.
- ix) OPEN-CLOSE indication /LED shall be provided for indication of full open/close position.
- x) Automatic phase correction facility and potential free contact for annunciation of power failure shall be provided.
- xi) The following individual potential free relay contacts shall be provided in the power supply feeder or separate GVDC (Gate valve damper control room) panel for remote annunciation to facilitate continuous monitoring of the actuator.
 - a) Actuator (valve) running in OPEN direction.
 - b) Actuator (valve) running in CLOSE direction.
 - c) Actuator in remote mode.
 - d) Actuator in local mode.
 - e) Actuator power switched off /single phasing.
 - f) Torque switch trip, thermo switch trip and overload relay trip

15.06.10 Name Plate

Name plate shall be provided on the actuators with at least following data (a) Tag no. (b) Torque Rating (c) Full travel time.

15.06.11 Painting

The actuator shall be painted with epoxy-based paint (the colour shall be indicated by the supplier). Paint shade shall be as mentioned in General technical requirement.

15.06.12 Packing

The actuators shall be properly packed for transport by rail/ road/sea as applicable.

15.06.13 Overload Protection

The actuator motor shall be provided with thermostat for overload protection.

15.06.14 Tests

- i) The actuator and all components thereof shall be subject to routine factory tests as per relevant IS Standards. In addition, if any special test is called for in equipment specification, the same shall be performed.
- ii) Following routine test shall be conducted as per IEC/IC standard. (a) Meggar Test, (b) Continuity test, (c) Operational test. Test certificates duly signed by inspecting agency shall be furnished.
- iii) The actuator shall be type tested as per IEC/National Standard, by international/national recognized test house. The test certificates issued by this house shall be furnished.
- iv) Test Witness
Tests shall be performed in the presence of Purchaser/Purchaser's representative so desired by the Purchaser/ Purchaser. The Bidder shall give at least fifteen (15) days advance notice of the date when the tests are to be carried out.

15.06.15 Drawing and Manuals

Following drawings/ data and Manuals to be submitted for approval: -

- i) Instruction manuals on Installation, tests
- ii) Actuator Data sheet.
- iii) Internal wiring diagram and control schematic.
- iv) Torque switch and Limit switch contact development.
- v) QAP for Test reports.
- vi) Manufacturers Catalogue
- vii) Instruction manuals on installation methods, tests etc.



**KORADI THERMAL POWER STATION
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SECTION: C
SUB SECTION : C&I

**C&I SPECIFICATION FOR
HVAC SYSTEM**

**SPECIFICATION FOR FIELD INSTRUMENTS &
CONTROL PANEL**



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.



- 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.

7.01.13 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 choking 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.

7.01.19 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 ₂ O column / Kg/cm ²
3.	Draught	:	mm of H ₂ O column
4.	Vacuum	:	Kg/cm ² (abs)/mm of Hg column
5.	Temperature	:	Degree Celsius (°C)
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



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 including 70 Kg/cm ² ± 0.25% of calibrated span for six months for Ranges more than 70 Kg/cm ²
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



		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 $\pm$ 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.



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7.05.02 Resistance Temperature Detector (RTD)

Sl. No.	Features	Essential / Minimum Requirements
1	Type	Platinum (Duplex), Ungrounded.
2	Resistance	100 ohm at 0 °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.



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 Thermowell (b) Compression fittings / unions. (c) Flanges etc. (for flanged connections only) (d) Forged / barstock Thermowell as per ASME PTC code. Process connection 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.

7.05.04 Thermowells

- Shall be one-piece solid bored type of 316 SS of step-less tapered design. (As per ASME PTC 19.3, 1974)
- For Mill classifier outlet long life solid sintered tungsten carbide material of high abrasion resistance shall be provided.
- 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).
- For furnace zone, impervious ceramic protecting tube of suitable material along with Incoloy supporting tubes and adjustable flanges.



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 and solid-bearing or slurry type process fluids.
		d) Gauge saver wherever required
		e) 3-Way stainless steel Gauge valve for pressure gauges. Process connection 1/2" NPT.
		f) 5-valve SS316 manifold constructed from bar stock for differential pressure gauge. Process



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		connection ½" NPT.
		g) Union, nut & tail piece and other Installation accessories as required.
16	Applicable standard	: IS-3624 / 1996
17	Electrical Contracting	: 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 rigid stem type
2	Sensing Element 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 by steel armour.
2	Glass	: Toughened borosilicate
3	Body material	: forged Carbon steel / stainless steel as per process requirements/ flanged connection
4	End connection	: As per ASME PTC and drain /vent valve 15NB
5	Accuracy	: $\pm 2\%$
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 drain and 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 Pressure Test	: 1.5 times maximum working pressure



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

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 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


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 connection	:	1/2" NPT (F) / Flanged
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

2	Probe		b) Rope type probes may be used only where required probe 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 gasket conforming 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 $\pm 10\%$, 50Hz / 24V DC $\pm 10\%$,
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	:	1/2" NPT with brass cable gland
13	Accessories	:	Counter flange, cable gland, prefab cable and stainless steel 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.

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
C.	Repeatability	:	100%
	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 pipe Root valve type Root valve material Root valve size	Same as main pipe Globe 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



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	$\pm 2\%$ 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.



- 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 digital Hand 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 : $\pm 1\%$
- xiv. Electrical connection : Plug and socket
- xv. Accessories : All mounting hardware required like



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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TECHNICAL SPECIFICATION CONTROL & INSTRUMENTATION

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01	Type	Microprocessor based Smart, HART protocol compatible
02	Stages of operation	Continuous
03	Material -	
	i) Displacer	AISI 316 SS
	ii) Suspension wire	AISI 316 SS
	iii) Torque tube housing	Carbon steel or SS as per application
	iv) Torque tube	Inconel
	v) Displacer chamber	CS or SS as per process application
	vi) Transmitter Housing	Die cast aluminum or better
04	Operating Voltage	16-48 Volts D.C.
05	Transmission	2-wire
06	Output Signal	Superimposed digital signal over 4-20 mA DC
07	Signal processing	Solid-state electronic circuitry
08	Static / overload pressure	Maximum static pressure without permanent deformation or loss of accuracy
09	Turn-down ratio	10 : 1 or better
10	Zero & Span	Easily accessible (local zero & span adjustment and non-interactive type)
11	Enclosure	Weather proof as per IP-65 with durable corrosion resistant epoxy coating
12	Output Indicator	LCD type
13	Nameplate	Tag number and Service engraved in stainless steel tag plate
14	Ambient Temperature	0 - 50 deg.C
15	Load Impedance	600 Ohms at 24 Volts DC (minimum)
16	Process Connection	2" Companion flange with nuts, bolts and gaskets
17	Performance	
	Accuracy	+ 0.5 % of span or better
18	Stability	a) +/- 0.1% of calibrated span for 5 year for ranges upto and including 70 Kg/cm ² b) +/- 0.25% of calibrated span for 5 years for ranges more than 70 kg/cm ² (g)
18	Accessories	a) Counter Flange, nuts, bolts, gaskets etc.
		b) Weights for 5 point calibration of instruments
		c) Vent and drain valves and plugs
		d) Special calibration tool/ configurator, if any
		e) ½"NPT cable gland
19	Preferred Features	a) Test plug connection and cutout terminals physically separated from other electronics
		b) Electronic Damping facility (adjustable)



7.09.02 ULTRASONIC TYPE LEVEL TRANSMITTERS:

Sl. No.	Features	Essential / Minimum Requirements
1.	Principle	Detection of reflected ultrasonic pulse
2.	Application	As per process requirement
3.	Type of Transmitter	Non-contact Microprocessor based 2 wire type, HART protocol compatible Ultrasonic transmitter
4.	Output signal	Galvanically isolated 4-20 mA DC (Analogue) along with superimposed digital signal (based on HART protocol)
5.	Sensor Accuracy	+/- 0.1% of calibrated span
6.	Sensor Repeatability	3 mm or better
7.	Power supply	24 V DC +/- 10%
8.	Status	For power, Hi / Lo / V. Hi / V. Lo - level indication, fault etc.
9.	Temperature compensation	To be provided within transducer
10.	Configuration	Sensor unit and Electronic units are to be separate. It shall be possible to mount the Electronic unit at a remote accessible location from the transducer. All cables and weather proof fittings to interconnect transducer to electronic unit shall be provided by Bidder
11.	Housing	Weather proof as per IP-65 with durable corrosion resistant coating.
12.	Calibration	Through HART Communicator.
13.	Zero and Span adjustment	Continuous, tamper proof, remote as well as manual adjustability from instrument. It shall be possible to calibrate the instrument without any level in the tank/sump etc
14.	Sensor Material	Corrosion resistant material to suit individual application requirement.
15.	False signal tolerance	Transmitter shall be capable of ignoring false echoes from internal tank/sumps obstructions such as pipes, heating coils or agitator blades. Also transmitter shall have adjustable damping circuitry
16.	Range	Range of transmitter shall be capable of covering the complete level span of tank taking care of blocking distance, frequency attenuation due to surface, obstructions etc

Sl. No.	Features	Essential / Minimum Requirements
17.	Display	Minimum 4-character LCD display with integral keypad, access protected by user code
18.	Diagnostics	On line, Loss of echo alarm etc
19.	Load Impedance	500 ohms minimum
20.	Electrical Connection	Plug and socket
22.	Accessories	- All weather canopy for protection from direct sunlight and direct rain. - All mounting hardware and accessories required for erection and commissioning mounting fittings material shall be SS 316. - For hazardous areas, explosion proof enclosure as described in NEC article 500.
23.	Mounting	2" flanged for sensor and Transmitter on panel / surface
24.	Humidity	1% to 95% non-condensing
25.	Output contacts	2SPDT Potential free changeover contacts @ 5A 230v AC

Note:

- Contractor can also provide Radar type transmitter in place of ultrasonic transmitters subject to approval by Owner during detailed Engineering.
- Four wire type transmitters can also be provided for applications where 2-wire transmitter has some technical limitations, subject to Owner's approval during detailed engineering stage. However, in such cases isolated 4-20 mA DC (analogue) output shall be provided. Power supply required for such transmitters shall be 240V/AC UPS/ 24V DC.
- For applications where transmitter location is not accessible, the transmitter shall have separate sensor unit and electronic unit for such applications. It shall be possible to mount the electronic unit at accessible location.

7.09.03 GUIDED WAVE RADAR TYPE LEVEL TRANSMITTER

Sl. No.	Feature	Requirement
1.	Type	Microprocessor based 2 wire types, HART protocol compatible Guided wave radar transmitter.
2.	Principle	TDR (Time domain reflectometry)
3.	Application	Ash / Coal / Lime/ As per process requirement
4.	Probe Type & Material	Coaxial probe of SS316/316L. If required, probeshall be suitable for over fill prevention.
5.	Output signal	4-20 mA DC along with superimposed digitalsignal (based on HART protocol), suitable for over fill prevention.



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Sl. No.	Feature	Requirement
6.	Accuracy	+/- 0.5% of calibrated span or minimum 5mm.
7.	Power supply	24 VDC+/-10%.
8.	Housing	Weather proof as per IP-65, metallic housing with durable corrosion resistance coating.
9.	Adjustment/ calibration	Using hand held HART calibrator / centralized PC based system (as applicable).
10.	Zero & span adjustment	Continuous, temper proof, remote as well as manual adjustability from instrument. It should be possible to calibrate the instrument without any level in the tank/sump etc.
11.	Display	Integral digital display.
12.	Load Impedance	500 ohms (minimum).
13.	Electromagnetic compatibility	Shall meet EN61326-1(1997) and Amdt A1, classA equipment / EN 50081-2 & EN50082-2
14.	Mounting	External cage shall be provided where ever side mounting is required. External cage and other mounting accessories to be provided by the contractor. Where ever top mounting is required, all mounting accessories, stilling well (as required) etc., shall be provided by the contractor. All weather canopy shall be provided for protection from direct sunlight and direct rain for open locations.
Note: Four wire type transmitters can also be provided for applications where 2- wire transmitter has some technical limitations, subject to Owner's approval during detailed engineering stage. However, in such cases isolated 4-20 mA DC (analogue) output shall be provided. Power supply required for such transmitters shall be 240V AC UPS/ 24V DC.		



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7.14.28 CO₂ Analyser

(a)	Principle	:	IR Type With Gas Filter Correlation
(b)	Range	:	0-10,000 ppm
(c)	Minimum Detectable Limits	:	0.04 ppm
(d)	Zero Drift (24 Hr. Basis)	:	< 0.1 ppm Per Day
(e)	Span Drift (24 Hr. Basis)	:	+/- 1 % Per day
(f)	Response Time	:	60 Seconds
(g)	Accuracy	:	+/- 0.1 ppm
(h)	Linearity	:	+/- 1% of Full Scale Reading
(i)	Operating Temperature	:	5-45 ° C



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(j)	Signal Output	:	4-20 mA DC/RS 232 Or RS 485 Link
(k)	Power Supply	:	240 V AC (UPS)
(l)	Mounting	:	Rack Mounted

Humidity & Temperature Sensor with LCD display for AC Plant in respective building.

Humidity Sensor		
Measurement range	:	0-100%r.h.
Range of use	:	0-100%r.h.
Measurement accuracy at 23° C 0-100% r.h.	:	±2%
Temperature dependency	:	≤0.05% r.h./ ° C
Output signal, linear (terminal I1)	:	DC4-20mA = 0-100%r.h.
Temperature Sensor		
Range of use	:	0-50° C & -35 to 35° C
Sensing element	:	Pt1000 class A
Measurement accuracy at 15-35° C	:	±0.5K
Output signal, linear (terminal I2)	:	DC4-20mA = 0-50° C & -35 to 35° C
General Sensor Data		
Power supply		
Operating voltage	:	AC 24V ±20%
Degree of Protection & Safety Class		
Degree of protection of housing		
With enclosed cable gland	:	IP 65 to IEC 529
Safety class	:	III to EN 60 730

Environmental Condition		
Temperature (housing with electronics)	:	-40 to 70° C
Humidity	:	5 to 95% r.h. (non condensing)
Location	:	In each AHU room, return air line and each Control room, cubicle room, meeting room, training room, & conference room etc.

Electronic Flowmeter

The electronic flow meter shall include flow sensor and flow indicator cum integrator / totalizer and shall include all required accessories for satisfactory operation. The flow meter shall be based on full bore electromagnetic principle and shall be electronic type of proven design, make and model acceptable to the owner.

The Bidder shall submit all necessary technical literature and details of selection criteria of the instrument offered to substantiate the model selected. The Bidder shall also furnish list of similar installation along with feedback on satisfactory performance of the instruments.

The flow meter shall meet or exceed the following requirement:

- (a) Output : 4-20 mA DC Isolated output
- (b) Accuracy : $\pm 0.5\%$ of calibrated span or better *
- (c) Repeatability : $\pm 0.2\%$ of calibrated span or better
- (d) Power Supply : 240V AC $\pm 10\%$, 50 HZ $\pm 5\%$ / 24 V DC, to be arranged by the contractor.
- (f) Protection class : IP-65
- (e) Flow tube SS304
- (f) liner Hard Rubber

The flow meter shall provide local indication for instantaneous flow. It should also be possible to get local display for daily and monthly discharge. The flow meter shall indicate totalizer/ integrator to get the daily and monthly discharge as stated above.



9.00.00 CONTROL VALVE ACTUATORS AND DAMPERS

9.01.00 GENERAL REQUIREMENTS

9.01.01 The control valves and accessories equipment furnished by the Bidder shall be designed, constructed and tested in accordance with the latest applicable requirements of code for pressure piping ANSI B 31.1, the ASME Boiler & pressure vessel code, Indian Boiler Regulation (IBR), ISA, and other standards specified elsewhere as well as in accordance with all applicable requirements of the "Federal Occupational Safety and Health Standards, USA" or acceptable equal standards

9.01.02 All the control valves and accessories offered by the Bidder, shall be from reputed, experienced manufacturers of specified type and range of valves.

9.02.00 CONTROL VALVE SIZING & CONSTRUCTION

9.02.01 The design of all valve bodies shall meet the specification requirements and shall conform to the requirements of ANSI (USA) for dimensions, material thickness and material specification for their respective pressure classes.

9.02.02 The valve sizing shall be suitable for obtaining normal flow conditions with valve opening at approximately 80% of total valve stem travel and minimum flow conditions with valve stem travel not less than 10% of total valve stem travel. All the valves shall be capable of handling at least 120% of the required normal flow. Further, the valve stem travel range from minimum flow condition to maximum flow condition shall not be less than 50% of the total valve stem travel. The sizing shall be in accordance with the latest edition of ISA handbook on control valves. While deciding the size of valves, Bidder shall ensure that valves outlet velocity does not exceed 7 m/sec for liquid services, $MAC No. > 1/3$ for steam. Bidder shall furnish the sizing calculations clearly indicating the outlet velocity achieved with the valve size selected by him as well as noise calculations, which will be subject to Owner's approval during detailed engineering.

9.02.03 Control valves for steam and water applications shall be designed to prevent cavitation, wire drawing, flashing on the downstream side of valve and downstream piping. Thus for cavitation/ flashing service, only valve with anticavitation trim shall be provided. Detailed calculations to establish whether cavitation will occur or not for any given application shall be furnished. For flashing services, valve with hardened trim shall be provided.

9.02.04 Control valves for application such as SH Spray Control, RH spray Control, Heavy Oil Heating, pressurizing and Control system, HP/LP heater



Emergency level control, Emergency Make-up to condenser hotwell, GSC minimum flow, Deaerator Drain to Condenser Hotwell, Condensate spill to condensate reserve tank, condenser normal makeup and valve gland sealing supplying pressure control, CEPS minimum flow control, BFP circulation control valve shall have permissible leakage rate as per leakage Class V. All other control valves shall have leakage rate as per leakage Class-IV as per ANSI / FCI /70.2,2006 or equivalent.

9.02.05 The control valve induced noise shall be limited to 85 dBA at 1 meter from the valve surface under actual operating conditions. The noise abatement shall be achieved by valve body and trim design and not by use of silencers except for few cases as per contractor's standard and proven practice subject to employer's approval.

9.02.06 Control valves for steam and water application shall be provided with rangability of 30:1 for all services except for applications wherein control valves are envisaged to be operated in lower range like Reheater spray and superheater spray system wherein control valve with rangability of 50:1 shall be provided

9.03.00 VALVE CONSTRUCTION

9.03.01 All valves shall be of globe body design & straightaway pattern with single or double port, unless otherwise specified or recommended by the manufacturer to be of angle body type. Rotary valve may alternatively be offered when pressure and pressure drops permit.

9.03.02 Valves with high lift cage guided plugs & quick-change trims shall be supplied.

9.03.03 Cast Iron valves are not acceptable.

9.03.04 Bonnet joints for all control valves shall be of the flanged and bolted type or other construction acceptable to the Owner. Bonnet joints of the internal threaded or union type will not be acceptable.

9.03.05 Plug shall be of one-piece construction cast, forged or machined from solid bar stock. Plug shall be screwed and pinned to valve stems or shall be integral with the valve stems.

9.03.06 All valves connected to vacuum on downstream side shall be provided with packing suitable for vacuum applications (e.g. double vee type chevron packing)

9.03.07 Valve characteristic shall match with the process characteristics. Trim materials shall be as per Control valve manufacturer's standard.

9.03.08 Flanged valves shall be rated at no less than ANSI press class of 150 lbs.



9.04.00

VALVE MATERIALS

Sl. No.	Service	Body Material
1.	Non-corrosive, non-flashing and non-cavitation service	Carbon steel ASTM-A216 Gr.WCB for fluid temperature below 2750C Alloy steel ASTM- A217Gr. WC6 for fluid temperature above 275deg C
2.	Severe flashing/ cavitation services	AlloysteelASTM-A217 Gr.WC9
3.	Low flashing/ cavitation service	Alloy steel ASTM-A217 Gr.WC6
4.	Condensate, DM water service	A351CF8M

Note: Valve body rating shall meet the process pressure and temperature requirement as per ANSI B16.34.

However, Bidder may offer valves with body and trim materials better than specified materials and in such cases Bidder shall furnish the comparison of properties including cavitation resistance, hardness, tensile strength, strain energy, corrosion resistance and erosion resistance etc. of the offered material vis-a-vis the specified material for Owner's consideration and approval.

9.05.00

END PREPARATION

9.05.01

Valve body ends shall be either butt welded/socket welded, flanged (Rubber lined for condensate service) or screwed as finalized during detailed engineering and as per Owner's approval. The welded ends wherever required shall be butt welded type as per ANSI B 16.25 for control valves of sizes 65 mm and above. For valves size 50 mm and below welded ends shall be socket welded as per ANSI B 16.11. Flanged ends wherever required shall be of ANSI pressure-temperature class equal to or greater than that of the control valve body.

9.06.00

VALVE ACTUATORS

9.06.01

The Bidder shall be responsible for proper selection and sizing of valve actuators in accordance with the pressure drop and maximum shut off pressure and leakage class requirements. The valve actuators shall be capable of operating at 600C continuously.

9.06.02

Valve actuators and stems shall be adequate to handle the unbalanced forces occurring under the specified flow conditions or the maximum differential pressure specified. An adequate allowance for stem force, at least 0.15 Kg/sq.cm. Per linear millimetre of seating surface, shall be provided in the selection of the actuator to ensure tight seating unless otherwise specified. The travel time of the pneumatic actuators shall not exceed 10 seconds.



9.07.00 CONTROL VALVE ACCESSORY DEVICES

- 9.07.01 All pneumatically actuated control valve accessories such as air locks, hand wheels, limit switches, microprocessor based smart electronic positioners, E/P Converters, diffusers, external volume chambers, position transmitters (capacitance or resistance type only), tubing and air sets, solenoid valves shall be provided as per the requirements.
- 9.07.02 The microprocessor based smart electronic positioners shall have the following features:
- 9.07.03 It shall accept 4-20 mA signal from the control system as input and provide a compatible signal for driving the pneumatic actuator.
- 9.07.04 In addition to electrical to pneumatic signal conversion & positioning functions, it shall also perform detailed diagnostics & make available the actuator/control valve faults via a HART interface. The HART signal for the detailed faults shall be superimposed on the 4-20 mA control signal itself. The faults to be covered shall include valve jamming, air supply failure, leakage etc.
- 9.07.05 The Positioner shall have provision of 4-20mA position feedback output to the control system.
- 9.07.06 Positioner shall have facility of characterization of the valve (i.e. equal percentage, quick opening, linear, etc.).
- 9.07.07 The Positioner shall have facility of detection of control signal failure & making the valve either stay put/open/close as per process requirement upon this condition.
- 9.07.08 In Vibration prone areas, positioners shall be located away from the control valve/damper. I/P converters and associated accessories shall be furnished.

9.09.00 AIR SUPPLY

- 9.09.01 Input signal: 4-20mA DC (as required by the design of control system), Output signal: 0.2 to 1.0 kg/cm sq., Linearity: 0.5% of span or better, Hysteresis: 0.1% of span or better, Ambient temp. Effect: less than 0.02% of span per deg C between -20 to +60 deg C. Mounting: Close to actuator (but not on the actuator), output capacity to suit the actuator, protection class IP-55, along with o/p signal Pressure gauge (0-1.6 Kg/cm², 2 1/2 "dial).
- 9.09.02 On loss of control signal, the last set point pressure shall be maintained so that the associated control valve remains in stay put position without using any solenoid valve. The allowable drift rate will be $\pm 2\%$ of set point/hour maximum.
- 9.09.03 On loss of Air supply, the last set point pressure shall be maintained so that the associated control valve remains in stay put position.


9.17.00
CONTROL DAMPER DRIVES

REV. - 0

9.17.01

Pneumatic and motor actuator type, located in flue gas/air area with damper shaft bearings mounted externally. Bearings are grease lubricated. Blades (SS) shall be linked together. Accessories like position transmitters (2 wires) with 4-20mA DC output. Position indicator, position locks, limit/torque switches, etc. shall be supplied. Positioners with all required accessories, required for the positioning of control damper drives shall be provided. Spare cams for accommodating any change in characteristic to achieve better process control during commissioning shall be supplied as required.

9.18.00
AIR FILTER REGULATOR

- i) Filter Element : Sintered Bronze
- ii) Filter Size : 5 microns
- iii) Input Air : 10.0 Kg/Sq. cm (maximum)
Output : Adjustable from 0-2.0 Kg / Sq. cm or 0-7.0 Kg / Sq. cm (continuous) as applicable.
- iv) Effect of Supply : Maximum 0.02 Kg/Sq. cm for a change pressure variation in supply pressure of 4 Kg/Sq. cm
- v) Bowl Material : Metallic.
- vi) Accessories : 2" dial size output pressure gauge
- vii) Feature : No perceptible drop of pressure on opening the drain port.

9.19.00
SOLENOID VALVE

- i) Operating Principle : Electromagnetic (noiseless)
- ii) Coil voltage rating : 24V DC /48V DC (in general) other 220V DC/ 240V AC /110V AC as required
- iii) Ways : 3 ways in general other depending on requirement
- iv) Port size : 1/4" NPT all ports
- v) Body : SS Bar Stock
- vi) Trim : AISI SS-316
- vii) Manual Operator : In built
- viii) Duty : Suitable for continuous energization
- ix) Sealing : Airtight and leak proof
- x) Ambient Temperature : 0 - 50OC
- xi) Fluid Temperature : 0-150OC (approx.)
- xii) Coil Enclosure : Stainless Steel
- xiii) Insulation : Class-H
- xiv) Coil Casing : IP-65 (Explosion proof for NEC Class-1, Division-1 area)
- xv) Mounting : On pipe or on panel
- xvi) Cable Connection : 1/2" NPT cable gland
- xvii) Accessories : Mounting brackets, nuts and bolts
- xviii) Special feature : (i) LED indication



(ii) Double coil type for open & close operation of valve / damper.

9.20.00 TEST AND EXAMINATION

9.20.01 All valves shall be tested in accordance with the quality assurance programme agreed between the Owner and Bidder, which shall meet the requirements of IBR and other applicable codes mentioned elsewhere in the specifications. The tests shall include but not be limited to the following:

9.20.02 Non Destructive Test as per ANSI B-16.34.

9.20.03 Hydrostatic shell test in accordance with ANSI B 16.34 prior to seat leakage test. Valve closure test and seat leakage test in accordance with ANSI-B 16.34/ FCI 70.2 and as per the leakage class indicated above.

9.20.04 Functional Test: The fully assembled valves including actuators control devices and accessories shall be functionally tested to demonstrate times from open to close position.

9.20.05 CV Test: CV test shall be carried out as type test on each size, type and design of the valves as per ISA 75.02 standard and test report shall be furnished for Owner's approval.

9.21.00 CONTROL VALVE QUANTITIES

9.21.01 Bidder shall furnish all the control valves under this main plant package corresponding mechanical sections and as finalized during detailed engineering stage.



10.00.00 CONTROL AND INSTRUMENTATION FOR PLANT AUXILIARY SYSTEMS

10.01.00 GENERAL REQUIREMENTS

10.01.01 Contractor shall provide complete Control and Instrumentation system with all accessories, auxiliaries and associated equipment's and cables for the safe, efficient and reliable operation of the plant auxiliary systems.

10.01.02 For certain systems where PLC is integrally mounted on the equipment, Contractor's standard and proven practice shall also be taken into consideration. This shall be finalized during detailed engineering.

10.01.04 Transmitters and electro-pneumatic positioner shall be SMART type. Each SMART equipment shall communicate in the form of analog signal 4-20 mA DC with superimposed digital signal having proven HART protocol to facilitate configuration, zero adjustment, calibration and diagnostic from remote location. All microprocessor based transmitters shall have the same type of protocol.

10.01.05 Power supply for Transmitters, contact interrogation, interposing relay and solenoid shall generally be ungrounded 24V D.C. Power supplies for interrogation, relay and solenoid shall be provided from bulk power supply modules separate from control rack power supplies. In all cases, redundancy in power modules shall be considered.

10.01.06 Complete all necessary instruments and devices, which are needed for the completeness of the plant auxiliary system/equipment, shall be supplied.

10.01.07 Final control device for regulating control shall have pneumatic actuator. Actuators for isolating and inching duty dampers and valves shall be, in general, electrical motor operated.

10.01.08 Electronics located outside control room areas shall be tropicalized and enclosed in dust & weather proof cabinets suitable for the environment.

10.01.09 The instruments and control equipment shall be logically grouped in electronic cabinets in functional order for convenient fault location, troubleshooting and maintenance.

10.01.10 On-line automatic periodic testing, self-checking & diagnostic facility shall be provided with fault indication for easy identification of the faulty module. The system shall continuously check health of the component elements including the stand-by ones and shall permit carrying out of the on-line checks while



maintaining safe condition of the plant without endangering the safety of equipment and without influencing the process being controlled.

- 10.01.11 Failure of equipment used for alarm & trip purposes shall initiate alarm.
- 10.01.12 Automatic un-administered switchover to standby equipment (such as fan /blower/pump) is foreseen in case of either running equipment is not adequate to maintain the desired process condition or due to tripping of running equipment.
- 10.01.13 End positions of manually operated suction valves of critical pumps and all other manual operated critical isolation valves shall be monitored & interlocked.
- 10.01.14 In case of HT motors, winding temperature for each stator winding and bearing temperature of motors & driven equipment shall be monitored for abnormal rise.
- 10.01.16 All Drives shall have its local control station comprising of start and emergency stop pushbutton and with a local & remote selection switch in SWGR/MCC (Refer electrical volume of the specification). Local stop pushbutton shall always be active. During the trial run of drives from local, safety permit and protection shall be ensured.
- 10.01.18 Instruments and control equipment shall be guaranteed to meet the performance, functional and accuracy requirements enumerated in the specification. All field wiring should be through conduits. All fittings, cable glands etc. shall be strictly as per NEC recommendation article, 500 to 503.
- 10.01.19 Any predictable or planned deterioration and/or obsolescence of equipment shall be clearly brought out in the Bid.
- 10.01.20 The control system shall be designed to prevent abnormal swings due to loss of control power, instrument air, failure of any system component, open/short circuits or any other such failure or degradation in the system and shall drive the plant and equipment to fail safe condition.
- 10.01.21 Mean Time between Failure (MTBF) of the instruments shall be considerably higher than the equipment they shall cater to in order to avoid shutdown on



account of instrumentation failure. All instruments and control equipment shall ensure high reliability, low downtime and ease of maintenance. All modulating devices shall be in fail-safe condition during any failures.

- 10.01.22 Bidder shall introduce redundant control equipment or instruments wherever it is felt that the introduction of the same may lead to reduction of downtime of plant and equipment, in addition to the cases clearly identified in the specification.
- 10.01.23 In cases where continuous monitoring of performance of equipment is envisaged, Bidder shall supply instruments of suitable accuracy class to meet the accuracy requirements of the calculation as per ASME standard.
- 10.01.24 For data lines, communication lines, Ethernet/Can networks/LAN, Coaxial lines, plant communication system, modular surge protection device should be used as per IEC standard.
- 10.01.25 All electronic cards/modules shall also be protected from failure against accidental/inadvertent application and these modules may be designed to operate at lower voltage levels such as 24V/48V.
- 10.01.26 Protective systems and their safety features shall be guaranteed to ensure the main equipment safety in the event of tripping, mal-operation and malfunction.
- 10.01.27 All instruments/equipment shall be capable of performing satisfactorily in continuous commercial operation conforming to all relevant codes and regulatory requirement under the specified environmental conditions.
- 10.01.28 The Control system shall be able to operate in non-air conditioned area.



- 18.02.13 The Control system cabinets shall house all types of modules / hardware to achieve all functions of Control System including signal conditioning modules, controller modules, I/O modules, communication controller modules and all other requisite hardware for a complete system. All system cabinets shall be totally enclosed (with front and back doors and side panels).
- 18.02.14 The nameplates for panels / consoles, all devices shall be provided both on the front and the rear.
- 18.02.15 Panels, cabinets, desks, distribution boxes, junction boxes, terminal boxes and all other field mounted equipment / enclosures located in outdoor, indoor and air conditioned environment shall suit the environmental condition of the area meeting Indian standard IS2147 and shall not be lower than the requirement indicated in the following table:

Sl. No.	Location	
1.	Indoor type non- ventilated enclosure in non-hazardous area	IP-54
2.	Indoor type ventilated enclosure in non-hazardous area	IP -43
3.	Enclosure in Air conditioned area	IP-32 with suitable canopy at top to prevent ingress of dripping water.



4.	Outdoor type in non-hazardous areas	IP-55
5.	Outdoor in hazardous areas	As per requirements of the NEC Code for the location

18.02.16 The construction of electrical enclosures located in areas subject to conditions classified in the National Electrical Code (NEC) as hazardous shall be of a type designated suitable for the environment in which they are located.

18.02.24 Cabinets/Enclosure/Panels

Sl No	Item	:	Description
(a)	Material of construction		Cold rolled steel sheet
(b)	Thickness of Sheet	:	(i) 2.0 mm for faces supporting instruments / terminals.
(c)	Construction	:	Welded throughout as per approved National Standards.

(d)	Panel height	:	2300 mm. (approx)
(e)	(i) Corners	:	7 mm inner radius.
	(ii) Dimensional	:	a. In height & length - 3 mm.
	(iii) Tolerances	:	b. In height between adjacent sections - 2 mm.
		:	c. Total for a group - 6 mm.
(f)	Doors	:	Double, recessed, turned back edges.
	(i) Thickness of Sheet	:	2 mm.
	(ii) Hinges	:	Stainless steel.
	(iii) Door latches	:	Three point type.
	(iv) Door gaskets	:	Neoprene rubber on fixed frame to result dust proof/weatherproof enclosure.
	(v) Opening of the doors	:	Outward.
	(vi) Louvers	:	With removable wire mesh to ensure dust and vermin proof.
(g)	Color of interior	:	Brilliant white.
(h)	Colour external	:	RAL 7032.
(i)	Painting	:	Epoxy powder coated or better.
(j)	Gland plates	:	Removable 3 mm thick. (bottom)
(k)	Cable entry	:	Bottom.

(l)	Hardware	:	(i) Anti-vibration pad- 15 mm.
		:	(ii) Predrilled base channel - 10 equivalent for all sides.
		:	(iii) Stainless steel buff- finished thick kick plate for all sides.
		:	(iv) Stainless steel scratch strips desk edges fixed with pan-head recessed screws.
		:	(v) Rubber strips to ensure air between kick plate and finished floor.
		:	(vi) Lifting hook / Eye bolt.
		:	(vii) Drawing pocket.
		:	(viii) Door switch, lamps, heaters and fans, thermostat .
(m)	Enclosure Protection	:	As per environment condition of the area of installation

18.02.25 Control Panels/Desk Mounted Instruments And Electrical System Accessories

S.No.	Item	Description
1	COUPLING RELAY	
1.1	Type	Octal base plug-in type/ DIN rail Mounting.
1.2	Coil voltage	24 V D.C. in general / other as required.
1.3	Contact	2 NO & 2 NC (Minimum).
1.4	Contact rating	250 V/5A (A.C)/220V/2A (D.C).
1.5	Operating range	70 to 110% of rated voltage.
1.6	Insulation	2 kV for 1 minutes between terminal & earth.



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1.7	Mechanical life	20 million operations.
1.8	Coil protection	Diode.
1.9	Indication	Coil on LED.
1.10	Enclosure	Transparent cover.
1.11	Connection	Screw terminals.
1.12	Mounting	Projection mounting inside panel / DIN rail mounting.
2	DISTRIBUTION BOARDS	
2.1	Type	Fixed, Modular.
2.2	Power distribution	Through MCCB.
2.3	Enclosure	Sheet Steel, IP54.
2.4	Mounting	Free standing (Can be attended from both front & back).



14.04.00 **TERMINAL BLOCKS**

14.04.01 All terminal blocks shall be rail mounted/post mounted, cage clamp type/other standard type with high quality non-flammable insulating material of melamine suitable for working temperature of 105 deg. C. The terminal blocks in field mounted junction boxes, temperature transmitters, instrument enclosures/racks, etc., shall be suitable for cage clamp connections. The terminal blocks in Control Equipment Room logic/termination/marshalling cubicles shall be suitable for post mounted cage clamp connection at the field input end. The exact type of terminal blocks to be provided by the Bidder and the technical details of the same including width etc. shall be subject to Owner's approval.

14.04.02 All the terminal blocks shall be provided complete with all required accessories including assembly rail, locking pin and section, end brackets, partitions, small partitions, test plug bolts and test plug (as specified above for SWGR connections) transparent covers, support brackets, distance sleeves, warning label, marking, etc.

14.04.03 The marking on terminal strips shall correspond to the terminal numbering on wiring diagrams. At least 20% spare unused terminals shall be provided everywhere including local junction boxes, instrument racks/enclosures, termination/marshalling cabinets, etc. All terminal blocks shall be numbered for identification and grouped according to the function. Engraved labels shall be provided on the terminal blocks.

14.04.04 The terminal blocks shall be arranged with at least 100 mm clearance between two sets of terminal blocks and between terminal blocks and junction box walls.

14.04.05 For ensuring proper connections, Bidder shall provide suitable accessories along with insulation sleeves. The exact connecting accessory shall be finalized as per application during detail engineering stage subject to Purchaser's / Consultant's approval without any cost repercussions.

14.04.06 Internal wiring in factory pre-wired electronic equipment cabinets may be installed according to the bidder's standards as to wire size and method of termination or internal equipment. Terminal blocks for connection of external



circuits into factory pre-wired electronic equipment cabinets shall meet all the requirements as specified above.

14.04.07 TBs with fuse should be provided for all input signals to control system panels.

14.05.00 **PREFABRICATED CABLE**

14.05.01 Used for interconnection between systems /marshalling cabinets. Used for panel external wiring, tinned copper. Conductor of 0.5 sq mm cross-section with seven strands twisted pair with 20 twists/ meter. Insulation material shall be PVC, heat resistant with FRLS properties.

14.06.00 **PANELS/CABINETS INTERNAL WIRING**

14.06.01 All internal wires shall be provided with tag and identification nos. etched on tightly fitted ferrules at both ends. All wires directly connected to trip devices shall be distinguished by one additional red colour ferrule.

14.06.02 Maximum of 2 wires shall be terminated per terminal. Wiring raceways, straps shall be flame retardant. All wiring shall be ferruled. Wires carrying power and signal wires shall be routed in separate raceways. Accessories like MCB, cable support, fuses etc shall be supplied. Cable entries shall be cemented with fireproof compound.

14.06.03 All external connection shall be made with one wire per termination point. Wires shall not be tapped or spliced between terminal points.

14.06.04 All floor slots of desk/panels/cabinets used for cable entrance shall be provided with removable gasketed gland plates and sealing material. Split type grommets shall be used for prefabricated cables. All the special tools as may be required for solder less connections shall be provided by Bidder.

14.06.05 Wire sizes to be utilized for internal wiring:

- i) Current (4-20 mA), low voltage
signals (48V) - 0.5 Sq.mm.
- ii) Ammeter/voltmeter circuit,
- 1.5 Sq.mm.
- control switches etc. for electrical system.
- iii) Power supply and internal
illumination - 2.5Sq.mm.



14.09.00 **JUNCTION BOX (JB)**

14.09.01 Junction boxes to be supplied by bidder's as on required basis.

14.09.02 Junction Boxes shall have following features:

- i) Single door type, explosion proof type and front open with cable entry from bottom.
- ii) 12/24/36/48/64 way with 20% spares terminals.
- iii) Spring-loaded terminals shall be used.
- iv) 4mm thick fibreglass reinforced polyester.
- v) JB shall have Hinged Door with steel handle and IP lock. Door gasket shall be of synthetic rubber.
- vi) Suitable for mounting on walls, columns, structures etc. The brackets, bolts, nuts, screws, glands and lugs required for erection shall be of brass, included in Bidders scope of supply.
- vii) Terminals shall be rail mounted cage-clamp type suitable for conductor size upto 2.5 mm². Terminals shall have screwed connection for conductor cross section above 2.5Sq.mm.
- viii) An M6 earthing stud shall be provided.
- ix) Enclosure shall be IP: 65 or better.
- x) 3mm (min) Gland plate shall be provided for cable entry.



2.25.00 Marshalling, Relays & Relay Cabinets

- 2.25.01 System cabinet(s) and corresponding marshalling and termination cabinet(s) shall be a single shipping section, so that the internal wiring from field terminal to the module is done completely at the factory itself.
- 2.25.02 The system cabinets shall be furnished with side panels even within a shipping section.
- 2.25.03 Marshalling cabinets and relay cabinets shall be separate from system cabinets for terminating inputs from field, MCC / SWGR etc. for further wiring to control system and for terminating outputs from control system to MCC / SWGR etc.
- 2.25.04 In case DCS supplier provides system cabinets with suitable partition to create separate marshalling area on the rear side of the system cabinet, ensuring that dust ingress does not take place in system area, the same can also be accepted subject to Employer's approval during detailed engineering stage.
- 2.25.05 Contractor shall design the cabinet internal arrangement, floor cutout and cable gland plate such that all the cables entering or leaving the cabinet can be properly glanded in the gland plate. In case, glanding is not possible Contractor shall indicate in his proposal his suggested procedure for cable entry and securing the cable at place.
- 2.25.07 The protection class of cabinets and environmental rating shall be as defined in Basic Design Criteria. Temperature rise inside cabinet shall not be more than 10 deg C with respect to ambient temperature in any condition. Dual blowers/fan with blower/fan failure alarm shall be provided in each cabinet with proper enclosure. Suitable louvers with wire mesh shall be provided on the cabinet. Contractor shall furnish detailed calculation of heat dissipation of various components housed in the cabinet, during detailed engineering to ensure that



temperature rise is limited as specified above. Further, temperature sensor (RTD) shall be provided in each system cabinet to monitor temperature inside cabinet and suitable alarms shall be configured to indicate high temperature inside the cabinet.

- 2.25.08 The cabinets shall be totally enclosed, free standing type and shall be constructed with minimum 3 mm thick steel plate frame and 2 mm thick CRCA steel sheet or as per supplier's standard practice for similar applications, preferred height of the cabinet is 2200 mm. The cabinets shall be equipped with full height front and rear doors. The floor mounting arrangement for other cabinets shall be as required by the Employer and shall be furnished by the Contractor during detailed engineering.
- 2.25.09 Front and rear doors shall be provided with locking arrangements with a master key for all cabinets. If width of a cabinet is 600 mm or above, double doors shall be provided.
- 2.25.10 Two spray coats of inhibitive epoxy primer-surface shall be applied to all exterior and interior surfaces. A minimum of 2 spray coats of final finish color shall be applied to all surfaces. The final finished thickness of paint film on steel shall not be less than 65-75 micron for sheet thickness of 2 mm and 50 microns for sheet thickness of 1.6 mm. As an alternative, single coat of anodic dip coat primer along with single textured powder coating with epoxy polyester meeting the thickness requirement is also acceptable.
- 2.25.11 The Bidder shall furnish sufficient touch-up paint for one complete finish coat on all exterior factory applied painted surface of each item of equipment.
- 2.25.12 The finish colors for exterior and interior surfaces shall conform to following shades– Colour shade will be RAL7032 for outside front & back and Brilliant white inside.
- 2.25.13 Cabinets shall be designed for a grounded installation on the building structure. Any isolation from the building ground which is required by equipment design shall be provided internal to the cabinet.
- 2.25.14 All alarm contacts located within cabinets as well as inputs/outputs from other related system shall be suitably terminated in the cabinets.
- 2.25.15 All the relays provided by Contractor shall be electromechanical type suitable for control supply of 24V DC meeting following specification requirements:

Sl. No.	Description	1 COC Slim Relay(< 7mm)	2 COC Heavy Duty Relays
1	Application	for Signal Exchange and 24 V DC Solenoids	Other applications like Electrical Interface, Trip PB contact multiplication etc.
2	Operating Voltage	24 V DC	24 V DC
3	Complete Relay with base Width	<7 mm	
4	No. of Contacts	One changeover contact	Two changeover contacts


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5	Contact material	AgNi/ AgSnO	AgNi/ AgSnO /Ag Alloy
6	Contact Rating	Min 6 A at 24 V DC/ 240 V AC	* Min 5 A at 240 V AC & 0.2A at 220 V DC
7	The Coil burden of relays	<2.5 W at 24 V DC	<2.5 W at 24 V DC
8	Relay Working voltage range / Release Voltage shall be in line with IEC 61810	80% to 110% of rated voltage/ 5% or higher of rated voltage	80% to 110% of rated voltage/ 5% or higher of rated voltage
9	Relay shall be capable to meet requirement of fast switching applications: a. Operating time b. Release time	a. Max 10 ms b. Max 10 ms	a. Max 40 ms b. Max 60 ms
10	Relay Electrical Life	Min 50000 operations at rated load	Min 100000 operations at rated load
11	Relay Mechanical Life	Min 5x106 operations	Min 107 operations
12	Relay base with integral terminal blocks Mounting	DIN Rail	DIN Rail
13	Relay/ Relay base shall be provided with a freewheeling diode	Y	Y
14	Relay/ Relay base shall have LED indication for coil activation.	Y	Y
15	Reverse Polarity Protection	Y	Y
16	Relay connection type	Screw less connection like Push in/ Cage clamp/ Spring type	Screw/Push in/ Cage clamp/ Spring type
17	Jumpering provision	Relay base shall have provision for plug-in jumpering without need for additional wiring	
18	Standard Compliance	Relays along with base shall comply to CE, UL, ROHS, IEC61810 standards.	Relays along with base shall comply to CE, UL, ROHS, IEC61810 standards.
19	Operating Temperature	Relay: 0-80 Deg C	Complete



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		Complete relay with base: 0-60 Deg C	relay with base : 0-45 Deg C
20	The Insulation of the Relay Module between the coil & contact	4 kV at 50Hz for 1min	2kV at 50Hz for 1min
21	Manual test lever/ latching provision	NOT to be provided	NOT to be provided



13.08.00

LOCAL CONTROL PANEL

- The control panels shall be totally enclosed type, conforming to degree of protection IP-55 or better.
- Generally, the local control panels shall be free-standing, floor-mounted, dead-front assemblies.
- Floor-mounted control panels shall be assembled on channel/angle base plates with anti-vibration mountings and stainless steel kick plates.
- Control panels shall be of folded sheet steel construction, minimum 2 mm. thick, and free from all surface defects.
- The panels shall have sufficient structural reinforcement to ensure a plane surface, to limit vibration, and to provide rigidity during shipment and installation.
- All floor-mounted panels shall have rear door.
- Doors shall have concealed type hinges and padlocking arrangement. Doors shall be grounded by flexible copper braid.
- All doors and removable covers shall be provided with neoprene rubber gaskets all round and latches sufficiently strong to hold them in alignment when closed.
- Working height of the panels shall be limited between 750 mm and 1800 mm above floor level.
- Local control panel shall be provided with two nos control transformer for control supply(1x100% standby)

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1.0 SCOPE

This specification covers the Design, Manufacture, Inspection and Testing at the manufacturer's works, proper packing for transportation and delivery to site, supervision, erection, and commissioning at site of Local Panels required for control and monitoring of the Auxiliary Plant & Equipment.

2.0 CODES AND STANDARDS

2.1 All the equipments specified herein shall comply with the requirements of the latest issue of the relevant National and International standards.

2.2 As a minimum requirement, the following standards shall be complied with:

- a) IS-6005 : 1998 : Code of practice for phosphating of iron and steel.
- b) IS-5 : 2007 : Colors for ready mixed paints and enamels.
- c) IS-1248:2003 : Direct Acting Indicating Analog Elec Measuring Instruments.
- d) IS/IEC 60947:Part 1:2004 : Low Voltage switchgear & control gear: Part-I (General Rules)
- e) IS-8828:1996 : Circuit breaker for household and similar installations.
- f) IS-13947 (Part-I):1993 : Low Voltage switchgear & control gear : Part-I (General Rules)
- g) ISA-18.1:1979 : Annunciator Sequences and Specification
- h) NFPA-496:2003 : Purged & Pressurised Enclosure for Electrical Equipment in Hazardous Locations.

3.0 TECHNICAL REQUIREMENTS

3.1 Panel Construction

3.1.1 The local panels shall house the secondary instruments, annunciation system, Single loop controller, Control switches / push buttons, indicating lamps/LED cluster, relays, timers and other devices required for operation and monitoring of the equipment locally.

3.1.2 The panels shall be of free standing type either welded construction on angle iron (minimum section of 50 x 50 x 4 mm) structure or folded construction by sheet metal formation depending upon the equipments to be mounted on it. The panels shall be robustly built and stiffeners as necessary shall be provided.

3.1.3 The panel shall be suitably reinforced to ensure adequate support for all instruments mounted thereon. All welds on exposed panel surfaces shall be ground smooth.

3.1.4 The salient features of construction shall be:

- Sheet material: Cold rolled sheet steel
- Frame thickness: Not less than 3.0mm
- Enclosure thickness: Not less than 3.0 mm for load bearing sections (Mounted with instruments)
2.0 mm for doors and Not less than 2.0 mm for others
- Panel Height: Not less than 2365 mm
- Gland plate thickness: 3.0mm
- Base channel: ISMC 100 with anti-vibration mounting & foundation bolts.

3.1.5 The panel shall be provided with rear doors with integral lockable handle. The door when locked shall be held at minimum three places. The door width shall not be more than 550mm. The doors shall be provided with suitable stiffeners to prevent buckling. The handle shall be on the right side of the door. The door shall be removable type with concealed hinges to facilitate maintenance work. Suitable pocket inside the door shall be provided for keeping the drawings / documents. Double door shall be provided with suitable glass windows, as per the requirement.

3.1.6 Suitable neoprene gasket shall be provided on all doors and removable covers. Suitable ventilation system along with louvers shall be provided at bottom and top of the doors covered with removable wire mesh.

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3.1.7 The class of protection shall be in accordance with IP-55 ।

3.1.8 All steel surfaces shall be cleaned by sand / pellet blasting, treated for pickling, degreasing and phosphating etc. by seven tank method. The panel shall have a high quality finish and appearance. The panel shall be painted with two coats of primer followed by two coats of epoxy / synthetic enamel based final paint of color shade and finish Minimum thickness of the paint shall be 85 microns for external paint and 70 microns for internal paint.

3.1.9 The cable glands of the required size and type shall be supplied alongwith the Panel.

3.1.10 All operable and indicating devices shall be mounted on the front of the panel while aux. Relays / timers MCBs etc. required for realization of control logics shall be mounted on a mounting plate inside the panel. Auxiliary relays and timers etc. shall be grouped according to the control function. No operable or indicating devices shall be mounted below 750 mm and above 1800 mm (w.r.t. finished ground level). The devices shall be located in such a way so as to ensure easy access for operation / maintenance.

3.1.11 Single / dual control power supply feeders of voltage class as specified shall be provided by the purchaser. In case redundant power supply feeders are provided then auto changeover unit shall be mounted on the panel are in the panel supplier's scope. Where DC control power supply is specified an additional 240V, 50 Hz AC supply feeder for powering of space heater and lighting shall be provided by the purchaser. Suitable arrangement shall be provided inside the panel to receive and terminate the power supply feeder(s). For this purpose MCBs of suitable current rating shall be provided by the vendor. A supervisory relay along with a pilot lamp to indicate control supply 'ON' shall be provided on the panel. Any other power supply required for the operation of the devices mounted in the panel shall be arranged by the vendor.

3.1.12 The internal wiring shall be carried out with 1100 volt grade PVC insulated copper multi strand wire / flexible of 1.5mm² size. AC & DC wires shall be kept separate from each other. Separate coloured wires to be used for AC and DC circuits. All wires shall be properly numbered and identified with ferrules as per the Control scheme / wiring diagram. Wires shall be routed and run through PVC troughs.

3.1.13 Terminal blocks shall be clip on type, 1100 volts grade. Separate terminal blocks shall be used for AC & DC circuits. The terminals shall be suitable for terminating 0.5 mm² to 2.5mm² external cables. The TB points in terminal block shall be cage clamp type / screw type. The terminal for ammeters shall be provided with removable links for shorting CTs. Each terminal strip shall be provided with identification strip. The terminal shall not be mounted below 250 mm height from finished floor. The panel shall have ten (20) percent spare terminal.

3.1.14 The interior of each panel shall be suitably illuminated through fluorescent lamps / tube lights with shrouded cover of minimum 15W operable on 240V 50 Hz AC power supply through panel door switch. A 15 Amp. 3-pin Power receptacle shall be provided.

3.1.15 Suitable space heaters operable on 240 Volts 50 Hz AC power system shall be provided at the panel bottom. These shall be designed to maintain the panel temperature five (5) deg. C above the ambient temperature during maintenance shutdown. Suitable isolating and control devices comprising of MCB, thermostat etc. shall be provided for the space heater.

3.1.16 The panel shall be provided with a copper earth bus of 25 x 6 mm size running throughout the width of the panel. It shall be terminated internally with 10 mm bolts at extreme ends for connection to; main station earth. The panel mounted equipments / devices shall be connected to earth bus through green coloured PVC insulated stranded copper conductor of 2.5 mm² size.

3.1.17 Local Panel shall be provided with main name plate of 150 mm x 40 mm size having inscription of 20 mm height. The individual devices on the panels shall be as provided with separate name plate with inscription of 3 mm height. The instrument / devices shall be provided with stick on label plates inside the panel. The material of the main and individual labels shall be three (3) ply 3 mm thick Traffolyte

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Sheet / 2 mm Anodised Aluminium Plate. The inscription shall be with white letters on black background on traffolyte sheet. The labels shall be fixed by self tapping non-rusting screws.

3.1.18 Vendor shall furnish electric load and heat load list (in case panel is to be placed in ac environment) of each panel.

3.2 Hazardous Area Panel Requirement

3.2.1 The Local Panel located in hazardous area shall be pressurized as per NFPA-496 requirements to render it non-hazardous. Alarms shall be provided for local and remote annunciation when pressurisation falls below 2.5 mm of water column. Protection shall be of type Z of NFPA-496. It shall not be possible to switch ON the power of purged section unless it is purged as per the recommendation of NFPA-496. Vendor must provide a protective device on the panel to protect the panel from over pressurisation.

3.2.2 Vendor shall supply pressurisation kit consisting of valves, restriction orifices, dual filter regulation, pressure gauges, pressure switches, rotameter etc. Pressurisation kit shall be surface mounting on a metal board and located outside the local panel. Pressurisation kit shall further consist of solenoid valve flow switch, timer blow off safety device etc., so as to make purging fully automatic. However final start shall be manual. Panel protection against over pressure to be provided as per NFPA-496.

3.2.3 Pressurised local control panel pressurization kit assembly design shall provide minimum leakage flow through the Local Control Panel. Panel venting shall be as per NFPA-496.

3.2.4 All components in the local panel like indicating instruments, push buttons switches, lamps etc., which are required to be energized without panel pressurization or before completion of purge cycle shall be explosion proof as per NEMA-7 & suitable for area classification.

3.2.5 All push buttons etc. requiring frequent operation during machine running shall have good positive sealing. Weatherproof housing or cover to be provided wherever necessary. Vendor shall provide pressurisation bypass switch outside explosion proof enclosure of pressurized panel with lamp indication. This shall be used only during maintenance. All hinges, screws, other non-painted metallic parts shall be of stainless steel material.

3.2.6 Provision to switch off manually all types of power shall be provided in the panel. In addition, it shall also be possible to switch off power circuits / components which are powered from motor control centre or control room manually in case of pressurization failure. All such cables from MCC and main control room shall be terminated in explosion proof boxes (NEMA-7).

3.3 Control & Monitoring devices

3.3.1 Instruments like Indicators, recorders, single loop controllers etc. as applicable and specified elsewhere for the plant / equipment shall be supplied and mounted on the panel.

3.3.2 Alarm Annunciator System

It shall be solid state discrete facia type having a sequence of ISA-S18.1A or as specified, opaque facia windows of 70 mm x 50 mm size, having two (2) lamps per window, and hooter of 10W, and provision for repeat group alarm at remote. The annunciator shall be provided with ten (10) percent spare windows or minimum two (2) windows along with electronics.

3.3.3 Relays

The relays shall be electromagnetic type suitable for specified control supply. Its contact configuration and rating shall be suitable for the specified control function. However minimum contact rating shall be 5 Amp AC & 2 Amp DC as applicable. There shall be ten (10) percent spare contacts.

3.3.4 Timers

The timers shall be electronic type suitable for specified control supply. Its contact configuration and rating shall be suitable for the specified control function. However, minimum contact rating shall be 5 Amp AC & 2 Amp DC as applicable.

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3.3.5 Control / Selector Switches
Switches shall be Rotary Cam type with minimum of 5 Amps AC & 2 Amp DC continuous current rating. Selector switches shall be stay put type while control switches shall be spring-return-to-neutral type. Contact configuration and rating shall be as per the control function requirement. The switches shall be lockable type wherever specified. Each switch shall be provided with engraved plates indicating the switch position / functions.

3.3.6 Push Buttons / Indicating Lights
The push buttons shall be momentary action self-resetting type, however stop P.B. for unidirectional drives shall be provided with manual reset facility. Its contact configuration & rating shall be as required for the control function but minimum 2 NO + 2 NC of 5 Amp. AC rating. It shall have round coloured projecting tab and engraved escutcheon plate / inscription plate. Colour coding of push buttons shall be as under:

RED	Motor OFF / Valve CLOSE	YELLOW	Alarm acknowledge	Left Hand Side
GREEN	Motor ON / Valve OPEN	BLACK	Lamp test	Right Hand Side

Indicating lights shall be suitable for direct connections across specified power supplies. It shall be fitted with built in resistance to prevent circuit tripping on shorting of lamp filament. It shall be fitted with LED cluster type lamp replaceable from front.

GREEN	Motor OFF / Valve CLOSED condition	AMBER	Motor tripped	Left Hand Side
RED	Motor ON / Valve OPEN condition	WHITE	Normal / healthy	Right Hand Side

3.3.7 Ammeters
Ammeter shall be 96 x 96 mm size, 90 deg. deflection, 1.5% accuracy, 1 Amp. CT operated or with 4-20mA input and Flush mounting type as called for
Ammeters for motors shall have six (6) times folded scale at upper end to enable motor starting current indication

3.3.8 Miniature Circuit Breaker (MCB)
These shall be instantaneous magnetic trip type for short circuit in addition to current time inverse delayed thermal trip feature for over current protection. The housing of MCB shall be made of non-ignitable, high impact material. It shall have minimum short circuit rating of 9 KA for AC Voltages and 4 KA for DC Voltages.

3.3.9 Makes of various instruments / devices shall be as given below

1.	Alarm Annunciators	:	Procon / IIC
2.	Ammeters	:	AEP / IMP
3.	Control / Selector Switches	:	Alsthom / Kaycee / Siemens / L&T
4.	Push Buttons / Indicating Lamps	:	Siemens / L&T / Teknic / Alsthom
5.	Auxiliary Relays	:	Jyoti / Siemens / L&T / OEN
6.	Timers	:	L&T / Alsthom / Bhartiya Cutler Hammer
7.	MCBs	:	S&S Power Engg. / Indo Asian / MDS
8.	Terminal Blocks	:	Jyoti / Elmex

4.0 TESTING AND INSPECTION

4.1 The bidder shall adopt suitable quality assurance program to ensure that the equipments offered will meet the specification requirements in full.

4.2 BHEL's standard Quality Plan for LCP is enclosed with the specification. The bidder shall furnish his acceptance to BHEL's QP and submit the signed and stamped copy of QP along with the offer.

	SPECIFICATION FOR LOCAL PANELS	SPECIFICATION NO.: PE-SS -999- 145 -054A	
		VOLUME	II B
		SECTION	D
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		SHEET	5 OF

4.3 The vendor shall conduct the following tests as a minimum requirement:

4.3.1 Routine Tests

1. High Voltage (H.V.)
2. Insulation Resistance (I.R.)
3. Functional

4.3.2 Type Tests

1. Enclosure Class Test

5.0 SPARES AND CONSUMABLES

5.1 Commissioning Spares and consumables

The bidder shall supply all commissioning spares and consumables 'as required' during Start-up, as part of the main equipment supply.

5.2. Mandatory Spares

The bidder shall offer alongwith main offer, the Mandatory Spares as specified elsewhere in the specification. The Mandatory Spares offered shall be of the same make and type as the main equipment.

5.3. Recommended Spares

The bidder shall furnish a list of Recommended Spares indicating the normal service expectancy period and frequency of replacement; quantities recommended for 3 years operation alongwith unit rate against each item to enable BHEL/BHEL's Customer to place a separate order later, if required.

6.0 DRAWINGS AND DOCUMENTS

6.1 The bidder shall furnish the following documents in required number of copies along with the bid :

2. General Arrangement Drawing.
3. Catalogue and technical information for instruments and devices.
4. Quality Plan.

6.2 The vendor shall furnish the following documents in required number as agreed after the award of contract:

2. GA Drawing indicating layout of instruments, construction details, foundation details, cable gland plate alongwith cable glands and all details mentioned in this specification.
3. Control Schematic Diagram along with grouping of different terminals for various functions.
4. Catalogue and technical information for instruments and devices with selected options clearly marked.
5. O&M Manuals.
6. "As Built" Drawing.
7. CDs.

7.0 MARKING AND PACKING

7.1 Panel with all instruments / devices mounted on it shall be suitably packed & protected for the entire period of despatch, storage and erection against impact, abrasion, corrosion, incidental damage due to vermin, sunlight, high temperature, rain moisture, humidity, dust, sea-water spray (where applicable) as well as rough handling and delays in Transit and storage in open.



20.00.00 VARIABLE FREQUENCY DRIVE SYSTEMS (VFDS)

20.01.00 INTENT OF SPECIFICATION

This section covers the technical requirements of VFDS for various high voltage motors and other LV motors.

20.02.00 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the relevant IS/IEC standards including amendments, if any, except where modified and/or supplemented by this specification.

IS:3700	Essential Ratings and Characteristics of Semiconductor Devices
IS:3715	Letter symbols for semi-conducting devices
IS:4411	Code of designation of semi-conducting devices
IS:5001	Guide for preparation of drawings of semiconductor devices and Integrated Circuits
IS:5469	Code of practice for the use of semiconductor Junction Devices
IS: 14901	Semi-conductor devices- Discrete devices & Integrated Circuits
IS:15880	Three Phase Cage Induction motors when fed from IGBT Converters-Application Guide IS/IEC:60947 Low Voltage Switchgear and Control gear.
IEC:60146-1-3	Semiconductor Convertors general requirements and line commutated convertors-Transformer & reactors
IEC:61800	Adjustable speed electrical power drive systems
IEEE:519	Recommended Practices and requirements for Harmonics Control in Electrical Power Systems
IEC:60056	HT breaker
IEC 60289	DC reactor
IS:2026,	Transformers
IEC:60076,	
IEC 61378	
IS: 2099,	Bushing
IEC 60137	
IEC 60529	Degrees of protection provided by enclosures (IP Code)
IEC1000-4-2	Electrostatic immunity test
IEC1000-4-4	Fast transient immunity test
IEC1000-4-5	Surge immunity test
IEC 62271-102	High-voltage switchgear and controlgear; Pt.102: Alternating current disconnectors and earthing switches

The equipment shall also conform to the provisions of CEA Regulations.



In case Indian standards are not available for any equipment, standards issued by IEC/IEEE/ NEMA or equivalent agency shall be applicable.

20.03.00 TECHNICAL REQUIREMENTS OF HIGH VOLTAGE VFDS

- 20.03.01 The VFD shall produce a variable voltage and variable frequency output to provide continuous operation over the application speed range. The VFD shall be capable of operating with the output short circuited at full current or with the output open circuited at rated voltage. VFD shall be capable of operating squirrel cage induction motor.
- 20.03.02 The drive system shall provide controlled speed over the range specified in 'Mechanical' section or elsewhere. Speed accuracy within this range, expressed as a percent of top speed, shall be within 0.1% of base speed without encoder or pulse tachometer feedback.
- 20.03.03 A "heavy duty" rating shall be available with 100% continuous current with a short time duty rating of 150% overload for one minute, once every 10 minutes (suitable for constant torque loads). The VFD shall be capable of 100% breakaway torque without tachometer feedback. Breakaway torque with tachometer feedback shall be 150%.
- 20.03.04 The VFD shall utilize sensorless direct vector control or full vector control, with pulse tachometer feedback, for optimum performance. The Variable frequency drive (VFD) system shall be of a modern proven design for similar applications in power plants/industry. The system shall be with minimum eighteen (18) pulse design
- 20.03.05 The VFD shall provide near sinusoidal voltage and current waveforms to the motor at all speeds and loads. Output current THD shall be less than 5%.
- 20.03.06 Standard induction motors shall not require de-rating or upgraded turn-to-turn insulation and shall not require additional service factor. The motor insulation system shall not be compromised thermally or due to dv/dt stress. Dv/dt at the motor terminals (line-to-line) shall be limited to 10 volts per microsecond.
- 20.03.07 The motor insulation system shall not be compromised due to excessive peak voltage of the output waveform. The VFD shall provide stable operation of the motor without compromising the motor insulation system, regardless of motor cable distance. If an output filter is required to mitigate reflected waves, or to meet any special requirements of the application, it must be integral to the VFD controller.
- 20.03.08 If output filters are used in the VFD, a selective harmonic elimination (SHE) switching technique must be available to eliminate a potential harmonic resonance in the operating speed range. VFD induced torque pulsations to the output shaft of the mechanical system shall be less than 1% to minimize the possibility of exciting a resonance.



- 20.03.09 For VFDs controlled HT motors, it shall be IE2 class as per IS 12615. VFD system efficiency shall be a minimum of 96% at 100% speed & 100% load. System efficiency shall include VFD, input transformer or line reactor, harmonic filter (if applicable) power factor correction unit (if applicable), and output filter (if applicable). Control power supplies, control circuits, cooling fans or pumps, shall be included in all loss calculations.
- 20.03.10 The VFD shall be capable of riding through a loss of power of 5 cycles.
- 20.03.11 Maximum audible noise from the VFD or associated VFD system shall not exceed 85 dB (A).
- 20.03.12 The VFD shall be capable of maintaining a minimum true power factor (Displacement PF. X Distortion PF.) of .98 from 30-100% power. If the VFD vendor cannot meet the true power factor requirement, then a power factor correction unit shall be provided.
- 20.03.13 The VFD system shall be designed for a minimum availability of 99.9%. The VFD system shall be designed for a Mean Time between Failures (MTBF) of 100,000 hours. The VFD system shall be designed for a minimum life expectancy of 25 years.
- 20.03.14 Fiber optic interface boards shall be used to provide gating and diagnostic feedback signals for power semiconductor devices. The diagnostic feedback system shall allow constant control of the device as well as constant monitoring of device health and temperature feedback.
- 20.03.15 The VFD shall be capable of automatically restarting in the event of a momentary loss of power, or a clearing of a drive trip. An automatic restart delay parameter shall be available in the drive with an adjustment range of 0 - 10 seconds.
- 20.03.16 The VFD system shall be capable of operating with voltage sag of 30% on the input power line. (The motor shall not be allowed to reach a pull out condition.)
- 20.03.17 A continuous copper ground bus shall be provided along the entire length of the controller lineup.
- 20.03.18 A bypass starter shall be provided. A double power bus configuration shall be utilized in the bus compartment (one is the main power bus, the other is the variable frequency bus). In order to ensure maximum safety and to allow fully isolated service access to the VFD while on bypass, an output vacuum contactor, isolating switch, mechanical and electrical interlocking shall be included with the bypass starter. Comprehensive motor protection scheme for protection and control for operation VFD during bypass mode shall be finalized during detailed engineering.

20.03.19 The VFD shall have the following minimum protection features:

At Input Source Side:

- i) Under voltage (adjustable)
- ii) Over voltage (adjustable)
- iii) Instantaneous over current (adjustable)
- iv) Ground fault (adjustable)
- v) Overload (adjustable)

On System Level:

- i) Gate driver power supply under voltage
- ii) Control power over / under voltage and signals
- iii) Over temperature protection

At Output Motor Load Side:

- i) Short circuit protection (instantaneous over current)
- ii) Overload (delayed over current)
- iii) Over voltage (adjustable)
- iv) Motor over speed (adjustable)

Motor Protection:

- i) Electronic motor overload protection.
- ii) RTD relay for sensing actual motor temperature and drive shutdown.
- iii) A motor stall protective function
- iv) A multi-functional motor protection relay (MPR)
- v) Motor space heater control.

20.03.20 The VFD shall have a user-friendly operator interface terminal with the following minimum features:

- i) Large LCD display screens (minimum 16 line – 40 characters) that are easy to read and provide 'at a glance' indication of drive operating status
- ii) User configurable bar type LCD metering for motor speed, load, torque, and voltage Elapsed time indication.
- iii) Extensive diagnostic functions that provide separate fault and warning queues in nonvolatile memory that retain information under all conditions
- iv) On-line help that provides enhanced fault text messages.
- v) Trend buffers for at least 8 variables that allow one-shot or multi-shot trending.
- vi) Multi-level password access to ensure that only qualified personnel have access to critical parameters but still allow easy access to other levels of personnel.



- vii) Extended use of plain language messages to eliminate need to look up error codes or decipher the meaning of error messages.
- viii) Start-up wizard, including auto tuning, that is interactive and user-friendly

20.03.21 VFD shall be provided with digital communication capability to allow direct control and status Communication with a DCS,PLC, SCADA or other control system. Communication modules for Remote I/O, DeviceNet, and ControlNet will be suitable for DIN rail mounting or communication board mounting

20.03.22 The VFD system shall be air-cooled, provided with a mixed flow cooling fan, mounted integral to the VFD enclosure. The VFD shall include air-flow pressure switches and temperature detectors to monitor proper operation of the air cooling system. If a fan fails, the system must generate alarm indication of the fan failure. Vane type air-flow switches are not acceptable. If required, provision shall be made for ducting VFD exhaust air outside the control room.

20.03.23 VFD enclosures for air-cooled VFDs shall be IP: 31. Door vents shall consist of louver panel. Safety screens shall be located behind each louver panel. Cabinets and doors shall be fabricated using minimum 2.5 mm thick steel for sturdy construction. All doors shall be gasketed to provide environmental protection and secure fits. The converter cabinet door and cabling cabinet door shall be interlocked with up-stream isolators or breakers with a key lock. Interlocking shall be fully coordinated to prevent access to all medium voltage compartments.

20.03.24 The VFD shall be provided with Indoor, dry type rectifier duty transformer for input impedance devices. It shall have the following features:

- i) One (1) normally closed auto reset thermal switch per coil, wired in series to a terminal strip.
- ii) Class H insulation, limiting temperature rise to F limits.
- iii) HV and LV bus to ends.
- iv) Delta primary with +/- 5% taps.
- v) Wye secondary winding (6 pulse or PWM rectifier).
- vi) Three (3) secondary windings: One (1) Delta, two (2) extended Delta at Delta – 20 degrees and Delta +20 degrees (18 pulse).
- vii) 5 to 8 percent impedance
- viii) Fully insulated from phase to ground and neutral to ground.
- ix) Fully insulated between secondary windings (18 pulse).
- x) Lifting eyes on core and coil assembly - complete unit.
- xi) Removable jacking and lifting provisions on enclosure base assembly - complete unit.
- xii) Tap changing via solid bus jumpers.
- xiii) Diagrammatic nameplate.
- xiv) Two (2) enclosure ground pads - 2 hole stainless steel.
- xv) Base suitable for jacking, pulling and rolling.
- xvi) Ventilated indoor enclosure with cable entry/exit.

- xvii) The transformer shall be designed for continuous operation at its base kVA rating (natural cooling) without exceeding the temperature rise. The short time rating shall be adequately designed to deliver the power demanded by the drive without loss of insulation life.
- xviii) Forced cooled transformers are not allowed.

20.03.25 VFDS shall have the following functions and features:

- i) PWM control strategy
- ii) Modular design of power cell
- iii) Power cells connecting in series topology and wave stacking method;
- iv) AVER (automatic voltage regulator) function of output voltage
- v) Torque boost function
- vi) Rotating speed (fly) start function,
- vii) Transient power loss function,
- viii) Auto-start function
- ix) Synchronizing switch function
- x) Power cell by-pass function
- xi) Protection of overload and over-current
- xii) Protection of open-phase
- xiii) Protection of over-voltage
- xiv) Overheat protection
- xv) Current limited function
- xvi) Interlock protection of control power supply
- xvii) Two sets of control power hot standby for redundancy
- xviii) Power cell communicate with controller through optic fiber,
- xix) System running in closed-loop,
- xx) Multiple communication methods with host computer

20.04.00 TECHNICAL REQUIREMENTS OF LOW VOLTAGE VFDS

20.04.01 VFDS shall be rated for 415 V supply voltage. If isolation transformer is required at input, the same shall be provided.

20.04.02 VFDS shall be sized for the specific application with a design margin of atleast 10% over the motor rating. The drive shall be rated to operate at a design ambient of 50°C. It shall be ensured that harmonics are filtered and not reflected at source.

20.04.03 Variable speed drives shall be provided for better speed response, range ability, control stability and for ease of control, and smooth, efficient and optimum speed operation of the machine drives.

20.04.04 The drive shall be housed in sheet steel enclosure of IP-42 degree of protection. The unit shall be complete with ACB/MCCB at incomer, contactor, semiconductor fuses, meters, indication lamps, annunciations, protections, redundant cooling fans etc.

20.04.05 VFDS shall be at-least 12 Pulse type with active front end rectifiers with total harmonic current distortion limited to less than 4%. For drives less than 100 KW Six (6) pulse can be offered meeting all other requirements.

20.04.06 For VFDs controlled LT motors, it shall be IE2 class as per IS 12615.

20.04.07 VFDS system shall have the following features:-

High input line-side power factor throughout the speed range.

- i) Low harmonics on the input line-side, with the total and individual harmonic contents not exceeding the limits established in IEEE-519.
- ii) Low load side harmonics with near sinusoidal current in the drive circuit.
- iii) Suitable for regenerative operation as may be required for the drive application.
- iv) Input and output side choke
- v) Soft start and soft stop, with capability for bi-directional operation of the drive as may be required.
- vi) Reduced shoot through faults.
- vii) High starting torque as may be required for the drive application.
- viii) Suitable for various drives operating with driven equipment having constant torque, constant power, or load torque varying with square or cube of speed.
- ix) Faster response and have a wide speed range.
- x) Greater tolerance to load side drive machine parameter variations.
- xi) Wide range of low frequency and super synchronous speed frequency range of operation as may be required.
- xii) Low torque pulsations throughout the lowest & highest frequency range.
- xiii) Stability throughout the lowest and highest load range.
- xiv) Reduced voltage spikes inflicted on the motor / VFDS equipment that can occur during commutation.
- xv) VFDS shall be capable of flying restart.
- xvi) VFDS shall have dynamic braking unit and resistor feature.
- xvii) DOL starter By pass arrangement.

20.05.00 VFDS will comprise frequency converter having following features:

20.05.01 Voltage or Current Source DC link Pulse Width Modulated (PWM) Converter configuration suitable for operation at automatically produced fixed ratio of Voltage / Frequency (V/ F) throughout the complete speed range of the motor; and for operation in constant torque and constant power mode as appropriate.

20.05.02 The converter will comprise line commutated power converter connected to AC mains either directly or by a suitably rated converter transformer.

20.05.03 For the Voltage Source Inverter Configuration, the DC link voltage output by



the power supply converter will be smoothened by an L-C circuit and the constant voltage output that will be fed to a forced commutated three phase inverter output system. The system will be complete with shunt capacitors selected to cater to the reactive power requirements of the motor.

- 20.05.04 For the Current Source Inverter Configuration, the DC link voltage output by the power supply converter will be by a smoothing choke in series with the converter and the constant current output of the choke will be fed to a suitably commutated three phase inverter output system. The smoothing reactor will be sized to avoid conditions of discontinuous current operation of the converter at its lowest frequency of operation and will be uniformly insulated and protected against voltage surges that could occur during load throw-off.
- 20.05.05 Provided with suitable input transformer if required to transform the input system network voltage to the optimal voltage of the converter and to reduce the short circuit capacity and to reduce 'line notching' that can occur during commutation. The Input transformer will have appropriate phase shifting multiple windings to eliminate the 5th & 7th harmonics and their multiples.
- 20.05.06 Suitable regulating equipment that will be so designed as to enable the drive motor system to respond to load change with good dynamic accuracy, excellent speed holding accuracy and fine speed setting resolution. From the instrumentation control system, isolated 4-20 mA dc controller output signal will be made available as a set point for the speed controller in the regulation system. The system will include as part of the speed controller any transducer/ converter that may be required to interface with the above signal. Facility for signal measurement at important points in the regulating system will also be provided.
- 20.05.07 Independently adjustable voltage boost for VFDS start up and operation at the lower end of the frequency.
- 20.05.08 Separately adjustable ramp up and ramp down time facilities.
- 20.05.09 Complete features for drive soft start and soft or extended stop as required with features required for bi-directional operation of the drive as may be required for the particular application.
- 20.05.10 Close loop control to keep output voltage unaffected by system voltage and load changes. Regulation of output voltage will not be more than plus 2% to minus 2% under steady state (zero to full load) and 8% under transient conditions.
- 20.05.11 Maximum drift in set frequency will be plus 1% to minus 1%.
- 20.05.12 All facilities as required for onsite adjustments of current limits, trip time, maximum frequency, minimum frequency, start compensation, voltage boost, slip compensation, accuracy rate, deceleration rate and others as required.



- 20.05.13 Comprehensive protection and fault display circuit including under / voltage (supply, over current, short circuit / earth fault due to inverter and / or motor fault , internal / external fault provisions for tripping unit. covering as a minimum Over current protection, fast acting short circuit & transient suppression circuits, Overload protection, Phase sequence monitoring and protection, Single phase protection, Mains & Internally generated Transient Over Voltage Protection, Under Voltage and mains supply failure protection, Control supply failure, IGBT fuse failure, Gate suppression for output circuit faults, Thermistor protection relay for protection of windings of motors greater than or equal to 75 kW, necessary di/dt & dv/dt protection, Device / Cubicle overheating protection, Ventilation failure, and any other protection as required for the type of scheme provided.
- 20.05.14 Where closed loop dynamic and fast speed response is required for drives, necessary multi loop control system will be provided complete with tachometers provided in the drive shaft.
- 20.05.15 The control system will consist of a multi loop system having two internal loops. One loop is for speed control and the other is for the control of current. Each loop will have its own controller, along with an acceleration ramp function, which sets the desired value of the speed in accordance with a linear ramp function and thus prevents sudden variation in the controller input.
- 20.05.16 The primary controlled variable will be speed which will be measured by means of a tachometer, which will be provided on the drive shaft and compared with the reference speed input. The error in speed will actuate a speed controller to establish the reference current input. This reference value will be subtracted from the actual current value and the error signal actuates the current controller, the output of this should be connected to the gate control unit, which controls the firing of the IGBT.
- 20.05.17 The inner current loop is made more active than the speed control loop. The speed and current controllers will be capable of accepting the form and type of feedback signal provided by the error detector and must provide at its output a signal of the proper type to operate the IGBT.
- 20.05.18 All necessary indication and monitoring equipment that will as a minimum include speed indicator for motors with a provision for repeat indication signal for use with DCS instrumentation system, speed reference, speed feedback, current reference, current feedback, regulated power supply voltages; voltmeter, ammeter, frequency, power factor meter, kW meter at mains input supply side, pulse output meter; voltmeter, ammeter, frequency, kW meter torque meter kW meter and speed indicator on the load side.
- 20.05.19 Audio visual Alarm annunciation (with visual and audio alarm acknowledge facilities) as required that will as a minimum include drive in monitoring mode, drive in regenerating mode, control electronic power supply, over temperature, motor over current, rectifier over current, motor overload, any other motor / converter faults.

	MAHARASHTRA STATE POWER GENERATION CO. LTD.	VOLUME – III
	KORADI THERMAL POWER STATION 2X660 MW UNITS - 11 & 12 PROJECT	PART – B
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	TECHNICAL SPECIFICATION ELECTRICAL	REV. - 0

- 20.05.20 Necessary Input and output Filters will be provided at appropriate locations to suppress harmonics at the input and the output of the VFDS converter system and to improve the input power factor.
- 20.05.21 The VFDS panel will be located indoors inside electrical rooms. The VFDS panel will have self ventilating & cooling fans fed with power drawn from within the VFDS panel complete with fan motor starters including switch & HRC fuses, contactors & overload relays as per details given for MCC in the previous sections of this report.
- 20.05.22 VFDS unit will be controlled from following 3 different locations
- VFDS panel
 - Local Operator Panel or Local Control Station
 - DCS
- 20.05.23 Following minimum control facilities will be provided on each of the VFDS Panel and the Local Operator Panel:-
- Incoming switch and HRC fuses.
 - Start / Stop PBs to switch ON / OFF of the drive.
 - All necessary contactors and switch with HRC fuses or current limiting circuit breakers for the drive control and protection along with overload protection.
 - Raise / Lower PBs for speed variation of the drive.
 - Auto / Manual Selector Switch for selection of the mode of operation.
 - VFD / Bypass starter selection
- 20.05.24 In Auto mode, frequency will be controlled from the instrument control PLC / DCS system by a 4 to 20 mA signal. For ON / OFF control of the motor in the Auto mode, 4-20 mA interlock signal from instrumentation PLC system will be wired to the VFDS panel.
- 20.05.25 In the Manual mode, the Selector Switch will be provided to select the motor control either from VFDS Panel or from the field.
- Drive Ready Indication and
 - Speed Indicator
 - DCS interface covering :-
 - Wiring of 4-20 mA signal input from DCS/PLC for speed variation.
 - Wiring of DCS / OFF input signal / contact for motor Start / Stop.
 - Wiring of 4-20 mA signal output to DCS/PLC for speed indication.
 - Wiring of contacts to remote for Drive Ready Indication

20.06.00 PAINTING

Painting shall be carried out by approved process. After preparation of the under surface the equipment shall be painted with epoxy based paint by



powder coating. The final thickness of paint film on steel shall not be less than 85 microns. Final shade shall be RAL-7035.

20.07.00 TESTS

All the equipment supplied shall be of type tested quality. All the type test for all HT VFD's of each rating shall be conducted as per relevant IEC and IS standards. Type test on HT VFD's shall be conducted at independent laboratory and same shall be witnessed by customer.

For LT VFD's , Type test reports shall be submitted for each voltage class and current rating. . In case the Bidder is not able to submit report of the type test(s) conducted,, or in case the type test report(s) are not found to be meeting the specification requirements and the type test reports are not withing 5 years from the date of Bid opening, the Bidder shall conduct all such tests under this contract free of cost to the Purchaser and submit the reports for approval,for which a minimum 7 days notice shall be given by the Bidder. Charges for these shall be deemed to be included in the equipment price.

All the routine and acceptance test as per relevant standards shall be conducted on all the VFD's and shall be witnessed by the customer.

20.08.00 DRAWINGS & DOCUMENTS

The following drawings and documents shall be submitted for approval during detail engineering stage.

- i) Technical data sheet
- ii) General arrangement and section drawing
- iii) Single line diagram & Schematic wiring diagrams
- iv) Metering and protection drawing
- v) Foundation Plan & loading details
- vi) VFDS sizing calculation
- vii) Test reports
- viii) Manufacturing quality plan

DATA SHEET-A

Sl. No.	Description	Unit	Specificaion Requirement
1.0	Type of drive		Inverter (IGBT based PWM controlled) AC drives
2.0	Manufacturer		*
3.0	Application		Fans/Pumps/Coal feeders
4.0	Type of Motor/Model No. of the VFD		VFD shall be considered as per the technological requirement
5.0	Rating of drive	kW	Squirrel cage induction motor
6.0	Quantity		*

Sl. No.	Description	Unit	Specification Requirement
7.0	Rated power factor		*
8.0	Efficiency		*
9.0	Rated output voltage	kV	*
10.0	Full load current	kA	*
11.0	Type of duty		a)100% continuous b) 150% overload for 1 minute in 24 hours
12.0	Quadrants of operation		*
13.0	Full wave rectification		12 pulse
15.0	Power supply system		
	a)Input power supply		415V, 3 ph, 50Hz
	b)Variation in voltage		+10%
	c)Variation in frequency		+5%
	d)Combined voltage & frequency variations		10%
	e) System fault level	kA	50 kA 1 sec
	f)Type of earthing		Solidly earthed
15.0	Location		Indoor
16.0	Type of cooling		*
17.0	Input and output cables		
	a)Size & type		*
	b)Entry		Bottom
18.0	Dimensions		*
19.0	Degree of protection		IP42
20.0	Power loss ride through time	Sec.	2
21.0	Control characteristics		
	a) Control Method		Drive level control using digital system.
	b) Output freq. range		*
	c) Frequency accuracy		0.01%
	d) Frequency resolution	Hz	0.001
	e) Speed regulation		0.5% of max. speed
	f) Speed range		*
	g)Accelerate/decelerate time		*
	Harmonic limitations		
22.0	I)Voltage harmonics		
	a)Source side		Maximum 5%
	b)Load side		Maximum 5%
	II)Current Harmonics		
	a)Source side		
23.0	i) 5 th		Maximum 30%
	ii) 7 th		Maximum 20%
	iii) 11 th		Maximum 10%
25.0	Miscellaneous		
	a)Soft-start		Yes



MAHARASHTRA STATE POWER GENERATION CO. LTD.

VOLUME – III

KORADI THERMAL POWER STATION
2X660 MW UNITS - 11 & 12 PROJECT

PART – B

RFx No. 3000046202 (BTG Package)

TECHNICAL SPECIFICATION ELECTRICAL

REV. - 0

Sl. No.	Description	Unit	Specificalton Requirement
	b)Flying restart		Yes
	c)Auto restart		Yes
25.0	Kinetic buffering		Yes (Preferablly for a back up time of 2 sec.)
Note	‘**’ indicated above shall be filled by the Contractor		
	‘***’ Contractor shall furnish the data after placement of order		



**KORADI THERMAL POWER STATION
2 x 660 MW UNITS - 11 & 12 PROJECT**

SECTION: C
SUB SECTION : C&I

**C&I SPECIFICATION FOR
HVAC SYSTEM**

SIGNL EXCHANGE BETWEEN DRIVES & DCS

|

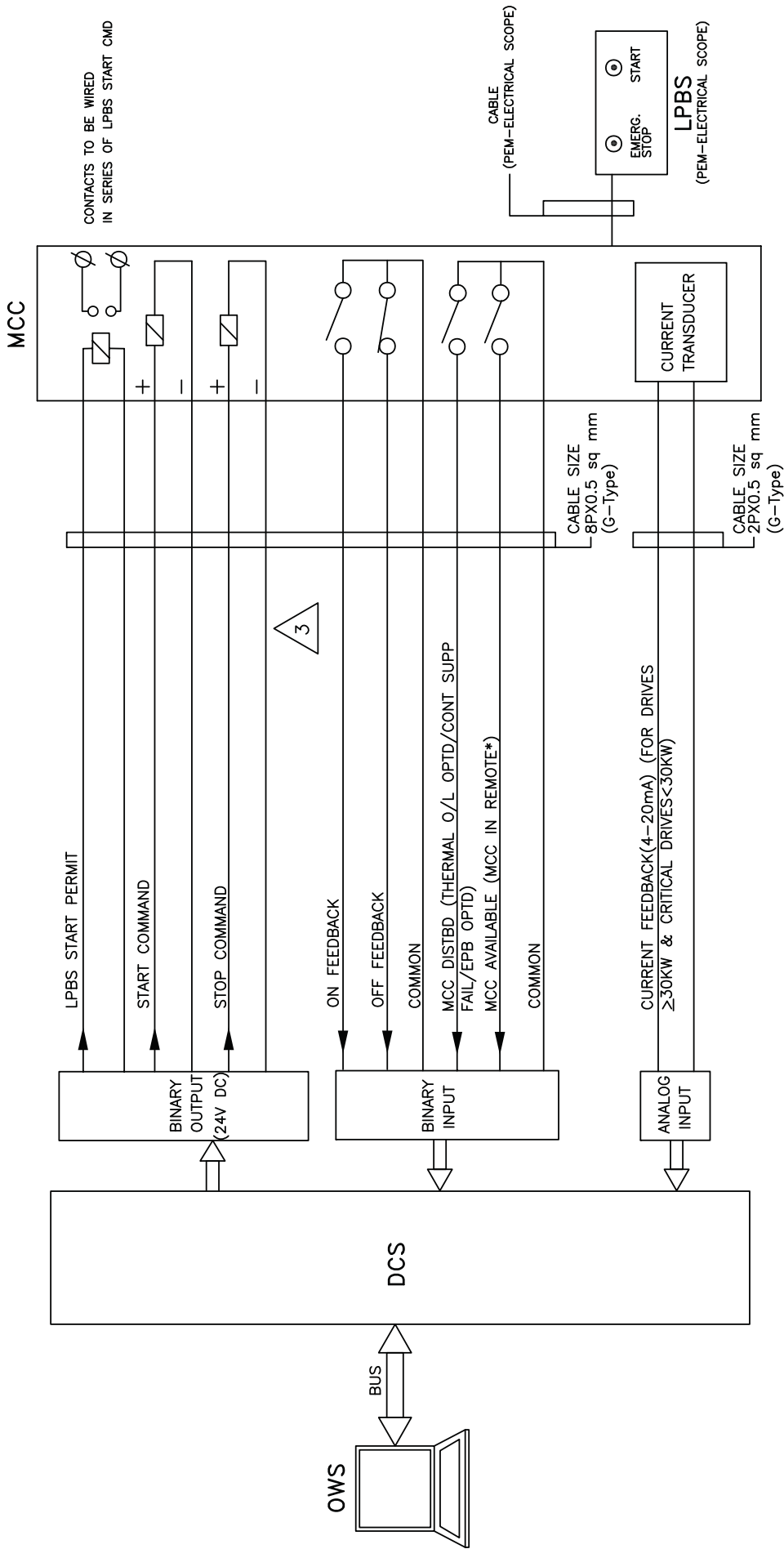
MCC



* SELECTOR SWITCH IN TRIAL(LOCAL) OR MCC(TEST) POSITION



DCS INTERFACE FOR UNIDIRECTIONAL LT DRIVE(CONTACTOR OPERATED)



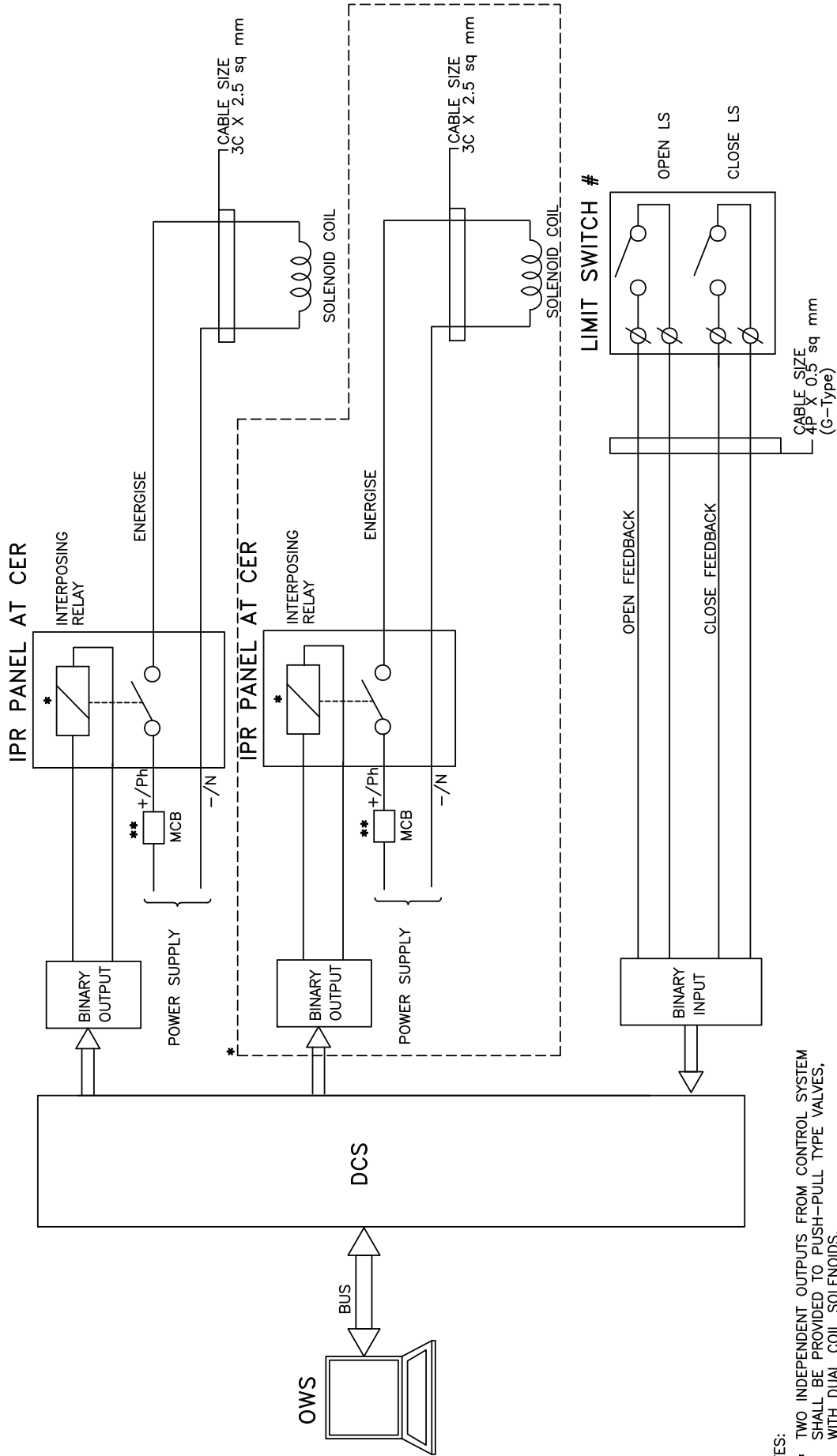
2

* SELECTOR SWITCH IN NORMAL(REMOTE) POSITION

NOTE: INTERPOSING RELAYS(IPRs) TO BE SUPPLIED ALONG WITH MCC.

	PROJECT: 2X660 MW KORADI TPP UNIT 11&12 - BTG		DRG.NO.	PE-DM-527-145-H002
	TITLE DDCMIS INTERFACE FOR UNIDIRECTIONAL LT DRIVE		DATE	20.08.2025
			REV.NO.	05
		SHT	10	OF 13

DCS INTERFACE FOR SOLENOID DRIVE (24V DC / 240V AC UPS)



NOTES:

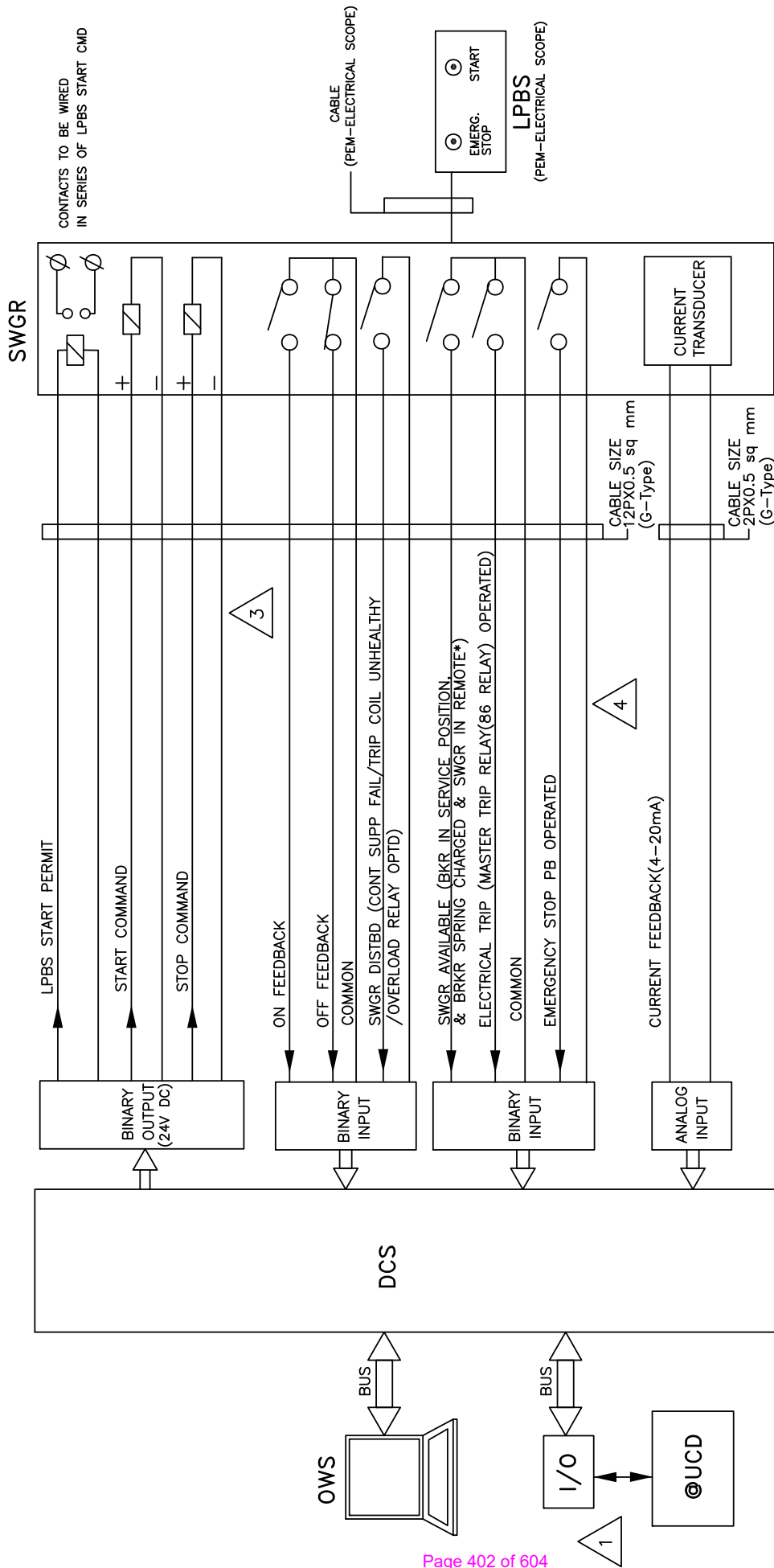
* TWO INDEPENDENT OUTPUTS FROM CONTROL SYSTEM SHALL BE PROVIDED TO PUSH-PULL TYPE VALVES, WITH DUAL COIL SOLENOIDS.

** MCB SHALL BE PROVIDED FOR EACH SOLENOID

FOR ON/OFF TYPE, SOLENOID ACTUATED CONTROL VALVE.

 Mahindra Company	PROJECT: 2X660 MW KORADI TPP UNIT 11&12 - BTG		DRG.NO.	PE-DM-527-145-H002
	TITLE		DATE	20.08.2025
	DDCMS INTERFACE FOR SOLENOID DRIVE		REV.NO.	05
			SHT	11 OF 13

DCS INTERFACE FOR HT/LT UNIDIRECTIONAL DRIVES(BREAKER OPERATED)



© WHEREVER APPLICABLE

* SELECTOR SWITCH IN NORMAL(REMOTE) POSITION

NOTE:— INTERPOSING RELAYS(IPRs) TO BE SUPPLIED ALONG WITH SWITCHGEAR.

	PROJECT: 2X660 MW KORADI TPP UNIT 11&12 – BTG		DRG.NO.	PE-DM-527-145-H002
	TITLE DDCMIS INTERFACE FOR UNIDIRECTIONAL HT DRIVE		DATE	20.08.2025
			REV.NO.	05
		SHT	12	OF 13

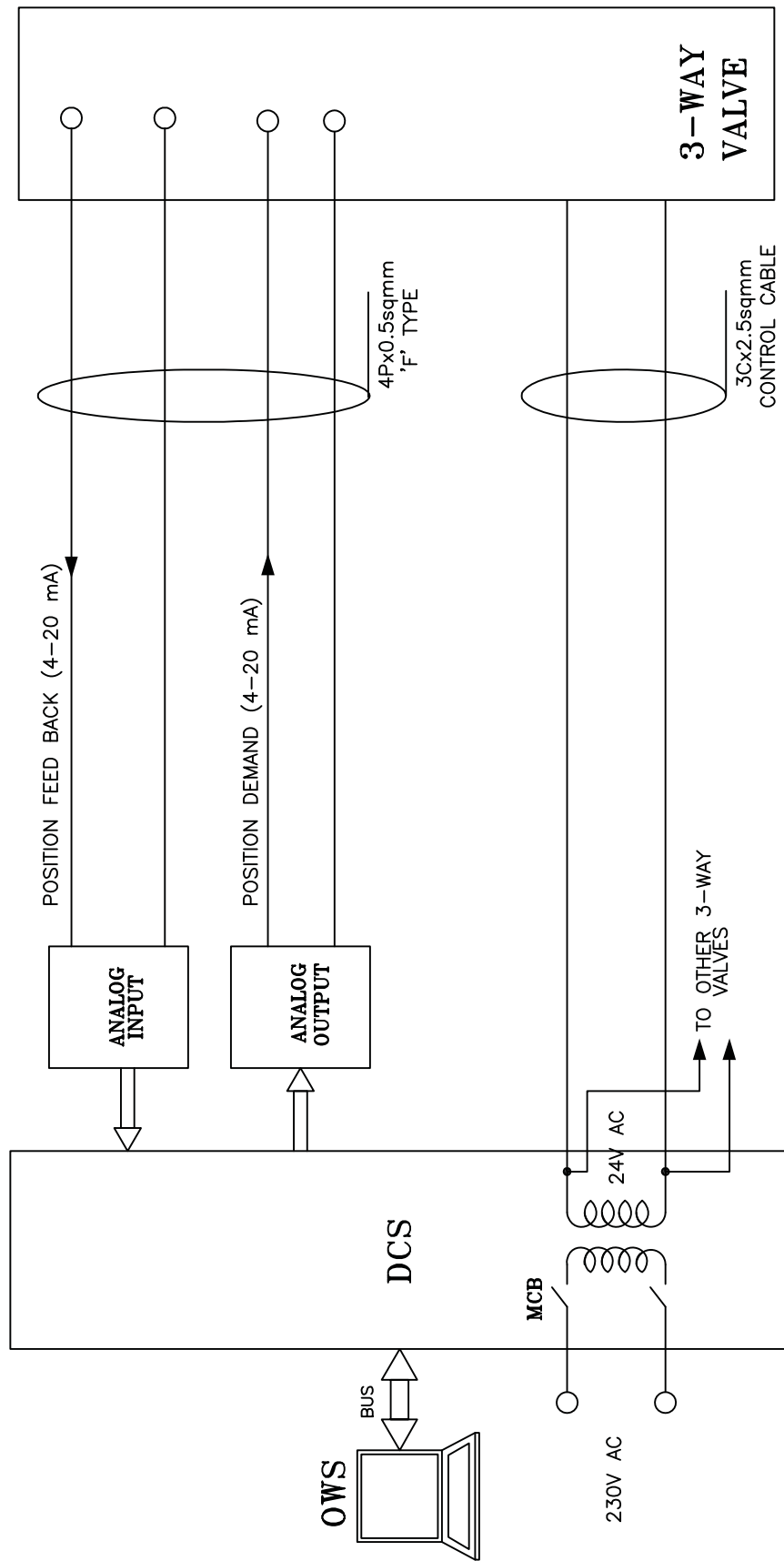
OWS



*** APPLICABLE TO VALVES WHERE PROTECTION OPEN/CLOSE ACTION FOR CONTROL DEMAND OVERRIDING IS REQUIRED.

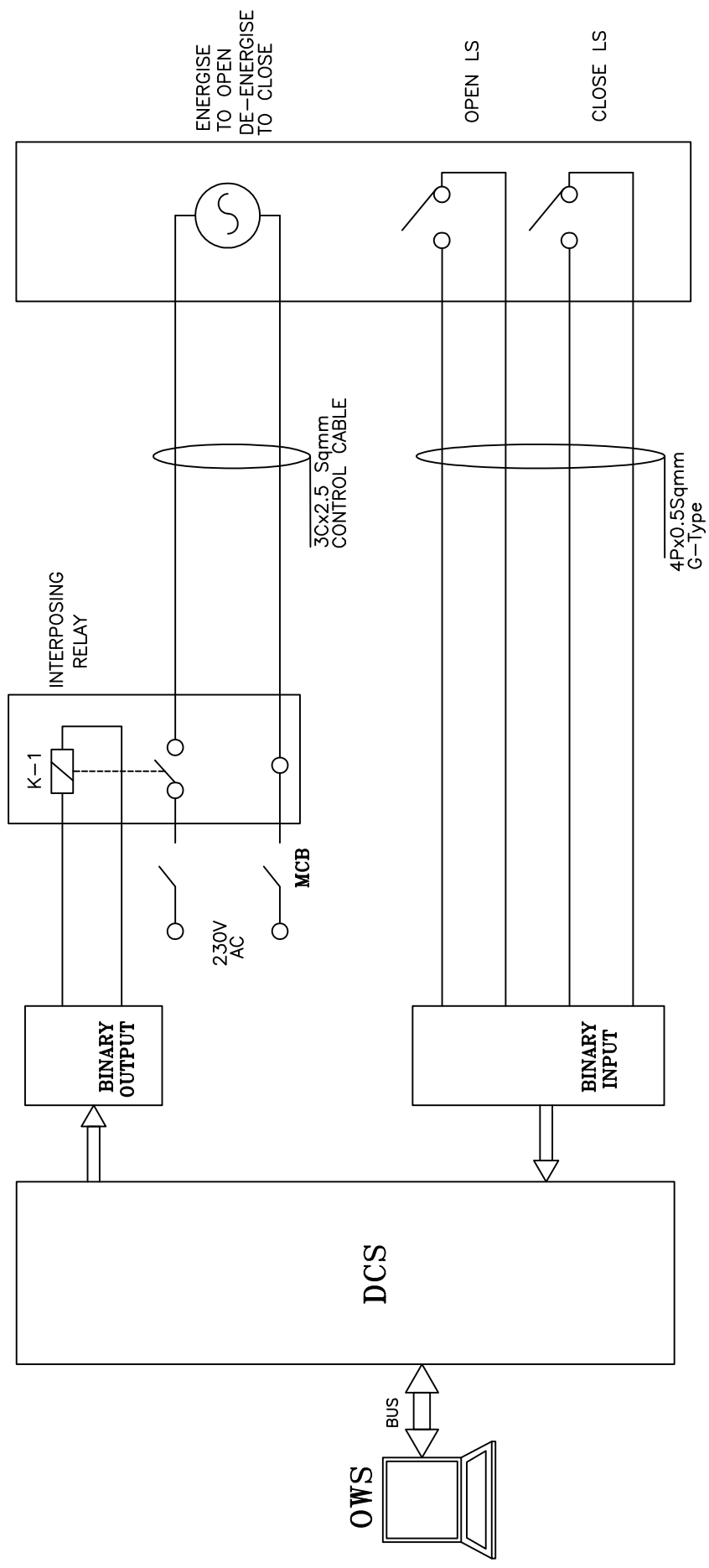
	PROJECT:		2X660 MW KORADI TPP UNIT 11&12 - BTG	DRG.NO.	PE-DM-527-145-H002
	TITLE		TYPICAL HOOK-UP DIAGRAM ANALOG DRIVE	DATE	20.08.2025
				REV.NO.	05
				SHT	13 OF 13

DCS INTERFACE FOR 3-WAY MIXING VALVE (MOD-AC)



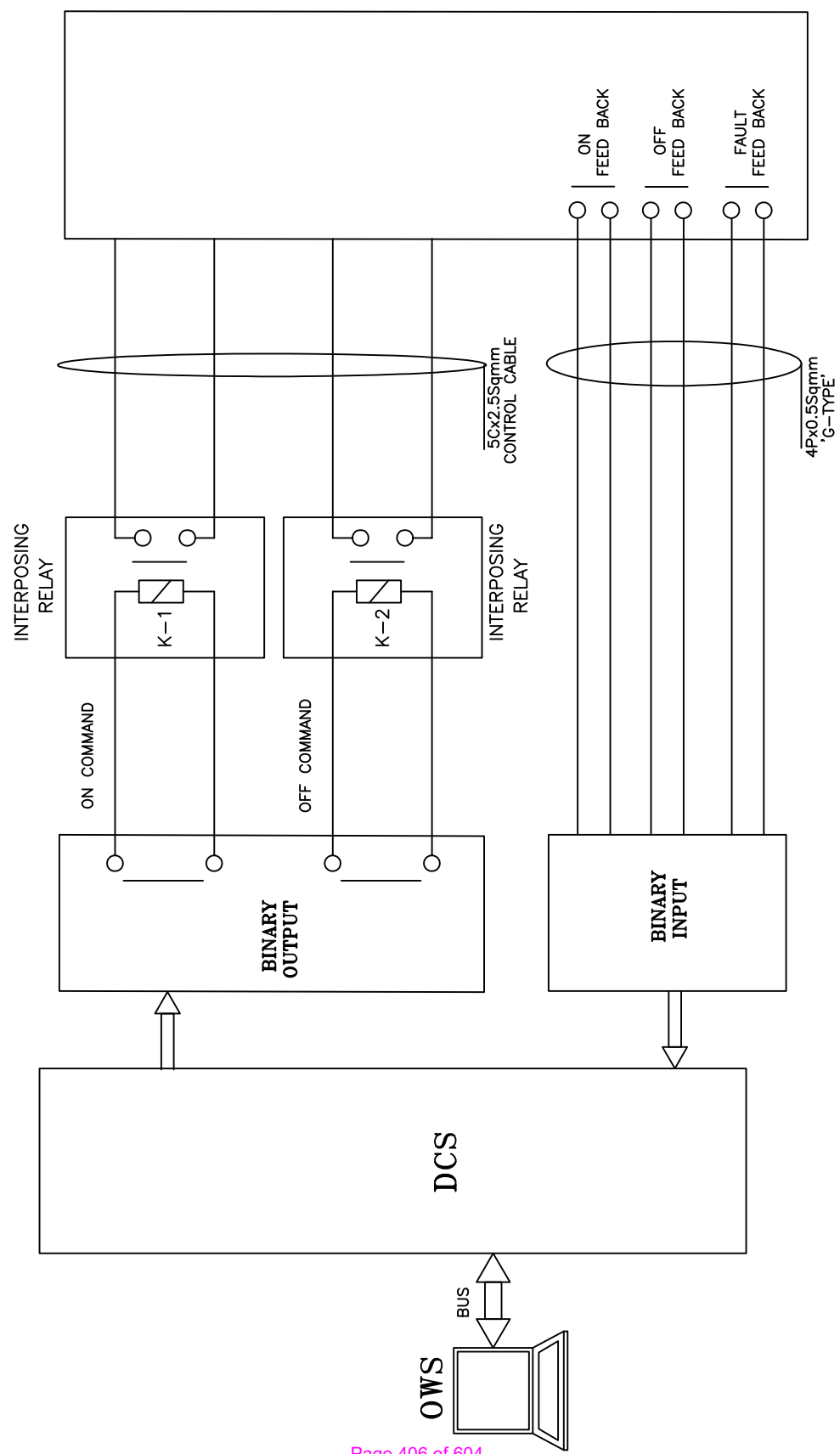
PROJECT: 2X660 MW KORADI TPS	DRG.NO.	
	DATE	
	REV.NO.	
TITLE: DRIVE INTERFACE SCHEME	SHT 2	OF 6

DCS INTERFACE FOR MOTORIZED OPERATED FIRE DAMPER (BID-FD)



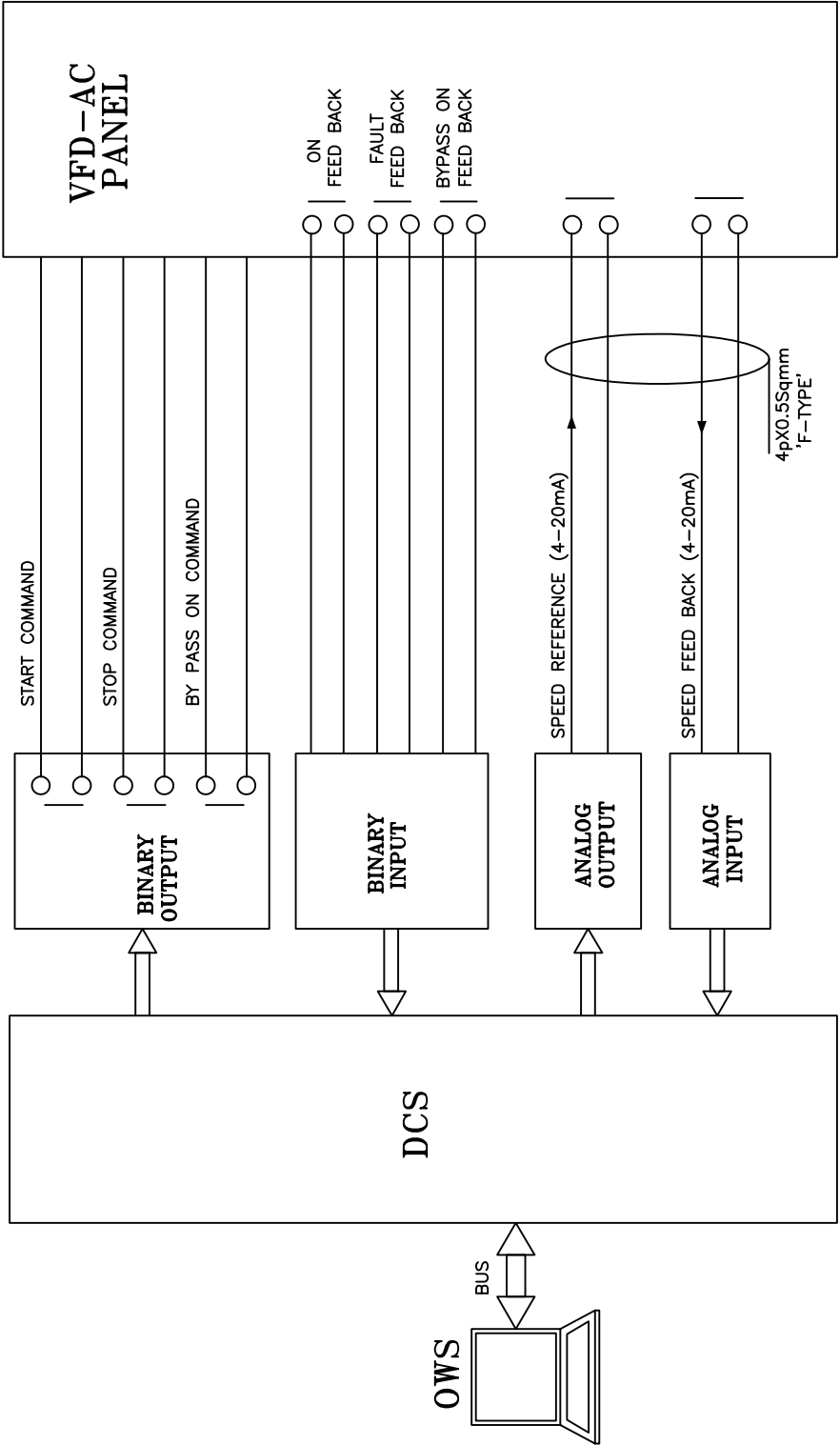
	PROJECT: 2X660 MW KORADI TPS		DRG.NO.	
	TITLE: DRIVE INTERFACE SCHEME		DATE	
			REV.NO.	
			SHT 3 OF 6	

HOOK-UP DIAGRAM FOR SCREW CHILLER MACHINE(SCM)/ACCU



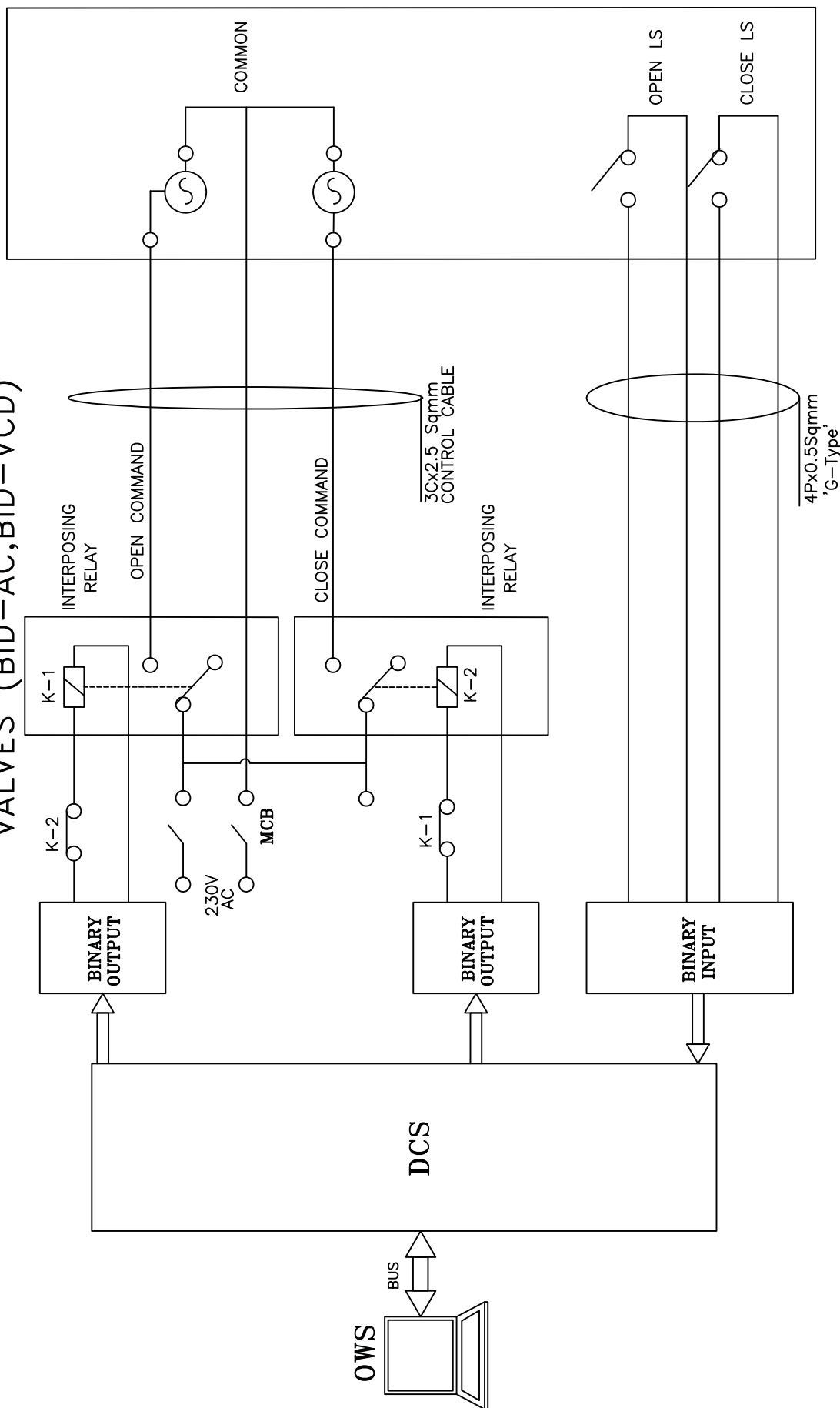
	PROJECT: 2X660 MW KORADI TPS			DRG.NO.	
	TITLE: DRIVE INTERFACE SCHEME			DATE	
				REV.NO.	
				SHT 4 OF 6	

DCS INTERFACE FOR AHUS VFD(VFD-AC)



	PROJECT: 2X660 MW KORADI TPS				DRG.NO.	
	TITLE: DRIVE INTERFACE SCHEME				DATE	
					REV.NO.	
		SHT	5	OF	6	

DCS INTERFACE FOR MOTORIZED OPERATED VALVES (BID-AC,BID-VCD)



PROJECT: 2X660 MW KORADI TPS

TITLE: DRIVE INTERFACE SCHEME

DRG.NO.

DATE

REV.NO.

SHT 6 OF 6



**KORADI THERMAL POWER STATION
2 x 660 MW UNITS - 11 & 12 PROJECT**

SECTION: C
SUB SECTION : C&I

**C&I SPECIFICATION FOR
HVAC SYSTEM**

PROCESS CONNECTION AND PIPING



8.00.00 PROCESS CONNECTION AND PIPING

8.01.00 GENERAL REQUIREMENTS

8.01.01 Process connection & piping including all impulse piping, sample piping, pneumatic piping/tubing, valves, valve manifolds, fittings and all other accessories required for proper installation & completeness of impulse piping system, sampling piping system and air supply system shall be provided by the Contractor on as required basis.

8.01.02 The rating of material of impulse pipes, tubes, fittings, valves and their installation thereof shall conform to the latest edition of standards as per following table:

Impulse Pipes, Tubes (Material, Rating)	ANSI B31.1, ANSI B31.1a, ANSI/ISA 77.70
Valves (Material, Pr. Class, Size)	ASTM A182/ASTM A105 as per ASME 16.34
Fittings (Size, Rating, Material)	ANSI B31.1, ANSI B31.1a, ASME B16.11-2009
Installation Schemes	BS 6739-2009, ANSI/ISA 77.70

Instrument air filters cum regulator set with mounting accessories shall be provided for pneumatic device requiring air supply.

8.01.03 All transmitters and switches (except for fuel oil applications) shall be suitably grouped together and mounted inside
 (i) Local Instruments Enclosures (LIE) in case of Open Areas of the Plant like Boiler Area, Coal Handling, Chimney Area, FGD area, CW Pump House, DM Plant, PT Plant, Ash Handling Plant etc.
 (ii) Local Instrument Racks (LIR) in case of covered areas like Turbine Area, Generator Area etc.
 (iii) Local Indicators/Gauges shall also be suitably grouped in Local Instrument Racks

8.01.04 In case grouping is not possible and these are to be installed individually, canopy with suitable mounting arrangement shall be provided. All electric actuators, pneumatic control valves, Junction Boxes, Solenoid boxes and Local control panels which are not installed inside building, suitable canopy shall be provided and design of canopy shall be approved by Employer during detailed engineering.

8.01.05 Local Instrument Enclosures (LIEs) and Local Instrument Racks (LIRs) complete with all fittings, mountings & accessories, drains and Utility Lighting, Cable & Grounding cable etc. shall be provided by the Contractor on as required basis. The Degree of Protection of LIE and JB of LIE/LIR shall be IP-



55. The instrument racks shall be constructed from 1.6 mm sheet plate and shall be free standing type constructed of suitable 3 mm thick channel frame of steel and shall be provided with a canopy to protect the equipment mounted in racks from falling objects, water etc. The canopy shall not be less than 3 mm thick steel and extended beyond the ends of the rack.

For skid mounted instruments and instruments integral to equipments, process connection and piping can be in line with bidder's standard and proven practice.

8.01.07 All materials supplied under this section shall be suitable for intended service, process, operating conditions and type of instruments used and shall fully conform to the requirements of this specification. The bidder is responsible for the performance of equipment furnished under this specification on system basis.

8.01.08 Bidder to note that any reducers, nipple etc. for proper connection of the impulse piping system to root valves / isolation valves / stubs etc. shall be in Bidder's scope only, unless otherwise clearly excluded.

8.02.00 IMPULSE PIPING, TUBING, FITTINGS, VALVES AND VALVE MANIFOLDS

8.02.01 All impulse pipe shall be of seamless type conforming to ANSI B36.10 for schedule numbers, sizes and dimensions etc. The material of the impulse pipe shall be same as that of main process pipe. Stainless steel tube shall be provided inside enclosures & racks from tee connection to valve manifold and then to instrument. For high pressure/temperature the material shall be ASTM A 213 TP 316H it and for other applications material shall be ASTM A 213 TP 316L. The wall thickness of the tube shall be in accordance with the ANSI B31.1 standard. The bending radius of the tube shall be greater than 6D. All fittings shall be forged steel and shall conform to ANSI B16.11. The material for bar stock tube fitting (for straight application) shall be 316 SS. Metal thickness in the fittings shall be adequate to provide actual bursting strength equal to or greater than those of the impulse pipe or SS tube, with which they are to be used.

8.02.02 The source shut-off (primary process root valve) and blow down valve shall be of 1/2-inch size globe valve type for all applications except for air and flue gas service wherein no source shut-off valves are to be provided. The end



MAHARASHTRA STATE POWER GENERATION CO. LTD.

VOLUME - III

**KORADI THERMAL POWER STATION
2x660 MW UNITS - 11 & 12 PROJECT**

PART - C

RFx No. 3000046202 (BTG Package)

TECHNICAL SPECIFICATION CONTROL & INSTRUMENTATION

REV. - 0

connections of valves shall be of socket welded type unless otherwise specified in the instrument installation diagrams The disc and seat ring materials of carbon steel and alloy steel valves be ASTM A-105 and ASTM A-182, Gr. F22, hard faced with stellite. The valve design shall be such that the seats can be reconditioned and stem and disc may be replaced without removing the valve body from the line.

8.02.03 The valve manifolds shall be of 316 stainless steel with pressure rating suitable for intended application. 2-valve manifold shall be used for pressure measurements using pressure transmitters/ pressure switches. 5-valve manifold shall be used for remaining applications like differential pressure transmitter, DP, flow and level measurements.

8.02.04 For Pr./D. P gauges in fluid application two / five valve manifold on each impulse line to the instrument and in Air / Flue gas application two valve manifold on each impulse line to the instrument shall be provided near the instrument. These shall be in addition to the three ways gauge cock provided along with the pr./D. P gauges.

8.03.00 AIR SUPPLY PIPING

8.03.01 All pneumatic piping, fittings, valves, air filter cum regulator, purge Rotameter and other accessories required for instrument air for the various pneumatic devices/ instruments shall be provided. This will include as a minimum air supply to pneumatically operated control valves, actuators, instruments, continuous and intermittent purging requirements etc.

8.03.02 Instrument air supply shall be provided for continuous purging requirements of local instrument enclosures (LIEs) and any other instrument supplied by the Bidder which requires instrument air. Service air supply shall also be provided for any other instrument supplied by the Bidder requiring service air.

8.03.03 For individual supply line and control signal line to control valve, 1/4-inch size light drawn tempered copper tubing conforming to ASTM B75 shall be used.

8.04.00 INSTALLATION AND ROUTING

8.04.01 All instrument piping, tubing and its accessories shall be supported in a safe manner to prevent excessive vibrations and anchored sufficiently to prevent undue strain on connected equipment. Instrument piping & tubing shall not be routed across equipment removal areas, above or below monorails, cranes, removable gratings, cable trays.

8.04.02 Instrument Piping System for steam and liquid measurements, the impulse pipe should preferably slope downward from source connection to instrument and instrument shall be installed below the source point. Impulse piping for air and flue gas shall slope upwards and instrument shall be installed above source point. Wherever required expansion loops shall be provided.



8.04.03 Special accessories such as condensing pots/ reservoirs shall be provided and installed wherever required. For separator level measurement required balancing chamber shall be provided and installed.

8.04.04 Colour coding of all impulse pipes shall be done by the Bidder in line with the colour coding being followed for the parent pipes.

8.04.05 The air supply headers, sub-headers and branch pipes shall be supported properly by clamps or supports to be provided and fabricated by the Bidder. Air supply piping shall be installed with a slope of over 1/100 to prevent accumulation of condensed water within the pipe. Signal/control air tubing shall run with the minimum number of changes in direction. Suitable identification tags shall be provided for easy link up and checking of proper connections. Single and multitubes shall run with the minimum number of changes in direction. Suitable identification tags shall be provided for easy check-up and for connections.

8.05.00 PIPING/TUBING SUPPORT

8.05.01 Impulse piping and sample piping shall be supported at an interval not exceeding 1.5 meters. Each pipe shall be supported individually using slotted angle mounted clamps with necessary fixtures. Tubing shall run in proper perforated trays with proper cover. Tubing shall be supported inside the trays by aluminium supports. Hangers and other fixtures required for support of piping and trays shall be provided, either by welding or by bolting on walls, ceilings and structures. Hanger clamps and other fastening hardware shall be of corrosion resistant metals and hot-dip galvanized.

8.06.00 SHOP AND SITE TESTS

Hydrostatic and pneumatic tests shall be performed on all pipes, tubing and systems and shall conform to ANSI B31.1.

8.06.01 Hydrostatic Testing

All instrument piping/ tubing shall be hydrostatically tested upon completion of erection. The test pressure shall be 1.5 times the maximum process pressure. The test shall be performed either with the testing of associated process piping or without the associated process piping (by closing the root valve). In both the cases the instrument shall be isolated by closing the shut-off valve.

8.06.02 Air Testing

All air headers & branch pipes shall be air tested by pressure decay method as per ANSI B31.1. Flexible hoses and short signal tubing shall be tested



at normal pressure for leakage. Long signal tubing shall be tested by charging each tube with air at 2 kg/ sq. cm. through a bubbler sight glass. The boiler draft and vacuum piping shall be air tested by the same method as long signal tubing.

8.07.00 LOCAL INSTRUMENT ENCLOSURE AND RACKS

8.07.01 Transmitters and switches, devices, etc. (except for all fuel oil applications which shall be mounted close to be tapping points) mounted in the field shall be suitably grouped together and mounted (i) local instruments enclosure in case of open areas of the plant like boiler area, etc. and (ii) In local instrument racks in case of covered areas. These local instrument enclosures and racks shall be furnished as per the actual requirements finalized during detailed engineering stage. The exact grouping of instruments in a particular instrument enclosure/instrument rack shall be as finalized during detailed engineering stage subject to Owner's approval.

8.07.02 LIEs / LIRs shall be of different sizes depending on the number of transmitters located in it. These dimensions along with the number of instruments shall be as finalized during detailed engineering stage without any price repercussions.

8.07.03 The internal layout shall be such that the impulse piping/ blow down lines are accessible from back side of the enclosure / rack and the transmitters etc. are accessible from front side for easy maintenance. Bulkheads, especially designed to provide isolation from process line vibration shall be installed on instrument enclosures/racks to meet the process sensing line connection requirement.

8.07.04 Anti-vibration pads shall be installed for each enclosure/ rack. The enclosures shall be constructed of 1.6 mm sheet plate and shall be of modular construction with one or more modules and two end assemblies bolted together to form an enclosure. Channel and frame shall be 3 mm thick. Double inter locking doors shall be provided. The doors shall be the three-point locking type constructed of not less than 1.6 mm thick steel.

8.07.05 Gaskets shall be used between all mating sections to achieve protection class of IP-55. The junction box for racks also shall conform to IP 55 protection class.

8.07.06 Enclosures/racks shall be reinforced as required to ensure true surface and to provide adequate support for instruments and equipment mounted therein. Centre posts or any member which would reduce access shall not be provided.

8.07.07 All liquid filled blow down lines, except those measuring vacuum shall be connected to a two-inch header which is extended through one end of the enclosure and turned downward for directing the blow down into a drain. The material of the blow down header shall be carbon steel as per ASTM A 106 Gr C.


8.07.08 Painting Color Scheme for Impulse Piping

SL No.	Area / Equipment	Impulse Pipe Ground Color		Identification Tag/Band		
		Color	RAL	Color	ISC No.	RAL
1	Air	Grey	9002	Sky Blue	101	
2	Water	Grey	9002	Sea Green	217	
3	steam	Aluminum		Signal Red	537	3001
4	Air steam mixture	Aluminum		Sky Blue	101	
5	Gas	Grey	9002	Canary Yellow	309	
6	Oils	Grey	9002	Light Brown	410	
7	Pulverized Fuel	Grey	9002	Silver Grey	628	
8	Fire Installations	Fire Red	536 (ISC) 3001 (RAL)	White		9010
9	HP Dosing	Grey	9002	Dark Admiralty Grey	632	
10	LP Dosing / acid / alkali Piping	Grey	9002	Signal Red	537	
11	Ash Piping	Grey	9002	French Blue	166	



**KORADI THERMAL POWER STATION
2 x 660 MW UNITS - 11 & 12 PROJECT**

SECTION: C
SUB SECTION : C&I

**C&I SPECIFICATION FOR
HVAC SYSTEM**

ERECTION HARDWARE



19.02.00 **Erection Practices and Guidelines**

19.02.01 The specification provides the general guidelines to be followed for the warehousing, handling, testing, erection, pre-commissioning checks and commissioning of various types of instruments and accessories.

19.02.02 Guidelines provided herein shall be adhered to while erecting an instrument or accessory in the plant beyond Control Room areas.

1. Care should be taken to avoid damage to the instruments during handling and transportation. Special care shall be taken while handling breakable, spillable, fragile and delicate items.
2. Before erection, all instruments shall be subjected to calibration and other functional checks at Bidder's site laboratory. The instruments shall be unpacked with utmost care and as per instructions furnished on the respective packages, using appropriate tools and implements.
3. All instruments, jigs, tools and tackle for the purpose of performing the tests shall be provided by Bidder.
4. All instruments shall be tagged with engraved aluminum / stainless steel tag plates and shall be secured to the instrument with metallic wire fasteners, during the test.
5. For instruments found acceptable and conforming to the declared performance parameters of the manufacturer, the test report shall be prepared.
6. Minor repairs and adjustments of the instruments shall be performed by Bidder. Once the defective instrument has been successfully repaired, it shall again be subjected to calibration and functional checks, as indicated above.
7. A record of such repairs and adjustments shall be systematically maintained by Bidder.
8. For instruments where the extent of damage is such that the same cannot be repaired at site, a failure report shall be generated by Bidder, enumerating the nature of fault / damage. Cases where the damages are only superficial and which does not affect the appearance and performance of the instrument/s, the decision as to whether such instruments are fit for erection shall solely lie with Owner / Consultant.
9. In no case, erection work shall be taken-up in areas where heavy equipment movement is foreseen, major welding activity is under progress, heavy structural items are being erected or any other major activity is being carried out or is anticipated, which may cause damage to the erected instrument or its support.
10. If any erected instrument or its accessories are found to be vulnerable to damage or to be fouling / interfering with progress of other activities in the area, same shall be dismantled / removed. During re-erection of such instruments, all the necessary steps as indicated in the specification for the erection of the instrument shall be carried out afresh.
11. After erection, the instruments shall be covered with transparent polyethylene sheets to protect from unauthorized handling.



12. Color PVC adhesive tapes shall be put on the polyethylene cover to indicate various stages of activities. Red tape shall indicate erection under progress. Yellow tape shall indicate completeness of erection. Blue tape shall imply approval of erection and Green tape shall signify the commissioning of the instrument. Adhesive paper tapes shall be fixed on the respective tapes to inscribe the dates of completion of activities
13. Location of field instruments shall be consistent with tapping points on pipes and equipment.
14. No field mounted instrument shall be installed in such a manner that it depends on rigidity of the impulse piping or the electrical connection to it for support.
15. Handrails shall not be used, in general, for mounting or supporting instruments.
16. The place where the instrument is to be installed must be easily accessible from nearest floor / platform level and there must have enough clear space to allow maintenance work and lay-down.
17. The installed position must be such as not to cause any inconvenience to repair, removal, observation, inspection and maintenance of the installed equipment and other items nearby.
18. The nearby high temperature equipment or process piping shall not give rise to any injurious effect to instruments.
19. There will be no safety valve or effluent drain point which may cause injurious effect near the instrument. In general, no instrument shall be erected in areas prone to vibration.
20. Instruments which are outside the building or shed and are not located within transmitter rack shall be provided with protective cover or canopy to provide effective protection against dust, rain, sun etc. The cover shall be provided immediately after mounting the instrument.
21. All clamps, supports, stands etc. required for installation and erection of instruments and their accessories, shall be painted.
22. No field mounted instruments shall be installed without simultaneously taking up impulse line work connected with the instrument.
23. Proper precaution is to be taken to protect the installations, instruments, accessories, devices etc. by isolation / removal from possible damages during flashing, pressure testing of main pipe lines, air headers, vessels, equipments etc.
24. Wherever practicable the height of the instrument from its working floor / platform shall be between 1000-1400 mm. The illumination at the locations where instruments are located shall be adequate so that the scales can be read unassisted.
25. Sub-trays, where required, shall be erected for proper routing of the cables and tubes and no cable shall be laid unsupported.
26. The indicating meters shall be oriented properly so that the scale can be read unassisted and unobstructed from the approach floor / platform.
27. Accessibility to all field instruments with isolation valves shall be provided with platform wherever needed.
28. For high pressure instrument tapping, double isolation valve shall be provided.


19.03.00 Field Instruments
19.03.01 Pressure / Differential Pressure (DP) Transmitters / Level Transmitters

1. Pressure and DP transmitters shall in general be transmitter rack mounted or shall be mounted locally on fabricated structures. Displacer type level and transmitters shall, however, be mounted directly on the vessel / stand pipe attached to the vessel.
2. All manifolds, cocks and valves shall be pressure tested at rated hydraulic test pressure. All air line and draft / vacuum service cocks and valves shall be leak tested.
3. Manifolds / valves shall be mounted on / connected to transmitter at Bidder's workshop / site and the assembly shall be leak tested after completion of the plumbing. The leak test shall be performed with compressed air and soap solution at pressure not exceeding the maximum overload pressure of the transmitter.
4. All tests on the transmitters shall be performed after mounting / connecting of the manifold / valve assembly.
5. For transmitters located in transmitter racks, the erection activities shall normally include mounting of the transmitter with its manifold / valve assembly on appropriate support structures in the rack with proper fasteners, viz. U-clamps, bolts etc., proper leveling of the transmitter, all pipe connections from process to the transmitter, piping from transmitter to drain valve / vent valve, supporting / clamping of the valve, pipe connections from transmitter / valve to drain pot / drain header / nearest system drain, cabling from transmitter to the rack / external junction box using flexible conduits, termination of the cable with appropriate lugs, sleeves and markers, mounting and connecting all settling chambers / damper pots / siphons etc., as applicable.
6. For transmitters mounted on stanchions, brackets etc., such supporting structures shall be designed properly to support all transmitter accessories.
7. For pneumatic transmitters (if any), all necessary work related to signal and supply air tubing shall be part of erection activity. Thus, supply air tubing from the nearest instrument air take-off points with formation of additional sub-headers, where necessary, air supply piping / tubing with all associated fittings, signal air tubing up to nearest pneumatic junction box / local controller / Control Room shall be part of transmitter erection.
8. For displacer type level transmitters, the blanks provided on the vessel / stand pipe shall be removed and the transmitter shall be mounted with proper gaskets, bolts and nuts. All nut and bolt heads shall be properly greased before tightening.
9. For external cage type level transmitters, additional supports to the transmitters in the form of bracings / pedestals, if felt necessary, shall be fabricated and erected. While supporting / mounting such structures due consideration shall be given to the movement / expansion of the main equipment.
10. For transmitters mounted on local structures, cabling shall be done up to the nearest junction box through suitable flexible / rigid conduits.



11. Attention shall be paid to allow free space for the removal of transmitter cover.
12. During installation of level instruments on vessels, if the nozzles on vessels are found to be out of alignment, necessary modification or addition of spool pieces as required, for proper installation, shall be carried out.

19.03.02 Temperature Instruments / Thermowells

1. Welded thermowells shall be welded on pipes / vessels / equipment by certified welders only and all post-weld tests shall be performed as per main pipeline specification.
2. All thermowells shall be thoroughly cleaned with air jet and wire brush before insertion of temperature gauges / element.
3. The dial of temperature gauges and switches shall be oriented properly so that the scale can be read / set point can be adjusted unassisted from the approach floor / platform.
4. Capillary type instruments shall be mounted on appropriate support structure with clamps, bolts etc.
5. Bidder shall fabricate structures for routing, supporting and protecting the capillary tubes. Capillaries shall be clamped at intervals not more than 1 meter. Capillaries shall not run unsupported.
6. The cable take-off from temperature switches / elements shall be with flexible conduits up to the nearest sub-tray / junction box. Where appreciable movements of the pipelines are expected, adequate loop lengths shall be kept in the flexible conduits to allow the movement of the elements / switches without any strain.
7. In the phase between erection and cabling work all cable entry points shall be kept plugged with PVC caps.
8. Both the elements of duplex type elements shall be terminated at the junction box.
9. All compensating cables shall be terminated with proper polarity.
10. All cables shall be cross-ferruled at both the junction box and element head end.

19.03.03 Pressure Gauges / Switches, Differential Pressure Gauges / Switches
Pressure gauges / switches and differential pressure gauges / switches shall either be directly mounted on the process pipeline or shall be mounted on local brackets, gauge boards or open racks depending on accessibility and maintainability.

19.03.04 Standalone Field Mounted Electronic Controllers

Installation, supporting, cabling, calibrating, and commissioning of field mounted standalone electronic controllers (wherever used), fabrication of necessary supporting structures, pedestals, etc. shall be deemed as a part of the erection activity.

1. Bidder shall fabricate protective enclosure of canopy wherever deemed required.



2. The structure fabricated for installing the controller must have provision for mounting the associated accessories.
3. All copper tubing from the related I/P converter to the final control element shall be done in accordance with the specification laid down elsewhere in this specification.

19.03.05 Level Gauges / Switches

Level Gauges and Switches shall either be directly mounted on the vessel or on standpipe.

1. Float and switching mechanism shall be installed only after welding and installing the cage in position.
2. Bidder shall verify the following well in advance:
 - i) Necessary access platforms, ladders are provided.
 - ii) The center line of the tap-off valves are in plumb.
3. Necessary support structures, if required for installation of external cages / gauges shall be fabricated.
4. The erection activity of Level Gauges / Switches shall normally include mounting of the instrument, to vessel / stand pipe with necessary pipes, nipples, drain / vent valve, connection of drain to nearest system drain, cabling up to external junction box using flexible conduit, termination of cable with proper sleeves, conductor marker / ferrules and lugs etc.
5. Necessary sub-trays, wherever required, shall be erected for proper routing of cable.
6. The indicating side of gauge glasses shall be so oriented that it can be read unassisted and unobstructed from the approach floor / platform.
7. Illumination in the areas where level gauges are mounted shall be adequate for the level to be visible without the help of flash light. Areas where this requirement cannot be met, gauge glasses shall be provided with internal illumination.

19.03.06 Local Panels, Racks, Cubicles, Gauge Boards Enclosure and Structures

1. Local racks, panels, gauge boards, cubicles shall be installed at specified locations. Work shall also include fabrication and installation of gauge boards, stands, mounting brackets and frames, drain headers etc. with associated painting and civil work.
2. Bidder shall erect panels / cubicles / enclosures etc. only after ensuring availability of work front.
3. The panels shall be issued from warehouse or storage yard on the same day when the actual erection is performed.
4. Panel, once uncrated, must be installed on the same day.
5. Panels supplied in packed condition, will be properly slinged for lifting. When lifting unpacked panels eye-bolts shall be used. Unpacking should be done at store or installation site only.
6. During slinging or lifting of the panel, care shall be taken not to damage the structure or any instrument / equipment mounted on the panel.



7. Panels shall be slowly lowered on its foundations and shall not be subjected on unnecessary jerk or bounce.
8. Prior to the installation of panels the foundation shall be inspected for presence of foreign matters and existence of possible defects or damage. Position, shape and dimensions of the foundation shall be verified against corresponding drawing. Pockets for grouting shall normally be on the concrete base. Bidder shall arrange anchor bolts or grouting spikes and grout the same in the pocket.
9. Accurate center lines and auxiliary lines shall be marked-off with due consideration of proper alignment and level. Base channel of panel shall be dismantled from the panel and shall be positioned and set by grouted anchor bolts. Before fixing the bolts, the panels must be properly aligned and plumbed. Only brass shims may be used for leveling of the panels. Leveling of panel should be done by the help of spirit level or similar device.
10. Bidder shall arrange to provide suitable protective coverings for the panels since unpacking and after erection to avoid any damage due to movement of men and materials in the vicinity.
11. Retouching work of painted surface of panels shall be carried out wherever required.
12. During installation of panels and panel instruments the panels must be kept in perfectly clean condition.
13. All panels shall be suitably earthed as per guidelines furnished in the specification.
14. Only construction power shall be utilized during erection of panels. Under no circumstances power lines shall be tapped-off from the panels.

19.04.00 **Junction Boxes and Pull Boxes**

19.04.01 Bidder's scope of erection of junction boxes shall include mounting of junction boxes in appropriate locations indicated in the drawings, fabrication of necessary supports, pedestals, brackets, frameworks etc., for erection and final painting of the structures and the junction boxes.

1. Junction boxes and pull boxes shall be provided for multi-pair / multi-triad / multi-core cables and compensating cables. Canopies for JB & pull-boxes are to be provided wherever required to safe-guard from rain / water.
2. Junction boxes shall be provided either with un-drilled removable gland plates or with knock-outs. Before installation gland plates shall be drilled / knock-outs shall be removed based on the cable schedule.
3. The junction boxes shall be fixed to the nearest available structures as far as possible and shall have easy access with floor or platform. In certain cases, special pedestals may have to be fabricated and grouted / bolted to nearest available structure.
4. Before installation, junction boxes may have to be assembled by fixing terminal blocks, mounting rail etc. Any other connected job shall be a part of the junction box installation.



5. Unused knock-outs in the junction boxes shall be left plugged to prevent dust and moisture entry. Open, unused gland holes shall be provided with dummy gland with check nut.
6. All necessary nuts, bolts, screws, foundation bolts etc. for mounting the junction boxes and their supporting structure shall be supplied by Bidder.
7. Identification tags for the cables shall be provided both inside and outside the junction boxes close to the glanding point.
8. Junction box mounting shall include the fabrication of steel supporting structures as well as other connected jobs. Canopy shall be provided above each junction box to protect from water, debris, etc.
9. Bidder shall arrange to repaint junction box if the paint is damaged due to improper handling. Wherever required, Bidder shall arrange to perform retouching of paint on the junction boxes. Proper identification numbers shall be labeled on the junction boxes for ease of identification.
10. After erection, junction boxes shall be covered with polyethylene sheets.
11. Ideally the height of junction boxes shall be 1000-1400 mm from the approach floor level.

19.05.00

Transmitter Racks

1. The location of transmitter racks shall normally be pre-assigned. However, depending on site conditions, some may have to be relocated at site
2. Guidelines provided for erection of panels shall apply for erection of transmitter racks, as well.
3. Impulse lines shall normally terminate at a bulk head union at the top or back side of the closed type racks. In cases when bulk heads are not available, entry holes shall be drilled (not gas cut) and properly sealed after installation.
4. Bidder shall avoid hot bending of impulse pipes inside the enclosures. All bending and forming activity should be performed outside before fixing in position.
5. Bidder shall suitably support the drain / vent valves, manifolds etc. With the necessary clamps, bolts, washers etc.
6. Bidder's scope of work shall also include terminating all rack mounted transmitters with electrical wires / cables in flexible conduits up to the terminal blocks with necessary cable and conduit supports, clamps, glands, sleeves, conductor markers / ferrules, lugs etc.
7. Cabling from transmitter rack-up to local junction box through flexible conduits, supporting and fixing of conduits at both ends, glanding of cables, ferruling and terminating are in Bidder's Scope of Work.

19.06.00

Stanchions, Site Structures and Mounting Frames

Bidder's scope of work shall include fabrication and installation of mounting frames, pedestals, canopies, protective enclosures and local gauge boards for mounting local instruments, Analyser and junction boxes. Bidder's scope shall also include mounting of the instruments in these local stanchions / pedestals / gauge / boards with all necessary mounting fixtures, piping,



painting cabling up to local junction box and any other associated civil work like chipping, grouting etc.

1. All faces supporting instruments shall be constructed with MS sheets of thickness not less than 3 mm.
2. All instruments shall be mounted as per the recommendation of the manufacturer. Associated impulse and drain pipe work and supporting of accessories, cabling up to local junction box shall be Bidder's responsibility.
3. Structures supporting indicating instruments shall be so oriented that the dials are visible unassisted from the nearest approach floor / platform. Ideally the height of instruments shall be 1000-1400 mm from the approach floor level
4. Bidder shall fabricate 3 mm MS / Aluminum canopies for shielding of instrument from direct exposure to rain.

19.07.00 Earthing

Bidder's scope of work shall include the earthing of all instruments / equipment, enclosures and other metallic parts and objects. Necessary wires, lugs, sleeves, markers / ferrules etc. shall be supplied. In addition to the general guidelines given below, Bidder shall remain responsible to follow the instrument / equipment manufacturer's grounding recommendation.

19.08.00 Control Valves and Accessories

Bidder's scope of work shall include erection of control valves along with all related accessories like air filter regulator, valve positioners, limit switches, position transmitters and indicators, solenoid valves, airlock relays, volume chambers etc. Bidder's scope of work shall also include all related interconnecting tubing work for the above accessories and terminating all electrical connections up to local junction box. Any supporting structures, pedestals etc. required to make the installation complete shall be considered part of erection activity. Bidder's scope of work also includes testing and commissioning of all pneumatic control valves.

1. The general conditions laid down for erection of field instruments shall also be valid for control valves (wherever applicable).
2. Slight reorientation of flanges, if necessary, shall be considered a part of erection activity.
3. Before installation, Bidder shall verify the adequacy and check the make / model etc. of each item with respect to the data sheet and hook-up diagrams.
4. Control valve should be identified with regard to their tag number, control action, Cv value, flow direction etc. as inscribed on the tag plate vis-à-vis the data sheet.
5. The orientation and position of the control valve shall be such that difficulties shall not arise while removing, repairing or servicing the valve after installation.
6. Bidder shall install valves only after ensuring proper flow direction.



7. The preferred position of a control valve is diaphragm up.
8. Air supply line shall be drawn from nearest air header by means of a GI sub-header to the vicinity of the installation. Isolation / needle valve to be provided on air line to each control valve / damper.
9. Tubing work shall generally comprise of tubing between I/P converter to valve positioner / solenoid valve / actuator, air supply to filter regulator from nearest GI sub-header, filter regulator to positioner / actuator.
10. Bidder's scope of cabling pertaining to control valve erection shall include cabling from solenoid valves, limit switches and electronic position transmitter up to local junction box.
11. Bidder shall include gaskets, nuts, bolts, site fabricated clamps and other erection items required to complete the installation.
12. All air piping / tubing shall be blown clean with compressed air at 3.5 Kg/sq. cm and complete lines along with fittings must be tested for leakage with soap bubbles.
13. After installation, the control valves shall be greased at greasing nipples wherever applicable.
14. After completing the installation satisfactorily in all respect, Bidder shall perform the following tests.
 - i. Linearity of stem movement shall be checked at four points (inputs 25%, 50%, 75%, 100% of spring range) while rising and while falling.
 - ii. Hysteresis shall be checked.
 - iii. Response time shall be noted.
 - iv. Operation of airlock relay shall be checked.
 - v. Operation of stay put conditions (under electrical signal failure shall be checked).
15. After testing, the valve shall be boxed up with blind gaskets at both ends to prevent entry of foreign materials and clogging of plug and seat.
16. During steam blowing / acid cleaning it may be necessary to remove the valve as a whole or in part breaking a part of top-work and reconnect the spool piece. The removal, reinstallation, dismantling and reconnection of tubing and cabling shall be in Bidder's scope of work.

19.09.00

Flow Elements

i) Orifice Plate

For orifice plates with flange taps Bidder's scope shall include fixing of nipple and first take-off valve, fixing and supporting condensation pot (wherever applicable) and insertion of orifice plate with suitable gaskets, nuts and bolts. For orifice plates with D, D/2 tapping, pipe welded stubs shall be available.

1. The length of the take-off nipples shall be sufficient so that the first take-off valve protrudes beyond the thermal insulation.
2. The take-off nipples shall be screwed / welded according to the design requirement.
3. The hand wheel of the take-off valves shall be so oriented that they can be operated conveniently from approach platform, ladder etc. Otherwise approach platform, ladder shall be provided.
4. For steam services, condensation pots shall be connected to the tapping point before or after first take-off valves. Utmost care shall be taken to ensure that both the condensation pots are at the same level. All



necessary bracing, saddle etc. shall be fabricated and used to support the condensation pots with the main pipe.

5. Orifice plates shall be inserted with proper orientation with respect to fluid flow in line.
6. Orifice plate should only be inserted in position for checking the alignment. Thereafter, it will be withdrawn and preserved till pre-commissioning activities are over.
7. Bidder shall supply suitable gaskets while fixing the orifice plates in position.
8. The orifice bar handle, shall be so oriented that the imprints are readable unassisted from the access floor of platform.
9. Bidder shall ensure proper orientation of drain or vent holes.

ii) Flow Nozzles

Flow Nozzles shall normally be shop assembled in branch pipe and welded in position with main pipe. The flow nozzles shall generally have D-D/2 tapping and shall be shop assembled with take-off nipples and root valves. Bidder's scope of work shall include connecting the condensation pots (for steam services) before installation of the differential pressure instrument.

19.10.00

Control Panels / Desks, Consoles and Cubicles / Cabinets

This section provides guidelines for the erection of desks, panels, consoles, cabinets etc., in the Control Room, Control Equipment Room, Local Control Room and other such locations.

1. After Inter-sectional bolting with necessary nuts and bolts, inter-sectional wiring shall be terminated at both ends.
2. After installation, the main incoming fuse of each panel section shall be removed and preserved till commissioning.
3. For panels, desks, consoles etc. supplied without instruments and accessories mounted on them, Bidder shall mount and terminate all instruments and desk accessories as per drawing. Bidder shall also dress and bunch the cables properly after termination is over.
4. After installation the following tests shall be carried out:
 - a) Visual inspection for proper alignment and inter-sectional services.
 - b) Meggering shall be done between terminal blocks and ground before terminating the panel instruments.
 - c) Visual inspection of surface finish for scratches & blemishes.
 - d) Tightness of nuts and bolts to be physically checked.
 - e) Dressing and bunching to internal wires after termination to panel instruments.

I. Common Control Room / Computer Room Panels / Desks and Consoles / Local Control Panels / Consoles and Desks

Bidder's scope of work shall include the installation of Operator's Terminals, Engineering Terminals, Performance Calculation Terminals and other terminals, consoles and some other peripheral devices in the Common Control Room / Computer Room / Local Control Room wherever applicable.



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VOLUME - III

**KORADI THERMAL POWER STATION
2x660 MW UNITS - 11 & 12 PROJECT**

PART - C

RFx No. 3000046202 (BTG Package)

TECHNICAL SPECIFICATION CONTROL & INSTRUMENTATION

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Associated activities shall include laying, glanding and terminating prefabricated cables, related structural work and other completing activities viz. modification of internal wirings, mounting and termination of instruments / equipment supplied loose etc.

1. Erection of panels and desks in Control Room area shall involve precise alignment and matching of surfaces. Bidder shall perform all related activities to achieve an aesthetic completion of the job. All necessary realignment, foundation work, packing and filling shall be done to compensate for shifting, waviness, misalignment etc.
2. When bolting the panel sections, care shall be taken not to leave excessive strain on any of the surfaces. All necessary packing and filling materials shall be provided.
3. Instruments and accessories supplied loose for mounting on panels shall be installed only after installation of the panels.
4. Tools and tackle recommended by the desk / panel / console manufacturer shall only be used.
5. No element shall be forced or hammered into its slot.
6. If matching prefab connectors are available in pig-tail form the properness of connection shall be checked by Bidder before plugging-in. Bidder shall be fully responsible for improper connection of the connectors.
7. Bidder's activities shall also include splitting of gland plates, if required, to admit plug-in connector, mounting of special cable clamps on the gland plates and dressing, routing and clamping of the prefabs within the panel / desk / console.



19.11.00

Panel Mounted Instruments (For Local Panel, wherever Applicable)

1. Before erection all instruments and accessories shall be subjected to visual and calibration checks and other functional checks as per manufacturer's standard at site laboratory
 2. All instruments, jigs, tools and tackle for the purpose of performing the tests shall be provided by Bidder.
 3. Minor repairs, adjustments of the instruments and accessories shall be performed. Once the instrument has been successfully repaired it shall be subjected to test, afresh.
 4. A record of such repairs and adjustments shall be systematically maintained.
 5. If any erected instrument or its accessories are found to be vulnerable to damage or to be fouling / interfering with progress of other activities in the area, same shall be dismantled / removed.
 6. During re-erection of such instruments, all the necessary steps as indicated in this specification for the erection of the instrument shall be carried out afresh.
 7. Completion of erection of any panel mounted instrument or accessory shall be signified by its mounting, fixing, termination, power connection, earthing, touch-up painting, tagging of the instrument and mounting of its title plate.
 8. On completion of erection, a certificate signifying Owner / Consultant's approval to erection, in an agreed proforma, shall be obtained from Owner / Consultant after joint inspection of the erected instrument by Owner / Consultant and Bidder.
 9. After obtaining the completion certificate, all power line fuses of instruments shall be removed by Bidder and shall be kept in his custody only to be reinserted when directed by Owner / Consultant.
- I. Panel Mounted Indicators
 1. Instruments shall be carefully unpacked so that no damage occurs to the instruments during unpacking.
 2. Clamps, clips or saddles if provided to lock the servo mechanism during shipment shall be removed carefully to free the movements.



3. Mechanical checking for freedom of movement of the instruments within its mounting bin and locking in position shall be performed where applicable.
4. Instruments shall be calibrated for indication accuracy at least at four points on the scale. Repeatability and hysteresis of indication and signaling contacts shall also be checked by adjusting the set points at four points of the scale.
5. After calibration, the multiplication factor, tag number, service inscriptions shall be properly affixed on instruments in cases where such inscriptions are not already present or factory inscriptions need to be changed.
6. The panel cut-outs shall be checked for properness of dimension, smoothness of edges etc. and necessary minor modification work on the panel, if required shall be performed by Bidder.
7. The mounting bin wherever applicable shall be installed, leveled and plumbed at location first, without the instrument and shall be terminated with proper lugs only.
8. Instruments mounted in bins shall have flexible connector connected both at bin and instrument end. The instrument shall be powered from Bidder's test power pack through panel terminal block and the span and zero of the instruments shall be rechecked and adjusted if necessary.

II. Electrical Transducers

1. This category of instruments shall include AC/DC current transducers, voltage transducers, MVAR transducers, MW transducers, Frequency transducers, PF transducers, etc. Bidder's scope of work shall include mounting and terminating these instruments in position on transducer panel located in CER as per approved drawings.
2. Bidder shall test and calibrate the instruments. The special testing equipments, if required, shall be provided by Bidder.

III. Desk / Panel Accessories

A few control and instrumentation items of various packaged equipment are to be installed, as per approved mounting drawings supplied by the equipment supplier. Following is the procedure to be adapted for erection of the same:

1. Bidder's scope of erection shall include mounting, connecting and terminating the desk accessories along with their respective tag plates, as applicable, on the Panels / desks.
2. All loose supply items shall be carefully unpacked to avoid damage to the surface, connectors, contacts or lenses.
3. The panel cut-outs shall be checked for properness of dimension, smoothness of edges etc. and necessary minor modification work on the panel, if required, shall be performed.
4. Manufacturer's recommended tools and tackle shall only be used.

5. Prefab cables may be kept coiled and supported in the panel in the form of pig-tails. Such strapping shall be removed carefully before plugging-in the connector plugs.
6. All connectors shall be properly identified before coupling. Plugs shall be properly oriented before connection. Bidder may be required to connect additional isolating diodes within the connectors if envisaged by Owner / Consultant.

IV. Annunciation System (For Local Panel based systems)

1. Minor modifications in the desk / panels, if required, shall be carried.
2. Bidder shall check the fascia inscriptions and their positions with respect to drawings and carry out any rearrangement or reallocation of existing fascia inscriptions.
3. Annunciation push buttons (Accept / Test / Reset) and hooters shall be mounted in position and wired up to fascia terminal block or logic cabinet, as required.
4. The testing of annunciation system shall comprise of :
 - System test for sequence
 - Point wise status acceptance test (initiation test)
 - IR check at logic cabinet and fascia w.r.t ground
 - Operation of push buttons and hooters.

19.16.06
Criteria for Handing-over of Control & Instrumentation System

1. Bidder shall apply in writing to Owner / Consultant for handing over of the complete Control & Instrumentation System after successful demonstration of tests as specified up to "Availability Guarantee Test".
2. Owner / Consultant shall take over charge of the C&I system subject to fulfilment of the conditions enumerated hereunder:
 - a) All site check-list prepared by Owner / Consultant are fruitfully attended by Bidder and certified by Owner / Consultant.
 - b) All Operation / Instruction manuals are updated to incorporate changes made up to Availability Test Run.
 - c) All Close loop controls, Binary & Sequential controls should be working on auto and all interlocks are demonstrated to be functional.
 - d) All equipment and system supplied by Bidder are in working condition.
 - e) All short supply items, as per Contract, are refurbished by Bidder.
 - f) The above conditions are in addition to fulfilment of any / all other contractual obligations of Bidder towards Owner / Consultant. Partial handing-over of systems / equipments shall not be permissible, except if desired so by Owner / Consultant in special cases.



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SECTION: C
SUB SECTION : C&I

**C&I SPECIFICATION FOR
HVAC SYSTEM**

QUALITY ASSURANCE PLAN/CHECK LIST


7.00.00 QUALITY ASSURANCE AND CONTROL

7.01.00 All materials, components, structures and equipments covered under this specification shall be tested/checked at all stages of procurement, manufacturing, construction, erection, commissioning as per a comprehensive quality assurance programme.

7.02.00 The bidder including his suppliers and sub-contractors shall prepare their quality plans in line with the requirements of the specification and standard practices and implement it after approval by the owner and owner's consultant. This will include both Manufacturer's Quality Plans (MQPs) and Field Quality Plans (FQPs). MQPs and FQPs shall be submitted well in advance so that the same can be reviewed and approved by owner/owner's consultant well in advance before start of works.

7.03.00 Manufacturing quality plan shall detail out, for all the components, equipments & items various tests/inspection to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by bidder's quality control organization, the relevant reference document and standards, acceptance norms and inspection documents raised etc. during all stages of material procurement, manufacture, assembly and final testing/performance testing.

7.04.00 Field quality plans shall be submitted and shall detail out for all the items, the quality practices and procedure etc. to be followed by the bidder's site quality control organization during various stages of site activities including receipt of materials/equipments at site, preservation and storage, pre-assembly, fabrication, construction, erection, pre-commissioning and commissioning. The bidder shall provide all necessary means for execution of inspection and testing, according to the requirements including specialised instruments if any.

7.05.00 The bidder has primary responsibility for ensuring the quality of items of equipment supplied under the contract and remains accountable when manufacture or erection is subcontracted.

7.06.00 It is therefore a requirement of the specification that work is only subcontracted to companies with effective quality control organizations and that the bidder monitors the performance of these by the attendance at tests of experienced

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inspectors employed by the bidder. The bidder shall, at the appropriate time, prove that his material and/or equipment comply with all the requirements of this specification, such proof being the successful completion of tests and inspections.

- 7.07.00 Routine test and type test certificates shall be submitted for each item of equipment, wherever applicable.
- 7.08.00 All materials, components and equipment supplied under the contract shall be subject to inspection by the owner, his authorised representative or any statutory authority like IBR inspector, should they so require during manufacture, construction, erection and after completion.
- 7.09.00 No materials/equipment shall be dispatched from the manufacturer's works before the same is either accepted subsequent to pre-dispatch final inspection including verification of records of all previous tests/inspections by the owner/owner's authorized representatives, or such pre-dispatch final inspection is waived by the Owner and dispatch is authorized after review of test reports.
- 7.10.00 All materials used or supplied shall be accompanied by valid and approved material certificates and test and inspection reports and dispatch clearance duly approved by the Owner. These certificates and reports shall indicate the acceptable identification number of the material they proposed to certify. The material certified shall also have the identification details stamped on it.
- 7.11.00 All material used for equipment construction including castings and forgings etc. shall be of tested quality as per relevant codes/standards. Details of results of the test conducted to determine the mechanical properties, chemical analysis and details of heat treatment procedures recommended and actually followed shall be recorded on certificates and time temperature chart. Tests shall be carried out as per applicable material standards and/or agreed details.
- 7.12.00 All the sub-vendors proposed by the bidder for procurement of major bought out items including castings, forgings, pumps, heat exchangers, semi finished and finished components/equipment - (list of which shall be drawn up by the bidder and finalized with the owner) shall be subject to owner's approval.
- 7.13.00 All welding shall be carried out as per welding procedure drawn and qualified in accordance with requirements of ASME Section IX. Welding procedures shall be submitted to the Owner for approval prior to carrying out qualification test in the presence of Owner's representative.
- 7.14.00 All welders/welding operators employed on any part of the contract either in the Supplier's works or at site or elsewhere shall be qualified as per ASME Section-IX.
- 7.15.00 Test results of qualification tests and specimen testing shall be furnished to the Owner/owner's authorized representative for approval. However, wherever required by the Owner, tests shall be conducted in presence of Owner's/owner's authorized representative.
- 7.16.00 All the heat treatment results shall be recorded on time temperature charts and verified with recommended regimes.

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- 7.17.00 The type and extent of inspection of items shall be in accordance with the relevant International/Indian Standards/Indian Boiler Regulations and other standards approved by the owner/owner's representative, supplemented or amended by the requirements of this section of the specification or as specified elsewhere in the Specification.
- 7.18.00 Wherever owner's/owner's representative's (inspector) witness is required as per approved quality plans or inspection categorisation plans, the owner and owner's representative shall be notified (inspection call) along with all required details including details of item to be inspected, approved MQPs, address/place of inspection, inspection date etc, at least 21 days in advance, prior to the planned inspection date at manufacturer's works. All test reports and supporting documents shall be made available to owner's inspector at the time of inspection; irrespective of whether it has been furnished earlier.
- 7.19.00 All site inspections as per approved FQP shall be notified along with all details including details of item to be inspected, location, inspection protocols etc., at least 5 working days in advance.
- 7.20.00 The owner/owner's representative, within fifteen days from the date of receipt of such notice/inspection call, shall intimate the bidder, the probable date of visit for the inspection. All efforts shall be taken by the owner to ensure that such date shall not be later than eight days from the date of inspection as intimated by the bidder.
- 7.21.00 If the owner or his representative does not attend on the notified date or in the event the owner grants waiver for such inspection, the test may be proceed as per approved quality plan, unless an alternative date has been requested by the Owner.
- 7.22.00 Participation by owner/owner's representative in or their absence from or failure to participate in any Tests (other than the Performance Tests) shall not relieve or absolve the Bidder from any Guarantee or Warranty or obligations of services under or in pursuance of the contract.
- 7.23.00 In the event, the inspector could not witness the inspection on the scheduled date for the reasons attributable to the bidder/subcontractor; all the costs of deputing the inspector shall be borne by the bidder.
- 7.24.00 With respect to site inspections, the bidder shall, wherever required, give due notice to the owner/owner's representative whenever work is ready before covering up or putting out of view. The inspector shall then either carry out the inspection, examination, measurement or testing or notify the bidder that it is waived.
- 7.25.00 If the inspector is not satisfied with any test and requires a re-test, the tests shall be repeated under the same terms and conditions. If such retesting demonstrate that the work, equipment or material being so tested conforms to the requirements of Contract, then the owner shall bear the cost of such additional Test and the cost of any required uncovering and covering the goods and shall grant the extension of time for completion, if necessary. If however such retesting confirms inspector's conclusion and cause the owner to incur additional costs, such costs shall be recoverable from the bidder.

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7.26.00 If, as a result of inspection, examination or testing, the inspector decides that any equipment, system, materials, design or workmanship has failed in such inspection, examination or tests or is defective or otherwise not in accordance with the contract, the inspector may reject such equipment, system, materials, design or workmanship and shall notify the bidder promptly, stating his reasons. The bidder shall then promptly correct or replace, such item or portion so as to pass retesting and otherwise meet and conform to such requirements. No changes to project schedule or increase in the price shall be granted with respect to such additional testing. Bidder shall bear any cost resulting due to such rejections.

7.27.00 Notwithstanding anything contained hereinabove, the pressure parts of the boiler coming under the ambit of statutory inspection (IBR), shall be carried out by the owner's personnel only.

7.28.00 Reference to special codes and standards, where designated either directly or as "relevant", is intended to provide a measure of performance, safety, in-shop and on-site testing, and methods of construction and/or installation which must be equal or superior in order to be considered acceptable for use under this specification. If more than a single degree of quality or accuracy is permitted within the scope of particular code or standard, the highest quality shall be applicable and the degree of accuracy commensurate with the intended function shall be selected, but with the understanding that the final decision will be made by the Owner.

7.29.00 The bidder shall include in its proposal a comprehensive Quality Assurance Programme containing the overall quality management and procedures which it proposes to follow in the performance of the works to maintain the quality of product during various phases.

7.30.00 At the time of award of Contract, the detailed Quality Assurance Programme to be followed for the execution of the Contract will be mutually discussed and agreed to and such agreed programme should form a part of the Contract.

7.31.00 Test Certificate and Documentation

7.31.01 The results of all tests shall be certified by the manufacturer, bidder or independent agency as appropriate.

7.31.02 On completion of the inspection/tests, the bidder shall furnish the inspection report and test certificates as per the approved quality plans to the owner for approval and despatch clearance. The test reports shall invariably indicate identification data, including Model No., Sr. No., Billing Break-up reference etc. of the equipment, method of application and duration of test along with test results.

7.31.03 Document files containing material certificates, welding procedures, test report etc. shall be compiled for each item of plant and shall be suitably identified (including equipment classification reference) and bound.

7.31.04 Four copies of each document file containing inspection reports and certificates of site erection testing activities of a particular item of plant or system shall be supplied to the Owner prior to commissioning.

7.31.05 Copies of the performance and acceptance test reports shall be prepared and distributed as specified in Clause 'Performance and acceptance test data and reports' of this Section. All documentation as required by IBR shall also be prepared and submitted.

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7.31.06 Soft copies of above shall also be submitted.

		MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS		STANDARD QUALITY PLAN					SPEC. NO. :		DATE:			
				PROJECT:		CUSTOMER :		Q.P NO.: PE-QP-999-145-1056		DATE: 07.02.2020				
												ITEM: LOCAL CONTROL PANEL		SYSTEM: C&I
SL. NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	7	8	9	D	M	C	N
1	2	3	4	6	M	C/N								
3.0	Cables / Wires	1. Visual / Surface defects 2. IR and HV 3. Conductor a) Resistance b) Size c) Sheet colour	MA MA MA	Visual Electrical Electrical Measurement Visual	100% 100% 100% 100%	10% 10% 10% 10%	IS:1554 or IS:694 IS:1554 or IS:694 IS:1554 or IS:694 IS:1554 or IS:694	IS:1554 or IS:694 IS:1554 or IS:694 IS:1554 or IS:694 IS:1554 or IS:694	Inspection Report Inspection Report Inspection Report Inspection Report	✓ ✓ ✓ ✓	P/W P/W P/W P/W			
4.0	Electrical Components like Annunciator Transformers Lamps Switches PBs Contactors Relays	1. Verification at make and Type 2. Verification of Test Certificates 3. Operation / Functional check	CR CR CR	Visual Scrutiny of Type / Routine T.Cs. Electrical	Sample 100% Sample + 100%	Sample 10% Sample + 10%	Approved Drg/Datasheet Relevant Indian Std & Catalogue Relevant Indian Std & Catalogue	Approved Drg/Datasheet Relevant Indian Std & Catalogue Relevant Indian Std & Catalogue	Test Certificate Inspection Report Inspection Report	✓ ✓ ✓	P/W P/W P/W			+ for relay & contactors only

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:	<i>[Signature]</i> 19/07/2018	CHETAN MALIK	Checked by:	<i>[Signature]</i> 20/07/2018	KUNDAN PRASAD
Reviewed by:	<i>[Signature]</i> 19/07/2018	RK RAINA	Reviewed by:	<i>[Signature]</i> 19/07/2018	RK JAISWAL

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS		STANDARD QUALITY PLAN				SPEC. NO. :		DATE:		
PROJECT:		CUSTOMER :				QP NO.: PE-QP-999-145-1056		DATE: 07.02.2020		
ITEM: LOCAL CONTROL PANEL		PROJECT:				PO NO.: --		DATE: --		
SYSTEM: C&I		SECTION: C				SHEET 4 OF 9				
SL. NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY	REMARKS
1	2	3	4	5	6	7	8	9	M C N	
6.0	Blanking / Bending / Forming	1. Dimensions 2. Surface defects after bending	MI MA	Measurement Visual	100% 100%	Approved Drg/Datasheet Manufacturing Standard	Approved Drg/Datasheet Manufacturing Standard	Inspection Report Inspection Report	PW PW	
7.0	Nibbling / Punching	1. Cutout Sizes 2. Deburring	MI MA	Measurement Visual	100% 100%	Approved Drg/Datasheet Approved Drg/Datasheet	Approved Drg/Datasheet Approved Drg/Datasheet	Inspection Report Inspection Report	PW PW	
8.0	ASSEMBLY Frame Assembly & Sheet fixing	1. Dimensions 2. Alignment 3. Welding Quality 4. Surface defects	MA MA MA MA	Measurement Measurement Visual Visual	100% 100% 100% 100%	Approved Drg/Datasheet Approved Drg/Datasheet Approved Drg/Datasheet Approved Drg/Datasheet	Approved Drg/Datasheet Approved Drg/Datasheet Approved Drg/Datasheet Approved Drg/Datasheet	Inspection Report Inspection Report Inspection Report Inspection Report	PW PW PW PW	

ENGINEERING				QUALITY	
Prepared by:	Sign & Date	Name	Checked by:	Sign & Date	Name
by: <i>[Signature]</i>		CHETAN MALIK	by: <i>[Signature]</i>		KUNDAN PRASAD
Reviewed by: <i>[Signature]</i>		RK RAINA	Reviewed by: <i>[Signature]</i>		RK JAISWAL

BIDDER/ SUPPLIER	
Sign & Date	Seal

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS		STANDARD QUALITY PLAN				SPEC. NO.:		DATE:			
		CUSTOMER :		QP NO.: PE-QP-999-145-1056		DATE: 07.02.2020					
		PROJECT:		PO NO.: -		DATE: -					
		ITEM: LOCAL CONTROL PANEL		SYSTEM: C&I		SECTION: C		SHEET 5 OF 9			
SL. NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY	REMARKS
1	2	3	4	5	6	7	8	9	10	11	12
9.0	Pre-treatment and Painting	1. Pretreatment Process	MA	Visual	100%	10%	Manufacturing Standard	Manufacturing Standard	Inspection Report	PW	V
		2. Process parameters like bath temp. concentration etc.	MA	Measurement	Periodic	Periodic	Manufacturing Standard	Manufacturing Standard	Inspection Report	PW	V
		3. Dipping / Removal Time	MA	Measurement	100%	10%	Manufacturing Standard	Manufacturing Standard	Inspection Report	PW	V
		4. Surface quality after every dip	MA	Visual	100%	10%	Manufacturing Standard	Manufacturing Standard	Inspection Report	PW	V
		5. Primer after phosphating	MA	Visual, Thickness	100%	10%	Manufacturing Standard	Manufacturing Standard	Inspection Report	PW	V
		6. Putty Application & Rubbing after primer	MA	Visual	100%	10%	Manufacturing Standard	Manufacturing Standard	Inspection Report	PW	V
		7. Paint first coat	MA	Visual, Thickness	100%	10%	Manufacturing Standard	Manufacturing Standard	Inspection Report	PW	V

BHEL				BIDDER/ SUPPLIER				FOR CUSTOMER REVIEW & APPROVAL			
ENGINEERING		QUALITY		Sign & Date		Sign & Date		Doc No:		Sign & Date	
Prepared by:	Signature	Name	CHETAN MALIK	Checked by:	Signature	Name	KUNDAN PRASAD	Reviewed by:	Signature	Name	Seal
Reviewed by:	Signature	Name	RK RAINA	Reviewed by:	Signature	Name	RK JAISWAL	Approved by:	Signature	Name	Seal

MANUFACTURER/ BIDDER/ SUPPLIER		STANDARD QUALITY PLAN				SPEC. NO. :		DATE:			
NAME & ADDRESS		CUSTOMER :				QP NO.: PE-QP-999-145-1056		DATE: 07.02.2020			
PROJECT:		ITEM: LOCAL CONTROL PANEL				PO NO.: -		DATE: -			
SYSTEM: C&I		SECTION: C				SHEET 6 OF 9					
SL. NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY	REMARKS	
1	2	3	4	5	6	7	8	9	10		
					M	C/N			M	C	N
					100%	10%			P/W	V	
					100%	10%			P/W	V	
10.	Panel Wiring	1. Wiring Layout 2. Wiring Termination (Crimped Lugs) 3. Ferrule numbers 4. Colour of wiring 5. Size of Conductor	MA MA MA MA MA	Visual Visual Visual Visual Measurement	100% 100% 100% 100% 100%	Approved Drg/Datasheet Approved Drg/Datasheet Approved Drg/Datasheet Approved Drg/Datasheet Approved Drg/Datasheet	Inspection Report Inspection Report Inspection Report Inspection Report Inspection Report	Inspection Report Inspection Report Inspection Report Inspection Report Inspection Report	P/W P/W P/W P/W P/W		
11.	Component Mounting	1. Correct components 2. Fixing	MA MA	Visual Visual	100% 100%	Approved Drg/Datasheet Approved Drg/Datasheet	Inspection Report Inspection Report	Inspection Report Inspection Report	P/W P/W		

BHEL			
ENGINEERING		QUALITY	
Sign & Date	Name	Sign & Date	Name
Prepared by:	CHETAN MALIK	Checked by:	KUNDAN PRASAD
Reviewed by:	RK RAINA	Reviewed by:	RK JAISHWAL

BIDDER/ SUPPLIER	
Sign & Date	Seal

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

MANUFACTURER/ BIDDER/ SUPPLIER		STANDARD QUALITY PLAN				SPEC. NO. :		DATE:			
NAME & ADDRESS		CUSTOMER :				QP NO.: PE-QP-999-145-1056		DATE: 07.02.2020			
		PROJECT:				PO NO.: -		DATE: ~			
		ITEM: LOCAL CONTROL PANEL				SYSTEM: C&I		SECTION: C			
SL NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY	REMARKS
					M	C/N					
1	2	3	4	5	6		7	8	9	**	
12.	FINAL TESTING										
	1. Workmanship	MA	Visual	100%	10%	Manufacturing Standard	Inspection Report	✓	W	At Random by BHEL, based on 100 % Internal test reports by Mfr.	
	2. Component layout (neatness, accessibility & safety) Mounting / Proper fixing of all components	MA	Visual	100%	10%	Approved Drg/Datasheet	Inspection Report	✓	W		
	3. Components identification Marking / Name plates	MA	Visual	100%	10%	Approved Drg/Datasheet	Inspection Report	✓	W		
	5. Dimensions	MA	Measurement	100%	10%	Approved Drg/Datasheet	Inspection Report	✓	W		
	6. Door functioning	MA	Functional	100%	10%	Approved Drg/Datasheet	Inspection Report	✓	W		
	7. Paint Shade	CR	Visual	100%	10%	Approved Drg/Datasheet	Inspection Report	✓	W		

BHEL				BIDDER/ SUPPLIER				FOR CUSTOMER REVIEW & APPROVAL			
ENGINEERING		QUALITY		BIDDER/ SUPPLIER		FOR CUSTOMER REVIEW & APPROVAL		Doc No:		Sign & Date	
Prepared by:	Sign & Date	Name	Checked by:	Sign & Date	Name	Reviewed by:	Sign & Date	Name	Seal	Reviewed by:	Seal
by: <i>[Signature]</i>	<i>15/02/2020</i>	CHETAN MALIK	by: <i>[Signature]</i>	<i>15/02/2020</i>	KUNDAN PRASAD	by: <i>[Signature]</i>	<i>15/02/2020</i>	RK RAINA	<i>[Signature]</i>	by: <i>[Signature]</i>	<i>15/02/2020</i>
by: <i>[Signature]</i>	<i>15/02/2020</i>	RK RAINA	by: <i>[Signature]</i>	<i>15/02/2020</i>	RK JAISWAL	by: <i>[Signature]</i>	<i>15/02/2020</i>			by: <i>[Signature]</i>	

		MANUFACTURER/ BIDDER/ SUPPLIER			STANDARD QUALITY PLAN			SPEC. NO. :		DATE:	
		NAME & ADDRESS			CUSTOMER :			QP NO.: PE-QP-999-145-1056		DATE: 07.02.2020	
					PROJECT:			PO NO.: --		DATE: --	
					ITEM: LOCAL CONTROL PANEL			SYSTEM: C&I		SECTION: C	
										SHEET 8 OF 9	

SL. NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY				REMARKS
					M	C/N			9	D	M	C	N		
1	2	3	4	5	6		7	8	9	✓	P/W	W			
		8. Paint Thickness	CR	Measurement	100%	10%	Approved Drg/Datasheet	Approved Drg/Datasheet	Inspection Report	✓	P/W	W			
		9. Workmanship of Gaskets	MA	Visual	100%	10%	Manufacturing Standard	Manufacturing Standard	Inspection Report	✓	P/W	W			
		10. Wiring Layout	MA	Visual	100%	10%	Approved Drg/Datasheet	Approved Drg/Datasheet	Inspection Report	✓	P/W	W			
		11. Wire Termination	MA	Pulling manually	Sample	Sample	---	Firm termination	Inspection Report	✓	P/W	W			
		12. Continuity	MA	Electrical	100%	10%	---	Continuity OK	Inspection Report	✓	P/W	W			
13.	TYPE TEST	Degree of Protection	CR	Mech. Protection	Sample	Sample	Approved Drg/Datasheet	Approved Drg/Datasheet	Type Test Certificate	✓	P/W	V			
14	ROUTINE TEST	IR before & after HV Test	CR	Electrical	100%	10%	Approved Drg/Datasheet	Approved Drg/Datasheet	Inspection Report	✓	P/W	W			

BHEL				BIDDER/ SUPPLIER				FOR CUSTOMER REVIEW & APPROVAL			
ENGINEERING		QUALITY		Sign & Date		Sign & Date		Doc No:		Reviewed by:	
Prepared by:	Signature	Name	CHETAN MALIK	Checked by:	Signature	Name	KUNDAN PRASAD	Sign & Date	Signature	Name	Seal
Reviewed by:	Signature	Name	RK RAINA	Reviewed by:	Signature	Name	RK JAISWAL	Sign & Date	Signature	Name	Seal

		MANUFACTURER/ BIDDER/ SUPPLIER		STANDARD QUALITY PLAN				SPEC. NO.:		DATE:		
		NAME & ADDRESS		CUSTOMER :		PROJECT:		QP NO.: PE-QP-999-145-1056		DATE: 07.02.2020		
				ITEM: LOCAL CONTROL PANEL		SYSTEM: C&I		PO NO.: --		DATE: --		
						SECTION: C				SHEET 9 OF 9		
SL. NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY	REMARKS	
1	2	3	4	5	M	C/N	7	8	9	M	C	N
15	FUNCTIONAL TEST	1. Control Logic Operation 2. Instrument Calibration 3. Temperature rise	CR	Electrical	100%	10%	Approved Drg/Datasheet	Approved Drg/Datasheet	Inspection Report	P/W	W	
				Electrical	10%	10%	Approved Drg/Datasheet	Approved Drg/Datasheet	Inspection Report	P/W	W	
				Electrical	100%	10%	Approved Drg/Datasheet Relevant IS.	Approved Drg/Datasheet Relevant IS.	Inspection Report	P/W	W	

NOTES:

- Customer's specification for painting shall be included in the technical specification. In the absence of Customer's spec. for painting, vendor to obtain BHEL's approval on their painting specification / procedure.
- Copies of all TC's (Test Certificates) for components shall be submitted to BHEL for verification and acceptance.
- BHEL reserves the right to conduct repeat tests, if required.

LEGENDS:

*RECORDS, IDENTIFIED WITH "TICK" (✓) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION, D: DOCUMENTATION,
 ** M: SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER, C: MAIN SUPPLIER/ BHEL/ THIRD PARTY INSPECTION AGENCY, N: CUSTOMER,
 P: PERFORM, W: WITNESS, V: VERIFICATION, AS APPROPRIATE
 MA: MAJOR, MI: MINOR, CR: CRITICAL

ENGINEERING				BHEL			
Sign & Date	Name	Checked by:	Sign & Date	Name	Checked by:	Reviewed by:	Sign & Date
	CHETAN MALIK			KUNDAN PRASAD			
	RK RAINA			RK JAISWAL			

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:		Sign & Date	Name
Reviewed by:			Seal
Approved by:			



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR FLOW SWITCH

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	100%	APPROVED SPEC./ DATA SHEETS	P	W	V	
	TYPE						
	RANGE						
	MODEL / TAG No.						
	END CONNECTION						
	DIMENSIONS						
	SIZE						
2	ACCURACY & REPEATABILITY (WET CALIBRATION)	100%		P	W	V	
3	HV / IR	100%		P	W	V	
4	CONTACT RATING / No. OF CONTACTS	RANDOM		P	W	V	
5	MATERIAL TC FOR BODY, WET PARTS, SENSING ELEMENT	ONE / LOT		P	W	V	
6	ACCESSORIES AS APPLICABLE	100%		P	W	V	
7	DEGREE OF PROTECTION	ONE / LOT		P	W	V	
8	OVER PRESSURE TEST	100%		P	W	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL,
P = Perform, W = Witness, V = Verification

Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Manufacturer to carry out routine test for 100%
- Contractor to provide compliance certificate for tests/checks verified by contractor and submit the same alongwith test certificates to be verified by BHEL.



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR TEMPERATURE SWITCH

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	100%	APPROVED SPEC./ DATA SHEETS	P	W	V	
	TYPE						
	MODEL/TAG NO.						
	RANGE/SCALE						
	END CONNECTION						
2	DIMENSIONS CHECK	100%		P	W	V	
3	ACCURACY	100%		P	W	V	
4	SWITCHING DIFFERENTIAL	100%		P	W	V	
5	CONTACT RATING / No. OF CONTACTS	RANDOM		P	W	V	
6	MATERIAL TC FOR BULB, CAPILLARY, ARMOUR	ONE / LOT		P	V	V	
7	HV / IR	RANDOM		P	W	V	
8	DEGREE OF PROTECTION	TYPE TEST		P	V	V	
9	THERMOWELLS						
	DIMENSIONS, PROCESS CONN	100%		P	W	V	
	MATERIAL TC	ONE / LOT		P	V	V	
	HYD TEST	100%		P	W	V	
	IBR CERTIFICATE, IF APPLICABLE			P	V	V	
10	REPEATABILITY	100%		P	V	V	
11	HYSTERESIS	100%		P	V	V	
12	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW		P	W	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL,
P = Perform, W = Witness, V = Verification

Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Contractor to provide compliance certificate for tests/checks verified by contractor and submit the same alongwith test certificates to be verified by BHEL.
- Manufacturer to carry out routine test for 100%



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR PRESSURE SWITCH

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	V	V	
	1.1 MODEL NO/TAG NO						
	1.2 RANGE						
	1.3 END CONN						
	1.4 NO. OF CONTACT						
2	CALIBRATION			P	V	V	
	2.1 REPEATABILITY						
	2.2 SET POINT ADJUSTMENT						
	2.3 DIFFERENTIAL						
3	OVER PR & LEAK TEST			P	V	V	
4	ELECT. INSULATION/HV TEST	ONE	P	V	V		
5	REVIEW OF TC FOR MATERIALS OF	FOR LOT	V	V	V		
	5.1 SENSOR						
	5.2 MOVEMENT						
	5.3 PROCESS CONNECTION						
	5.4 HOUSING						
6	REVIEW OF TC FOR DEGREE OF PROTECTION	TYPE TEST	V	V	V		
7	REVIEW OF TC OF MICROSWITCH	FOR LOT	V	V	V		

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to carry out ROUTINE TEST on 100 %.
- Contractor to provide compliance certificate for tests/checks verified by contractor and the same alongwith test certificates to be verified by BHEL



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR FLOAT OPERATED LEVEL SWITCH

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	V	V	
	MODEL NO/TAG NO						
	TYPE						
	END CONNECTION						
2	ON/OFF DIFFL	SEE NOTE-5	---	P	W	V	
3	REPEATABILITY			P	W	V	
4	IR TEST			P	W	V	
5	HV TEST			P	V	V	
6	PR. TEST ON CHAMBER			P	V	V	
7	MATL. TC FOR CHAMBER & FLOAT	FOR LOT	---	V	V	V	
8	CONTACT CONFIG. & RATING FOR MICROSWITCH	FOR LOT	---	V	V	V	
9	TC FOR DEGREE OF PROTECTION	TYPE TEST	---	V	V	V	
10	MANUFACTURER TO ENSURE WELDING PROCEDURE, WELDERS & NDT AS PER ASME FOR PR >40 KG/CM2	SEE NOTE-1 BELOW	---	P	V	V	
11	CHECK FOR TEMP. SUITABILITY FOR MICROSWITCH AND LEAD WIRE		---	V	V	V	
12	ACCESSORIES AS APPLICABLE		APPROVED SPEC./ DATA SHEETS	V	V	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Manufacturer to carry out ROUTINE TEST on 100 %.
- When material correlation is not available, MFR's compliance to be provided
- IBR certificates shall be provided wherever required.
- Contractor to provide compliance certificate for tests/checks verified by contractor and the same alongwith test certificates to be verified by BHEL



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR ANALYTICAL INSTRUMENTS

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	V	V	
	VISUAL						
	MAKE, MODEL No.						
	POWER SUPPLY						
	TYPE						
2	DIMENSIONS CHECK			P	V	V	
3	FUNCTIONAL CHECK			P	V	V	
4	LEAKAGE TEST			P	V	V	
5	HV / IR TEST			P	V	V	
6	LINEARITY			P	V	V	
7	RESPONSE TIME			P	V	V	
8	ENCLOSURE CLASS			P	V	V	
9	ACCESSORIES, AS APPLICABLE			P	V	V	
10	ACCURACY / CALIBRATION			P	V	V	
11	ALARM CONTACT TEST			P	V	V	
12	ANALOG OUTPUT CHECK			P	V	V	
13	BURN-IN TEST OF ELECTRONIC PARTS	1/LOT		P	V	V	
14	IN-BUILT INDICATOR, ZERO, SPAN, RANGE SCALE SELECTION ETC	SEE NOTE-1 BELOW		P	V	V	

Legend :

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P = Perform, W = Witness, V = Verification

Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Contractor to provide compliance certificate for tests/checks verified by contractor and submit the same alongwith test certificates to be verified by BHEL.



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR ANNUNCIATORS

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	TYPE/ MODEL						
	DIMENSIONS OF HARDWARE						
	MODULARITY						
	SEQUENCE						
	FACIA DETAILS						
2	FUNCTIONAL TEST	100%		P	W	V	
3	IMMUNE TO STEP VARIATIONS IN THE POWER SUPPLY	SEE NOTE-1 BELOW		P	W	V	
4	DEGREE OF PROTECTION FOR ENCLOSURE	TYPE TEST		P	W	V	
5	I/R CHECK	SEE NOTE-1 BELOW		P	W	V	
6	RESPONSE			P	W	V	

Legend :

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Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Manufacturer to carry out ROUTINE TEST on 100 %.
- Contractor to provide compliance certificate for tests/checks verified by contractor and submit the same alongwith test certificates to be verified by BHEL.



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR TRANSMITTER

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECKS FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	VISUAL.						
	MODEL/TAG No						
2	PROCESS CONNECTION			P	W	V	
3	ACCURACY			P	W	V	
4	REPEATABILITY			P	W	V	
5	HYSTERESIS			P	W	V	
6	EFFECT OF TEMP VARIATION ON ACCURACY			P	W	V	
7	SPAN / ZERO ADJUSTMENT	ONE / TYPE		P	W	V	
8	EFFECT OF SUPPLY VOLTAGE VARIATION			P	W	V	
9	EFFECT OF LOADING (500 OHM METERS)			P	W	V	
10	HIGH PRESSURE TEST	SEE NOTE-1 BELOW		P	W	V	
11	BURN-IN TEST	ONE / TYPE		P	W	V	
12	DEGREE OF PROTECTION			P	W	V	
13	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW		V	V	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- When material corelation are not available manufacturer's compliance to be provided.
- Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR TEMPERATURE ELEMENT

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	TYPE						
	MODEL No./TAG No.						
	PROCESS CONNECTION						
2	STABILITY			P	W	V	
3	INSULATION RESISTANCE			P	W	V	
4	ENCLOSURE CLASS			P	W	V	
5	RESPONSE TIME			P	W	V	
7	ACCURACY			P	W	V	
8	HYDROSTATIC TEST			P	W	V	
9	ELECTRICAL CHARACTERISTIC OF SENSOR (CONTINUITY OF T/C WIRES & INSULATION RESISTANCE OF RTD LEADS w.r.t. BODY			P	W	V	
10	TEMP CURVES / CHARTS			P	V	V	
11	AMBIENT TEMP. EFFECT CHECK			P	W	V	
12	HV TEST			P	W	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Contractor to provide compliance certificate for tests/checks verified by contractor and submit the same alongwith test certificates to be verified by BHEL.
- IBR certificate to be provided, if applicable



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR SOLENOID VALVES

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	TYPE						
	MAKE						
	MODEL No.						
2	MATERIAL (BODY. PLUNGER/TRIM)			P	W	V	
3	PORT SIZE			P	W	V	
4	CABLE CONNECTION SIZE			P	W	V	
5	ENCLOSURE CLASS			P	W	V	TYPE TEST CERTIFICATE TO BE FURNISHED BY VENDOR
6	No. OF COILS & INSULATION CLASS			P	W	V	TEST CERTIFICATE TO BE FURNISHED FOR INSULATION CLASS BY VENDOR
7	POWER SUPPLY CHECK			P	W	V	
8	IR / HV TEST			P	W	V	
9	FUCTIONAL TEST			P	W	V	

Legend :

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Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR TEMPERATURE GAUGE

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	DIAL SIZE						
	MODEL NO./TAG NO./TYPE						
	RANGE/SCALE						
	END CONNECTION						
2	CALIBRATION			P	W	V	
	ACCURACY						
	REPEATABILITY						
	HYSTERESIS						
3	OVER TEMP. TEST	1 OF TYPE		P	W	V	
4	AMBIENT TEMP. COMPENSATION CHECK			P	V	V	
5	REVIEW OF TC FOR MATERIALS OF	FOR LOT		V	V	V	
	SENSOR						
	MOVEMENT						
	PROCESS CONNECTION						
	THERMOWELL						
	HOUSING						
6	REVIEW OF TC FOR DEGREE OF PROTECTION	TYPE TEST		V	V	V	
7	THERMOWELL	SEE NOTE-1 BELOW	AS PER APPD DWG		V	V	
	MATERIAL TC & DIMN. CHECK						
	HYD.TEST						
	OVER RANGE TEST						

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Manufacturer to carry out ROUTINE TEST on 100 %.
- IBR certificate to be provided if called for in specn.
- Contractor to provide compliance certificate for tests/checks verified by contractor and submit the same alongwith test certificates to be verified by BHEL.



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR PRESSURE & DP GAUGE

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	SENSOR TYPE						
	DIAL SIZE						
	MODEL NO/TAG NO						
	RANGE/SCALE						
	SWITCH CONTACT RATING & NOS.						
	END CONNECTION						
2	CALIBRATION			P	W	V	
	ACCURACY						
	REPEATABILITY						
	SET POINT ADJUSTMENT						
3	OVER PRESSURE & LEAK TEST	P		W	V		
4	OPERATION OF PRESSURE. RELIEF DEVICE	ONE		P	W	V	
5	REVIEW OF TC FOR	FOR LOT		V	V	V	
	MATERIALS OF SENSOR						
	MOVEMENT						
	PROCESS CONNECTION						
	HOUSING						
6	REVIEW OF TC FOR DEGREE OF PROTECTION	TYPE TEST	V	V	V		
7	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW	V	V	V		

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Manufacturer to carry out ROUTINE TEST on 100 %.
- When material correlation is not available, MFR's compliance to be provided
- Contractor to provide compliance certificate for tests/checks verified by contractor and submit the same alongwith test certificates to be verified by BHEL.

[illegible]

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

1. Quantum of check shall be as below :
100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Manufacturer to carry out ROUTINE TEST on 100 %.
4. Contractor to provide compliance certificate for tests/checks verified by contractor and submit the same alongwith test certificates to be verified by BHEL.

[illegible]

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

1. Quantum of check shall be as below :
100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Manufacturer to carry out ROUTINE TEST on 100 %.
4. Contractor to provide compliance certificate for tests/checks verified by contractor and the same alongwith test certificates to be verified by BHEL

		MANUFACTURER / BIDDER / SUPPLIER NAME & ADDRESS			STANDARD QUALITY PLAN				SPEC. NO:		DATE:		
		PROJECT:			CUSTOMER :			QP NO. PE-QP-999-145-H010 Rev No. 0		DATE: 04.01.2024			
					ITEM: ROTAMATER			PO NO.:		DATE:			
		Component & Operations		Type of Check		Reference document		Acceptance norms		Format of record		Agency	
SR. No.	Class	Characteristics	Quantum of check	6	7	8	9	*	D	M	B	C	
1	2	3	4	5									10
1.0	Material / Components	1. Physical, Chemical properties	MA	Physical, Chemical Test	1/Heat	Approved drg./ data sheet	Approved drg./ data sheet	Mill Test Certificate*	✓	P	---	---	* In case correlated TC is not available, testing in NABL lab shall be carried out.
1.1	Orifice Plate, Flanges, By-pass piping	2. Finish and dimensions	MA	Visual, Measurement	100%	Manufacturing standards / drgs.	Manufacturing standards / drgs.	Inspection Report / Log Book	✓	P	---	---	Compliance certificate to be verified
1.2a	Metal Tube	Strength	MA	UTS/Y/S/ES	1/Heat	Approved drg./ data sheet	Approved drg./ data sheet	Test Certificate / Inspection Report	✓	P	---	---	
1.2b	Glass Tube	Transparency, Toughness	MA	Toughness & Thermal shock, Visual, Measurement	100%	Approved drg./ data sheet	Approved drg./ data sheet	Test Certificate / Inspection Report	✓	P	---	---	
2.0	Assembly	1. Marking – Tag No., Model, Range	MA	Visual	100%	Approved drg./ data sheet	Approved drg./ data sheet	Inspection Report	✓	P	V***	---	
		2. Scale graduation	MA	Visual	100%	Approved drg./ data sheet	Approved drg./ data sheet	- do -	✓	P	V***	---	***10% qty. or minimum of 2 no's / type & size
		3. Dimensions & End connections*	MA	Measurement	100%	Approved drg./ data sheet	Approved drg./ data sheet	- do -	✓	P			* End connection to be checked with "GO" & "NO-GO" gauge.

BHEL				BIDDER/ SUPPLIER				FOR CUSTOMER REVIEW & APPROVAL					
ENGINEERING		QUALITY		Sign & Date		Doc No:		Name		Sign & Date		Seal	
Name	Sign & Date	Name	Sign & Date	Seal				Reviewed by					
Prepared by	Shikha Thakur	Checked by	Kusum Gautam					Approved by					
Reviewed by	M. Kesharwani	Reviewed by	Harish Kumar										
Approved by	Girish Bhagchandani	Approved by											

	MANUFACTURER / BIDDER / SUPPLIER NAME & ADDRESS			STANDARD QUALITY PLAN			SPEC. NO:			DATE:																
				CUSTOMER :			QP NO. PE-QP-999-145-H010 Rev No. 0			DATE: 04.01.2024																
PROJECT:			PO NO.:			SYSTEM: S&CE			DATE:																	
ITEM: ROTAMATER			Acceptance norms			Format of record			Agency			Remarks														
Quantum of check			Reference document			8			9			D			M			B			C			10		
6			7																							
M			B/C																							
5			4			3			2			1			SR. No.			Component & Operations								
Type of Check			Class			Characteristics			1			2			3			4			5					

3.0	Routine Test	1. Calibration	CR	Measurment	100%	---	Approved drg./ data sheet	- do -	✓	P	V	---	
		2. Hydro Test	CR	Measurment	100%	---	Approved drg./ data sheet	- do -	✓	P	V	---	1.5 x Design Pressure Duration-30 min
4.0	Painting	Shade & finish	MA	Measurment	100%	---	BHEL Tech spec	- do -	✓	P	V	---	DFT check
5.0	Packing	Soundness of packing	MA	Visual	100%	---	BHEL Tech spec	- do -	✓	P	---	---	

LEGEND:

* RECORDS, IDENTIFIED WITH "TICK"(✓) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION, **D:** DOCUMENTATION.

** **M:** SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER/SUB-CONTRACTOR, **B:** BHEL/ BHEL NOMINATED THIRD PARTY INSPECTION AGENCY, **C:** CUSTOMER

P: PERFORM, **W:** WITNESS, **V:** VERIFICATION, AS APPROPRIATE.

CR - Critical characteristics
MA - Major characteristics
MI - Minor characteristics

UTS -Ultra Tensile Strength
YS -Yielding Strength
ES -Elongation Strength

BHEL				BIDDER/ SUPPLIER				FOR CUSTOMER REVIEW & APPROVAL					
ENGINEERING		QUALITY		Sign & Date		Doc No:		Name		Sign & Date		Seal	
Name	Sign & Date	Name	Sign & Date	Seal		Reviewed by		Approved by					
Shikha Thakur		Checked by	Kusum Gautam										
M. Kesharwani		Reviewed by	Harish Kumar										
Girish Bhagchandani		Approved by											

	MANUFACTURER / BIDDER / SUPPLIER NAME & ADDRESS		QUALITY PLAN: STANDARD QUALITY PLAN		SPEC. NO:		DATE:	
			CUSTOMER:		QP NO.: PE-QP-999-145-H 011, Rev.00		DATE: 03.01.2024	
			PROJECT:		PO NO.:		DATE:	
			ITEM: ULTRASONIC FLOW METER		SYSTEM: S&CE		SHEET 1 OF 2	

Sr No.	Component & Operations	Characteristics	Class	Type of Check	Quantum of check		Reference document	Acceptance norms	Format of record		Agency				Remarks
1	2	3	4	5	M	B/C	7	8	9	*	D	M	B	C	10
1.0 RAW MATERIAL															
1.1	Electronic Housing	Chemical Property	MA	Visual	100%	-	Approved Data Sheet	Approved Data Sheet	Test Certificate	V	P	--	--	--	
1.2	Cable gland	Chemical Property	MA	Visual	100%	-	Approved Data Sheet	Approved Data Sheet	Test Certificate	V	P	--	--	--	
1.3	Mounting Material like chain etc.	Chemical Property	MA	Visual	100%	-	Approved Data Sheet	Approved Data Sheet	Test Certificate	V	P	--	--	--	
2.0 IN PROCESS INSPECTION															
2.1	Sensor, Electronics Housing	Dimension	MA	Measurement	100%	-	Approved Data Sheet	Approved Data Sheet	Inspection Report	V	P	--	--	--	
3.0 FINAL INSPECTION															
3.1	Complete Assembly	Overall dimension and end connection	MA	Measurement	100%	100%	Approved Data Sheet	Approved Data Sheet	Inspection Report	V	P	W	--	--	
		Marking-Tag No., direction of flow	MI	Visual	100%	100%	Approved Data Sheet	Approved Data Sheet	Inspection Report	V	P	W	--	--	
		Degree of Protection	MA	Visual	100%	-	Approved Data Sheet	Approved Data Sheet	Inspection Report	V	P	V	--	--	Certificate for DOP, as per IEC-60529:2001 shall be produced for verification
3.2	Functional test & power ON	Electrical	MA	Visual	100%	100%	Approved Data Sheet	Approved Data Sheet	Inspection Report	V	P	W	--	--	
3.3	HART Communication	Calibration with Hand Held Communicator	MA	---	100%	100%	Mfr. Standard	Mfr. Standard	Inspection Report	V	P	W	--	--	
3.4	Calibration	Calibration	MA	Performance Test	100%	-	Approved Data Sheet	Approved Data Sheet	Test Certificate	V	P	V	--	--	CALIBRATION Test to be carried out at FCRI

ENGINEERING				BHEL				BIDDER/ SUPPLIER				FOR CUSTOMER REVIEW & APPROVAL			
Prepared by	Name	Sign & Date		Sign & Date	Seal	Doc No:		Name	Sign & Date	Seal					
Reviewed by	Madhav Gupta	Prepared by	Kusum Gautam	Sign & Date	Seal										
Approved by	M. Kesharwani	Reviewed by	Harish Kumar												
	Girish Bhagchandani	Approved by	Harish Kumar												

	MANUFACTURER / BIDDER / SUPPLIER NAME & ADDRESS			STANDARD QUALITY PLAN				SPEC. NO.:		DATE:	
								CUSTOMER :		QP NO.: PE-QP-999-145-H 11	
	PROJECT:			SYSTEM: S&CE				PO NO.:		DATE:	
								ITEM: ELECTRO MAGNETIC FLOW METER		SHEET 1 of 2	

S No.	Component & Operations	Characteristics	Class	Type of Check	Quantum of check		Reference document	Acceptance norms	Format of record			Agency			
1	2	3	4	5	6		7	8	9	*	**			10	
					M	B/C				D	M	B	C		
1.1	RAW MATERIAL														
	a) Meter Body b) Tube c) Electrodes d) Earthing Ring e) Liner	Physical, Chemical properties	MA	Physical, Chemical tests	1/Heat	----	Approved Drg / Data Sheet	Approved Drg / data Sheet	Mill Test Certificate*	✓	P	V	-	* In case correlated TC is not available, testing in NABL lab shall be carried out.	
1.2	FLANGES (WITH MATCHING FLANGES)														
	a) Forgings	Chemical, Mech Properties, & Heat Treatment	MA	Chemical, Mech Properties, & Heat Treatment	100%	----	ANSI B 16.34	ANSI B 16.34	MTC & HT certificate	✓	P	V	-		
	b) Machining	Dimensions	MA	Measurement	100%	----	Approved Drg / Data Sheet	Approved Drg / Data Sheet	Inspection Reports	✓	P	V	-		
2.0	IN-PROCESS														
	Machining of Components and Assembly	Dimension	MA	Measurement	100%	----	Approved Drg / Data Sheet	Approved Drg / data Sheet	Inspection Reports	✓	P	V	-		
3.0	ASSEMBLY (INCLUDING ELECTRONIC COMPONENT) and FINAL INSPECTION														
		Overall dimensions	MA	Measurement	100%	100%	Approved Drg / Data Sheet	Approved Drg / data Sheet	Inspection Reports	✓	P	W	-		
3.1	Complete Assembly	a) Marking b) Tag no. c) Direction of flow d) Model no. e) Display f) Process end connection, g) Degree of Protection**	MA	Visual	100%	100%	Approved Drg / Data Sheet	Approved Drg / data Sheet	Inspection Reports	✓	P	W	-	** Certificate for DOP, as per IEC-60529:2001 shall be produced for verification.	

BHEL				QUALITY				BIDDER/ SUPPLIER				FOR CUSTOMER REVIEW & APPROVAL			
ENGINEERING								Sign & Date				Doc No:			
Name	Sign & Date	Name	Sign & Date	Seal				Sign & Date				Name			
Prepared by: Atul Ranjan		Checked by: Suman Nakwal													
Reviewed by: M.Kesharwani		Reviewed by: Harish Kumar													
Approved by: Girish Bhagchandani		Approved by: Harish Kumar						Reviewed by:							
								Approved by:							

	MANUFACTURER / BIDDER / SUPPLIER NAME & ADDRESS			STANDARD QUALITY PLAN			SPEC. NO.:		DATE:	
	PROJECT: ITEM: ELECTRO MAGNETIC FLOW METER			CUSTOMER :			QP NO.: PE-QP-999-145-H 11		DATE: 04.01.2024	
				PO NO.:			DATE:			
				SYSTEM: S&CE			PO NO.:		SHEET 2 of 2	

S No.	Component & Operations	Characteristics	Class	Type of Check	Quantum of check		Reference document	Acceptance norms	Format of record		Agency			Remarks
1	2	3	4	5	6		7	8	9	*	**			10
					M	B/C					D	M	B	
3.2	Functional Test	a) Accuracy	MA	Electrical	100%	100%	Approved Drg / Data Sheet	Approved Drg / Data Sheet	Inspection Reports	✓	P	W	-	
		b) Repeatability					Manufacturer standards	> 100MOHM at 500V	Inspection Reports	✓	P	W	-	
		Lining Porosity	MA	Spark Test	100%	100%	Manufacturer standards	Manufacturer standards	Inspection Reports	✓	P	W	-	
3.3	Electro Magnetic Flow Meter	Calibration	MA	Performance test	100%	---	Approved Data Sheet	Approved Data Sheet	Test Certificate	✓	P	V	-	CALIBRATION Test to be carried out at FCRI or NABL approved laboratory.
4.0	ACCESSORIES													
	Mounting Accessories	Quantity Verification	MA	Visual	100%	100%	Approved Drg / Data Sheet	Approved Drg / Data Sheet	Inspection Reports	✓	P	W	-	Quantity to be checked physically
5.0	PAINTING	Shade & finish	MA	Measurement	100%	100%	Approved Data Sheet	Approved Data Sheet	Inspection Reports	✓	P	V	-	DFT check
6.0	PACKING	Soundness of Packing	MA	Visual	100%	100%	Tech. Spec	Tech. Spec	---	✓	P	V	-	

LEGEND:

*RECORDS, IDENTIFIED WITH "TICK"(✓) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION, D: DOCUMENTATION
 ** M: SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER/SUB-CONTRACTOR, B: BHEL/ BHEL NOMINATED THIRD PARTY INSPECTION AGENCY, C: CUSTOMER,
 P: PERFORM, W: WITNESS, V: VERIFICATION, AS APPROPRIATE, MA: MAJOR, MI: MINOR, CR: CRITICAL.

ENGINEERING				BHEL		BIDDER/ SUPPLIER		FOR CUSTOMER REVIEW & APPROVAL			
						Sign & Date		Doc No:			
Name				Sign & Date		Sign & Date		Sign & Date		Name	
Prepared by:	Atul Ranjan			Checked by:		Suman Nakwal					
Reviewed by:	M.Kesharwani			Reviewed by:		Harish Kumar		Reviewed by:			
Approved by:	Girish Bhagchandani			Approved by:		Harish Kumar		Approved by:			

		MANUFACTURER / BIDDER / SUPPLIER NAME & ADDRESS				STANDARD QUALITY PLAN				SPEC. NO:		DATE:	
						CUSTOMER :				QP NO.: PE-QP-999-145-H024, Rev No.:00		DATE: 04.01.2024	
		PROJECT:				PO NO.:				DATE:			
		ITEM: FLOW ORIFICE				SYSTEM: S&CE				SHEET 1 OF 2			

SNo.	Component & Operations	Characteristics	Class	Type of Check	Quantum of check		Reference document	Acceptance norms	Format of record				Agency	Remarks
					M	B/C			9	*	D	M		
1.0	2	3	4	5			7	8				**		10
1.01	MATERIAL													
	Orifice Plate	Physical, Chemical properties	MA	Physical, Chemical tests	1/Heat	----	Approved Drg / Data Sheet	Approved Drg / data Sheet	Mil Test Certificate*	✓	P	V	-	* In case correlated TC is not available, testing in NABL lab shall be carried out.
1.02	FLANGES													
a	Forgings	Chemical, Mech Properties, & Heat Treatment	MA	Chemical, Mech Properties, & Heat Treatment	100%	----	ASME B16.36 ASME B16.47	ASME B16.36 ASME B16.47	MTC Cert. HT certificate*	✓	P	V	-	\$ In case thickness is more than 40 mm
b	Machining	Dimensions	MA	Measurement	100%	----	Approved Drg / Data Sheet	Approved Drg / Data Sheet	Inspection Reports	✓	P	V	-	
2.0	IN PROCESS													
	Machining of orifice	Dimension	MA	Measurement	100%	----	Approved Drg / Data Sheet	Approved Drg / data Sheet	Inspection Reports	✓	P	V	-	
		Surface finish	MA	Measurement	100%	----	Approved Drg / Data Sheet	AGA-3 / ISO5167-2	Inspection Reports	✓	P	V	-	Surface roughness Tester
		Surface flaw on machined surface for Orifice Plate	MA	Di-Penetrant test	100%	----	ASTM 165 / IS-3658	ASTM 165 / IS-3658	Inspection Reports / Test Certificate	✓	P	V	-	
3.0	ASSEMBLY and FINAL INSPECTION													
		Overall dimensions	MA	Measurement	100%	100%	Approved Drg / Data Sheet	Approved Drg / data Sheet	Inspection Reports	✓	P	W	-	All test reports & dimension reports shall be verified by BHEL at the time of Final Inspection.
		Marking, Tag no. Direction of flow	MA	Visual	100%	100%	Approved Drg / Data Sheet	Approved Drg / data Sheet	Inspection Reports	✓	P	W	-	Positive material identification testing shall be performed by vendor and the same shall be witnessed by BHEL.

BHEL				BIDDER/ SUPPLIER		FOR CUSTOMER REVIEW & APPROVAL		
ENGINEERING		QUALITY		Sign & Date		Doc No:		
Name	Sign & Date	Name	Sign & Date	Seal		Name	Sign & Date	Seal
Prepared By: NEHA JAIN		Prepared By: KUSUM GAUTAM				Reviewed by:		
Reviewed By: S.C.SHARMA		Reviewed By:				Approved by:		
Approved By: GIRISH BHAGCHANDANI		Approved By: HARISH KUMAR						

		MANUFACTURER / BIDDER / SUPPLIER NAME & ADDRESS				STANDARD QUALITY PLAN				SPEC. NO:		DATE:			
						CUSTOMER :				QP NO.:PE-QP-999-145-H024, Rev No.:00		DATE: 04.01.2024			
						PROJECT:				PO NO.:		DATE:			
						ITEM: FLOW ORIFICE				SYSTEM: S&CE		SHEET 2 OF 2			
		Calibration	MA	Performance test	One per type	---	Approved Data Sheet	Approved Data Sheet	Test Certificate	✓	W	V	-	CALIBRATION Test to be carried out at IIT-J FCRI or NABL approved laboratory.	
4.0	PAINTING	Shade & finish	MA	Measurement	100%	---	BHEL Tech Spec	BHEL Tech Spec	Inspection Reports	✓	P	V	-		DFT check
5.0	PACKING	Soundness of Packing	MA	Visual	100%	100%	Tech. Spec	Tech. Spec	---	✓	P	V	-		

LEGENDS:

*RECORDS, IDENTIFIED WITH "TICK"(✓) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION, **D:** DOCUMENTATION

** **M:** SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER/SUB-CONTRACTOR, **B:** BHEL/ BHEL NOMINATED THIRD PARTY INSPECTION AGENCY, **C:** CUSTOMER,

P: PERFORM, **W:** WITNESS, **V:** VERIFICATION, **MA:** MAJOR, **MI:** MINOR, **CR:** CRITICAL.

BHEL				BIDDER/ SUPPLIER		FOR CUSTOMER REVIEW & APPROVAL							
ENGINEERING		QUALITY		Sign & Date		Doc No:		Name		Sign & Date		Seal	
Name	Sign & Date	Name	Sign & Date	Seal		Reviewed by:		Reviewed by:		Seal			
Prepared By:	NEHA JAIN	Prepared By:	KUSUM GAUTAM			Approved by:		Approved by:					
Reviewed By:	S.C.SHARMA	Reviewed By:	HARISH KUMAR										
Approved By:	GIRISH BHAGCHANDANI	Approved By:											

		MANUFACTURER/BIDDER/ SUPPLIER NAME & ADDRESS				STANDARD QUALITY PLAN				SPEC. NO. : --		DATE: --			
										CUSTOMER :--		QP NO.: PE-QP-999-145-H 006 REV 00		DATE: 04.01.2024	
										PROJECT: --		PO NO.: --		DATE: --	
										ITEM: CONTROL VALVE		SYSTEM: S&CE		SHEET 1 OF 8	
SL NO.	COMPONENT & OPERATIONS	CHARACTERISTIC CHECKED	CATEGORY	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY	REMARKS					
2	Body & Bonnet castings/forgings ,plug, valve stem, seat ring/cage	Physical, Chemical properties Heat Treatment	4	5	6 M B/C	7	8	9	** M B C						

1.0 RAW MATERIAL													
1.1	Body & Bonnet castings/forgings ,plug, valve stem, seat ring/cage	Physical, Chemical properties	MA	Physical, Chemical tests	100%	10%	Approved drg/ datasheet	Approved drg/data sheet	Test Certificate	✓	P/ W	✓	
		Heat Treatment	MA	Review of H. T. Certificate	100%	10%	Approved drg/ datasheet	Approved drg/data sheet	Test Certificate	✓	P/ W	✓	1. Applicable for body /bonnet only 2. IBR certificate(if applicable) to be verified.
		Internal quality of castings/forgings	MA	RT for Body & UT for Bonnet	100%	10%	ASME B 16.34	ASME B 16.34	Test Report/ Film	✓	P/ W	✓	Applicable for body and bonnet for rating ANSI 900 and above.
		Surface Quality	MA	1.Visual	100%	10%	ANSI/ MSS-SP-55	ANSI/ MSS-SP-55	Inspection Report	✓	P/ W	✓	Applicable for body/bonnet only.
		Pressure Test for shell	MA	Hyd. Test	100%	10%	ISA-S-75.19	ISA-S-75.19	Inspection Report	✓	P/ W	✓	For Body and Bonnet after machining.

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BHEL				BIDDER/ SUPPLIER				FOR CUSTOMER REVIEW & APPROVAL					
ENGINEERING		QUALITY		Sign & Date		Doc No:		Name		Sign & Date		Seal	
Prepared by:	CHETAN MALIK	Checked by:	SUMAN NAKWAL	Sign & Date	Seal	Reviewed by:		Reviewed by:		Sign & Date		Seal	
Reviewed by:	SURESH CHAND SHARMA	Reviewed by:	HARISH KUMAR			Approved by:		Approved by:					
Approved by:	GIRISH BHAGCHANDANI												

	MANUFACTURER/BIDDER/ SUPPLIER NAME & ADDRESS			STANDARD QUALITY PLAN				SPEC. NO : --	DATE: --	
	CUSTOMER :-- PROJECT: -- ITEM: CONTROL VALVE SYSTEM: S&CE							QP NO.: PE-QP-999-145-H 006 REV 00	DATE: 04.01.2024	
									DATE: --	
								PO NO.: --	SHEET 2 OF 8	
SL NO.	COMPONENT & OPERATIONS	CHARACTERISTIC CHECKED	CATEGORY	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY	REMARKS
2		3	4	5	6	7	8	9	**	
					M B/C				M B C	

1.2	Diaphragm	Surface Quality	MA	Visual	100%	10%	Mfr. standard	COC./Test Certificate	COC/Test Certificate	✓	P/ V	V	
		Hardness	MA	Measurement	100%	10%	Mfr. standard	COC/Test Certificate	COC/Test Certificate	✓	P/ V	V	
		Endurance/ Life cycle	MA	Cyclic Test 10,000 cycles	One/ type	One/ type	Mfr. standard	No damage	COC/Test Certificate	✓	P/ V	V	
1.3	Spring	Composition	MA	Chemical-Analysis	One Sample/ Heat	One Sample/ Heat	Mfr. Standard	COC/Test Certificate	COC/Test Certificate	✓	P/ V	V	
		Mech. Properties	MA	Mech. Test	One Sample/ Heat	One Sample/ Heat	Mfr. Standard	COC/Test Certificate	COC/Test Certificate	✓	P/ V	V	
		Performance	MA	1.Stiffness Ratio	100%	10%	Mfr. standard	COC/Test Certificate	COC/Test Certificate	✓	P/ V	V	
				2.Scrapping	100%	10%	Mfr. standard	COC/Test Certificate	COC/Test Certificate	✓	P/ V	V	
				3.Cyclic Test (Endurance)	One/ type	One/ type	Mfr. standard	COC/Test Certificate	COC/Test Certificate	✓	P/ V	V	

BHEL				BIDDER/ SUPPLIER		FOR CUSTOMER REVIEW & APPROVAL			
ENGINEERING			QUALITY			Doc No:			
Name	Sign & Date	Name	Sign & Date	Sign & Date	Seal	Name	Sign & Date	Seal	
Prepared by: CHETAN MALIK	Checked by: SUMAN NAKWAL	Reviewed by: SURESH CHAND SHARMA	Reviewed by: HARISH KUMAR			Reviewed by:			
Approved by: GIRISH BHAGCHANDANI						Approved by:			

		MANUFACTURER/BIDDER/ SUPPLIER NAME & ADDRESS				STANDARD QUALITY PLAN				SPEC. NO : --		DATE: --			
						CUSTOMER :--				QP NO.: PE-QP-999-145-H 006 REV 00				DATE: 04.01.2024	
						PROJECT: --				PO NO.: --				DATE: --	
						ITEM: CONTROL VALVE									
SYSTEM: S&CE		QUANTUM OF CHECK		REFERENCE DOCUMENT		ACCEPTANCE NORMS		FORMAT OF RECORD		AGENCY		REMARKS			
SL NO.	COMPONENT & OPERATIONS	CHARACTERISTIC CHECKED	CATE GORY	TYPE OF CHECK	6		7	8	9	**					
	2	3	4	5	M	B/C				D	M	B	C		

				4. Dimension (Measurement)	One sample/ Lot	One sample /Lot	Mfr. Standard	COC/Test Certificate	COC/Test Certificate	✓	P/ V	V	
2.0 IN PROCESS INSPECTION													
2.1	After machining, i, Body ii Bonnet iii Plug iv Valve Stem v seat ring vi cage	Surface flaws	MA	Visual & MT/PT	100% (on accessi ble surfaces)	10%	ASME B 16.34	ASME B 16.34	Inspection Report	✓	P/ W	V	Butt weld ends shall be included.
		Dimensional checks	MA	Measurement	100%	10%	Appd Drg.	Appd Drg.	Inspection Report	✓	P/ W	V	
		Hard Facing (wherever applicable)	MA	Hardness Measurement	One sample/ Lot	One sample /Lot	Appd Datasheet	Appd Datasheet	Inspection Report	✓	P/ W	V	

BHEL						BIDDER/ SUPPLIER				FOR CUSTOMER REVIEW & APPROVAL					
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Prepared by:	Name CHETAN MALIK	Sign & Date	Name SUMAN NAKWAL	Sign & Date	Seal			Reviewed by:							
Reviewed by:	SURESH CHAND SHARMA		Reviewed by:	HARISH KUMAR				Approved by:							
Approved by:	GIRISH BHAGCHANDANI														

	MANUFACTURER/BIDDER/ SUPPLIER NAME & ADDRESS			STANDARD QUALITY PLAN				SPEC. NO : --		DATE: --	
				CUSTOMER :--				QP NO.: PE-QP-999-145-H 006 REV 00		DATE: 04.01.2024	
				PROJECT: --				PO NO.: --		DATE: --	
				ITEM: CONTROL VALVE							
SYSTEM: S&CE											
SL NO.	COMPONENT & OPERATIONS	CHARACTERISTIC CHECKED	CATEGORY	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY	REMARKS	
2		3	4	5	6	7	8	9	**		
					M	B/C			D	M	B C

FINAL TESTING/INSPECTION											
3.0 TESTS ON COMPLETED VALVE											
3.1	Actuator Chamber	Leakage	MA	Pneumatic Test	100%	10%	Mfr. standard	No Leakage	Test Certificate	✓	P/ W
3.2	Body	Leakage (Body Mount Leakage)	MA	Hydro Test	100%	10%	ISA-S-75.19/	No Leakage	Test Certificate	✓	P/ W
3.3	Seat Leakage	Seat Leakage	MA	Pneumatic / WaterTest	100%	10%	FCI-70.2	Approved Datasheet	Test Certificate	✓	P/ W
4.0 OPERATION TEST ON COMPLETED VALVE ASSEMBLY		Valve Travel	MA	Measurement	100%	10%	Approved datasheet	Approved Datasheet	Inspection Report	✓	P/ W
		Opening / Closing Time	MA	Measurement	100%	10%	Approved datasheet	Approved Datasheet	Inspection Report	✓	P/ W
		Linearity / Cam characteristic	MA	Measurement	100%	10%	Approved datasheet	Approved Datasheet	Inspection Report	✓	P/ W
		Repeatability	MA	Measurement	100%	10%	Approved datasheet	Approved Datasheet	Inspection Report	✓	P/ W
		Hysteresis	MA	Measurement	100%	10%	Approved datasheet	Approved Datasheet	Inspection Report	✓	P/ W
		Sensitivity	MA	Measurement	100%	10%	Approved datasheet	Approved Datasheet	Inspection Report	✓	P/ W

BHEL				BIDDER/ SUPPLIER		FOR CUSTOMER REVIEW & APPROVAL			
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Name	Sign & Date	Name	Sign & Date	Seal		Name	Sign & Date	Seal	
Prepared by: CHETAN MALIK	Checked by:	SUMAN NAKWAL	Sign & Date			Reviewed by:			
Reviewed by: SURESH CHAND SHARMA	Reviewed by:	HARISH KUMAR				Approved by:			
Approved by: GIRISH BHAGCHANDANI									

		MANUFACTURER/BIDDER/ SUPPLIER NAME & ADDRESS				STANDARD QUALITY PLAN				SPEC. NO. : --		DATE: --			
										CUSTOMER :--		QP NO.: PE-QP-999-145-H 006 REV 00		DATE: 04.01.2024	
										PROJECT: --		PO NO.: --		DATE: --	
										ITEM: CONTROL VALVE		SYSTEM: S&CE		SHEET 6 OF 8	
SL NO.	COMPONENT & OPERATIONS	CHARACTERISTIC CHECKED	CATEGORY	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY	REMARKS					
2		3	4	5	6	7	8	9	**						
					M	B/C			D	M	B	C			

5.0 AUXILIARY ITEMS(Performance test of auxiliary items shall be performed on the completely assembled valve) – Refer NOTE-3												
5.1	Air Filter Regulator	Performance Test	MA	Measurement	Each type	Each type	Mfr. Standard	No leakage	--	✓	P/ V	
		Overall leakage	MA	Visual(soap solution)	100 %	10%	Mfr. Standard	No leakage	--	✓	P/ V	
5.2	Air lock relay	Performance Test	MA	Leakage test	100%	10%	Mfr. Standard	No leakage	--	✓	P/ V	
5.3	Smart Positioner	Physical Verification Make/Model	MA	Visual	100%	10%	Approved drg/ datasheet	Approved drg/ datasheet	--	✓	P/ V	
		Degree of Protection	MA	IP/NEMA test	Each type	Each type	Relevant Standard	Relevant Standard	--	✓	P/ V	
		Calibration	MA	Measurement	Each type	Each type	Mfr. Standard	Mfr. Standard	--	✓	P/ V	
5.7	Electrical items (i) Limit Switches	Routine Test	MA	HV, IR, Continuity function	100%	10%	Approved Data sheet	Approved Data sheet	--	✓	P/ V	
		Degree of protection	MA	IP/NEMA Tests	One sample/ type	One sample/ Lot	Approved Data sheet	Approved Data sheet	--	✓	P/ V	

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Reviewed by:	SURESH CHAND SHARMA	Reviewed by:	HARISH KUMAR			Approved by:					
Approved by:	GIRISH BHAGCHANDANI										

	MANUFACTURER/BIDDER/ SUPPLIER NAME & ADDRESS			STANDARD QUALITY PLAN						SPEC. NO : --	DATE: --
				CUSTOMER :--						QP NO.: PE-QP-999-145-H 006 REV 00	DATE: 04.01.2024
				PROJECT: --						PO NO.: --	DATE: --
				ITEM: CONTROL VALVE			SYSTEM: S&CE				
SL NO.	COMPONENT & OPERATIONS	CHARACTERISTIC CHECKED	CATE GORY	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY	REMARKS	
	2	3	4	5	6	7	8	9	**		
					M	B/C			M	B	C

	(ii) Solenoids	Routine Test	MA	HV, IR, Continuity function	100%	One sample/ type	10%	Approved Data sheet	Approved Data sheet	--	✓	P/ V	✓	V	
		Degree of protection	MA	IP/NEMA Tests	One sample/ type	One sample /Lot	One sample /Lot	Approved Data sheet	Approved Data sheet	--	✓	P/ V	✓	V	
	(iii)Position Transmitter(if provided externally)	Routine Test	MA	HV, IR, Continuity function	100%	100%	10%	Approved Data sheet	Approved Data sheet	--	✓	P/ V	✓	V	
		Degree of protection	MA	IP/NEMA Tests	One sample/ type	One sample/ Lot	One sample /Lot	Approved Data sheet	Approved Data sheet	--	✓	P/ V	✓	V	
6.0	PAINTING	Paint Thickness	MA	Measurement DFT check	100%	100%	10%	Approved drg/data sheet	Approved drg/data sheet	Inspection Report	✓	P/ W	✓	V	
7.0	PACKING	Soundness of Packing against transit damage	MA	Visual	100%	100%	100%	Approved drg/data sheet	Approved drg/data sheet	Inspection Report	✓	P/ W	✓	V	

BHEL				BIDDER/ SUPPLIER		FOR CUSTOMER REVIEW & APPROVAL			
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Reviewed by:	SURESH CHAND SHARMA			HARISH KUMAR		Approved by:			
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**C&I SPECIFICATION FOR
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TYPE TEST REQUIREMENT



**16.00.00 a)
TYPE TEST**

16.01.00 GENERAL REQUIREMENTS

16.01.01 The contractor shall furnish the type test reports of all type tests as per relevant standards and codes as well as other specific tests indicated in this specification. A list of such tests are given for various equipment in table titled 'Type Test Requirement for C&I Systems' at the end of this sub-section. For the balance equipment instrument, type tests may be conducted as per manufactures standard or if required by relevant standard.

i) Out of the tests listed, the Bidder/ sub-bidder/ manufacturer is required to conduct certain type tests specifically for this contract (and witnessed by Owner or his authorized representative) even if the same had been conducted earlier, as clearly indicated subsequently against such tests.

ii) For the rest, submission of type test results and certificate shall be acceptable provided.

a) The same has been carried out by the Bidder/ sub-bidder on exactly the same model /rating of equipment.

b) There has been no change in the components from the offered equipment & tested equipment.

c) The test has been carried out as per the latest standards along with amendments as on the date of Bid opening.

16.01.02 In case the approved equipment is different from the one on which the type test had been conducted earlier or any of the above grounds, then the tests have to be repeated and the cost of such tests shall be borne by the Bidder/ sub-bidder within the quoted price and no extra cost will be payable by the Owner on this account.

16.01.03 As mentioned against certain items, the test certificates for some of the items shall be reviewed and approved by the main Bidder or his authorized representative and the balance have to be approved by the Owner.

16.01.04 The schedule of conduction of type tests/ submission of reports shall be submitted and finalized during pre-award discussion.

16.01.05 For the type tests to be conducted, Bidder shall submit detailed test procedure for approval by Owner. This shall clearly specify test setup, instruments to be used, procedure, acceptance norms (wherever applicable), recording of different parameters, interval of recording precautions to be taken etc. for the tests to be carried out.

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16.01.06	The Bidder shall indicate in the relevant BPS schedule, the cost of the type test for each item only for which type tests are to be conducted specifically for this project.		
16.01.07	The cost shall only be payable after conduction of the respective type test in presence of authorize representative of Owner. If a test is waived off, then the cost shall not be payable.		
16.01.08	Bidder shall prepare detailed shop and site "Draft Quality Assurance Program" to fully meet the requirements of this specification. The document shall cover the following: • Quality assurance and testing procedures from component inspection stage up to final acceptance test at site. • Formats for recording calibration / test results. • Formats for test reports. • Specifications of test equipment proposed to be used for shop and site tests. All applicable requirements of latest revised edition of I.S.A. Recommended practice MC-55.1 - 1982/ANSI MC 8.1-1975 regarding hardware testing of Digital process computers shall be fully met. The above "Draft Quality Assurance Program" shall be reviewed by Owner / Consultant. The "Quality Assurance Program" as approved by Owner / Consultant shall be used for conducting all shop and site tests.		
16.02.00	Inspection and Testing for I&C System Equipment The Owner / consultant reserves the right to inspect and approve the design, engineering, material selection, equipment and workmanship at all stages of implementation of I&C system (all control system, and field instrumentation packages). Bidder shall call for inspection / factory witness testing of the equipment well in advance notice to the Owner & consultant. Owner/consultant shall indicate his preference regarding the inspection of the equipment. It is Contractor's responsibility to schedule the inspection & testing of different equipment / systems in a properly phased manner.		
16.03.00	The following minimum equipment shall be considered for Inspection (witness) at manufacturer's works (Contractor's and sub suppliers) by Owner as specified: - Integrated DCS testing including testing of communication links. - Fail- safe type SIL 3 conforming SG Integral control systems for BMS & Boiler Protection system - Fail- safe type SIL 3 conforming to STG system protection system - TD BFP including turbine Protection system - All control valves - PADO (Optional) - Soot blower System (Optional) - Vibration Monitoring System and Vibration Analysis System - APC system - SWAS Analysers		
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xi. Flame Monitoring and Analysis System
16.04.00 Functional and Pre-Acceptance Test

The authorized quality assurance personnel of Bidder shall conduct all tests as per the requirements of approved quality assurance program and fully satisfy in compliance with specification requirements by all equipment / sub-systems and the system as a whole before sending notification for Factory Acceptance Test to Owner & Consultant. Bidder shall maintain accurate records for all pre-acceptance test which shall be properly documented and duly certified documents shall be furnished to Owner / Consultant at least one month prior to Factory Acceptance Test. The following test shall be carried out

- I. Input-output wiring check (for system cabinets, relay cabinets etc.).
- II. Special Requirement for Solid State Equipments/ Systems
- III. Test for Closed Loop Control System
- IV. Tests for Field Instruments and Devices
- V. Notification for Acceptance Test at Shop
- VI. Acceptance Test 9 as per Approved QAP)
- VII. On Site Tests
- VIII. DCS (Site Testing)
- IX. Loop Checking and Pre-Commissioning
- X. Supervisory Loops
- XI. Modulating Control Loops
- XII. Binary and Sequential Loops

16.05.00 TYPE TEST REQUIREMENT FOR C&I SYSTEMS

Sl. No.	Item	Test Requirements	Standard	Test to be Specifically Conducted	Owner's approval required on Test Certificate
Col.1	Col.2	Col.3	Col.4	Col.5	Col.6
1.	Elect. Metering Instruments	As per standard (Col.4)	IS-1248	No	Yes
2.	Transducers	As per standard (Col.4)	IEC-60688. IS-12784	No	Yes
3.	Thermocouples	Degree of protection test	IS-2147	No	No
4.	CJC Box	Degree of protection test	IS-2147	No	No
5.	RTD	As per standard (Col.4)	IEC-60751	No	No
6.	Electronic Transmitter	As per standard (Col.4)	BS-6447 /	No	Yes



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Sl. No.	Item	Test Requirements	Standard	Test to be Specifically Conducted	Owner's approval required on Test Certificate
Col.1	Col.2	Col.3	Col.4	Col.5	Col.6
			IEC-60770		
7.	E/P Converter	As per standard (Col.4)	Manufacturer Standard	No	Yes
16.	LIE/LIR/Junction Box	Degree of Protection Test	IS-2147	No	Yes

Note: Type Tests are to be conducted only for the items, which are being supplied as a part of this Package.



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APPLICABLE CODES AND STANDARDS

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17.01.02 Standards not indicated in the specification are acceptable subject to approval by the Owner / consultant. If they are established to be equal or superior to the standards indicated in the specification.

17.02.00 TEMPERATURE MEASUREMENTS

- i) Instrument and apparatus for temperature measurement - ASME PTC 19.3.
- ii) Temperature measurement - Thermocouples ANSI MC 96.1 -1982 .
- iii) Temperature measurement by electrical Resistance thermometers - IS:2806.
- iv) Thermometer - element - Platinum resistance - IS:2848/DIN 43760.

17.03.00 PRESSURE MEASUREMENTS

- i) Instruments and apparatus for pressure measurement - ASME PTC 19.2 (1964).
- ii) Bourdon tube pressure and vacuum gauges - IS 3624 – 1966
- iii) Electronic transmitters BS:6447.
- iv) Process operated switch devices (Pr. Switch) BS-6134.

17.04.00 FLOW MEASUREMENTS

- i) Instruments and apparatus for flow measurements - ASME PTC 19.5
- ii) Measurement of fluid flow in



closed conduits - BS-1042 /ISO5167.

17.05.00

**ELECTRONIC MEASURING INSTRUMENT & CONTROL HARDWARE/
SOFTWARE**

- i) Automatic null balancing electrical measuring instruments - ANSI C 39.4 (Rev. 1973): IS:9319.
- ii) Safety requirements for electrical and electronic measuring and controlling instrument - ANSI C 39.5.
- iii) Compatibility of analog signals for electronic industrial process instruments -ISA - S 50.1 (1982) ANSI MC 12.1.
- iv) Dynamic response testing of process control instrumentation ANSI MC-4.1 : ISA - S 26 (1968).
- v) Surge Withstand Capability (SWC) tests - ANSI C 37.90 a/IEEE-472 or suitable class of IEC-255-4 equivalent to ANSI C37.90a/IEEE-472.
- vi) Printed circuit boards - IPC TM - 650, IEC 326 C.
- vii) General requirement and tests for printed wiring boards - IS 7405 (Part-I)1973.
- viii) Edge socket connectors - IEC 130-11.
- ix) Requirements and methods of testing of wire wrap terminations DIN 41611Part-2.
- x) Dimensions of attachment plugs & receptacles - ANSI C 73 – 1973(Supplement ANSI C 73 a - 1980).
- xi) Direct acting electrical indicating instrument - IS:1248 - 1968 (R).
- xii) Standard Digital Interface for Programmable Instrumentation - IEEE-488.2 -1990.
- xiii) Information Processing Systems - Local Area Networks - Part 2: Logical Link Control - IEEE-802.2 .
- xiv) Standard for Local Area Networks: Carrier Sense Multiple Access with Collision Detection - IEEE-802.3 .
- xv) Supplements A, B, C and E to Carrier Sense Multiple Access with Collision Detection - IEEE-802.3 .
- xvi) Standard for Local Area Networks: Token - Passing Bus Access Method -IEEE-802.4 - 1985.
- xvii) Standard for Local Area Networks: Token - Ring Access Method and Physical Layer Specification - IEEE-802.5 .
- xviii) IEEE Guide to Software Requirements Specifications - IEEE-830 .
- xix) Hardware Testing of Digital Process Computers - ISA RP55.1 .
- xx) Electromagnetic Susceptibility of Process Control Instrumentation– SAMAPMC 33.1 .



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- xxi) Interface Between the Data Terminal Equipment and Data Circuit-
- xxii) Terminating Equipment Employing Serial Binary Data Interchange- EIA-232-D.
- xxiii) Electromagnetic Compatibility for Industrial Process Measurement and
- xxiv) Control Equipment, Part 3: Radiated Electromagnetic Field Requirements -IEC 801-3.

17.06.00 INSTRUMENT SWITCHES AND CONTACT

- i) Contact rating - AC services
NEMA ICS 2 .
- ii) Contact rating - DC services
NEMA ICS 2, N600.

17.07.00 ENCLOSURES

- i) Type of Enclosures - NEMA ICS6-110.15 through 110.22 (Type 4 to 13).
- ii) Racks, panels and associated equipment - EIA: RS - 310 C- 1983 (ANSI C83.9 - 1972).
- iii) Protection class for Enclosures, cabinets, control panels & desks - IS:2147 -1962.

17.08.00 APPARATUS, ENCLOSURES AND INSTALLATION PRACTICES IN HAZARDOUS AREA

- i) Classification of hazardous area - NFPA 70 - 1984, Article 500.
- ii) Electrical Instruments in hazardous dust location – ISA-RP 12.11
- iii) Intrinsically safe apparatus - NFPA 493 1978.
- iv) Purged and pressurised enclosure for electrical equipment in hazardous location - NFPA 496-1982.
- v) Enclosures for Industrial Controls and Systems - NEMA IS 1.1 - 1977.

17.09.00 SAMPLING SYSTEM

- i) Stainless steel material of tubing and valves for sampling system – ASTM A269-82, Grade TP 316.
- ii) Submerged helical coil heat exchangers for sample coolers ASTM D11 92- 1977.
- iii) Water and steam in power cycle - ASME PTC 19.11.
- iv) Standard methods of sampling system - ASTM D 1066-99.



17.10.00 **ANNUNCIATORS**

- i) Specifications and guides for the use of general purpose annunciators – ISA S 19.1, 1979.
- ii) Surge withstand capability tests - ANSI C 37.90a - 1989/IEEE-472 or suitable class of IEC 255-4 equivalent to ANSI C37.90a 1989/IEEE-472
- iii) Damp heat cycling test - IS:2106
- iv) Specification for Electromagnetic Susceptibility - SAMA DMC 33, 1/78

17.11.00 **PROTECTIONS**

- i) Relays and relay system associated with electric power apparatus. ANSI C 37.90, 1 - 1989.
- ii) General requirements & tests for switching devices for control and auxiliary circuits including contactor relays - IS:6875 (Part-I) - 1973.
- iii) Turbine water damage prevention - ASME TDP-1-1980.
- iv) Boiler safety interlocks - NFPA Section 85 B - 1984, 85 C - 1991.

17.13.00 **CONTROL VALVES**

- i) Control valve sizing - Compressible & Incompressible fluids - ISA S 75.01- 1985.
- ii) Face to face dimensions of control valves - ANSI B 16.00 - 1973.



- iii) ISA Hand Book of Control Valves
- (ISBN: B: 1047-087664-234-2).
- iv) Codes for pressure piping - ANSI
B 31.1
- v) Control Valve leak class - ISA RP
39.6

17.14.00 **PROCESS CONNECTION & PIPING**

- i) Codes for pressure piping "power
piping" - ANSI B 31.1.
- ii) Seamless carbon steel pipe
ASTM - A - 106.
- iii) Forged & Rolled Alloy steel pipe
flanges, forged fittings and valves and parts ASTM - A - 182.
- iv) Material for socket welded fittings
- ASTM - A - 105.
- v) Seamless ferritic alloy steep pipe
- ASTM - A - 335.
- vi) Pipe fittings of wrought carbon
steel and alloy steel - ASTM - A - 234.
- vii) Composition bronze of ounce
metal castings - ASTM - B - 62.
- viii) Seamless Copper tube, bright
annealed - ASTM - B - 168.
- ix) Seamless copper tube - ASTM -
B - 75.
- x) Dimension of fittings - ANSI - B -
16.11.
- xi) Valves flanged and butt welding
ends - ANSI - B - 16.34.

17.15.00 **INSTRUMENT TUBING**

- i) Seamless carbon steel pipe -
ASTM - A 106.
- ii) Material of socket weld fittings -
ASTM - A105.
- iii) Dimensions of fittings - ANSI - B
- 16.11.
- iv) Code for pressure piping,
welding, hydrostatic testing - ANSI B 31.1.



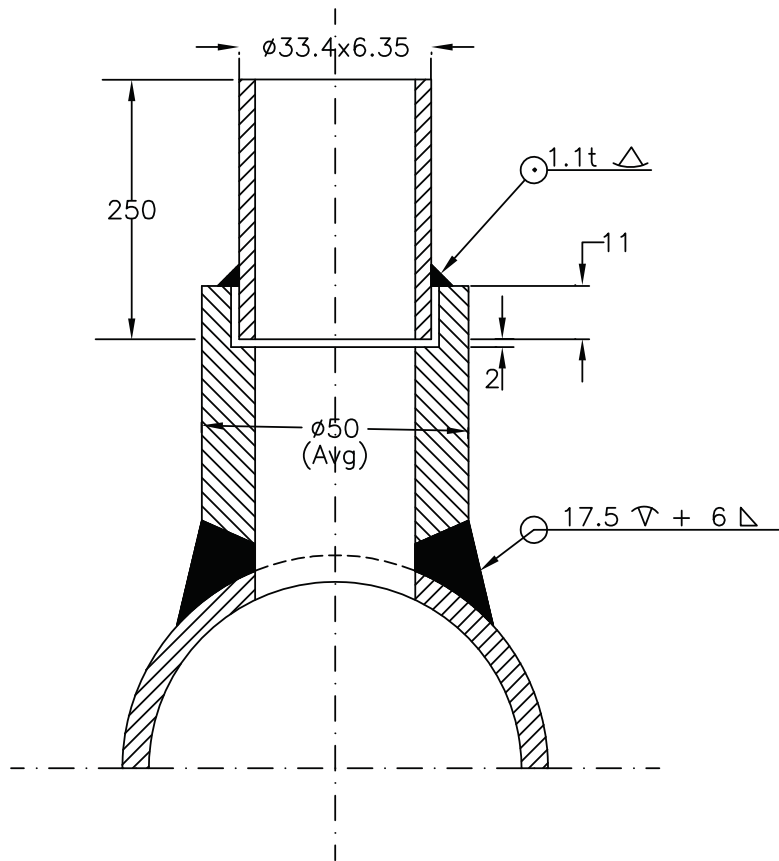
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INSTRUMENT INSTALLATION & HOOKUP DIAGRAM

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NOTE :

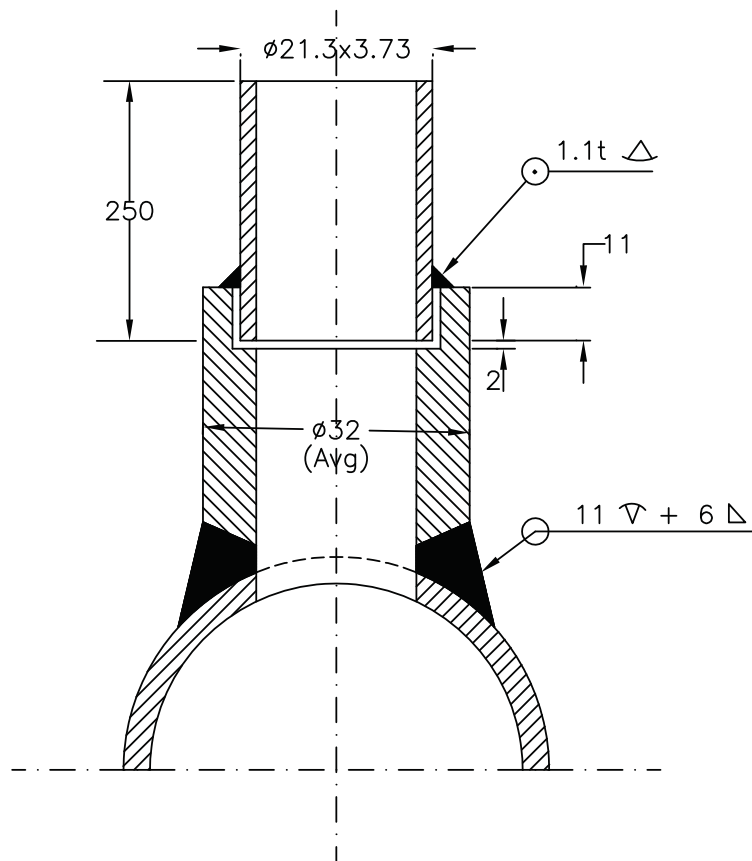
1. MATERIAL OF THE BOSS AND NIPPLE SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED AND CONFORM TO ANSI B16.11.
2. THE LENGTH OF NIPPLE SHALL BE 250 MM.
3. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE INDICATED
4. EDGE HOLE MUST BE CLEAN AND SQUARE OR ROUNDED SLIGHTLY (1/64" RADIUS) FREE FROM BURRS, WIRE EDGES OR OTHER IRREGULARITIES



TITLE : INSTRUMENT STUB DETAILS FOR PRESSURE MEASUREMENT

DRG. NO.
PE-DG-527-145-H101

(60Kg/Cm² < PRESS ≤ 455Kg/Cm², TEMP ≤ 425 DegC & Nb25, CLASS 6000#) REV. 00
OR (PRESS ≤ 455Kg/Cm², 425DegC < TEMP ≤ 500 DegC & Nb25, CLASS 6000#) SH. 3 OF 8 SHS.



NOTE :

1. MATERIAL OF THE BOSS AND NIPPLE SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED AND CONFORM TO ANSI B16.11.
2. THE LENGTH OF NIPPLE SHALL BE 250 MM.
3. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE INDICATED
4. EDGE HOLE MUST BE CLEAN AND SQUARE OR ROUNDED SLIGHTLY (1/64" RADIUS) FREE FROM BURRS, WIRE EDGES OR OTHER IRREGULARITIES



TITLE : INSTRUMENT STUB DETAILS FOR PRESSURE MEASUREMENT

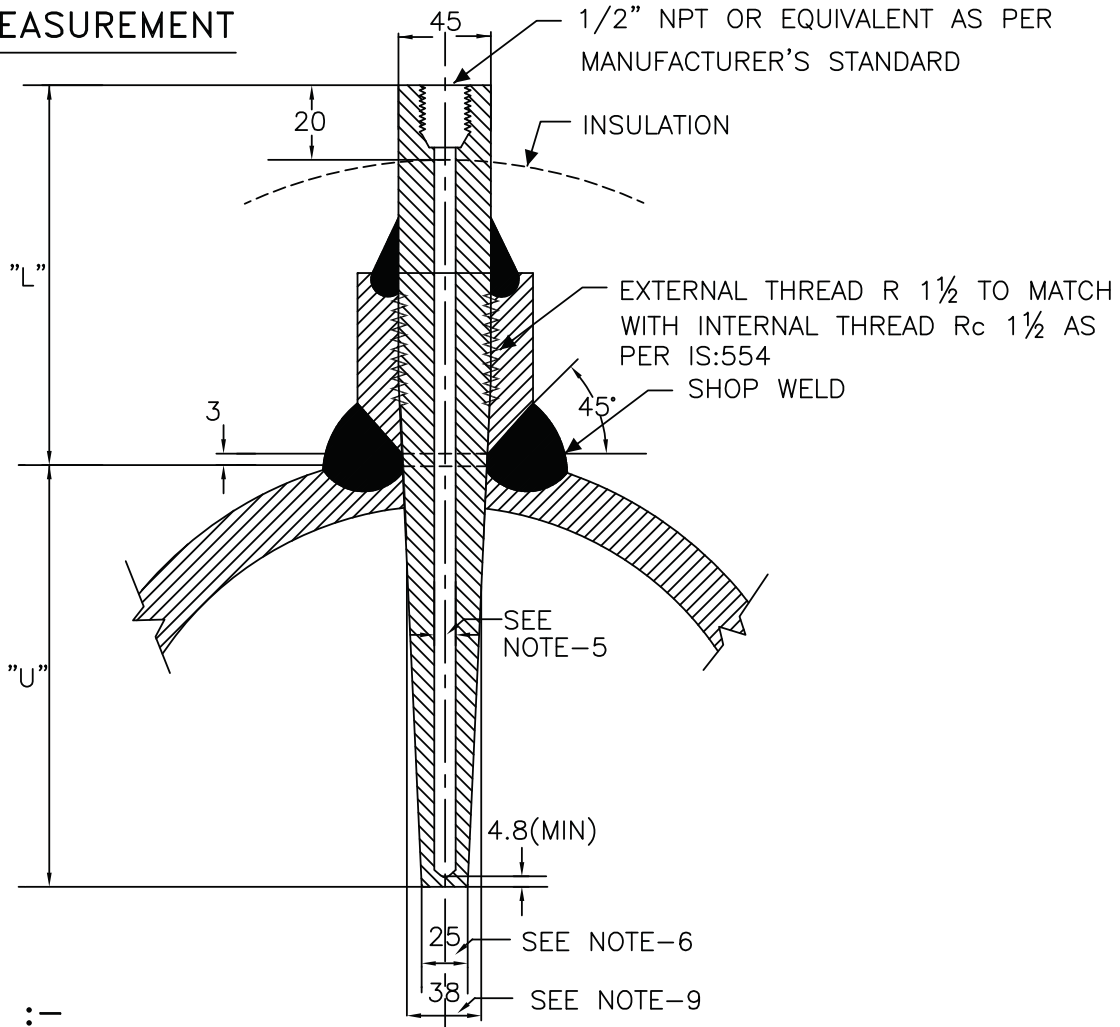
DRG. NO.
PE-DG-527-145-H101

REV. 00

(PRESS < 60Kg/Cm2, TEMP < 425DegC & Nb15, CLASS 3000#)

SH. 4 OF 8 SHS.

TEMP. MEASUREMENT



NOTES :-

1. THIS TYPE OF TEMPERATURE BOSS SHALL BE USED FOR THE DESIGN PRESS EQUAL/ ABOVE 40 KG/CM2(g) AND FOR DESIGN TEMP EQUAL/ABOVE 400 DegC EVEN IF THE DESIGN PRESSURE IS LESS THAN 40 Kg/Cm2(g)
2. THE MATERIAL OF THE BOSS SHALL BE SIMILAR TO PIPING MATERIAL.
3. MATERIAL OF THE THERMOWELL SHALL BE OF 316SS.
4. THERMOWELL SHALL BE DRILLED BAR STOCK TYPE.
5. INTERNAL BORE OF THE THERMOWELL SHOULD BE SELECTED BASED ON THE NORMAL SIZE OF THE SENSING ELEMENT AS PER ASME PTC-19.3.
6. THE BOTTOM DIAMETER OF THE THERMOWELL TYPICALLY SHOWN HERE SHALL BE SUBJECT TO VARIATION BASED ON THE INTERNAL BORE OF THERMOWELL AND THICKNESS OF THERMOWELL MATERIAL TO WITHSTAND THE PROCESS PRESS AND TEMP AS PER ASME PTC-19.3.
7. THE 'U' & 'L' DIMENSIONS SHALL BE SELECTED BASED ON PARTICULAR APPLICATION.
8. ORIENTATION OF STUB ON VERTICAL/ HORIZONTAL PIPES SHALL BE 90° TO THE CENTRE LINE OF THE PIPES, FOR PIPE SIZE LARGER THAN 4". HEIGHT OF STUB SHALL BE 64mm FOR PIPE OD < 200Nb AND 45mm FOR PIPE OD ≥ 200Nb.
9. THERMOWELL SHALL BE SUITABLE TO MATCH THE STUB DIMENSIONS AS PER Rc 1 1/2.
10. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE INDICATED.



TITLE :
INSTRUMENT STUB DETAILS
FOR TEMPERATURE MEASUREMENT
(APPLICABLE FOR PIPE SIZE ABOVE 4")

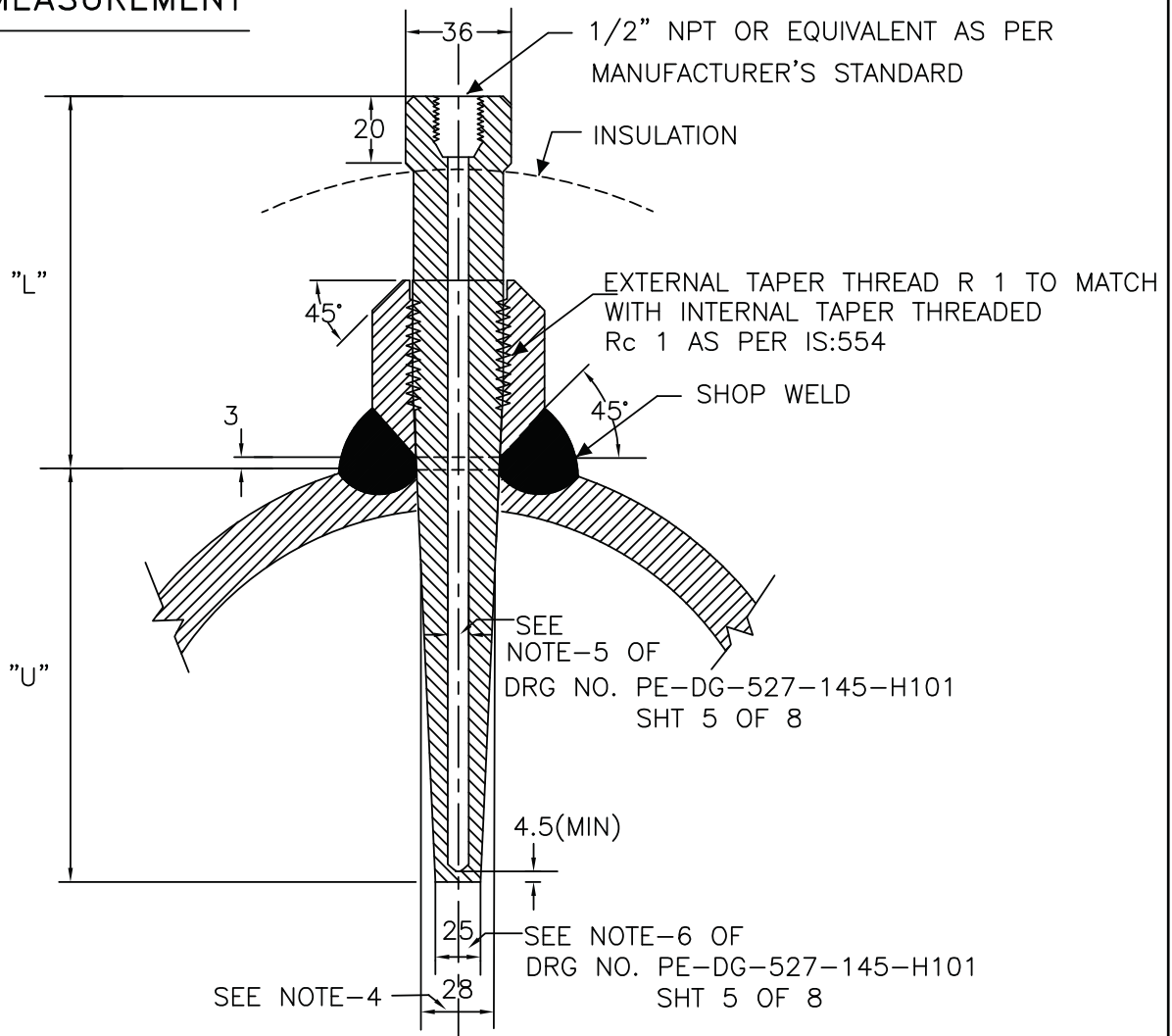
[(i) DESIGN PRESS = /> 40 Kg/Cm2(g) OR
(ii) DESIGN TEMP = /> 400 DegC]

DRG. NO.
PE-DG-527-145-H101

REV. 00

SH. 5 OF 8 SHS.

TEMP. MEASUREMENT



NOTES :-

1. THIS TYPE OF TEMPERATURE BOSS IS APPLICABLE FOR THE DESIGN PRESS/ TEMP BELOW 40 KG/CM²(g)/400°C.
2. FOR PRESS. TIGHT JOINTS THE BOSS SHOULD HAVE INTERNAL TAPERED PIPE THREAD Rc 1 AS PER IS:554. THE LENGTH OF THREAD ENGAGEMENT SHOULD BE AS PER ABOVE STANDARD.
3. SEE NOTES-2 TO 8 IN SHT. 5 OF 8 OF THIS DRG.
4. THERMOWELL SHALL BE SUITABLE TO MATCH THE STUB DIMENSIONS AS PER Rc 1.
5. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE INDICATED



TITLE :
INSTRUMENT STUB DETAILS
FOR TEMPERATURE MEASUREMENT
(APPLICABLE FOR PIPE SIZE ABOVE 4")

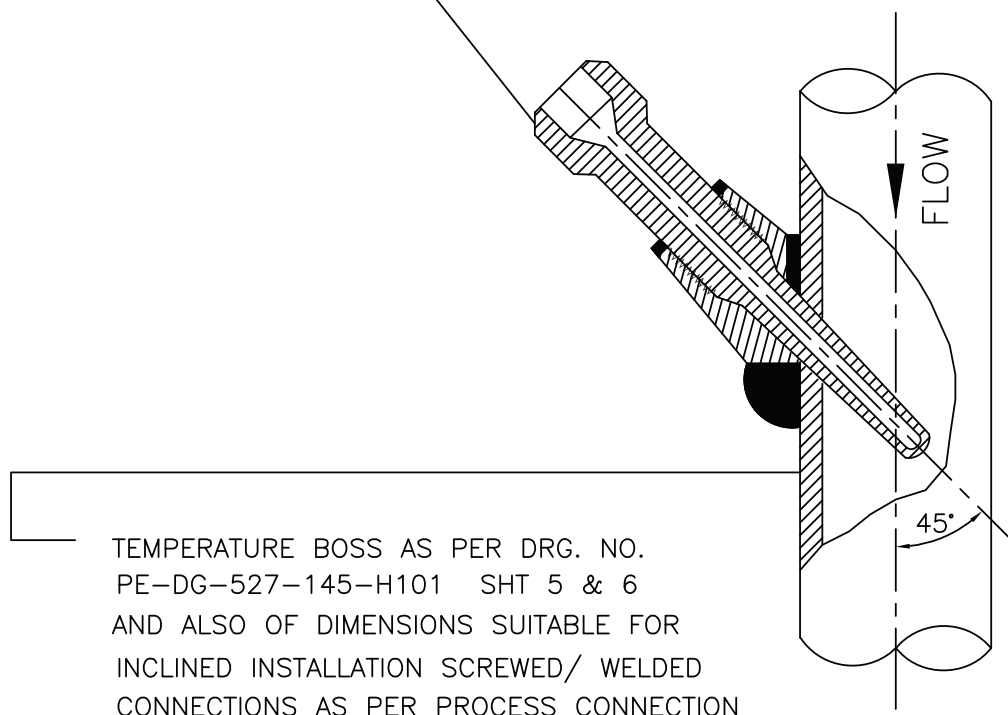
DRG. NO.
PE-DG-527-145-H101

REV. 00

[DESIGN PRESS < 40 Kg/Cm² (g) & DESIGN TEMP < 400 C]

SH. 6 OF 8 SHS.

THERMOWELL SUITABLE FOR THE BOSS
AS PER DRG. NO.
PE-DG-527-145-IH01 SHT 5 & 6



NOTES :-

1. INCLINED INSTALLATION OF THERMOWELL SHALL BE APPLICABLE FOR 4" AND SMALLER LINE SIZE BUT LIMITED TO MIN. 3" LINE SIZE.
2. FOR 2" AND SMALLER LINE SIZE NECESSARY EXPANDER OF MIN. 3" SIZE OF MAIN PIPING SPECIFICATION SHALL BE USED.
3. THIS TYPE OF INSTALLATION IS APPLICABLE FOR HORIZONTAL AND VERTICAL PIPE SECTION.
4. FOR STEAM SERVICES EXPANDER SECTION TO BE USED ONLY IN VERTICAL RUN.
5. THE EXPANDER SECTION SHALL BE OF ADEQUATE LENGTH (AT LEAST 3-4 TIMES DIA OF THE MAIN PROCESS PIPE AT BOTH SIDES OF THE INSTALLED THERMOWELL).

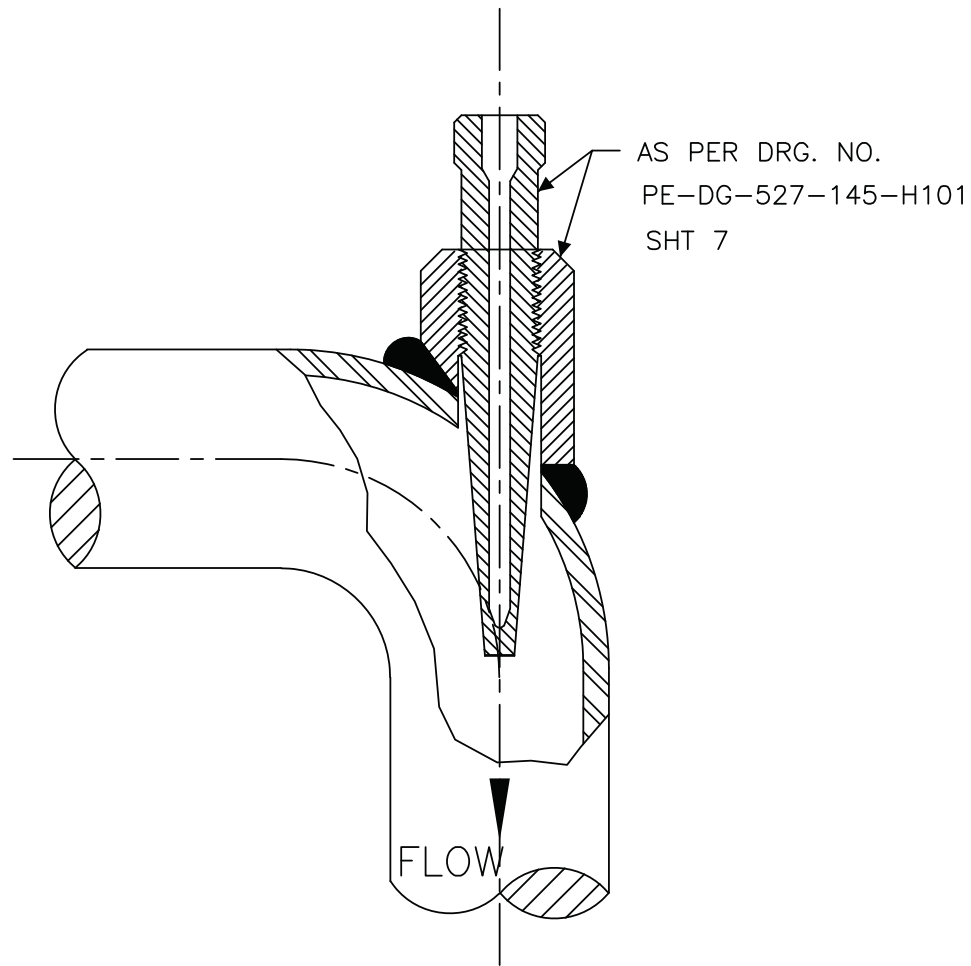


TITLE :
INSTRUMENT STUB DETAILS
FOR TEMPERATURE MEASUREMENT
THERMOWELL INSTALLATION

DRG. NO.
PE-DG-527-145-H101

REV. 00

SH. 7 OF 8 SHS.



NOTES :-

1. THIS INSTALLATION OF THERMOWELL SHALL BE APPLICABLE FOR 4" AND SMALLER LINE SIZE BUT LIMITED TO MINIMUM 3" LINE SIZE. THIS DETAIL IS APPLICABLE FOR THERMOWELL INSTALLATION IN BEND PIPES.
2. FOR 2" AND SMALLER LINE SIZE NECESSARY EXPANDER OF ELBOW FORM (AS SHOWN) OF MINIMUM 3" SIZE SHALL BE USED.
3. ELBOW EXPANDER SECTION IN HORIZONTAL PLANE TO BE USED FOR LIQUID SERVICE. FOR STEAM SERVICES EXPANDER SECTION TO BE USED IN VERTICAL PLANE.



TITLE :
**INSTRUMENT STUB DETAILS
 FOR TEMPERATURE MEASUREMENT
 THERMOWELL INSTALLATION**

DRG. NO.
PE-DG-527-145-H101

REV. 00

SH. 8 OF 8 SHS.

NOTES :-

1. IMPULSE PIPES SHALL BE OF SEAMLESS AND ANNEALED CONFORMING TO ANSI B36.10 IN LINE WITH THE MAIN PIPE MATERIAL.
2. PIPE FITTINGS SHALL BE OF FORGED MATERIAL CONFORMING TO ANSI B16.11-1991.
3. SNUBBER SHALL BE PROVIDED FOR PUMP DISCHARGE PRESS MEASUREMENTS.
4. IN CASE OF STEAM SERVICE SYPHON SHALL BE MADE BY BENDING THE TUBE OR PIPE.
5. VALVE MANIFOLDS & SNUBBER SHALL BE OF FORGED SS-316.
6. FOR SEA WATER APPLICATION SS316L FITTINGS TO BE PROVIDED.
7. 25NB x 15NB WELDED REDUCER SHALL BE USED FOR ROOT VALVE OF 25NB SIZE.
8. ROOT VALVES SHALL BE AS FOLLOWS:
 - i) FOR PRESS <40 ATA & TEMP <425 DEG C, ONE(1) NO. 15Nb, ROOT VALVE OF SUITABLE CLASS SHALL BE USED.
 - ii) FOR PRESS >40 ATA & TEMP <425 DEG C, TWO(2) NO. 15Nb, ROOT VALVE OF SUITABLE CLASS SHALL BE USED.
 - iii) FOR PRESS >40 ATA & TEMP >425 DEG C, TWO(2) NO. 25Nb, ROOT VALVES OF SUITABLE CLASS SHALL BE USED.
9. HORIZONTAL PIPE RUNS SHOULD HAVE A SLOPE IN THE DIRECTION  SHOWN OF 1:20 AS MINIMUM.
10. FOR PRESSURISED STEAM & WATER SERVICE THE ASSOCIATED INSTRUMENT SHOULD BE MOUNTED BELOW THE TAPPING POINT. FOR VACUUM/AIR/GAS SERVICE, THE ASSOCIATED INSTRUMENT SHOULD BE MOUNTED ABOVE THE TAPPING POINT.
11. SEAMLESS PIPE/SEAMLESS TUBE/CAPILLARY LENGTH SHALL BE SUCH THAT THE GAUGES/TRANSMITTERS/SWITCHES ARE MOUNTED IN ACCESSIBLE AREA.

LEGEND :-

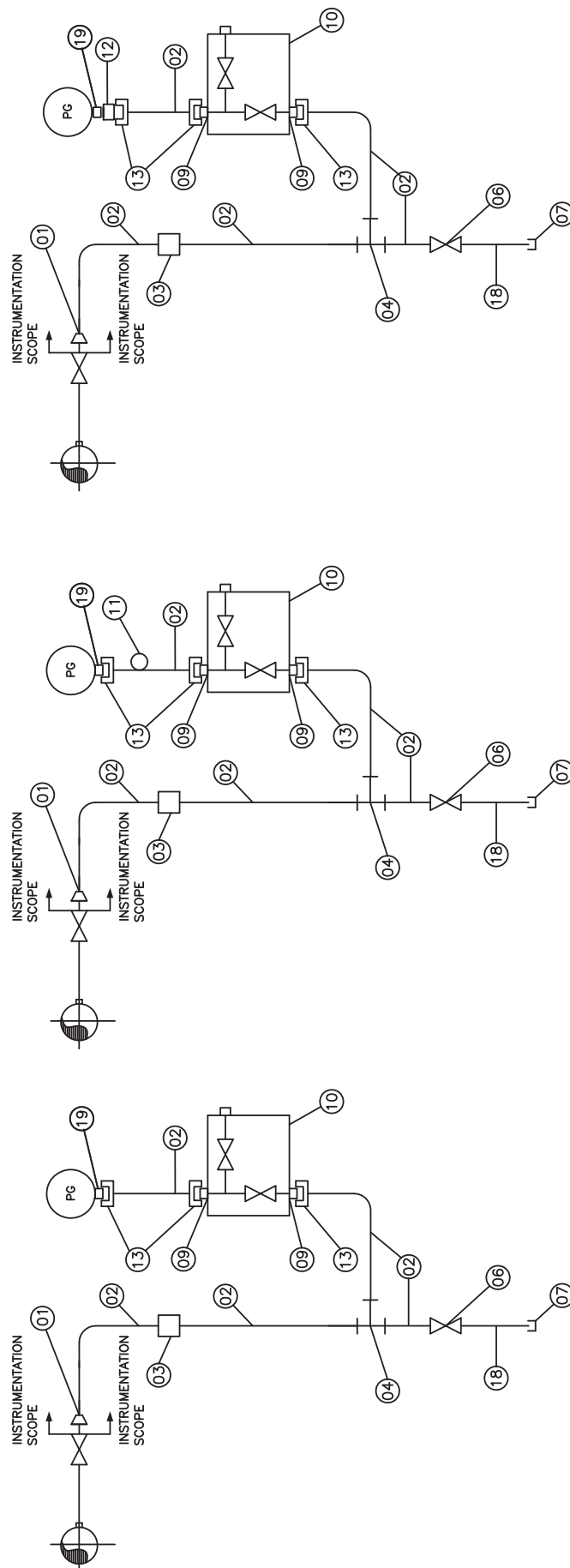
A/R – AS REQUIRED
 NPTF – NATIONAL PIPE THREAD FEMALE
 NPTM – NATIONAL PIPE THREAD MALE
 SW – SOCKET WELD



TITLE :-

INSTRUMENT INSTALLATION DIAGRAM
 NOTES

DRG. NO.	PE-DG-999-145-XXXX		
REV. NO.	00	DATE	
SHT	2	OF	9



PULSATING SERVICE

STEAM SERVICE

WATER SERVICE



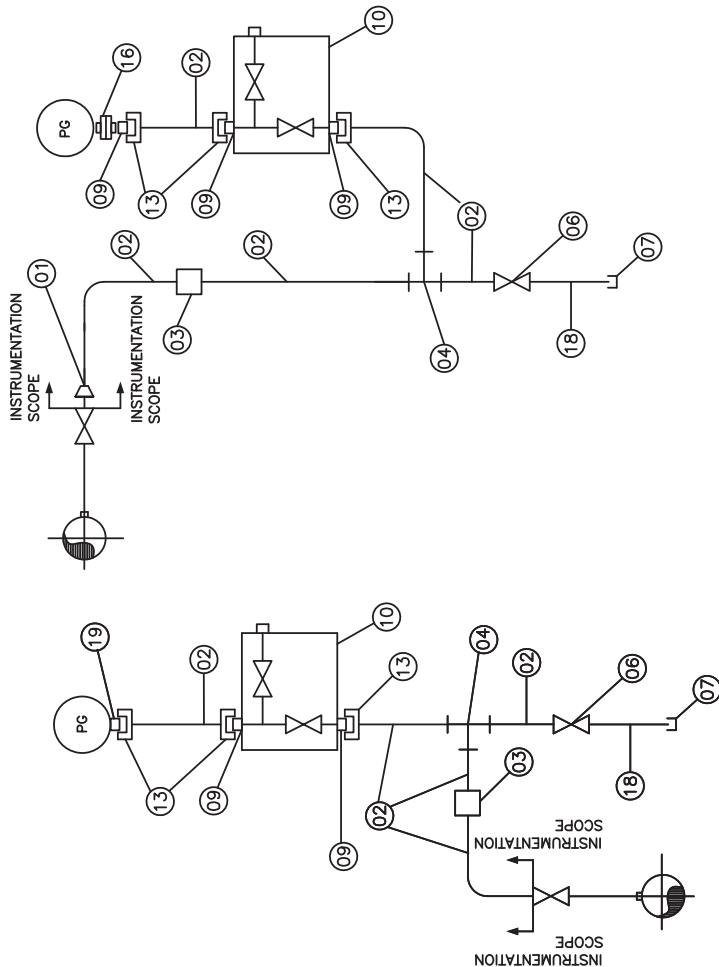
TITLE :-

INSTRUMENT INSTALLATION DIAGRAM

PRESSURE GAUGES

DRG. NO.	PE-DG-999-145-XXXX
REV. NO.	00
DATE	
SHT	3 OF 9

ITEM NO	ITEM/DESCRIPTION	MATERIAL	SIZE	QTY			CHEMICAL
				WATER	STEAM	PULSATING	
01	REDUCER (IF APPLICABLE)	SAME AS MAIN PIPE	1" X 1/2"SW	01	01	01	01
02	SEAMLESS PIPE	SAME AS MAIN PIPE	1/2"	A/R	A/R	A/R	A/R
03	FORGED COUPLING	SAME AS MAIN PIPE	1/2" SW	A/R	A/R	A/R	A/R
04	FORGED TEE	SAME AS MAIN PIPE	1/2" SW	01	01	01	01
06	FORGED GLOBE VALVE	SAME AS MAIN PIPE	1/2" SW	01	01	01	01
07	CAP	SAME AS MAIN PIPE	1/2" NPTF	01	01	01	01
09	ADAPTER – M TO M	SS316	M20X1.5M X 1/2" NPTM	02	02	02	03
10	TWO VALVE 3 WAY MANIFOLD WITH VENT PLUG	SS316	1/2" NPTF	01	01	01	01
11	SYPHON	SS316	1/2" SW	00	01	00	00
12	SNUBBER	SS316	M20X1.5M X M20X1.5F	00	00	01	00
13	NUT & TAIL PIECE WITH ANNEALED COPPER/SS304 WASHER	SS316	NUT SIZE : M20 X 1.5 WITH 100MM TAIL	03	03	03	03
16	CHEMICAL SEAL	SS316	1/2" NPTF X 1/2" NPTF	00	00	00	01
18	NIPPLE	SAME AS MAIN PIPE	1/2" NPTM X 1/2" SW	01	01	01	01
19	ADAPTER – M TO F	SS316	M20X1.5M X 1/2" NPTF	01	01	01	00



WITH CHEMICAL SEAL

(FOR VISCOUS NON-CORROSIVE FLUID ONLY)



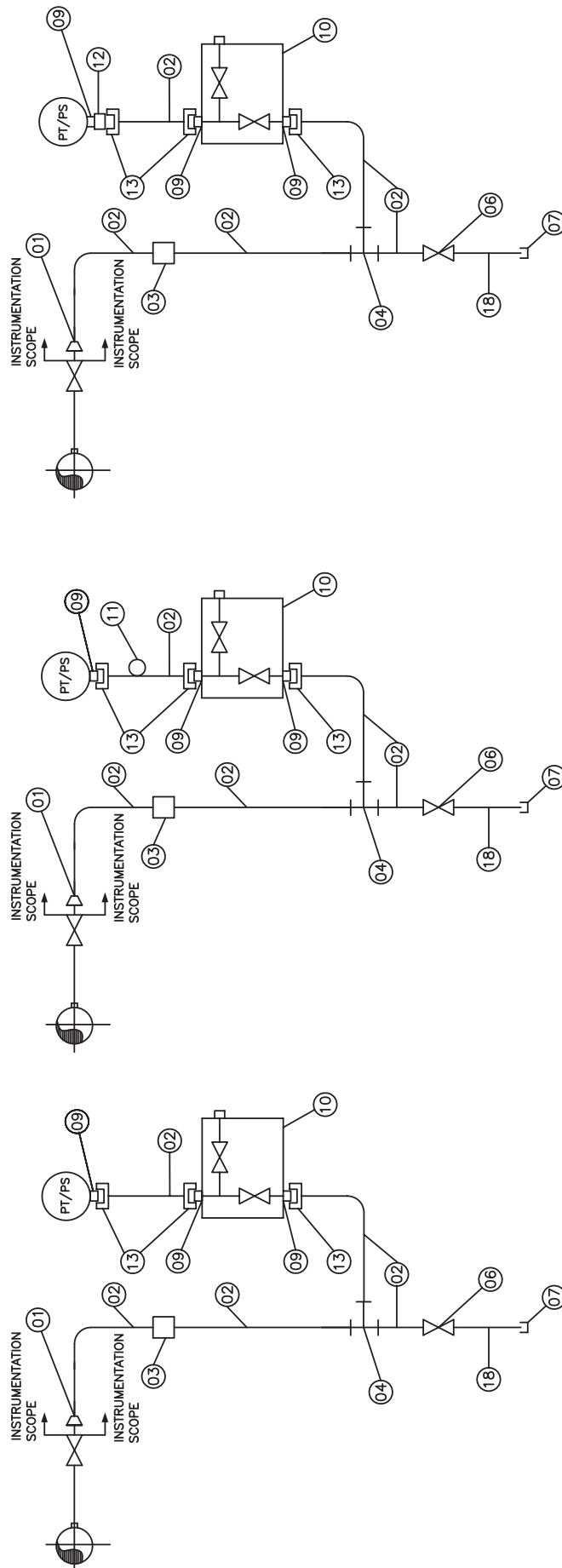
TITLE :-

INSTRUMENT INSTALLATION DIAGRAM PRESSURE GAUGES

DRG. NO. PE-DG-999-145-XXXX

REV. NO. 00 DATE

SHT 4 OF 9



PULSATING SERVICE

STEAM SERVICE

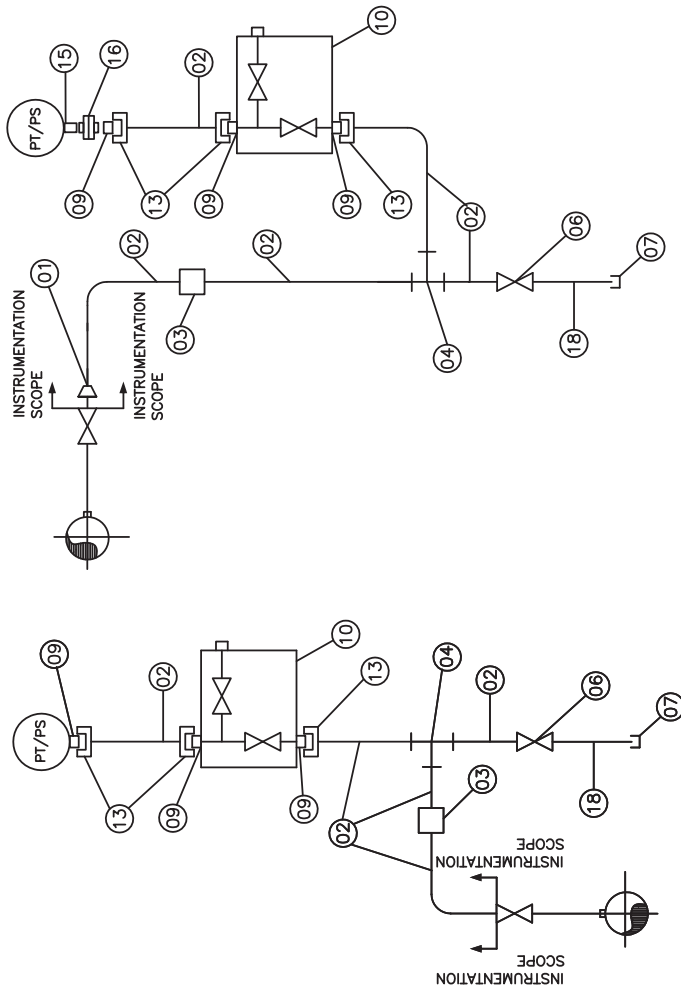
WATER SERVICE



TITLE :-

INSTRUMENT INSTALLATION DIAGRAM
PRESSURE SWITCHES/TRANSMITTERS

DRG. NO.	PE-DG-999-145-XXXX		
REV. NO.	00	DATE	
SHT	5	OF	9



AIR SERVICE

WITH CHEMICAL SEAL
(FOR VISCOUS NON-CORROSIVE FLUID ONLY)

ITEM NO	ITEM/DESCRIPTION	MATERIAL	SIZE	QTY				CHEMICAL
				WATER	STEAM	PULSATING	AIR	
01	REDUCER (IF APPLICABLE)	SAME AS MAIN PIPE	1" X 1/2"SW	01	01	01	00	01
02	SEAMLESS PIPE	SAME AS MAIN PIPE	1/2"	A/R	A/R	A/R	A/R	A/R
03	FORGED COUPLING	SAME AS MAIN PIPE	1/2" SW	A/R	A/R	A/R	A/R	A/R
04	FORGED TEE	SAME AS MAIN PIPE	1/2" SW	01	01	01	01	01
06	FORGED GLOBE VALVE	SAME AS MAIN PIPE	1/2" SW	01	01	01	01	01
07	CAP	SAME AS MAIN PIPE	1/2" NPTF	01	01	01	01	01
09	ADAPTOR – M TO M	SS316	M20X1.5M X 1/2" NPTM	03	03	03	03	03
10	TWO VALVE 3 WAY MANIFOLD WITH VENT PLUG	SS316	1/2" NPTF	01	01	01	01	01
11	SYPHON	CS	1/2" SW	00	01	00	00	00
12	SNUBBER	SS316	M20X1.5M X M20X1.5F	00	00	01	00	00
15	CONNECTOR – M TO M	SS316	1/2" NPTM X 1/2" NPTM	00	00	00	00	01
16	CHEMICAL SEAL	SS316	1/2" NPTF X 1/2" NPTF	00	00	00	00	01
13	NUT & TAIL PIECE WITH ANNEALED COPPER/SS304 WASHER	SS316	NUT SIZE : M20 X 1.5 WITH 100MM TAIL	03	03	03	03	03
18	NIPPLE	SAME AS MAIN PIPE	1/2" NPTM X 1/2" SW	01	01	01	01	01



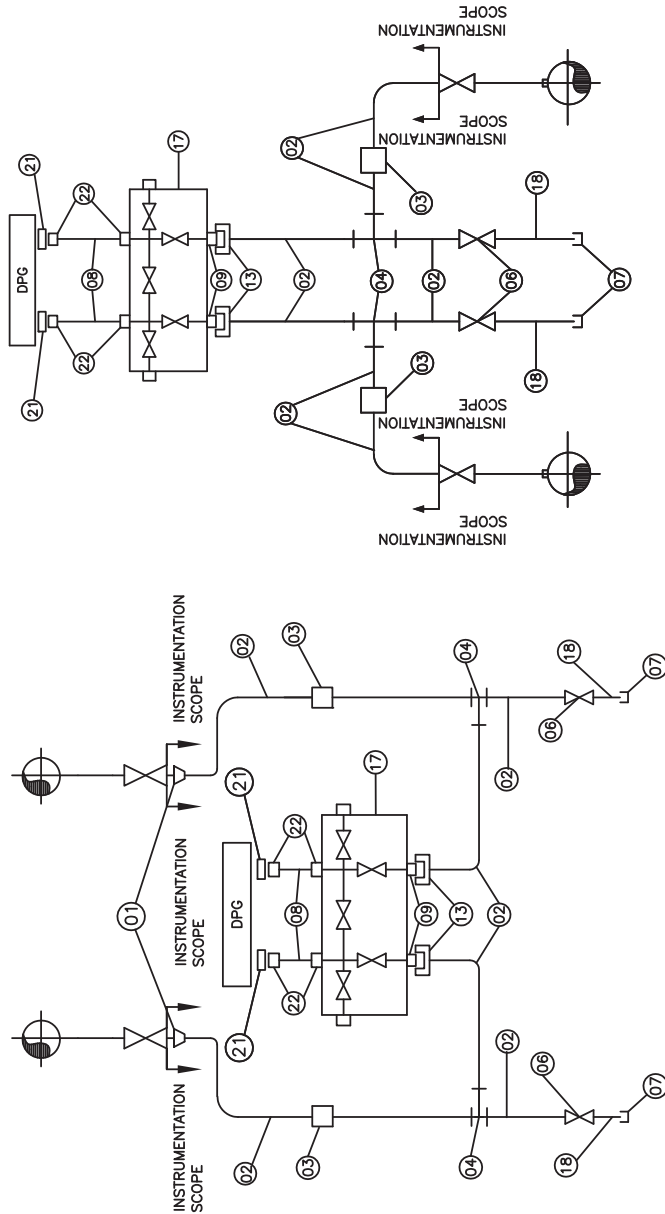
TITLE :-

INSTRUMENT INSTALLATION DIAGRAM PRESSURE SWITCHES/TRANSMITTERS

DRG. NO. PE-DG-999-145-XXXX

REV. NO. 00 DATE

SHT 6 OF 9



AIR SERVICE

WATER SERVICE

ITEM NO	ITEM/DESCRIPTION	MATERIAL	SIZE	QTY
01	REDUCER (IF APPLICABLE)	SS316	1" X 1/2" SW	02
02	SEAMLESS PIPE	SAME AS MAIN PIPE	1/2"	A/R
03	FORGED COUPLING	SAME AS MAIN PIPE	1/2" SW	A/R
04	FORGED TEE	SAME AS MAIN PIPE	1/2" SW	02
06	FORGED GLOBE VALVE	SAME AS MAIN PIPE	1/2" SW	02
07	CAP	SAME AS MAIN PIPE	1/2" NPTF	02
08	SEAMLESS TUBE	SS316	1/2" OD	A/R
09	ADAPTOR - M TO M	SS316	M20X1.5M X 1/2" NPTM	02
17	FIVE VALVE MANIFOLD WITH DRAIN PLUG	SS316	1/2" NPTF	01
16	CHEMICAL SEAL	SS316	1/2" NPTF X 1/2" NPTF	00
13	NUT & TAIL PIECE WITH ANNEALED COPPER/SS304 WASHER	SS316	NUT SIZE : M20 X 1.5 WITH 100MM TAIL	02
18	NIPPLE	SAME AS MAIN PIPE	1/2" NPTM X 1/2" SW	02
22	TUBE FITTING DFDC	SS316	1/2" NPTM X 1/2" OD TUBE	04
21	CONNECTOR - F TO F	SS316	1/2" NPTF X 1/2" NPTF	02



TITLE :-

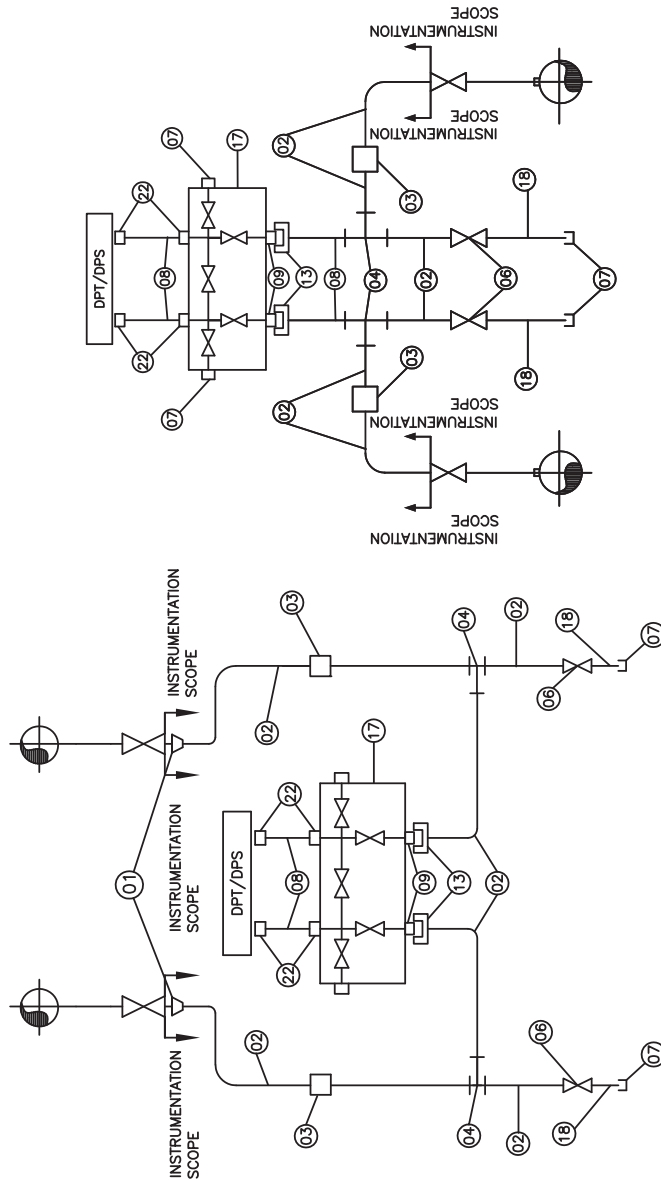
INSTRUMENT INSTALLATION DIAGRAM

DIFFERENTIAL PRESSURE GAUGES

DRG. NO. PE-DG-999-145-XXXX

REV. NO. 00 DATE

SHT 7 OF 9



AIR SERVICE

WATER SERVICE

ITEM NO	ITEM/DESCRIPTION	MATERIAL	SIZE	QTY	
				WATER	AIR
01	REDUCER (IF APPLICABLE)	SS316	1" X 1/2"SW	02	00
02	SEAMLESS PIPE	SAME AS MAIN PIPE	1/2"	A/R	A/R
03	FORGED COUPLING	SAME AS MAIN PIPE	1/2" SW	A/R	A/R
04	FORGED TEE	SS316	1/2" SW	02	02
06	FORGED GLOBE VALVE	SS316	1/2" SW	02	02
07	CAP	CS	1/2" NPTF	02	02
08	SEAMLESS TUBE	SS316	1/2" OD	A/R	A/R
09	ADAPTER – M TO M	SS316	M20X1.5M X 1/2" NPTM	02	02
17	FIVE VALVE MANIFOLD WITH DRAIN PLUG	SS316	1/2" NPTF	01	01
16	CHEMICAL SEAL	SS316	1/2" NPTF X 1/2" NPTF	00	00
15	CONNECTOR – M TO M	SS316	1/2" NPTM X 1/2" NPTM	00	00
13	NUT & TAIL PIECE WITH ANNEALED COPPER/SS304 WASHER	SS316	NUT SIZE : M20 X 1.5 WITH 100MM TAIL	02	02
18	NIPPLE	SAME AS MAIN PIPE	1/2" NPTM X 1/2" SW	02	02
21	CONNECTOR – F TO F	SS316	1/2" NPTF X 1/2" NPTF	00	00
22	TUBE FITTING DFDC	SS316	1/2" NPTM X 1/2"OD TUBE	04	04



TITLE :-

INSTRUMENT INSTALLATION DIAGRAM

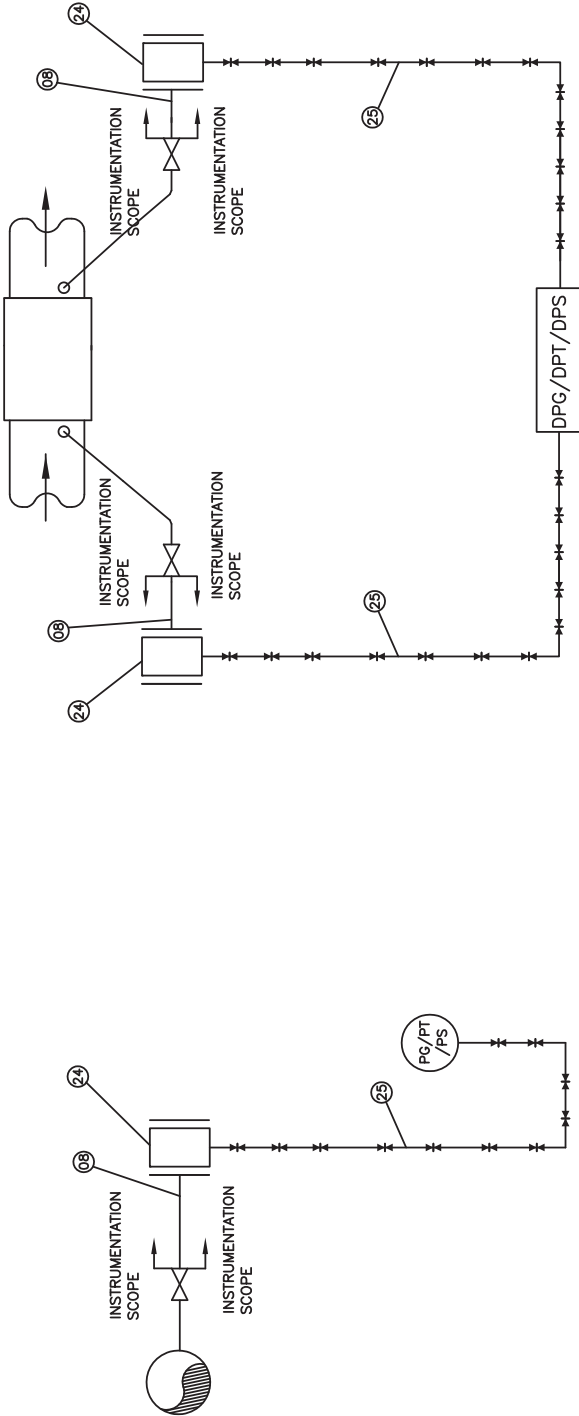
DIFFERENTIAL PRESSURE SWITCHES/TRANSMITTERS

DRG. NO. PE-DG-999-145-XXXX

REV. NO. 00 DATE

SHT 8 OF 9

ITEM NO	ITEM/DESCRIPTION	MATERIAL	SIZE	QTY	
				PG/PS/PT	DPG/DPS/DPT
24	FLANGE SUPPLIED WITH PG/PS PT/DPG/DPS/DPT TO SUIT 1/2" OR 1" NB PIPE	SAME AS MAIN PIPE	1/2" SW	01	02
08	SEAMLESS PIPE	SAME AS MAIN PIPE	1/2"	A/R	A/R
25	SS ARMORED CAPILLARY TUBE (MINIMUM 5M IN LENGTH)	SS316	-	A/R	A/R



TITLE :-

INSTRUMENT INSTALLATION DIAGRAM
WITH CAPILLARY TUBES

DRG. NO.	PE-DG-999-145-XXXX		
REV. NO.	00	DATE	
SHT	9	OF	9



**KORADI THERMAL POWER STATION
2 x 660 MW UNITS - 11 & 12 PROJECT**

SECTION: C
SUB SECTION : C&I

**C&I SPECIFICATION FOR
HVAC SYSTEM**

PROVENNESS CRITERIA



**KORADI THERMAL POWER STATION
2 x 660 MW UNITS - 11 & 12 PROJECT**

SECTION: C
SUB SECTION : C&I

**C&I SPECIFICATION FOR
HVAC SYSTEM**

The offered model of DCS must have been successfully supplied, erected, tested and commissioned as complete BTG Control & Instrumentation system for at least one unit of 500 MW or above for Thermal Power Station(s) with reheat type pulverized coal fired boiler which is in successful operation for a minimum period of one year as on date of opening of Bids. Similarly, all other C&I equipment/ systems/ sub-systems/ instruments and accessories in the power cycle shall also be of make and model whose guaranteed and trouble-free performance has been proven at least for one year for one reheat type pulverized coal fired units of unit size of 500 MW or above.



**KORADI THERMAL POWER STATION
2 x 660 MW UNITS - 11 & 12 PROJECT**

SECTION: C
SUB SECTION : C&I

**C&I SPECIFICATION FOR
HVAC SYSTEM**

SUB VENDOR LIST

|

	MAHARASHTRA STATE POWER GENERATION CO. LTD.	VOLUME-V
	KORADI THERMAL POWER STATION 2x660 MW UNITS - 11 & 12 PROJECT	
	RFx No. 3000046202 (BTG Package)	ANNEXURE - 4
	SUB-VENDOR LIST	REV. - 0

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
			Emerson Process Management (I) Ltd
2.00	Smart Electronic Transmitters (Pressure, Diff. Pressure)	1	
		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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	MAHARASHTRA STATE POWER GENERATION CO. LTD.		VOLUME-V
	KORADI THERMAL POWER STATION 2x660 MW UNITS - 11 & 12 PROJECT		
	RFx No. 3000046202 (BTG Package)		ANNEXURE - 4
	SUB-VENDOR LIST		REV. - 0

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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	MAHARASHTRA STATE POWER GENERATION CO. LTD.	VOLUME-V
	KORADI THERMAL POWER STATION 2x660 MW UNITS - 11 & 12 PROJECT	
	RFx No. 3000046202 (BTG Package)	ANNEXURE - 4
	SUB-VENDOR LIST	REV. - 0

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	WIKI Instruments India Pvt. Ltd., Pune
		7	Waree, Dadra
		8	B.C. Technomation (For WAREE Instruments), Bhopal
		9	Goa Instruments Pvt. Ltd., (old name:- Pyro Electric Goa)
		10	Bells Controls Ltd., Kolkata
		11	Switzer Instruments Ltd., Chennai
		12	Wika Alexander Wiegand GMBH&Co.,Germany
		13	Budenburg Gauge 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	Dwyer, 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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	KORADI THERMAL POWER STATION 2x660 MW UNITS - 11 & 12 PROJECT	
	RFx No. 3000046202 (BTG Package)	ANNEXURE - 4
	SUB-VENDOR LIST	REV. - 0

SR. NO.	ITEM		Koradi 2x660 MW
		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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MAHARASHTRA STATE POWER GENERATION CO. LTD.

VOLUME-V

**KORADI THERMAL POWER STATION
2x660 MW UNITS - 11 & 12 PROJECT**
RFx No. 3000046202 (BTG Package)
ANNEXURE - 4
SUB-VENDOR LIST
REV. - 0

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 Miltronics
		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

	MAHARASHTRA STATE POWER GENERATION CO. LTD.	VOLUME-V
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SR. NO.	ITEM			Koradi 2x660 MW
C	Electrical & Secondary Instruments			
1.00	Digital Indicator	1	ABB, Germany / Faridabad	
		2	Massibus, Gandhinagar	
		3	Lektrotek, Pune	
		4	Gossen / Camille Bauer / Metrawatt	
		5	Yokogawa, Japan / India	
2.00	Bargraph Indicators	1	ABB, Germany / Faridabad	
		2	Massibus, Gandhinagar	
		3	Lektrotek, Pune	
		4	Gossen / Camille Bauer / Metrawatt	
		5	M-system, Japan (Chino Laxsons Daman)	
3.00	Transducers	1	Siemens	
		2	Automatic Electric Ltd., Mumbai	
		3	Southern Transducers, Channai	
		4	Minilec, Pune	
		5	ADEPT, Pune	
		6	Meco, Mumbai	
4.00	Selector Switches and Control Switches	1	Kaycee	
		2	Alstom	
		3	L&T	
		4	Siemens	
		5	Recon	
		6	Switron	

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SR. NO.	ITEM		Koradi 2x660 MW
5.00	Mosaic Analog (Moving Coil) Indicators	1	Gossen, Germany
		2	Weigel, Germany
6.00	Mosaic Digital Indicators	1	Gossen, Germany
		2	Weigel, Germany
7.00	Interposing relays for Command Output to MCC	1	Jyoti
		2	Alstom
		3	Elasta
		4	Siemens
		5	ABB
8.00	Relays / Aux. Contactors	1	Telemecanique & ctrl's
		2	ABB
		3	Siemens
		4	GEC – Alstom
		5	L & T
		6	Schneider
		7	GE
		8	Areva
9.00	Limit Switches	1	Bhartiya Cutler & Hammer, Faridabad
		2	Switzer
		3	Telemechanics
		4	Technik
		5	Omron
		6	Honeywell
		7	Rotex
10.00	Miniaturized Push Buttons / ILPB (24X48MM) Mosaic Grid Compatible	1	Siemens
		2	TEW, Germany (Old name Subklew)
D	Control Desks & Panels:		
1.00	Unit Control Panels (UCP) / Electrical Control Panel (ECP) / CRT Desk / Operator Desk	1	Instrumentation Ltd. Kota
		2	Khoday Control Systems, Bengaluru
		3	Chemin Controls, Pondicherry
		4	Pushpak Products India Pvt. Ltd. Bengaluru
		5	Harmony Systems
		6	Cosmos Media Products Pvt. Ltd.
2.00	Mosaic Grid/ Mosaic Tiles & Other Mosaic items	1	Symo, Switzerland

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	KORADI THERMAL POWER STATION 2x660 MW UNITS - 11 & 12 PROJECT		
	RFx No. 3000046202 (BTG Package)		ANNEXURE - 4
	SUB-VENDOR LIST		REV. - 0

SR. NO.	ITEM		Koradi 2x660 MW
		2	TEW, Germany (old name SubKlew)
3.00	DCS or PLC Panels / Local Panels / Distribution boards	1	Control & Schematics
		2	Rittal
		3	L&T
4.00	Terminal Blocks	1	Elmex
		2	Phoenix
		3	WAGO
~~E~~	~~Analysers~~		
1.00	SWAS Analyzer	1	Polymetron / Zellwegger Analyticals
		2	ABB
		3	Orion, USA
		4	Rosemount Analyticals Chempure
		5	Hach Ultra, France
		6	Hach, USA
		7	Yokogawa
		8	Ametech
		9	Forbes Marshall (Swan Analytical Instruments)
		10	Emerson
2.00	SWAS (Steam and Water Analysis System) Panels	1	ABB Kent, U.K
		2	ABB Ltd. Faridabad
		3	Forbes Marshall
		4	Emerson Process Management
		5	Instrumentation Ltd, Kota
		6	Yokogawa
3.00	Continuous Emission Monitoring System (CEMS)	1	Forbes Marshall (Codel make CEMS Analyzer for In-situ type only)
		2	Envea India Pvt. Ltd., Navi Mumbai (For Extractive type only)
		3	AIC Pvt. Ltd. (For Extractive type only)
		4	Yokogawa India Ltd., Bangalore (For Extractive type only)
		5	ICE ASIA Pvt. Ltd., Rajasthan (For CO analyzers only)
		6	SICK India Pvt Ltd.
4.00	Ozone Analyzer	1	BMT Messtechnik, GMBH
5.00	Residual Ozone Analyzer	1	Eco Sensors/ Kauffmann Umwitteltechnik. EK
6.00	Ozone Leak Detector	1	OTTPL
7.00	AAQMS	1	Envea India Pvt Ltd.
		2	Swan Technical Services Pvt. Ltd.

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	SUB-VENDOR LIST		REV. - 0

SR. NO.	ITEM		Koradi 2x660 MW
		3	Thermofishers Scientific India Pvt. Ltd.
F	Control Valves / Actuators / Solenoid Valves		
1.00	Electrical Actuators for Regulating & open / close valves	1	Rotork Control (India) Ltd.,
		2	Auma (India) Ltd.,
		3	Limatorque India Ltd.
2.00	Pneumatic Actuators-Regulating & open / close	1	Instrumentation Ltd., Palghat
		2	Keltron Controls, Kerala
		3	Koso India Pvt. Ltd.
3.00	SH/RH Spray Control Valves	1	MIL Control Ltd.
4.00	SH/RH Spray Block Valves	2	Instrumentation Ltd
5.00	Feed Control Valves	3	Fisher Xomos Sanmar Ltd.
		4	Control Component INC., USA
		5	HORA (Holter Regelmaturen GMBH & CO.)
6.00	LFO / HFO Control & Trip Valves, Flow Control, Pressure Control, Temp. Control, & Burner Trip Valves, Ball Valves.	1	MIL Control Ltd.
		2	Instrumentation Ltd
		3	Fouress Engg (I) Ltd. Bangalore
		4	Samson Controls Ltd.
7.00	Soot Blower Pressure Reducing Valve	1	MIL Control Ltd.
		2	Instrumentation Ltd
		3	Fisher Sanmar Ltd.
		4	Control Component Inc. USA
		5	HORA (Holter Regelmaturen GMBH & CO.)
		6	Koso India Pvt Ltd.
8.00	APRDS Control Valves	1	Instrumentation Ltd
		2	Control Component Inc. USA
		3	HORA
		4	(Holter Regelmaturen GMBH & CO.)
9.00	Control valves - Non Critical	1	DeZURIK Copes Vulcan Ltd., U.K.
		2	Control Component INC., USA
		3	Fisher Sanmar Limited
		4	Instrumentation Ltd
		5	MIL Control Ltd.

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	RFx No. 3000046202 (BTG Package)	ANNEXURE - 4
	SUB-VENDOR LIST	REV. - 0

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	Precision 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	Precision 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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VOLUME-V

**KORADI THERMAL POWER STATION
2x660 MW UNITS - 11 & 12 PROJECT**

RFx No. 3000046202 (BTG Package)

ANNEXURE - 4

SUB-VENDOR LIST

REV. - 0

SR. NO.	ITEM		Koradi 2x660 MW
		6	Mannesmann AG, Germany
		7	Touvay and Cauvin Gulf EC, Dubai
		8	Jindal Saw Pipes Ltd., India
		9	Sumitomo Corporation, Japan / Kawasaki
		10	Ratnamani Metals & Tubes Ltd., Ahmedabad
5.00	Junction Box (FRP)	1	Devi Polymers, Chennai
		2	Suchitra Industries, Bangalore
		3	Rittal
		4	Hansel
		5	Shrenik & Company (Pushtron)
		6	L&T
6.00	Air Cylinder	1	Veljan Hydrair, Hyderabad
		2	Nucon Industries, Hyderabad
		3	Precision Engg. (PREAC), Banagalore
		4	ASCO, Chennai

	MAHARASHTRA STATE POWER GENERATION CO. LTD.	VOLUME-V
	KORADI THERMAL POWER STATION 2x660 MW UNITS - 11 & 12 PROJECT	
	RFx No. 3000046202 (BTG Package)	ANNEXURE - 4
	SUB-VENDOR LIST	REV. - 0

SR. NO.	ITEM		Koradi 2x660 MW

II	Electrical		
1.00	MOTOR ACTUATORS	(a)	ROTORK India
		(b)	AUMA India Pvt. Ltd.
		(c)	LIMITORQUE India Ltd.
		(d)	ANTRIEB TECHNIK Pvt. Ltd
11.00	PROXIMITY SWITCH	(a)	A.G.System Controls, Mumbai
		(b)	Jayashree Eletrodevices Pvt. Ltd.
12.00	VFD (LT MOTORS)	(a)	ABB
		(b)	SIEMENS
		(c)	L&T
		(d)	ALLEN BRADLEY
		(e)	GE FANUC
		(f)	Hitachi Hi-Rel
13.00	SAFETY SWITCHES (MECHANICAL)	(a)	A.G.System Controls, Mumbai

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SR. NO.	ITEM		Koradi 2x660 MW
		(b)	Jayashree Eletrodevices Pvt. Ltd.
		(c)	OMRON
		(d)	HONEYWELL
14.00	ANNUNCIATOR	(a)	PROCON
		(b)	IIC
		(c)	MINILEC (INDIA) PVT. LTD.
15.00	HOOTER	(a)	KHERAJ
		(b)	TULLU
		(c)	VAISHNO
16.00	CONTROL PANELS/(Relay Based)	(a)	POSITRONICS.
	LIGHTING PANELS/JBS	(b)	CONTROL & SCHEMATIC
		(c)	VIMAC ELECTRIC
		(d)	PRITHVI TECHNOLOGY
		(e)	POWEROL PANEL & CONTROL
		(f)	L&T
		(g)	SIEMENS
		(h)	SCHNEIDER
60.00	RELAY CONTROL PANEL (PCR)	(a)	ABB
		(b)	AREVA
		(c)	BHEL
		(d)	SIEMENS
68.00	CONTROL PANEL/DESK (PCR)	(a)	BHEL BHOPAL
		(b)	RITTAL INDIA

Notes:-

- 1) The above sub-vendor list is tentative & reference only. However sub-vendor list is subject to BHEL/end user approval without any commercial/delivery implication.
- 2) New subvendor if proposed by vendor during contract stage shall be subject to BHEL/end user approval without any commercial/delivery implication.



TITLE:
2X660 MW KORADI STP (UNITS-11&12)
AIR CONDITIONING SYSTEM
(O&M SERVICES)

SPECIFICATION No: PE-TS-527-553-A001

SECTION : I

SUB SECTION: C-5

REV. 00

DATE: AUGUST 2026

SECTION- I
SUB-SECTION-C-5
TECHNICAL SPECIFICATION
(OPERATION AND MAINTENANCE SERVICES FOR AC SYSTEM)



TITLE:
2X660 MW KORADI STP (UNITS-11&12)
AIR CONDITIONING SYSTEM
(O&M SERVICES)

SPECIFICATION No: PE-TS-527-553-A001

SECTION: I

SUB SECTION: C-6

REV. 00

DATE: AUGUST 2026

SHEET: 1 OF 6

1.0 OPERATION AND MAINTENANCE SERVICES

The bidder scope also covers the Operation and Maintenance (O&M) services for Preventive and Breakdown maintenance from the date of successful commissioning till handing over to end customer. However, actual date of start of O&M services shall be communicated to successful bidder by BHEL site personnel.

Bidder to note that the spares and consumables required for maintenance of the equipment during this O&M period shall be in bidder's scope of supply. Bidder shall use only genuine parts as mentioned in O&M Manual. Any damage or malfunction caused by the use of unauthentic parts or unqualified personnel shall be responsibility of bidder and as a consequence of above bidder is required to replenish the unauthorised part and abridge the qualified person without any commercial implication to BHEL.

O&M Services scope also covers all regular maintenance by trained service engineers and supply of genuine parts and lubricants as per the original equipment manufacturer's recommendations.

For the purpose of Operation of AC System, One-day shall be considered as 24 hours i.e. 3 shifts of 8 hours each. The AC System (along with related accessories) shall be operated on Round-the-clock basis on all the days of the year including Sundays and Public Holidays

O & M Personnel should be acquainted with local language. Governmental / Statutory approval w.r.t. O&M service as applicable shall be in bidder's scope.

Total duration of the Operation and Maintenance services has been envisaged for twelve (12) months for individual AC plants/control buildings identified in price format/specification. The duration of operation & maintenance services can be increased or decreased as per requirement and payment in such case shall be made on pro-rata basis.

The operation and maintenance services can be continuous or intermittent as per site requirement for individual AC plants/control buildings identified in price format/specification.

Bidder has to compulsorily maintain log book for the O & M staff engaged for O&M jobs and submit to Engineer in charge for certification for realization of the bills. After certification of the bill by Engineer in charge of BHEL, bidder shall claim the amount after completion of minimum 30 days.

Depending on start of O&M services, there is a possibility that some period of O&M services and Warranty period may overlap. **However, it is clarified that any maintenance required or any spare of AC System required to be replaced during Warranty period (as part of warranty clause requirement) shall not be made part of O&M Services. Bidder may take care of this fact while working out the prices of O&M services**



TITLE:
2X660 MW KORADI STP (UNITS-11&12)
AIR CONDITIONING SYSTEM
(O&M SERVICES)

SPECIFICATION No: PE-TS-527-553-A001

SECTION: I

SUB SECTION: C-6

REV. 00

DATE: AUGUST 2026

SHEET: 2 OF 6

Wherever AC system has been written in O&M Service Specification, the same shall be deemed as complete AC System.

The vendor shall deploy following minimum manpower for Operation of AC System.

- i. Two qualified and experienced AC operator per shift on "Round the Clock" basis throughout the year for all days of the year including Sundays & Public Holidays. There must be minimum 30 minutes overlapping between two shift operators to get familiarize with the status of AC System.
- ii. Two Helper per shift on " Round the Clock" basis throughout the year for all the days of the year including Sundays and Public Holidays. The helper shall assist the AC System Operator in day to day operation of AC System and accessories and shall assist him for keeping AC System equipment's in neat and tidy condition.

1.1 Responsibility of AC System Operator

- i. AC System operator shall be responsible for proper sequential operation of AC System including operation of standby equipment in a predefined sequence and stopping the same (when necessary) as per the procedural practice. In case of any abnormality (like non availability of power supply at incomer of AC System), he shall immediately report the matter to BHEL site Engineer for further action. Similarly, any malfunctioning in the system shall be immediately reported by him to BHEL site Engineer for suitable corrective action irrespective of time of occurrence of malfunctioning / abnormality in the system. A log book of all such outrages shall be maintained by AC system operator, which shall be shared with BHEL site engineer on periodic basis.
- ii. AC System operator shall take hourly readings of all the parameters of AC System / Equipment's including reading on main electrical panel of AC System. Temperature & RH readings inside all AC areas shall be taken at least once in a day. All the readings shall be recorded in a logbook register.

1.2 Responsibility of Helper.

- i. The AC System helper shall assist AC System operator for day to day smooth operation of AC System, like Checking of water levels of cooling tower, cleaning of Tanks, cleaning of strainers, checking water parameters of softening plant cleaning of AHU filters and other filters etc. as and when required. He shall be responsible for keeping all the equipment's of AC System as applicable in clean and tidy condition. He shall also carry out general cleaning of all AC equipment's including Electrical Panels (Part of AC System), AHU's etc. on regular basis.
- ii. The helper shall work under the control of AC System operator and shall always ensure that unusable junk materials are not allowed to be kept in AC System room or AHU rooms.



TITLE:
2X660 MW KORADI STP (UNITS-11&12)
AIR CONDITIONING SYSTEM
(O&M SERVICES)

SPECIFICATION No: PE-TS-527-553-A001

SECTION: I

SUB SECTION: C-6

REV. 00

DATE: AUGUST 2026

SHEET: 3 OF 6

- iii. Under such eventuality, he will report the matter to Plant Operator, who in turn will take suitable action including reporting the matter to BHEL site Engineer.
- 1.2.1 All the log book registers shall be arranged by vendor. Log book register duly paged and bounded will be maintained in good condition by vendor.
- 1.2.2 All the necessary tools & tackles and other materials, required for operation of AC System shall be kept by vendor under the control of AC System operator. These tools & tackles shall be separate from tools & tackles (as per price format) which shall be handed over to customer in new condition. Required testing instruments like refrigerant leak detector, Multi Meter (for Electrical portion of AC System), Sling psychrometer, Line Tester, Tool Kit, Torch, vacuum pump, oil charging pump, Pressure testing kit etc. should also be always available with Plant Operator.
- 1.2.3 In case of any operator / helper being on leave, vendor shall immediately take advance action and provide substitution so that minimum manpower as indicated above is not reduced on any day. In case a particular shift duty A/C Operator or helper does not turn up due to any reasons, the earlier duty person shall continue to make sure that AC System never remains unattended.

2.0 Maintenance of AC System

- i. Maintenance work under scope of the vendor shall broadly include but in no way limited to the following:
 - a) Preventive maintenance of the plant.
 - b) Servicing of the AC plants and associated equipment's at regular interval
 - c) Attending to complaints.
 - d) Replacement of worn out or defective components
 - e) Replacing of consumables like refrigerant gas, oil, chemicals and salt for softening plant as and when required.

No consumable or any other items of AC system shall be arranged by Customer and no extra payment shall be made by customer in this regard.

- ii. Vendor shall be responsible at all time, during the entire period of contract for satisfactory performance of AC system (including accessories) with zero down time. During emergency or breakdown, vendor's Engineer along with related technicians shall be available immediately even though it may be beyond normal working hours or on public holidays till the AC System is restored back into normal satisfactory condition. Response time for attending breakdown complaints shall not exceed 2 hours.



TITLE:
2X660 MW KORADI STP (UNITS-11&12)
AIR CONDITIONING SYSTEM
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- iii. Defective / worn out components shall be replaced only by genuine and original parts. OEM or its authorized dealer's invoice shall be submitted as proof of using genuine parts. All common spares required for AC system shall normally be kept available in the plant by the vendor. However, for critical spares, the same shall be made available in not more than 72 hours from the time of break-down requiring such spare.
- iv. Preventive Maintenance, servicing of AC System equipment's and accessories etc. shall be done by vendor in a planned manner in consultation with concerned customer's engineer. Preventive maintenance and service should be done as per the recommendations / guidelines of various OEMs
- v. Major servicing & over handling of equipment's like compressors, evaporators, condensers, pumps, AHU's, piping / ducting works, valves etc. shall be done by vendor once in a year.
- vi. In case any repair/services of particular equipment of system like chiller unit is to be carried out by vendor through OEM (or their authorized dealer), all the arrangements including tools, O&M spares etc. shall be the total responsibility of vendor.
- vii. Vendor shall arrange and maintain separate logbook register for services / maintenance of AC System. Record of work done for services/maintenance repairs etc. shall be recorded by vendor's engineer in this register. This register shall always be with updated records & shall be produced to customer's engineer on weekly basis or as & when required by him.
- viii. Vendor shall arrange and maintain sufficient stock of spares and consumable at site (AC room). Similarly, all necessary tools & instruments required for the purpose of servicing / maintenance / routine testing etc. shall also be arranged by vendor and should be available at site at all times.
- ix. Repairs / servicing works shall normally be done by vendor at site up to maximum possible extent. However, in case any equipment or accessories is essentially required to be taken by vendor out of the plant premises for repairing / servicing, all necessary arrangements including to and fro transportation shall be the responsibility of vendor. Vendor shall also inform concerned customer's engineer for doing procedural formalities (like issue of gate pass etc.), prior to taking out the materials out of Plant premises.
- x. In case bidder fails to supply the spares required for maintenance of the equipment, same shall be provided by BHEL at Bidders risk and cost.
- xi. Vendor shall be fully responsible for safety of his personal at all times. Vendor shall also be responsible for taking all safety precautions at all the times, especially during servicing / preventive maintenance and repairs of AC System equipment's etc.



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- xii. All the safety controls of AC Plant such as HP, LP, OP, Water pressure switch, inter locking etc. shall be positively checked at least once a month and same shall be recorded by vendor engineer
- xiii. Technicians & helpers engaged by the vendor shall wear uniform with nameplate for easy identification, while being within plant premises
- xiv. Vendor's engineer shall be focal point for customer. He shall report to customer engineer on daily basis, for taking necessary instructions and to update the status of AC system
- xv. If any damage to the equipment and its accessories has happened due to improper maintenance by bidder shall be recovered from the bidder.
- xvi. Bidder is to arrange all the safety gears like helmets, air plugs, safety shoes etc. during the maintenance for the O&M Staff.
- xvii. Bidder shall have to maintain storage shed along with site office during O & M contract also
- xviii. Fabrication and erection of platform/extra support for AC areas if felt necessary during operation and maintenance of the system has to be done by the bidder.

Notes:

1. The bidder shall take approval from Engineer-in charge of BHEL by submitting organization Chart of O&M staff for this site clearly indicating man power deployment with their educational background & experience with supporting documents.
2. The bidder shall be solely and wholly responsible for safety and security of workers engaged in the job and the BHEL property. In case of any accident the contractor shall pay proper compensation to the workers as per workmen's compensation act and repair/replace BHEL property at their own cost & arrangement. The bidder shall also make adequate provision of insurance for their workers at their own cost to cover them against the risk of accident.
3. The bidder and their workers engaged in the job shall follow all safety rules at the time of execution of work. It shall be responsibility of the bidder to supply all safety equipment as necessary to its O&M staff.
4. Beyond general shift if any trouble/breakdown occurs in the plant, Maintenance team must reach the plant without any delay along with Engineer/Site In-charge.
5. No Person from the list of manpower shall leave the plant site without prior permission from the Engineer in charge of BHEL.
6. However, in operation part, if any person is absent, substitute must be given immediately otherwise proportionate deduction will be made



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7. The replacement / substitute personnel for maintenance, manpower shall have the same educational qualification and experience.
8. If any additional manpower is required during O&M whatsoever under the scope of contract the same shall be made available by bidder in time within the cost. To cater the need of time bound maintenance jobs, the bidder shall depute additional manpower without any cost implication to BHEL
9. During execution of work if any personnel is found not suitable for the job or his presence inside powerhouse premises is felt undesirable, the personnel has to be replaced within 15 days.
10. BHEL will not be responsible for payment towards idle labour charges

Statutory Compliance by the bidder:

All Statutory compliances related to Labour, Health & Safety, Quality & Environment protection and insurance shall be as GCC Rev-07.



TITLE:
2X660 MW KORADI STP (UNITS-11&12)
AIRCONDITIONING SYSTEM
TECHNICAL SPECIFICATION

SPECIFICATION No: PE-TS-527-553-A001

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LIST OF ANNEXURES



AIR CONDITIONING SYSTEM

LIST OF INDICATIVE MAKES OF SUB-VENDOR ITEMS

SECTION-I

SUB SECTION -E

ANNEXURE-I

LIST OF MAKES OF SUB-VENDOR ITEMS



AIR CONDITIONING SYSTEM

LIST OF INDICATIVE MAKES OF SUB-VENDOR ITEMS

Sl. NO.	ITEM / EQUIPMENT	SUB SUPPLIER
1a.	SCREW CHILLER	YORK / TRANE / CARRIER / KIRLOSKAR / DUNHAM BUSH / MCQUAY (DAIKIN) / BLUE STAR / VOLTAS
1b.	VAPOUR ABSORBTION MACHINE	VOLTAS / THERMAX / KIRLOSKAR
2	DX CONDENSING UNIT	VOLTAS / BLUE STAR / CARRIER
3	PRECISION PACKAGE UNITS	STULZ / UNIFLAIR / EMERSON / BLUEBOX / CLIMADENTA
4	PACKAGE UNIT	VOLTAS / BLUE STAR / CARRIER
5	SPLIT AIR CONDITIONER	VOLTAS / BLUE STAR / CARRIER / HITACHI / LG
6	AIR HANDLING UNITS	VOLTAS / BLUE STAR / ZECO / CARRYAIRE(FLAKT) / EDGETECH / ETHOS / SYSTEM AIR / WAVES AIRCON
7	AHU FAN (CENTRIFUGAL FAN)	CB.DOCTOR / FLAKT / KRUGER / NICOTRA / COMEFRI / MARATHON / PATEL AIR
8	CHILLED & CONDENSER WATER PUMP	BEST & CROMPTON / JYOTI / SAM TURBO / KBL / KSB / M&P / VOLTAS / BEACON-WEIR / WORTHINGTON / FLOWMORE / SULZER / BHARAT PUMPS & COMPRESSORS LTD / FLOWSERVE INDIA CONTROL PVT LTD / V-FLOW PUMPS & SYSTEMS CO
9	COOLING TOWER	PAHARPUR / MIHIR / PCT / FLOWTECH / BELL
10	INDUCTION MOTORS (LT)	AS PER ELECTRICAL SPEC.
11	AIR FILTER	PUROLATOR / FMI / ANFILCO / TENACITY / JOHN FOWLER / SPECTRUM / AIR TECH / PUROMATIC
12	AXIAL FANS / F.A. FANS	FLAKT / KHAITAN / PATEL / NICOTRA / SARLA / KRUGER / MARATHON / C DOCTOR / HYDERABAD POLLUTION / SK SYSTEM / ADVANCE
13	INSULTATION MATERIAL	BEARDSHELL / K-FLEX / PARAMONT/ ARMAFLEX / SUPREME / LLOYDS / UP TWIGA /AEROCCELL
14	BALANCING VALVE	ADVANCE
15	BUTTERFLY VALVE	ADVANCE / AUDCO / FOURESS / INTER VALVE / BDK / WEIR BDK / TYCO / CRANE PROCESS / KEYSTONE / Fluidline / INSTRUMENTATION LTD / R and D MULTIPLES (METAL CAST) PVT LTD / SURYA VALVES AND INSTRUMENTS MFG CO / PENTAIR VALVES AND CONTROLS INDIA PRIVATE LIMITED / UPADHAYA VALVES MANUFACTURERS PRIVATE LIMITED / VENUS PUMPS AND ENGG. WORKS.
16	NON RETURN VALVE	LEADER / H.SARKAR / FLUID LINE / HI -TECH / CRESENT / A V VALVES / BANKIM & COMPANY / SHIVADURGA / SURYA VALVES AND INSTRUMENT MANUFACTURING/ ATAM VALVES/ GM DAULI & SONS/ KBL/ VENUS PUMPS AND ENGINEERING WORKS
17	GATE/GLOBE VALVES	CRESENT / BDK / AUDCO / FOURESS / KIRLOSKAR / SANT / BOMBAY METAL & ALLOYS / BANKIM / LEADER / H SARKAR / AV VALVES / VENUS PUMPS AND



AIR CONDITIONING SYSTEM

LIST OF INDICATIVE MAKES OF SUB-VENDOR ITEMS

		ENGG/SAMSON CONTROLS PVT. LTD./INSTRUMENTATION LTD./ Koso India Private Limited,/ Fluidline / KBL
18	3 WAY MIXING VALVE WITH ACTUATING MOTOR	SIEMENS BUILDING TECHNOLOGY /JOHNSON / BELIMO / HONEYWELL / RAPID CONTROL / ALC
19	MOTORIZED BUTTERFLY VALVE	ANERGY / ADVANCE / BELIMO / JOHNSON / HONEYWELL / SIEMENS
20	Y / POT STRAINER	MULTITEX / GREAVES COTTON / JAYPEE / SANT / OTOKLIN / GRAND PRIX / GUJARAT OTOLIFT / DS ENGG / SAROJINI ENTERPRISE / BHATIA ENGINEERING / FILTRATION ENGINEERS INDIA PVT LTD / SUNGOV ENGINEERING
21	PIPING - ERW	SURYA ROSHNI / TISCO / DADU PIPES / INDUS TUBE / WELSPUN / TATA / BST / JINDAL / SAIL
22	PIPING - CS SEAMLESS (ASTM A 106)	ISMT / MAHARASHTRA SEAMLESS
23	GI SHEETS FOR DUCTING	TISCO / INDIAN IRON & STEEL CO LTD. / RASHITRYA ISPAT NIGAM LTD. / ESSAR/ ISPAT INDUSTRIES / JSW STEEL / LLOYDS STEEL / BHUSHAN / TATA / SAIL / JINDAL
24	FIRE DAMPER	TSC / CARRYAIRE / RAVISTAR (SYSTEM AIR)
25	GRILL/DIFFUSER/VOLUME CONTROL DAMPER	AIR FLOW/ TSC /AIR MASTER/ CARYAIRE/RAVI STAR (SYSTEM AIR)
26	STRIP HEATER	ESCORTS / RACOLD / DASPASS/ ALCO/ HEATCO / HOTSET
27	PAN HUMIDIFIER	RAPID COOL/ HOTSET /ALCO
28	RELIEF / PURGE VALVE	BRASSOMATIC
29	THERMOSTATS	HONEYWELL / RANCO / PENN / DANFOSS / INDFOSS / JHONSON CONTROL /RANUTROL
30	HUMID STAT	JHONSON CONTROL / HONEYWELL / PENN
31	ANTI FREEZE THERMOSTAT	RANCO / HONEYWELL / PENN / DANFOSS / INDFOSS
32	FLOW SWITCH	AS PER C&I SPEC
33	FLOW METER	AS PER C&I SPEC
34	RH SENSOR/TEMP SENSOR	AS PER C&I SPEC
35	PLC BASED PANEL	AS PER C&I SPEC
36	OWS / PC	AS PER C&I SPEC
37	PRINTER	AS PER C&I SPEC
38	UPS	AS PER C&I SPEC
39	FIBRE OPTIC CABLE	AS PER C&I SPEC
40	ANNUNCIATOR FOR PANEL	AS PER C&I SPEC
41	LT ADAPTER BOX FOR AL TO CU CABLE CONVERTOR	AS PER C&I SPEC
42	METERING PUMP	SHAPO TOOLS / VK PUMPS
43	WATER SOFTENING PLANT	THERMAX / ION EXCHANGE / DOSI ION
44	PRESSURE GAUGE / PRESSURE TRANSMITTER	AS PER C&I SPEC



AIR CONDITIONING SYSTEM

LIST OF INDICATIVE MAKES OF SUB-VENDOR ITEMS

45	TEMP GAUGE / TEMPERATURE TRANSMITTER	AS PER C&I SPEC
46	DIFF PRESSURE SWITCH / DIFF PRESS TRANSMITTER	AS PER C&I SPEC
47	LEVEL SWITCH / LEVEL TRANSMITTER	AS PER C&I SPEC
48	ROTAMETER	AS PER C&I SPEC
49	BATTERY CHARGER	AS PER C&I SPEC
50	BATTERY (NI -Cd)	AS PER C&I SPEC
NOTES		
1. THE APPROVED SUB VENDOR LIST (CUSTOMER APPROVED) IS ATTACHED IN SPECIFICATION'S RESPECTIVE SUB-SECTION C-2, C-3, C-4 i.e. END CUSTOMER LIST OF MAKE FOR MECHANICAL, ELECTRICAL & C&I RELATED EQUIPMENTS . BIDDER TO FOLLOW THE SAME.		
2. IF ANY ITEMS ARE NOT COVERED IN APPROVED SUB VENDOR LIST (COVERED IN RESPECTIVE SECTION OF SPECIFICATION C-2, C-3 & C-4, INDICATIVE SUB VENDOR LIST CAN BE REFERRED ABOVE.		
3. INDICATIVE SUB VENDOR LIST IS SUBJECT TO BHEL AND CUSTOMER APPROVAL DURING DETAILED ENGINEERING STAGE WITHOUT ANY COMMERCIAL & DELIVERY IMPLICATION TO BHEL. BIDDER TO PROPOSE SUB VENDOR WITHIN 4 WEEKS OF PLACEMENT OF LOI. THEREAFTER NO REQUEST FOR ADDITIONAL SUB-VENDOR SHALL BE ENTERTAINED.		
4. THE INSPECTION CATEGORY WILL BE INTIMATED AFTER AWARD OF CONTRACT BY BHEL/CUSTOMER. HOWEVER, THE SAME WILL BE ADHERED BY THE BIDDER WITHOUT ANY COMMERCIAL AND DELIVERY IMPLICATION TO BHEL/ CUSTOMER.		

	TITLE: 2X660 MW KORADI STP (UNITS-11&12) AIR CONDITIONING SYSTEM MANDATORY SPARE LIST	SPECIFICATION NO. PE-TS-527-553-A001	
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		SUB-SECTION: E	
		REV 00	DATE: AUGUST 2026
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SECTION-I

SUB SECTION –E

ANNEXURE-II

MANDATORY SPARE LIST (DELETED)



TITLE:
2X660 MW KORADI STP (UNITS-11&12)
AIR CONDITIONING SYSTEM
LIST OF TOOLS & TACKLES AND LIST OF
COMMISSIONING SPARES

SPECIFICATION No: PE-TS-527-553-A001

SECTION: I

SUB-SECTION: E

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ANNEXURE-III

LIST OF TOOLS & TACKLES AND LIST OF COMMISSIONING SPARES (COVERED IN UNPRICED SCHEDULE)

	TITLE: 2X660 MW KORADI STP (UNITS-11&12) AIR CONDITIONING SYSTEM DRAWINGS / DOCUMENTS SUBMISSION PROCEDURE	SPECIFICATION No: PE-TS-527-553-A001	
		SECTION: I	
		SUB-SECTION: E	
		REV 00	DATE: AUGUST 2026
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SECTION-I

SUB-SECTION-E

ANNEXURE-IV

DRAWINGS / DOCUMENTS SUBMISSION PROCEDURE

	TITLE: 2X660 MW KORADI STP (UNITS-11&12) AIR CONDITIONING SYSTEM DRAWINGS / DOCUMENTS SUBMISSION PROCEDURE	SPECIFICATION No: PE-TS-527-553-A001	
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1.

Bidder shall submit soft copy / hard copy / CD ROMs of all the finally approved drawings and O&M Manuals as required by Customer/ Customer’s consultant/ BHEL-site/ BHEL-PEM. The exact number of hard copies/ CD ROMs of these documents to be submitted shall be notified to the bidder during detailed engineering and bidder shall submit the same without any commercial/ delivery implications to BHEL/ Customer.

2.

All the drawing documents along with the O&M manual (of all the revisions) are necessarily to be submitted in soft copies in addition to hard copies.

3.

Bidder to submit soft copies of all the drawing and document along with quality plans for BHEL review and approval.

4.

Editable copy of all the drawings and documents shall be provided.

5.

The date of submission of drawing documents shall be considered as the date of submission of hard and soft copies whichever is later.

6.

All the drawings shall be prepared on computer auto cad and other documents (like datasheet etc.) on MS office software. Bidder not complying to the requirement shall not be considered. For the execution of the contract regular meeting (generally once in 15 days or as per project requirement) is required.

7.

Vendor to come for meeting with the concerned dealing persons as per BHEL or customer requirement in a short notice.

8.

Bidder to also furnish the auto cad copy/ MS-Excel/ MS-word (as applicable) of the following documents after award of contract. However, any other auto cad copy/ MS-Excel/ MS-word of any other document as per the insistence of BHEL and customer will also be submitted by the bidder without any delivery and commercial implication to BHEL and customer.

a.

P&IDs.

b.

Equipment layout of AC plant, AHU room, PAC room, AC duct layout etc.

c.

Piping layout drawing.

d.

Valve schedule, Instrument schedule, Cable Schedule etc,

e.

I/O list and drive list.

f.

Any other document/ drawing as required by BHEL/ customer

Other requirements

1.

Successful bidder shall furnish detailed erection manual for each of the equipment as well as complete system supplied under this contract at least 3 months before the scheduled erection of the concerned equipment / component or along with supply of concerned equipment / component whichever is earlier.

2.

Document approval by customer under Approval category or information category shall not absolve the vendor of their contractual obligations of completing the work as per specification requirement. Any deviation from specified requirement shall be reported by the vendor in writing and require written approval. Unless any change in specified requirement has been brought out by the vendor during detail engineering in writing while submitting the document to customer for approval, approved document (with implicit deviation) will not be cited as a reason for not following the specification requirement.

3.

In case vendor submits revised drawing after approval of the corresponding drawing, any delay in approval of revised drawing shall be to vendor’s account and shall not be used as a reason for extension in contract completion. However, in case changes are necessitated due to any constraints at customer end, delay in review/ approval of such revised drawing beyond one month will be to customer’s account.

	TITLE: 2X660 MW KORADI STP (UNITS-11&12) AIRCONDITIONING SYSTEM MASTER DRAWING LIST WITH SCHEDULE OF SUBMISSION	SPECIFICATION No: PE-TS-527-553-A001	
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		SUB-SECTION: E	
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SECTION-I SUB-SECTION-E ANNEXURE-V MASTER DRAWING LIST WITH SCHEDULE OF SUBMISSION			

	TITLE: 2X660 MW KORADI STP (UNITS-11&12) AIRCONDITIONING SYSTEM MASTER DRAWING LIST WITH SCHEDULE OF SUBMISSION	SPECIFICATION No: PE-TS-527-553-A001	
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MASTER DRAWING LIST FOR AIR CONDITIONING SYSTEM				
S. No.	BHEL DOCUMENT NO.	Title	Schedule submission from LOA (No. of days)	Type of Document
1	PE-V0-527-553-A001	INSPECTION CATEGORISATION PLAN CUM SUB VENDOR LIST FOR AIR CONDITIONING SYSTEM	25	PRIMARY
2	PE-V0-527-553-A002	QAP OF SCREW CHILLER PACKAGE FOR AIR CONDITIONING SYSTEM	75	PRIMARY
3	PE-V0-527-553-A004	QAP OF VAM PACKAGE	75	PRIMARY
4	PE-V0-527-553-A005	QAP OF PRECISION PACKAGE AC UNIT (AIR COOLED)	75	PRIMARY
5	PE-V0-527-553-A006	QAP OF AIR HANDLING UNIT FOR AIR CONDITIONING SYSTEM	80	PRIMARY
6	PE-V0-527-553-A007	QAP OF PUMPS FOR AIR CONDITIONING SYSTEM	80	PRIMARY
7	PE-V0-527-553-A008	QAP OF COOLING TOWER FOR AIR CONDITIONING SYSTEM	80	PRIMARY
8	PE-V0-527-553-A009	QAP OF MOTORS FOR AIR CONDITIONING SYSTEM	80	PRIMARY
9	PE-V0-527-553-A011	HEAT LOAD CALCULATION FOR MAIN PLANT, ESP / VFD CONTROL ROOMS AND SERVICE BUILDING ETC FOR AIR CONDITIONING SYSTEM	25	Primary
10	PE-V0-527-553-A012	OPERATION & CONTROL PHILOSOPHY FOR AIR CONDITIONING SYSTEM	70	PRIMARY
11	PE-V0-527-553-A013	PRESSURE DROP CALCULATIONS FOR CHILLED AND CONDENSER WATER PIPING FOR AIR CONDITIONING SYSTEM	40	PRIMARY
12	PE-V0-527-553-A014	TDS AND GA OF SCREW CHILLER ALONG WITH FOUNDATION DETAILS FOR AIR CONDITIONING SYSTEM	75	PRIMARY
13	PE-V0-527-553-A016	TDS AND GA OF VAPOUR ABSORPTION CHILLER WITH CONDENSATE TANK ALONG WITH FOUNDATION DETAILS FOR AIR CONDITIONING SYSTEM	75	PRIMARY
14	PE-V0-527-553-A018	TDS AND GA OF COOLING TOWER ALONG WITH FOUNDATION DETAILS FOR AIR CONDITIONING SYSTEM	75	PRIMARY
15	PE-V0-527-553-A019	TDS AND GA OF AIR HANDLING UNITS ALONG WITH FOUNDATION DETAILS FOR AIR CONDITIONING SYSTEM	75	PRIMARY
16	PE-V0-527-553-A020	TDS AND GA OF CONDENSER AND CHILLEDWATER PUMPS ALONG WITH	75	PRIMARY

		TITLE: 2X660 MW KORADI STP (UNITS-11&12) AIRCONDITIONING SYSTEM MASTER DRAWING LIST WITH SCHEDULE OF SUBMISSION	SPECIFICATION No: PE-TS-527-553-A001	
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		FOUNDATION DETAILS FOR AIR CONDITIONING SYSTEM		
17	PE-V0-527-553-A021	TDS AND GA OF PAC / SPLIT AIR CONDITIONERS / CASSETTE AC	90	SECONDARY
18	PE-V0-527-553-A022	TDS AND GA OF MOTOR (PUMP, COOLING TOWER, AHU)	105	SECONDARY
19	PE-V0-527-553-A023	TDS OF INSULATION MATERIAL THERMAL & ACCOUSTIC INSULATION FOR DUCTING/PIPES (DUCT INSULATION, DUCT LINING, PIPE INSULATION) FOR AIR CONDITIONING SYSTEM	50	SECONDARY
20	PE-V0-527-553-A024	TDS AND GA OF FRESH AIR FANS FOR AIR CONDITIONING SYSTEM	70	PRIMARY
21	PE-V0-527-553-A025	TDS AND GA OF WATER SOFTENING PLANT ALONG WITH FOUNDATION DETAILS FOR AIR CONDITIONING SYSTEM	100	SECONDARY
22	PE-V0-527-553-A026	TDS AND GA OF AIR-COOLED PRECISION AC UNITS ALONG WITH FOUNDATION DETAILS FOR AIR CONDITIONING SYSTEM	75	PRIMARY
23	PE-V0-527-553-A027	TDS AND GA OF FOR 3-WAY MIXING VALVE FOR AIR CONDITIONING SYSTEM	85	SECONDARY
24	PE-V0-527-553-A028	TDS AND GA OF HEATERS AND HUMIDIFIER FOR AIR CONDITIONING SYSTEM	80	SECONDARY
25	PE-V0-527-553-A029	TDS AND GA OF FIRE DAMPER WITH ACTUATOR FOR AIR CONDITIONING SYSTEM	70	SECONDARY
26	PE-V0-527-553-A030	TDS AND GA OF VALVES (BALANCING VALVE, GATE VALVE, CHECK VALVE, GLOBE VALVE, BUTTER FLY VALVE (MANUAL & MOTORIZED), Y STRAINER) FOR AIR CONDITIONING SYSTEM	90	SECONDARY
27	PE-V0-527-553-A031	TDS AND GA OF AIR TERMINALS SUPPLY / RETURN AIR DIFFUSER/ GRILL, NRD, VCD ETC. FOR AIR CONDITIONING SYSTEM	60	SECONDARY
28	PE-V0-527-553-A032	TDS OF GI SHEET FOR AIR CONDITIONING SYSTEM	40	SECONDARY
29	PE-V0-527-553-A033	TDS OF PIPES FOR AIR CONDITIONING SYSTEM	40	SECONDARY
30	PE-V0-527-553-A034	TDS AND GA OF EXPANSION TANK, MAKEUP WATER TANK AND SOFT WATER TANK FOR AIR CONDITIONING SYSTEM	40	SECONDARY

	TITLE: 2X660 MW KORADI STP (UNITS-11&12) AIRCONDITIONING SYSTEM MASTER DRAWING LIST WITH SCHEDULE OF SUBMISSION	SPECIFICATION No: PE-TS-527-553-A001		
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31	PE-V0-527-553-A035	TDS AND GA OF FILTERS FOR AIR CONDITIONING SYSTEM	65	SECONDARY
32	PE-V0-527-553-A036	TDS FOR INSTRUMENTS (GAUGES-TEM, PR, LVL, PRES: SWITCH-TEMP, LVL, DP: SENSORS-TEMP, HUM ETC) FOR AIR CONDITIONING SYSTEM	120	SECONDARY
33	PE-V0-527-553-A037	PID FOR MAIN PLANT, SERVICE BUILDING, ESP ETC FOR AIR CONDITIONING SYSTEM	40	PRIMARY
34	PE-V0-527-553-A038	TYPICAL DETAILS / DRAWINGS DUCT FABRICATION/ SUPPORT / ERECT. FOR AIR CONDITIONING SYSTEM INSUL- DUCT/ PIPG & EQP CHD & COND WATR PIPE ERECT	45	SECONDARY
35	PE-V0-527-553-A039	AC DUCT & AHU RM LAYOUT WITH FOUNDATION DETAIL FOR UPS, UPS BATTERY CHARGER & CEP-VFD RM AT 8.5M	110	PRIMARY
36	PE-V0-527-553-A040	AC DUCT LAYOUT DRAWING FOR CONTROL RM ARES AT 17M ALONG WITH AHU RM LAYOUT WITH FOUNDATION DETAILS	100	PRIMARY
37	PE-V0-527-553-A040A	AHU ROOM LAYOUT WITH FOUNDATION DETAIL FOR MAIN POWER HOUSE	95	PRIMARY
38	PE-V0-527-553-A041	AC DUCT LAYOUT DRAWING FOR ESP, WITH AHU/PU RM LAYOUT WITH FOUNDATION DETAILS FOR INDR & OUTDR UNITS	125	PRIMARY
39	PE-V0-527-553-A042	AC DUCT LAYOUT DRAWING FOR SERVICE BUILDING WITH FIXING DETAILS OF DUCTABLE SPLIT ACS	130	PRIMARY
40	PE-V0-527-553-A045	CHD & COND WATER PIPING LAYOUT WITHIN PLANT ROON & UPTO VARIOUS AHU ROOMS, & COOLING TOWER AREA FOR POWER HOUSE	95	PRIMARY
41	PE-V0-527-553-A046	AC PLANT ROOM LAYOUT & COOLING TOWER AREA LAYOUT WITH COMPLETE FOUNDATION DETAIL ALONGWITH PIPING LAYOUT OF ALL EQUIPMENT FOR POWER HOUSE	95	PRIMARY
42	PE-V0-527-553-A047	REFRIGERENT PIPING CONNECTION LAYOUT BETWEEN INDOOR AND OUTDOOR OF INVERTER DUCTABLE SPLIT ACS ALONGWITH OUTDOOR UNIT FIXING DETAIL FOR SERVICE BUILDING	130	PRIMARY

	TITLE: 2X660 MW KORADI STP (UNITS-11&12) AIRCONDITIONING SYSTEM MASTER DRAWING LIST WITH SCHEDULE OF SUBMISSION		SPECIFICATION No: PE-TS-527-553-A001	
			SECTION: I	
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43	PE-V0-527-553-A051	AC PLANT ROOM LAYOUT FOR OTHER AUXILIARY BUILDING	140	SECONDARY
44	PE-V0-527-553-A052	SPLIT AC SCHEDULE ALONGWITH HEAT LOAD CALCULATION FOR AUXILIARY BUILDING	135	SECONDARY
45	PE-V0-527-553-A057	DEMONSTRATION TEST PROCEDURE FOR AIR CONDITIONING SYSTEM	120	SECONDARY
46	PE-V0-527-553-A058	O&M MANUAL FOR AIR CONDITIONING SYSTEM	180	SECONDARY
47	PE-V0-527-553-A062	DRIVE LIST & IO LIST FOR AC SYSTEM	135	SECONDARY
48	PE-V0-527-553-A063	LIST OF INSTRUMENTS / INSTRUMENT SCHEDULE FOR AC SYSTEM	125	SECONDARY
49	PE-V0-527-553-A064	CABLE INTER CONNECTION SCHEDULE FOR AC SYSTEM	150	SECONDARY
50	PE-V0-527-553-A067	LOGIC DRAWING FOR AC SYSTEM	150	SECONDARY
51	PE-V0-527-553-A068	TECHNICAL DATASHEET, GA & TYPE TEST OF JUNCTION BOX	135	SECONDARY
52	PE-V0-527-553-A069	TDS AND GA OF LOCAL CONTROL PANEL FOR AHU	100	SECONDARY
53	PE-V0-527-553-A070	CABLE SCHEDULE FOR AC SYSTEM	130	SECONDARY
54	PE-V0-527-553-A071	ELECTRICAL FEEDER LIST FOR AIR CONDITIONING SYSTEM	100	SECONDARY
55	PE-V0-527-553-A073	VALVE SCHEDULE FOR AC SYSTEM	60	SECONDARY

Note:

- Bidder to furnish hard copies/soft copies for above drawings / documents as per the dwg. / documents distribution as per project requirement.
- Drawings shall be prepared in Auto CAD and shall be shared with BHEL during detail engineering of review.
- Bidder to follow the drawing submission schedule. The successful bidder shall depute his design personnel to BHEL’s/ Customer’s/ Consultant’s office for across the table discussion for resolution of issues and to get documents approved within the stipulated time.
- Every revised submission incorporating comments – within 7 days. The drawings/ documents submitted by vendor shall be complete in all respects with revised drawing submitted incorporating all comments along with Customer Response Sheet (CRS). Any incomplete drawing submitted shall be treated as non- submission with delays attributable to vendor’s account.
- Revision made by the bidder in any drawings and documents shall be highlighted by indicating the no. of revisions in a triangle without fail so that the minimum time is required by BHEL to review the drawings and documents. Drawings/ documents to be submitted for BHEL review / approval shall be under Revision A, B, C... etc. while drawings /documents to be submitted thereafter for customer’s approval after purchaser’s approval shall be under R-0, 1, 2, 3 etc.

	TITLE: 2X660 MW KORADI STP (UNITS-11&12) AIRCONDITIONING SYSTEM MASTER DRAWING LIST WITH SCHEDULE OF SUBMISSION	SPECIFICATION No: PE-TS-527-553-A001	
		SECTION: I	
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6. Any other drawings and documents as required by BHEL / Customer / Consultant shall be furnished by the successful bidder during detail engineering stage for which no commercial implication shall be entertained by BHEL.

7. Detailed erection manual for each of the equipment as well as complete system supplied under this contract shall be submitted at least 3 months before the scheduled erection of the concerned equipment / component or along with supply of concerned equipment / component whichever is earlier.

8. The Field Quality Plan of bidder shall also be submitted by the successful bidder during detail engineering for customer’s / consultant’s approval. All comments made by customer/ consultant shall be incorporated by the successful bidder without any commercial and delivery implication.

9. All possible efforts shall be made by the bidder to get the approval of drawings and documents from BHEL / customer / consultant at the earliest and the documents prepared / generated by them or their sub-vendors shall be checked by their competent authority before submission to BHEL.

10. Primary documents shall be treated as basic Engineering documents for contractual purpose.

11. All drawings and documents including general arrangement drawing, data sheet, calculation etc. shall be furnished to BHEL during detailed engineering stage and shall include / indicate the following details for clarity w.r.t. inspection, construction, erection and maintenance etc.: -

➤ All drawings and documents shall bear BHEL’s title block and drawing / document number. However, BHEL’s drawing / document numbering scheme shall be furnished to the successful bidder after the placement of L.O.I.

➤ All drawings and documents shall indicate the list of all reference drawings including general arrangement.

➤ All drawings shall include / show plan, elevation, side view, cross - section, skin section, blow - up view, all major self-manufactured and bought out items shall be labelled and included in BOQ / BOM in tabular form.

➤ All text/ numeric in the document / drawings to be generated by the successful bidder will be in English language only.



TITLE:
2X660 MW KORADI STP (UNITS-11&12)
AIR CONDITIONING SYSTEM
FORMAT FOR OPERATION AND MAINTENANCE
MANUAL

SPECIFICATION No: PE-TS-527-553-A001

SECTION: I

SUB SECTION: E

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SECTION-I

SUB SECTION-E

ANNEXURE-VI

FORMAT FOR OPERATION AND MAINTENANCE MANUAL

	TITLE: 2X660 MW KORADI STP (UNITS-11&12) AIR CONDITIONING SYSTEM FORMAT FOR OPERATION AND MAINTENANCE MANUAL	SPECIFICATION No: PE-TS-527-553-A001	
		SECTION: I	
		SUB SECTION: E	
		REV 00	DATE: AUGUST 2026
		SHEET 2 OF 4	

Project name :
 Project number :
 Package Name :
 PO reference :
 Document number :
 Revision number :

Sl.no. & Sections	Description	Tick (√)if included in Manual			Remarks
		Yes	No	Not Applicable	
1.	COVER PAGE				
1.1	Project Name				
1.2	Customer/consultant Name				
1.3	Name of Package				
1.4	Supplier details with phone, FAX ,email address , Emergency Contact number				
1.5	Name and sign of prepared by , checked by & approved by				
1.6	Revision history with approval Details				
2.0	INDEX				
2.1	showing the sections & related page nos All the pages should be numbered section wise				
3.0	DESCRIPTION OF PLANT/SYSTEM				
3.1	Description /write up of operating principle of system equipment/ associated sub-systems & accessories/controls system , operating conditions, performance parameters under normal , start up and special cases				
3.2	Equipment list and basic parameter with Tag numbers				
3.3	Data sheets approved by Customer/for information and catalogues provided by original manufacturer				
3.4	Associated other packages and Interface /terminal points				
3.5	P&ID & Process Diagrams				
3.6	GA Layout drawings, As-built drawings , Actual photograph of items/system (Drawings of A2 & bigger sizes are to be attached in the last)				
3.7	Single line/wiring diagrams				
3.8	Control philosophy /control write-ups				

	TITLE: 2X660 MW KORADI STP (UNITS-11&12) AIR CONDITIONING SYSTEM FORMAT FOR OPERATION AND MAINTENANCE MANUAL	SPECIFICATION No: PE-TS-527-553-A001	
		SECTION: I	
		SUB SECTION: E	
		REV 00	DATE: AUGUST 2026
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Sl.no. & Sections	Description	Tick (√)if included in Manual			Remarks
		Yes	No	Not Applicable	
4.0	COMMISSIONING ACTIVITIES (IF NOT COVERED IN SEPARATE DOCUMENT I.E. ERECTION MANUAL, COMMISSIONING MANUAL)				
4.1	Pre-Commissioning Checks				
4.2	handling of items at site				
4.3	Storage at site				
4.4	Unpacking & Installation procedure				
5.0	OPERATION GUIDELINES FOR PLANT PERSONAL/USER/OPERATOR				
5.1	Interlock & Protection logic along with the limiting values of protection settings for the equipment along with brief philosophy behind the logic, drawings etc. to be provided.				
5.2	Start up, normal operation and shut down procedure for equipments along with the associated systems in step by step mode. Valve sequence chart, step list, interlocks etc. with Equipment isolating procedures to be mentioned.				
5.3	Do's & Don't of the equipments.				
5.4	Safety precautions to be taken during normal operation. Safety symbols, Emergency instructions on total power failure condition/lubrication failure/any other condition				
5.5	Parameters to be monitored with normal values and limiting values				
5.6	Trouble shooting with causes and remedial measures				
5.7	Routine operational checks, recommended logs & records				
5.8	Changeover schedule if more than one auxiliary for the same purpose is given				
5.9	Painting requirement and schedule				
5.10	Inspection, repair , Testing and calibration procedures				
6.0	MAINTENANCE GUIDELINES FOR PLANT PERSONAL				
6.1	List of Special Tools and Tackles required for				

	TITLE: 2X660 MW KORADI STP (UNITS-11&12) AIR CONDITIONING SYSTEM FORMAT FOR OPERATION AND MAINTENANCE MANUAL	SPECIFICATION No: PE-TS-527-553-A001	
		SECTION: I	
		SUB SECTION: E	
	REV 00	DATE: AUGUST 2026	
	SHEET 4 OF 4		

Sl.no. & Sections	Description	Tick (√)if included in Manual			Remarks
		Yes	No	Not Applicable	
	Overhaul/Trouble shooting including special testing equipment required for calibration etc.				
6.2	Stepwise dismantling and re-assembly procedure clearly specifying the tools to be used, checks to be made, records to be maintained, clearances etc. to be mentioned. Tolerances for fitment of various components to be given.				
6.3	Preventive Maintenance & Overhauling schedules linked with running hours/calendar period along with checks to be given				
6.4	Long term maintenance schedules especially for structural, foundations etc.				
6.5	Consumable list along with the estimated quantity required during commissioning, normal running and during maintenance like Preventive Maintenances and Overhaul. Storage/handling requirement of consumables/self-life.				
6.6	List of lubricants with their Indian equivalent, Lubrication Schedule, Quantity required for each equipment for complete replacement is to be given				
6.7	List of vendors & Sub-vendors with their latest addresses, service centres ,Telephone Nos., Fax Nos., Mobile Nos., e-mail IDs etc.				
6.8	List of mandatory and recommended spare parts list				
6.9	Tentative Lead time required for ordering of spares from the equipment supplier				
6.10	Guarantee and warranty clauses				
7.0	Statutory and other specific requirements considerations.				
8.0	List of reference documents				
9.0	Binding as per requirement				



TITLE:
2X660 MW KORADI STP (UNITS-11&12)
AIR CONDITIONING SYSTEM
SITE STORAGE AND PRESERVATION

SPECIFICATION No: PE-TS-527-553-A001

SECTION: I

SUB SECTION-E

REV 00

DATE: AUGUST 2026

SHEET 1 OF 16

SECTION-I

SUB-SECTION-E

ANNEXURE-VII

SITE STORAGE AND PRESERVATION

SITE STORAGE AND PRESERVATION GUIDELINES

FOR

MECHNANICAL BOPs

(Doc No: PE-DC-SSG-A001 REV.00)



PROJECT ENGINEERING MANAGEMENT, POWER SECTOR
BHARAT HEAVY ELECTRICALS LIMITED-NOIDA

CONTENT

- 1 SCOPE OF THE DOCUMENT
- 2 PURPOSE OF STORAGE & PRESERVATION
- 3 MEASURES TO BE TAKEN FOR STORAGE AND PRESERVATION
 - a) GENERAL STORAGE REQUIREMENTS
 - b) GENERAL PRESERVATION REQUIREMENTS
 - c) GENERAL INSPECTION REQUIREMENTS
- 4 TYPE OF STORAGE FOR VARIOUS EQUIPMENT
5. CONCLUSION
6. STACKING ARRANGEMENT FOR PLATES AND STRUCTURAL STEEL

1. SCOPE OF THE DOCUMENT

This guideline is prepared in intent to provide proper site storage and preservation of the Mechanical, Electrical and C & I items / equipment supplied under various bought out packages/items. This storage procedure shall be followed at different power plant sites by concerned agency for storage and preservation from the date of equipment received at site until the same are erected and handed over to the customer.

2. PURPOSE OF STORAGE & PRESERVATION

Many of the items may be required to be kept in stores for long period. It shall therefore be essential that proper methods of storage and preservation be applied so that items do not deteriorate, loose some of their properties and become unusable due to atmospheric conditions and biological elements.

3. MEASURES TO BE TAKEN FOR STORAGE, HANDLING & PRESERVATION

a) GENERAL STORAGE REQUIREMENTS

1. To the extent feasible, materials should be stored near the point of erection. The storage areas should have adequate unloading and handling facilities with adequate passage space for movement of material handling equipment such as cranes, fork lift trucks, etc. The storage of materials shall be properly planned to minimise time loss during retrieval of items required for erection.
2. The outdoor storage areas as well as semi-closed stores shall be provided with adequate drainage facilities to prevent water logging. Adequacy of these facilities shall be checked prior to monsoon.
3. The storage sheds shall be built in conformity with fire safety requirements. The stores shall be provided with adequate lights and fire extinguishers. 'No smoking' signs shall be placed at strategic locations. Safety precautions shall be strictly enforced.
4. Adequate lighting facility shall be provided in storage areas and storage sheds and security personnel positioned to ensure enforcement of security measures to prevent theft and loss of materials.
5. Adequate number of competent stores personnel and security staff shall be deployed to efficiently store and maintain the equipment / material.
7. The equipment shall be stored in an orderly manner, preserving their identification slips, tags and instruction booklets, etc., required during erection. The storage of materials shall be equipment-wise. Loose parts shall be stored in sheds on racks,

preserving the identification marks and tags in good condition. The group codes shall be displayed on the racks

6. At no time shall any materials be stored directly on ground. All materials shall be stored minimum 200 mm above the ground preferably on wooden sleepers

b) GENERAL PRESERVATION REQUIREMENTS

1. All special measures to prevent corrosion shall be taken like keeping material in dry condition, avoiding the equipment coming in contact with corrosive fluid like water, acid etc.
2. Materials which carry protective coating shall not be wrapped in paper, cloth, etc., as these are liable to absorb and retain moisture. The material shall be inspected and in case of signs of wear or damages to protective coating, that portion shall be cleaned with approved solution and coated with an approved protective paint. Complete record of all such observations and protective measures taken shall be maintained.
3. Generally equipment supplied at site are properly greased or rust protective oil is applied on machined/ fabricated components. However periodic inspection shall be carried out to ensure that protection offered is intact.
4. While handling the equipment, no dragging on the ground is permitted. Avoid using wire rope for lifting coated components. Use polyester slings (if possible) otherwise protective material (e.g. clothes, wood block etc.) should be used while handling the components with rope / slings
5. For Equipment supplied with finished paint, touch paint shall be done in case any surface paint gets peeled off during handling. Otherwise such surfaces shall necessarily be wrapped with polythene to avoid any corrosion. Further for equipment wherein finish coat is to be applied at site, site to ensure that equipment is received with primer coat applied.
6. It shall be ensured by periodic inspection that plastic inserts are intact in tapped holes, wherever applicable.
7. Pipes shall be blown with air periodically and it shall be ensured that there is no obstruction.
8. Silica gel or approved equivalent moisture absorbing material in small cotton bags shall be placed and tied at various points on the equipment, wherever necessary.
9. Heavy rotating parts in assembled conditions shall be periodically rotated to prevent corrosion/jamming due to prolonged storage.

10. All the electrical equipment such as motors, generators, etc. shall be tested for insulation resistance at least once in three months and a record of such measured insulation values shall be maintained.
11. Following preservatives/preservation methods can be used depending upon type of equipment
 - a. Rust preventive fluid (RPF)
 - b. Rust protective paints
 - c. Tarpaulin covers, in case of outdoor storage
 - d. De-oxy aluminate for weld-ments

c) GENERAL INSPECTION REQUIREMENTS

1. Period inspection of materials with specific reference to –
 - Ingress of moisture and corrosion damages.
 - Damage to protective coating.
 - Open ends in pipes, vessels and equipment -
 - In case any open ends are noticed, same shall be capped.
2. Any damages to equipment / materials.
 - In case of any damages, these shall be promptly notified and in all cases, the repairs / rectification shall be carried out.
 - Any items found damaged or not suitable as per project requirements shall be removed from site. If required to store temporarily, they shall be clearly marked and stored separately to prevent any inadvertent use.

4. TYPE OF STORAGE FOR VARIOUS EQUIPMENT

The types of storage are broadly classified under the following heads:

i **Closed storage with dry and dust free atmosphere. (C)**

The closed shed can be constructed by using cold-rolled / tubular components for structure and corrugated asbestos sheets / galvanised iron sheets for roofing. Brick walls / asbestos sheets can be used to cover all the sides. The floor of the shed can be finished with plain cement concrete suitably glazed. The shed shall be provided with proper ventilation and illumination.



ii **Semi-closed storage. (S)**

The semi closed shed can be constructed by using cold-rolled / tubular components for structure and corrugated / asbestos sheets for roofing. The floor shall be brick paved. If required a small portion of sides can be covered to protect components from rainwater splashing onto the components.





iii Open storage (O)

The open yard shall be levelled, well consolidated to achieve raised ground with the provision of feeder roads for crane approach along with access roads running all sides. One part of the open yard shall be stone pitched, levelled and consolidated with raised ground suitable for storing / stacking heavier and critical components with due space to handle them by cranes etc . Adequate number of sleepers, concrete block etc. to be provided to make raised platforms to stack critical materials.

A separate yard to be identified as “scrap yard” slightly away from main open yard to store wooden/steel scraps, which are to be disposed off. This is required to avoid mix up with regular components as well as to avoid fire hazard.

Some of the components, which are having both machined & un-machined surfaces and are bulky, shall be stored in open storage area on a raised ground and suitably covered with water proof / fire retardant tarpaulin.



The equipment listed below shall be stored and inspected as per requirement mentioned in the table below.

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
Raw material /mechanical items like pipes, plates, structure sections etc.)				
1.	Steel pipes (lined/unlined)	S	Damage , paint, corrosion, rubber lining peeling	Provide end cap
2.	MS Plates	S	Damage, paint, corrosion	
3.	SS Plates	S	Damage	
4.	Non-metallic pipes	S	Damage, cracks	Provide end cap
5.	Stainless steel pipes	S	Damage ,	Provide end cap
6.	MS sections, beams	S	Damage, paint, corrosion	
7.	Cable trays	S	Damage, condition of preservations	
8.	Insulation sheets	S	Damage	
9.	Insulation	C	Damage, packing	
10.	Hangers Rods	S	Damage, paint, packing	
11.	Tubes	S	Damage, paint , packing	Provide end cap
12.	Hume pipes	O	Damage	
13.	Castings	O	Damage, paint, corrosion	
Fabricated mechanical items (pressure vessels, tanks etc.)				
14.	Pressure vessels (unlined)	O	Damage, paint, corrosion,	Covered nozzles
15.	Atmospheric storage tanks (unlined)	O	Damage, paint, corrosion	Covered nozzles

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
16.	Pressure vessels (lined)	S	Damage, paint, corrosion, rubber lining	
17.	Atmospheric storage tanks(lined)	S	Damage, paint, corrosion, rubber lining	
18.	Support structures	O	Damage , paint, corrosion	
19.	Flanges	C	Damage , paint, corrosion	
20.	Fabricated pipes	S	Damage , paint, corrosion	Provide end cap
21.	Vessels internals	C	Damage , paint, corrosion ,packing	
22.	Grills	S	Damage , paint, corrosion	
23.	Angles	S	Damage , paint, corrosion	
24.	Bridge mechanism/clarifier mechanism	O	Damage , paint, corrosion	
25.	Cranes, rails	S	Damage , paint, corrosion	
26.	Stair cases	O	Damage , paint, corrosion	
27.	Ladders/handrails	O	Damage , paint, corrosion	
28.	Fabricated ducts	S	Damage , paint, corrosion	
29.	Isolation Gates	O	Damage , paint, corrosion	
30.	Fabricated boxes/panels	S	Damage , paint, corrosion	
Mechanical components like valves, fittings, cables glands, spares etc.)				
31.	Valves	S	Damage , packing	

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
32.	Fittings	S	Damage , packing	Provide end cap
33.	Cable glands	C	Damage , packing	
34.	Tools & tackles	C	Damage , packing	
35.	Nut , bolts, washers,	C	Damage , packing	
36.	Gasket & Packings	C	Damage , packing	
37.	Copper tubes	C	Damage , packing, corrosion	Provide end cap
38.	SS tubing	C	Damage , packing	Provide end cap
Rotating assemblies (pumps, blowers, stirrers, fans, compressors etc.)				
39.	Pumps	S	Damage , packing, corrosion	Shaft rotation
40.	Blowers/Compressors	S	Damage , packing, corrosion	Shaft rotation
41.	Agitators/stirrers/radial launders	C	Damage , packing, corrosion	Shaft rotation
42.	Rollers for chlorine tonner mounting	C	Damage , packing, corrosion	
43.	Centrifuge	S	Damage , packing,	
44.	Gear box	C	Damage , packing, corrosion	
45.	Bearings	C	Damage , packing, corrosion	
46.	Fans	S	Damage , packing, corrosion	
47.	Dosing skids	S	Damage , packing, corrosion	
48.	Pump assemblies	S	Damage , packing, corrosion	
49.	Air washers(INTERNALS)	S	Damage , packing	
50.	Air conditioners (split)	C	Damage , packing	

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
51.	Elevators(CONTAINERIZED)	O	Damage , packing, corrosion	
52.	Chillers/VA machines	S	Damage , packing	
53.	Air handling Unit/Package unit	S	Damage , packing	
54.	Chlorinators & Evaporators	C	Damage , packing	
55.	Ejectors	C	Damage , packing	
56.	Electrolyser	C	Damage , packing	
Miscellaneous items like chain pulley blocks, hoists etc.				
57.	Chain pulley blocks	S	Damage, Packing	
58.	Electric hoists	S	Damage, Packing	
59.	Fire extinguishers	C	Damage, expiry date	
60.	Fork Lift Truck	S	Damage, Packing	
61.	Hydraulic Mobile Crane	O	Damage, Packing	
62.	Mobile Pick Up & Carry Crane	O	Damage, Packing	
63.	Motor boats	O	Damage, Packing	
64.	Safety showers	S	Damage, Packing	
65.	Diffusers/dampers	S	Damage, Packing	
Chemicals and consumables (acid, alkali, paints, oils, reagents and special chemicals)				
66.	Hydro Chloric Acid (HCl)	Store in canes/ storage tank in dyke area	Date of production/ leakage/fumes	hazardous chemical
67.	Sulphuric acid (H ₂ SO ₄)	Store in canes/ storage tank in dyke area	Date of production/ leakage/fumes	hazardous chemical

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
68.	Sodium hydroxide (NaOH)	Store in canes/ storage tank in dyke area	Date of production/ leakage/ fumes/ breather	hazardous chemical ,breather to be checked for air ingress
69.	Sodium hypo chlorite	To be stored under shed	Date of production/ leakage/ fumes	hazardous chemical ,self-life normally 15-30 days after which strength of chemical decays
70.	Ammonia	S	Date of production/ leakage/ fumes	Store in closed storage tanks, hazardous chemical
71.	CW treatment chemicals	S	Date of production , Self-life	Store in closed canes
72.	RO/UF cleaning chemicals	S	Date of production , Self-life	Store in closed canes
73.	Lime	C	Damage to packing , seepage	Prevent moisture, rain
74.	Alum bricks	C	Damage to packing	Prevent moisture, rain
75.	Poly electrolyte	S		Store in closed storage tanks
76.	Laboratory chemicals(powder)	C	Damage, Packing self- life	
77.	Laboratory chemicals(liquid)	C	Damage, Packing self- life	
78.	Lubrication oils	C	Leakage	
79.	Paints	S	Leakage ,air tightness	
80.	Sand	O	Damage of packing	No hooks
81.	Salt (NaCl)	C	Damage of packing, water ingress	Prevent moisture, rain
82.	Anthracite	S	Damage of packing	
83.	Activated carbon	S	Damage of packing	

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
84.	Thermal insulation	S	Damage of packing	
85.	Cement	C	Damage of packing	Prevent moisture, rain
86.	Gravels	O	Damage of packing	
87.	ION exchange resins	C	Damage , packing	Refer manufacturer guidelines
88.	RO membranes	C	Damage , packing	Refer manufacturer guidelines
89.	UF membranes	C	Damage , packing	Refer manufacturer guidelines
90.	Cleaning chemicals	C	Damage , packing	Refer manufacturer guidelines
91.	Chemicals for analysers/calibration	C	Damage , packing	Refer manufacturer guidelines
Electrical and C & I items (motors, cables etc.)				
92.	Motors	C	Damage , packing	
93.	Cable drums	O	Damage	
94.	Control Panel /control desk, UPS ,JB	S	Damage, Packing	
95.	Instruments(gauges/analysers)	C	Damage	
Special items		As per Manufacturer's item, like Hydrogen cylinders, Ozonator, Analyser, Chlorine dioxide generators etc.		

5. CONCLUSION

Concerned storage agency at site should make sure that loss in equipment performance and wear & tear are minimised through proper storage and preservation. The above are broad guidelines and cover major equipment / materials. However specific storage practices shall be followed as per manufacturer recommendation. All the necessary measures even in addition to the ones mentioned above, if found necessary, should be taken to achieve the objective.

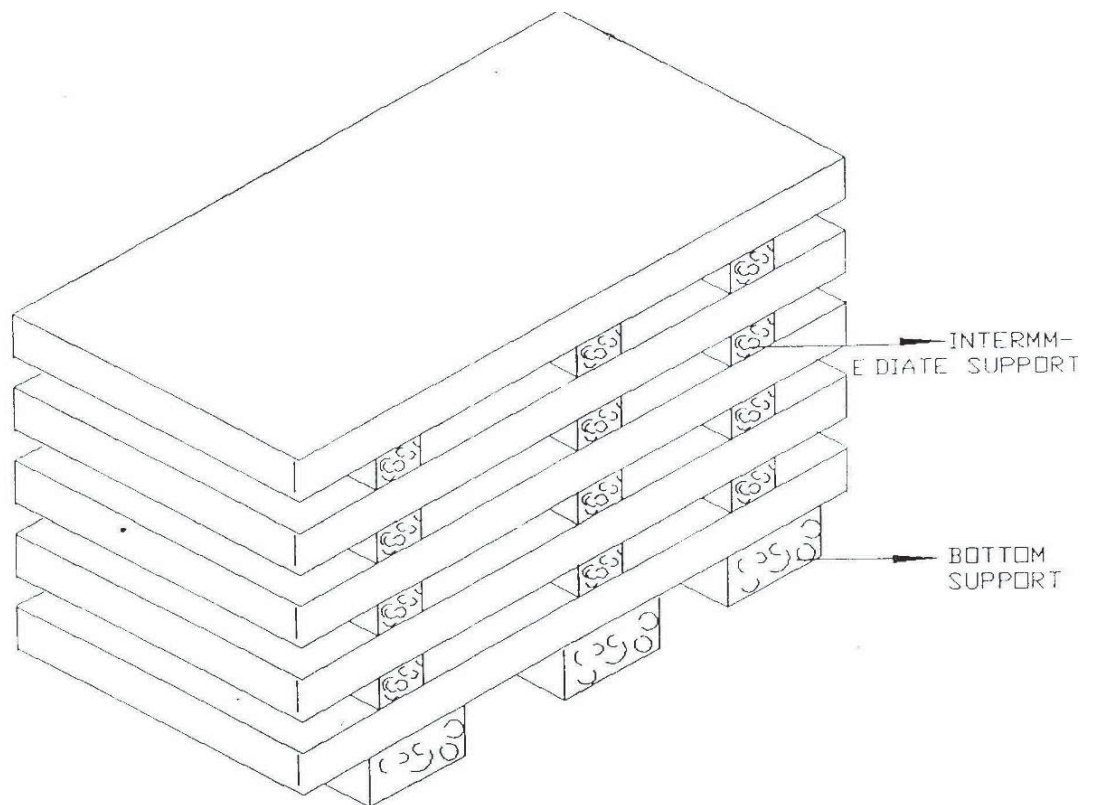


Figure – 1 – PLATE STACKING ARRANGEMENT

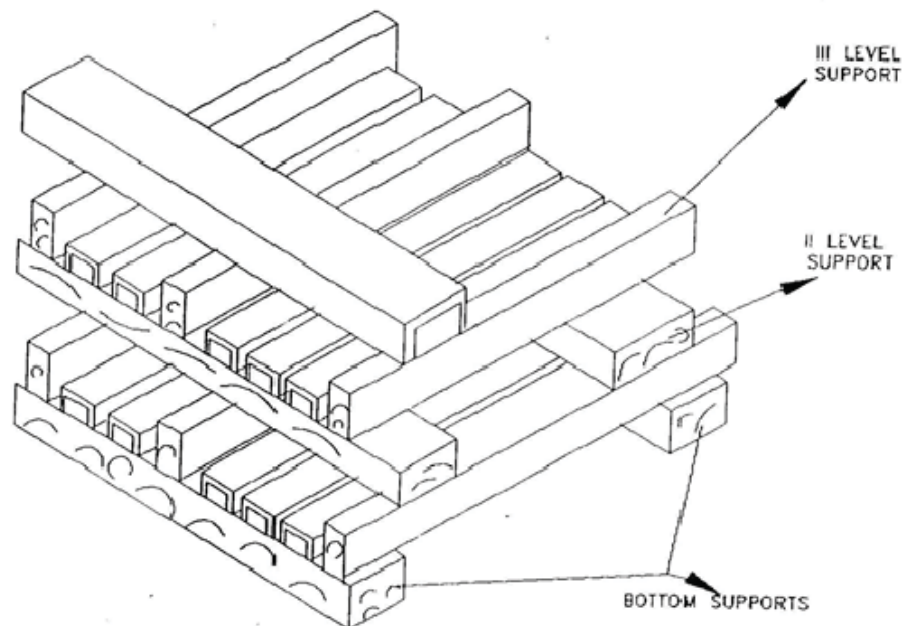


Figure – 2 – STRUCTURAL STEEL STACKING ARRANGEMENT



TITLE:
2X660 MW KORADI STP (UNITS-11&12)
AIR CONDITIONING SYSTEM
PAINTING & COLOUR SCHEME

SPECIFICATION No: PE-TS-527-553-A001

SECTION: I

SUB-SECTION: E

REV 00

DATE: AUGUST 2026

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SECTION-I
SUB SECTION E
ANNEXURE-VIII
PAINTING & COLOUR SCHEME
(AS PER SECTION C2-B)



TITLE:
2X660 MW KORADI STP (UNITS-11&12)
AIR CONDITIONING SYSTEM
PACKING PROCEDURE

SPECIFICATION No: PE-TS-527-553-A001

SECTION: I

SUB-SECTION: E

REV 00

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SECTION-I

SUB SECTION E

ANNEXURE-IX

PACKING PROCEDURE
(COVERED UNDER SECTION C2-B)

	TITLE: 2X660 MW KORADI STP (UNITS-11&12) AIR CONDITIONING SYSTEM	SPECIFICATION No: PE-TS-527-553-A001	
		SECTION: II	
		REV. 00	DATE: AUGUST 2026

SECTION-II



TITLE:
2X660 MW KORADI STP (UNITS-11&12)
AIR CONDITIONING SYSTEM
INSPECTION AND TESTING

SPECIFICATION No: PE-TS-527-553-A001

SECTION: II

SUB-SECTION: 1

REV 00

DATE: AUGUST 2026

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SECTION-II

SUB-SECTION-1

INSPECTION AND TESTING

	TITLE: 2X660 MW KORADI STP (UNITS-11&12) AIR CONDITIONING SYSTEM INSPECTION AND TESTING	SPECIFICATION No: PE-TS-527-553-A001	
		SECTION: II	
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		REV 00	DATE: AUGUST 2026
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1.01.00	Inspection and Tests during Manufacture.		
1.01.01	The method and techniques to be used by the Bidder for the control of quality during manufacture of all plant and equipment shall be agreed with the Owner.		
1.01.02	The Owner’s general requirements with respect to quality control and the required shop tests are set out elsewhere in this specification.		
1.01.03	Before any item of plant or equipment leaves its place of manufacture the Owner shall be given the option of witnessing inspections and tests for compliance with the specification and related standards.		
1.01.04	Advance notice shall be given to the Owner as agreed in the Contract, prior to the stage of manufacture being reached, and the piece of plant must be held at this stage until the Owner has inspected the piece, or has advised in writing that inspection is waived. If having consulted the Owner and given reasonable notice in writing of the date on which the piece of plant will be available for inspection, the Owner does not attend the Bidder may proceed with manufacture having forwarded to the Owner duly certified copies of his own inspection and test results.		
	The owner’s representative shall have at all reasonable times access to bidder’s or his sub-vendor’s premises and shall have power to inspect/ examine materials and workmanship or equipment under manufacture.		
	The Bidder shall forthwith forward to the engineer duly certified copies of the Test Certificates in six copies (one to the Purchaser and five to the Consulting Engineer) for approval. Further nine (9) copies of Shop Test Certificates shall be bound with Instruction Manuals referred to elsewhere.		
	For electrical equipment, routine tests as per relevant IS spec are to be carried out on all equipment. Type tests are also to be carried out on selected equipment as detailed in the specs of concerned electrical equipment.		
1.01.05	Under no circumstances any repair or welding of castings be carried out without the consent of the Engineer. Proof of the effectiveness of each repair by radiographic and/or other non-destructive testing technique, shall be provided to the Engineer.		
1.01.06	All the individual and assembled rotating parts shall be statically and dynamically balanced in the works. Where accurate alignment is necessary for component parts of machinery normally assembled on site, the Bidder shall allow for trial assembly prior to dispatch from place of manufacture.		
1.01.07	All materials used for the manufacture of equipment covered under this specification shall be of tested quality. Relevant test certificates shall be made available to the Purchaser. The certificates shall include tests for mechanical properties and chemical analysis of representative material. Equipment or parts coming under any statutory		

	TITLE: 2X660 MW KORADI STP (UNITS-11&12) AIR CONDITIONING SYSTEM INSPECTION AND TESTING	SPECIFICATION No: PE-TS-527-553-A001	
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Regulations shall be certified by a Competent Authority under the regulations in the specified format. 1.01.08 All pressure parts connected to pumping main shall be subjected to hydraulic testing at a pressure of 150% of shut-off head for a period not less than one hour. Other parts shall be tested for one and half times the maximum operating pressure, for a period not less than one hour. 1.01.09 All necessary non-destructive examinations shall be performed to meet the applicable code requirements. 1.01.10 All welding procedures adopted for performing welding work shall be qualified in accordance with the requirements of Section-IX of ASME code or IBR as applicable. All welded joints for pressure parts shall be tested by liquid penetrant examination according to the method outlined in ASME Boiler and Pressure Vessel code. Radiography, magnetic particle examination magnuflux and ultrasonic testing shall be employed wherever necessary/ recommended by the applicable code. At least 10% of all major but welding joints shall be radiographed unless otherwise stipulated. Statutory payments in respect of IBR approvals including inspection shall be made by the bidder. Bidder’s scope shall include to preparation of all necessary documents, co-ordination and follow-up for above approval. Owner shall only forward assistance/endorsement of documents /design /drawings /reports/records to be submitted for approval as stipulated/ required by Statutory Authorities till registration of the unit and clearance for commercial operation. 1.02.00 Performance Tests at Site 1.02.01 The full requirements for testing the system shall be agreed between the Owner and the Bidder prior to Award of Contract. The completely erected System shall be tested by the Bidder on site under normal operating conditions. The Bidder shall also ensure the correct performance of the System under abnormal conditions, i.e. the correct working of the various emergency and safety devices, interlocks, etc. 1.02.02 The Bidder shall provide complete details of his normal procedures for testing, for the quality of erection and for the performance of the erected plant. These tests shall include site pressure test on all erected pipe work to demonstrate the quality of the piping and the adequacy of joints made at site. 1.02.03 The Bidder shall furnish the quality procedures to be adopted for assuring quality from the receipt of material at site, during storage, erection, pre-commissioning to tests on completion and commissioning of the complete system/equipment. 1.03.00 For details of specific tests required on individual equipment refer to respective section of this specification. All Statutory testing / clearance is in Bidder’s scope including payment of all fees, etc. as required QAP FORMAT			

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	TITLE: 2X660 MW KORADI STP (UNITS-11&12) AIR CONDITIONING SYSTEM LIST OF DOCUMENTS TO BE SUBMITTED WITH BID	SPECIFICATION No: PE-TS-527-553-A001	
		SECTION: II	
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LIST OF DOCUMENTS TO BE SUBMITTED WITH BID

	TITLE: 2X660 MW KORADI STP (UNITS-11&12) AIR CONDITIONING SYSTEM LIST OF DOCUMENTS TO BE SUBMITTED WITH BID	SPECIFICATION No: PE-TS-527-553-A001	
		SECTION: II	
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BIDDER SHOULD SUBMIT THE SIGNED AND STAMPED COPY OF THE FOLLOWING DOCUMENTS:

1. Compliance cum confirmation certificate
2. Guaranteed power consumption
3. Un priced format for AC package
 - a. Unpriced format for Main package, tools and tackles and commissioning spares on BHEL e-procurement portal.
4. Deviation schedule /No deviation certificate in attached format 'Deviation sheet (Cost of withdrawal)'.
5. Pre-bid clarification schedule and signed copy of technical corrigenda, if any.



TITLE:
2X660 MW KORADI STP (UNITS-11&12)
AIR CONDITIONING SYSTEM
COMPLIANCE CUM CONFIRMATION
CERTIFICATE

SPECIFICATION No: PE-TS-527-553-A001

SECTION: II

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REV. NO. 00

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SECTION: II

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COMPLIANCE CUM CONFIRMATION CERTIFICATE

	TITLE: 2X660 MW KORADI STP (UNITS-11&12) AIR CONDITIONING SYSTEM COMPLIANCE CUM CONFIRMATION CERTIFICATE	SPECIFICATION No: PE-TS-527-553-A001	
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COMPLIANCE CUM CONFIRMATION CERTIFICATE

The bidder shall confirm compliance with following by signing / stamping this compliance certificate (every sheet) and furnish same with the offer.

- a) The scope of supply, technical details, construction features, design parameters etc. shall be as per technical specification & there are no exclusions, other than those mentioned under “exclusion and those resolved as per ‘Schedule of Deviations’, with regard to same.
- b) There are no other deviations w.r.t. specifications other than those furnished in the ‘Schedule of Deviations’. Any other deviation, stated or implied, taken elsewhere in the offer stands withdrawn unless specifically brought out in the ‘Schedule of Deviations’
- c) Bidder shall submit QP in the event of order based on the guidelines given in the specification & QP enclosed therein. QP will be subject to BHEL / CUSTOMER approval & customer hold points for inspection / testing shall be marked in the QP at the contract stage. Inspection / testing shall be witnessed as per same apart from review of various test certificates/ Inspection records etc. This is within the contracted price without any extra implications to BHEL after award of the contract.
- d) All drawings/ data-sheets / calculations etc. submitted along with the offer shall not be taken cognizance off.
- e) The offered materials shall be either equivalent or superior to those specified in the specification & shall meet the specified / intended duty requirements. In case the material specified in the specifications is not compatible for intended duty requirements then same shall be resolved by the bidder with BHEL during the pre-bid discussions, otherwise BHEL / Customer’s decision shall be binding on the bidder whenever the deficiency is pointed out.

For components where materials are not specified, same shall be suitable for intended duty, all materials shall be subject to approval in the event of order.

- f) The commissioning spares shall be supplied on ‘As Required Basis’ & prices for same included in the base price itself.
- g) All sub vendors shall be subject to BHEL / CUSTOMER approval in the event of order.
- h) Guarantee for plant/equipment shall be as per relevant clause of GCC / SCC / Other Commercial Terms & Conditions
- i) In the event of order, all the material required for completing the job at site shall be supplied by the bidder within the ordered price even if the same are additional to approved billing break up, approved drawing or approved Bill of quantities within the scope of work as tender specification. This clause will apply in case during site

	TITLE: 2X660 MW KORADI STP (UNITS-11&12) AIR CONDITIONING SYSTEM COMPLIANCE CUM CONFIRMATION CERTIFICATE	SPECIFICATION No: PE-TS-527-553-A001	
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commissioning, additional requirements emerges due to customer and / or consultant's comments. No extra claims shall be put on this account

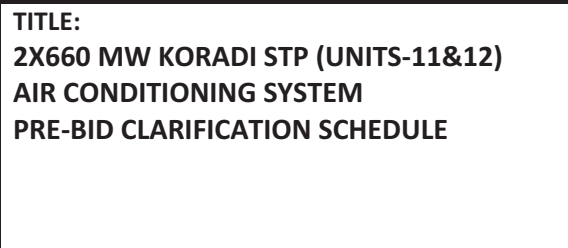
- j) Schedule of drawings submissions, comment incorporations & approval shall be as stipulated in the specifications. The successful bidder shall depute his design personnel to BHEL's / Customer's / Consultant's office for across the table resolution of issues and to get documents approved in the stipulated time.
- k) As built drawings shall be submitted as and when required during the project execution.
- l) The bidder has not tempered with this compliance cum confirmation certificate and if at any stage any tempering in the signed copy of this document is noticed then same shall be treated as breach of contract and suitable actions shall be taken against the bidder.
- m) Successful bidder shall furnish detailed erection manual for each of the equipment supplied under this contract at least 3 months before the scheduled erection of the concerned equipment / component or along with supply of concerned equipment / component whichever is earlier.
- n) Document approval by customer under Approval category or information category shall not absolve the vendor of their contractual obligations of completing the work as per specification requirement. Any deviation from specified requirement shall be reported by the vendor in writing and require written approval. Unless any change in specified requirement has been brought out by the vendor during detail engineering in writing while submitting the document to customer for approval, approved document (with implicit deviation) will not be cited as a reason for not following the specification requirement.
- o) In case vendor submits revised drawing after approval of the corresponding drawing, any delay in approval of revised drawing shall be to vendor's account and shall not be used as a reason for extension in contract completion.

	TITLE: 2X660 MW KORADI STP (UNITS-11&12) AIR CONDITIONING SYSTEM PRE-BID CLARIFICATION SCHEDULE	SPECIFICATION No: PE-TS-527-553-A001	
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PRE-BID CLARIFICATION SCHEDULE



SHEET: 2 OF 2

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TITLE:
2X660 MW KORADI STP (UNITS-11&12)
AIRCONDITIONING SYSTEM
NO DEVIATION CERTIFICATE

SPECIFICATION No: PE-TS-527-553-A001

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SECTION: II

SUB SECTION: 5

**NO DEVIATION CERTIFICATE
(REFER ANNEXURE-II OF GCC REV 07)**

	TITLE: 2X660 MW KORADI STP (UNITS-11&12) AIRCONDITIONING SYSTEM NO DEVIATION CERTIFICATE					SPECIFICATION No: PE-TS-527-553-A001			
						SECTION: II			
						SUB-SECTION: 5			
						REV: 00	DATE: AUGUST 2026		
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SL NO	VOUL ME/ SECTI ON	PAG E NO.	CLAU SE NO.	TECHNIC AL SPECIFICA TION/ TENDER DOCUM E NT	COMPLETE DESCRIPTI ON OF DEVIATION	COST OF WITHDR AWAL OF DEVIATI ON	REFERENCE OF PRICE SCHEDULE ON WHICH COST OF WITHDRAW AL OF DEVIATION IS APPLICABLE	NATURE OF COST OF WITHDRA WAL OF DEVIATION (POSITIVE/ NEGATIVE)	REASON FOR QUOTIN G DEVIATI ON
TECHNICAL DEVIATIONS									
COMMERCIAL DEVIATIONS									
PARTICULARS OF BIDDERS/ AUTHORISED REPRESENTATIVE									
NAME				DESIGNATIONS		SIGN & DATE			
NOTES:									
1. Cost of withdrawal of deviation will be applicable on the basic price (i.e. excluding taxes, duties & freight) only.									
2. All the bidders have to list out all of their Technical & Commercial Deviations (if any) in detail in the above format.									
3. Any deviation not mentioned above and shown separately or found hidden in offer, will not be taken cognizance of.									
4. Bidder shall submit duly filled unpriced copy of above format indicating "quoted" in "cost of withdrawal of deviation" column of the schedule above along with their Techno-commercial offer, wherever applicable. In absence of same, such deviation (s) shall not be considered and offer shall be considered in total compliance to NIT.									
5. Bidder shall furnish price copy of above format along with price bid.									
6. The final decision of acceptance/ rejection of the deviations quoted by the bidder shall be at discretion of the Purchaser.									
7. Bidders to note that any deviation (technical / commercial) not listed in above and asked after Part I opening shall not be considered.									
8. For deviations w.r.t. Credit period, Liquidated damages, Firm prices if a bidder chooses not to give any cost of withdrawal of deviation loading as per Annexure-VII, will apply. For any other deviation mentioned in un-priced copy of this format submitted with Part-I bid but not mentioned in priced copy of this format submitted with Priced bid, the cost of withdrawal of deviation shall be taken as NIL.									
9. Any deviation mentioned in priced copy of this format, but not mentioned in the un-priced copy, shall not									

	TITLE: 2X660 MW KORADI STP (UNITS-11&12) AIRCONDITIONING SYSTEM NO DEVIATION CERTIFICATE	SPECIFICATION No: PE-TS-527-553-A001	
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be considered.

10. All techno-commercial terms and conditions of NIT shall be deemed to have been accepted by the bidder, other than those listed in unpriced copy of this format.

11. Cost of withdrawal is to be given separately for each deviation. In no event bidder should club cost of withdrawal of more than one deviation else cost of withdrawal of such deviations which have been clubbed together shall be considered as NIL.

12. In case nature of cost of withdrawal (positive/negative) is not specified it shall be assumed as positive.

13. In case of discrepancy in the nature of impact (positive/ negative), positive will be considered for evaluation and negative for ordering.

	TITLE: 2X660 MW KORADI STP (UNITS-11&12) AIR CONDITIONING SYSTEM GUARANTEED POWER CONSUMPTION (GPC)	SPECIFICATION No: PE-TS-527-553-A001	
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SUB SECTION: 6

GUARANTEED POWER CONSUMPTION (GPC)

2X660 MW KORADI STP (UNITS-11&12)						
AIR CONDITIONING SYSTEM						
GUARANTEED POWER CONSUMPTION FIGURES						
S.NO.	DESCRIPTION OF EQUIPMENT	NO OF EQUIPMENT		TOTAL GUARANTEED POWER CONSUMPTION FOR EACH EQUIPMENT AT MOTOR INPUT TERMINAL AND CONTROL PANEL (IN KW)	DUTY FACTOR	TOTAL KW
		WORKING	STANDBY			
		3A	3B	4	5	6=3Ax4x5
A	AC-Plant-1: CENTRAL CHILLED WATER SYSTEM FOR MAIN CR AREAS					
i	Water cooled Screw Chiller	1	0		1	
ii	Chilled water pump	1	1		1	
iii	Condenser water pump	1	1		1	
iv	AHUs for AC load of the main CR areas and CER at 17m	2	1		1	
v	AHUs for AC load of the UPS room & CEP VFD at 8.5 m	1	1		1	
vi	Cooling tower	1	1		1	
B	AC Plant -2, FOR ESP CUM FGD CONTROL ROOM- FOR UNIT# 11					
i	Air cooled inverter type Precision AC (20 TR)	4	2		1	
C	AC Plant -3, FOR ESP CUM FGD CONTROL ROOM- FOR UNIT# 12					
i	Air cooled inverter type Precision AC (20 TR)	3	2		1	
D	AC-Plant-4: SERVICE BUILDING (G+4)					
i*	Air cooled inverter type Ducted Split AC (11 TR)	10	10		0.4	
ii*	Air cooled inverter type Ducted Split AC (8 TR)	12	12		0.4	
iii*	Air cooled inverter type Ducted Split AC (5 TR)	8	8		0.4	
iv*	Air cooled inverter type Ducted Split AC (3 TR)	5	5		0.4	
				TOTAL (KW)		
*In case of change in number of Air cooled inverter type Ducted Split ACs for service building during detailed engineering, GPC value of AC system shall be adjusted suitably based on GPC value deduced from figure quoted by the bidder in this format.						
Note:	Estimated power consumption (EPC) figure for the system (for working drives only) has been considered as 764 kW. So long bidder's quoted guaranteed power consumption (GPC) above remains within this EPC, there will be no technical loading of bid on power consumption for evaluation. However, if bidder's quoted GPC exceeds EPC, there shall be technical loading of bid for evaluation @ INR 3,69,973/- (Rs. Three Lakhs Sixty nine Thousand nine hundred and seventy three only) per kW of additional power over EPC. Bidder's guaranteed power consumption at motor input terminals (not shaft power) as furnished in relevant schedule shall be demonstrated by the successful bidder during performance testing at works/ site. In case power consumption is noted higher than EPC / bidder's quoted GPC whichever is higher, during inspection/ PG test, penalty @ INR 3,69,973/- (Rs. Three Lakhs Sixty nine Thousand nine hundred and seventy three only) per kW shall be levied on vendor.					