

UTTAR PRADESH RAJYA VIDYUT UTPADAN NIGAM LIMITED

1X660 MW PANKI TPP EXTN.

TECHNICAL SPECIFICATION FOR COMPRESSED AIR SYSTEM

SPECIFICATION NO.: PE- TS- 426- 555- A001, Rev 01



**BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR - PROJECT ENGINEERING MANAGEMENT
NOIDA, INDIA**

**1x660 MW PANKI TPS - CAS****INDEX**

SPECIFICATION NO. PE-TS-426-555-A001

REV 01

SHEET 1 OF 1

SECTIONS	TITLE	PAGE NO.
SECTION-I	SPECIFIC TECHNICAL REQUIREMENT	
	INTENT OF SPECIFICATION	3-5
	PROJECT INFORMATION WITH WIND AND SEISMIC DESIGN CRITERIA	6-13
SECTION-IA	SPECIFIC TECHNICAL REQUIREMENT - MECHANICAL	
	SCOPE OF SUPPLY, EXCLUSIONS, TERMINAL POINTS AND OTHER PROJECT SPECIFIC REQUIREMENTS.	14-20
	SPECIFIC TECHNICAL REQUIREMENTS - MECHANICAL	21-24
	CUSTOMER SPECIFICATION	25-54
	GENERAL TECHNICAL REQUIREMENT INCLUDING LP PIPING	55-176
	FUNCTIONAL / DEMOSTARTION GUARANTEE	177-179
	QUALITY ASSURANCE AND INSPECTION REQUIREMENT	180-196
	ANNEXURE-I (SUB-VENDOR LIST)	197-207
	ANNEXURE-II (DRWG / DOCS DISTRIBUTION SCHEDULE)	208-211
	ANNEXURE-III (MDL WITH SUBMISSION SCHEDULE)	212-214
	ANNEXURE-IV (INPUT DRAWINGS)	215-221
	ANNEXURE-V (MANDATORY SPARES)	222-225
	ANNEXURE-VI (PAINTING SPECIFICATION)	226-241
	ANNEXURE-VII (DM WATER ANALYSIS)	242-243
SECTION-IB	SPECIFIC TECHNICAL REQUIREMENT - ELECTRICAL	244-311
SECTION-IC	SPECIFIC TECHNICAL REQUIREMENT - C & I	312-397
SECTION-II	STANDARD TECHNICAL SPECIFICATIONS	398
SECTION-IIA	FORMAT FOR OPERATION AND MANITENANCE	399-402
SECTION-IIB	SITE STORAGE AND PRESERVATION	403-418
SECTION-III	DOCUMENTS TO BE SUBMITTED BY THE BIDDER	419
SECTION - IIIA	LIST OF DOCUMENTS TO BE SUBMITTED WITH BID	420-421
SECTION - IIIB	COMPLIANCE CUM CONFIRMATION CERTIFICATE	422-423
SECTION - IIIC	PRE BID CLARIFICATION SCHEDULE	424
SECTION - IIID	SCHEDULE OF TECHNICAL DEVIATION	425
SECTION - IIIE	ELECTRIC LOAD DATA	426-427
SECTION - IIIF	GUARANTEED POWER CONSUMPTION	428-429

1x660 MW PANKI TPS

COMPRESSED AIR SYSTEM

SECTION – I

(INTENT OF SPECIFICATION)



BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR PROJECT ENGINEERING MANAGEMENT
NOIDA-INDIA



**TECHNICAL SPECIFICATION FOR
COMPRESSED AIR SYSTEM
1X660 MW PANKI TPS**

SPECIFICATION NO. PE-TS-426-555-A001

INTENT OF SPECIFICATION

SECTION I

REV – 01

DATE: 17.06.2019

1.0 INTENT OF SPECIFICATION

- 1.1 The specification is intended to cover Supply part, Services part and Mandatory spares comprising of design (i.e. Preparation and submission of drawing /documents including “As Built” drawings and O&M manuals), engineering, manufacture, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting, maintenance tools & tackles (as applicable), fill of lubricants & consumables, mandatory spares along with spares for erection, start up and commissioning as required, forwarding, proper packing, shipment and delivery at site, unloading, handling, transportation & storage at site, in-site transportation, assembly, erection & commissioning, final painting at site, minor civil work, trial run at site, preparation of layout drawings and carrying out Performance guarantee / Functional / Demonstration tests at site (As applicable), training of customer/client O&M staff 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.
- 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 of COMPRESSED AIR 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 high 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.
- 1.5 The general term and conditions, instructions to tenderer 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.
- 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-III** 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 implication on account of the same. Further in case of any missing information in the



**TECHNICAL SPECIFICATION FOR
COMPRESSED AIR SYSTEM
1X660 MW PANKI TPS**

SPECIFICATION NO. PE-TS-426-555-A001

INTENT OF SPECIFICATION

SECTION I

REV – 01

DATE: 17.06.2019

specification not brought out by the prospective bidders as part of 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 / clarifications, if any, should be very clearly brought out clause by clause in the format enclosed in the specification; otherwise, it will be presumed that the vendor's offer is strictly in line with NIT specification. Each deviation shall be furnished with its cost of withdrawal in both priced and un-priced bid. In case of No-deviation, bidder to furnish the No-deviation / compliance certificate in the format enclosed in SEC-III of this specification.
- 1.9 In case all above requirements are not complied with, the offer may be considered as incomplete and would become liable for rejection.
- 1.10 Unless specified otherwise, all through the specification, the word contractor shall have same meaning as successful bidder /vendor and Customer/ Purchaser/Employer will mean BHEL and /or UPRVUNL and /or DCPL and / or NTPC.

1X660 MW PANKI TPS

COMPRESSED AIR SYSTEM

SECTION – I

(PROJECT INFORMATION)



BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR PROJECT ENGINEERING MANAGEMENT
NOIDA-INDIA

1.0 PROJECT INFORMATION

1.1	Owner	:	UTTAR PRADESH RAJYA VIDYUT UTPADAN NIGAM LIMITED, LUCKNOW	
1.2	Project Title	:	Panki Thermal Power Station (1x660MW)	
1.3	Owner's Engineer	:	DEVELOPMENT CONSULTANTS PVT. LTD and NTPC	
1.4	Project Site Location	:	Place	Panki
			District	Kanpur
			State	Uttar Pradesh
			Country	India
1.5	Latitude & Longitude of project site	:	North	N26°28'20"
			East	E 80°14'32"
1.6	Nearest Railway Station	:	Panki	5 km
1.7	Nearest Town	:	Kanpur	16km
1.8	Nearest Highway	:	National Highway - 25	
1.9	Nearest Airport	:	Kanpur	25 km
			Lucknow	80 Km
1.10	Nearest Commercial Airport	:	Delhi	140 km
1.11	Nearest Water Body	:	Lower Ganga Canal, adjacent to site	
1.12	Land	:	Land is in possession of UPRVUNL.	
1.13	Station Graded Level Elevation from Mean sea level (MSL)	:	Plant FGL → RL(+) 126.0M → EI(-) 0.500M Plant FFL → RL(+) 126.5M → EI(+/-) 0.000M	
1.14	Water			
1.14.1	Nearest Water Source	:	Lower Ganga Canal system running adjacent for project site	
1.14.2	Water Requirement for station	:	~ 1927 m ³ /hr considering closed cooling cycle with NDCT. Additional 700m ³ /hr for ash slurry preparation during emergency ash disposal to ash dyke.	
1.14.3	Raw Water Analysis from Upper Ganga Canal	:	Refer Appendix - I	
1.15	Site Ambient Condition			
1.15.1	Monthly mean (DBT)	:	Maximum	44.4 °C
		:	Minimum	3.8 °C
1.15.2	Extreme Recorded (DBT)	:	Maximum	47.3 °C
			Minimum	-0.9 °C
1.15.3	Monthly mean (WBT)	:	Maximum	27.3 °C
			Minimum	9.2 °C
1.15.4	Relative Humidity	:	Maximum	84 %
			Minimum	28 %
1.15.5	Average relative humidity		Annual Average	65 %
1.15.6	Rainfall	:	Annual average	832.6 mm

			Heaviest fall recorded in 24 hrs	247.4 mm
1.15.7	Basic Wind Speed	:	47.00 m/s	As per IS: 875 part – III
			For wind resistance design of structure & equipment refer relevant civil section	
1.15.8	Climatic condition	:	For detailed information refer attached Climatological data as published by IMD for Kanpur station.	
1.16	Seismic data	:	Zone – III	As per IS: 1893
			For earthquake resistance design of structure & equipment refer relevant civil section	
1.17	Fuel Data			
1.17.1	Coal Source	:	Coal requirement for this stage of the project is estimated as 2.99 million tones/annum considering 660 MW capacity, GCV of blended coal 4030 kcal/kg, Heat Rate as 2317 kcal/kwh and 90% PLF as per CERC operative norms effective from 1/4/2009.	
1.17.2	Coal Transportation	:	Thru BOXN wagons of Indian Railways System	
1.17.3	Coal Analysis	:	Refer Appendix – II	
1.17.4	Support Fuel (HFO / LDO) transportation	:	Support fuel will be transported by road tankers or by Railway system. Start-up / support fuel for the proposed project will be LDO/HFO.	
1.17.5	Support Fuel (HFO / LDO) analysis	:	Refer Appendix - II	

Appendix – I: Raw Water Analysis (Source - Lower Ganga Canal)

S. No.	Description	Unit	Parameter
1	Physical characteristics		
	pH at 25°C	-	8.00
	Turbidity	Silica Scale	500
	Total Suspended solids	ppm	250
	Total Dissolved solids	ppm	241
	Colour	Hazen	< 5
2	Cations		
	Calcium Hardness	ppm as CaCO ₃	80
	Magnesium Hardness	ppm as CaCO ₃	40
	Sodium + Potassium	ppm as CaCO ₃	36
	Iron	ppm as CaCO ₃	1.5
	Total Cations	ppm as CaCO ₃	157.5
3	Anions		
	Bicarbonate	ppm as CaCO ₃	100
	Carbonate	ppm as CaCO ₃	0.95

S. No.	Description	Unit	Parameter
	Hydroxyl	ppm as CaCO ₃	0.05
	Chlorides	ppm as CaCO ₃	20
	Sulphate	ppm as CaCO ₃	36
	Nitrate	ppm as CaCO ₃	0.5
	Total Anions	ppm as CaCO ₃	157.5
4	Carbon Di-oxide as CO ₂	ppm	1.97
5	Dissolved Silica	ppm as SiO ₂	10.0
6	Colloidal Silica	ppm as SiO ₂	0.5
7	Organic Matter	ppm as O ₂	4.0

Appendix – II : Coal Quality Parameter

Sl.N o.	Particulars	Unit	Performance / Design Fuel	Worst Fuel	Best Fuel
1.0.	Proximate Analysis (As Received Basis)	By Weight			
1.1.	Moisture	%	10.5	12	12
1.2.	Ash	%	35	43	32
1.3.	Volatile Matter	%	26	19	27
1.4.	Fixed Carbon	%	28.5	26	29
1.5.	Total	%	100	100	100
1.6.	Gross Calorific Value	kcal/kg	3700	3200	4200
2.0.	Ultimate Analysis (As Received Basis)				
2.1.	Moisture	%	10.5	12	12
2.2.	Ash	%	35	43	32
2.3.	Carbon	%	42	33.5	44
2.4.	Hydrogen	%	2.0	2.4	2.77
2.5.	Nitrogen	%	1.6	1.3	1.5
2.6.	Sulfur	%	0.46	0.45	0.5
2.7.	Oxygen	%	8.44	7.35	7.23
2.8.	Total	%	100	100	100
3.0.	Hard Groove Index		53	50	55
4.0.	Ash Fusion Range				
a)	Initial Deformation Temperature	⁰ C	1200	1154	1165
b)	Hemispherical Temperature	⁰ C	1350	1300	>1350

Sl.No.	Particulars	Unit	Performance / Design Fuel	Worst Fuel	Best Fuel
c)	Fusion Temperature	°C	>1400	>1400	>1400

Source: Saharpur Jamarpani Coal Mine, Jharkhand
Imported Coal

Sl. No.	Item	Unit	Design Coal
1.	Gross heating Value	Kcal/kg	5500

Source: Indonesia / South African coal

Appendix – III : Light Diesel Oil (LDO)
As per IS: 1460-2000

S.No.	Property	Unit	Value
1.0	Ash content (max)	% by mass	0.02
2.0	Carbon residue (Rams Bottom) max	% by mass	0.2
3.0	Cetane number (Min)	-	-
4.0	Pour Point (max)		
	a) Winter	°C	12
	b) Summer		21
5.0	Flash Point (min)		
	a) Abel	°C	--
	b) Pensky0Martens		68
6.0	Kinematic Viscosity at 38 deg	Cst	2.5 to 15.7
7.0	Sediments (max)	% by mass	0.1
8.0	Sulphur Content (max)	% by mass	1.8
9.0	Water Content (max)	% by volume	---
10.0	Gross Calorific Value (GCV), approx	kCal/kg	10,000
11.0	Density at 15°C	Kg/m ³	850 to 870

Appendix – IV : Heavy Fuel Oil (HFO)
As per IS: 1593-1982

S.No.	Property	Unit	Value
1.0	Viscosity at 50 °C	Cst	370
2.0	Density at 15°C (approx)	Kg/m ³	890 to 950
3.0	Flash Point (min)	°C	66
4.0	Pour Point (max)	°C	20
5.0	Water Content (max)	% by volume	1
6.0	Sediments (max)	% by weight	0.25
7.0	Sulphur Content (max)	% by weight	4.5
8.0	Ash content (max)	% by weight	0.1
9.0	Gross Calorific Value (GCV), approx	kCal/kg	10,000

2.0 Access to Site

The nearest town Kanpur is about 16 km from site. It is easily accessible by Railway/Road.

Dedicated railway link is available for the transportation of coal and fuel oil for the power plant. No problem is envisaged in accessibility and transportation of heavy equipment to site by road or rail.

3.0 Plant Rating, Capacity, Availability, PLF

Plant continuous rating will be 660 MW at generator terminals based on the following site conditions.

- Ambient air temperature
- Condenser cooling water inlet temperature of 33°C and 10°C temperature rise across the condenser.
- Generator power factor of 0.85 (zero point eight-five).
- Fuel specification as given elsewhere.
- Design temperature for electrical equipment is 50°C.

The VWO capacity of the steam turbine 660 MW will be 105% or 693 MW and the Boiler maximum Continuous Rating (MCR) will be established to match the steam requirement at VWO conditions. The capacity of the unit is selected so as to deliver the rated output even after ageing that will occur between overhauls, as a result of deposition of salts in turbine blades, wear and tear etc.

4.0 Power Evacuation

The power generated from the proposed project will be evacuated over the 400 KV through a 400 KV open switchyard. Further to Switchyard distribution will be by UPTRANSCO. Interconnection of proposed 400 KV Switchyard with existing 220 kV switchyard shall be done as specified elsewhere in specification.

स्टेशन : कानपुर (ए)
STATION : Kanpur (A)

[illegible]

1X660 MW PANKI TPS

COMPRESSED AIR SYSTEM

SECTION I-A

SPECIFIC TECHNICAL REQUIREMENT -MECHANICAL



BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR PROJECT ENGINEERING MANAGEMENT
NOIDA-INDIA



COMPRESSED AIR SYSTEM

1X 660MW PANKI TPS EXTN

DOCUMENT NO.: PE-TS-426-555-A001

SCOPE OF SUPPLY, EXCLUSION & TP.

SECTION-IA

REV. 01

DATE: 17.06.2019

1. SCOPE OF SUPPLY AND SERVICES:

The scope of work under this specification shall be as below.

Items not specifically mentioned but deemed necessary by the Tenderer for making the system completely reliable and efficient shall also be considered as if included.

- 1.1 Total lump sum for Equipment & Services as specified, comprising of design & engineering, manufacture, inspection & testing at manufacturer's works, painting at manufacturer's works, duly packed for transportation, delivery to site, unloading storage & handling at site, erection & commissioning, carrying out performance/acceptance tests at site & final painting of complete Compressed Air System consisting of following equipment:
 - 1.1.1 Three (3) Nos. Instrument Air Compressors (Oil Free Screw) each of minimum 40 NM³/Min capacity at 8.5 Kg/sqcm (g) discharge pressure with suction filter with silencer, inter cooler and after cooler with moisture separators, automatic drain traps, instruments, control system and other accessories.
 - 1.1.2 Three (3) Nos. heat of compression desiccant type (rotary drum type or conventional twin tower type) Air Drying Plants of minimum 44.0 Nm³/min capacity (1.1 times the IA compressor capacity) with all instruments, control panels and other accessories as specified.
 - 1.1.3 Three (3) Nos. Service Air Compressors (Oil Free Screw) each of minimum 40 NM³/Min capacity at 8.5 Kg/sqcm (g) discharge pressure with suction filter with silencer, inter cooler and after cooler with moisture separators, automatic drain traps, instruments, control system and other accessories.
 - 1.1.4 Six (6) Nos. Air Receivers of 15 cum capacity each adjacent to compressor house, two (2) nos of 10 cum capacity each in TG hall, one (1) no of 2 cum capacity and one (1) no of 5 cum capacity in DM plant area, one (1) nos of 5 cum capacity in FGD area and one (1) nos of 5 cum capacity in CHP area. Each air receiver shall be complete with instruments, relief valve, drain connection with electronic timer controlled solenoid operated automatic trap stations and other accessories as specified.
 - 1.1.5 Three (3) Nos. Electronic Dew point meters.
 - 1.1.6 Pipes and fittings for compressed air line & interconnecting airline, cooling water line including hanger/supports, auxiliary structural members etc. inclusive of all cu-tubing for control air piping, fittings, valves, Counter flanges, bolts, nuts, gaskets etc. at all piping terminals, base plates, support plates, anchor bolts, nuts, sleeves, inserts, lifting lugs, eye bolts etc and other accessories as required including drain piping - Lot.
 - 1.1.7 All airline and water line valves – Lot.
 - 1.1.8 Field instruments as specified in technical specification, all instruments necessary for performance testing of compressors as well as air drying plants – Lot.
 - 1.1.9 Microprocessor/PLC based integrated control system for each compressor and dryer. – Lot.
 - 1.1.10 Cables as specified – Lot.
 - 1.1.11 Maintenance and erection tools and tackles, start up and commissioning spares, consumables, first fill of lubricants inclusive of packing – Lot
 - 1.1.12 Any other item not included above or in specification but required for Compressed Air System.
 - 1.1.13 All commissioning spares & consumables for trouble free operation shall be in scope of bidder.



COMPRESSED AIR SYSTEM

1X 660MW PANKI TPS EXTN

DOCUMENT NO.: PE-TS-426-555-A001

SCOPE OF SUPPLY, EXCLUSION & TP.

SECTION-IA

REV. 01

DATE: 17.06.2019

1.1.14 Civil works: - Minor dressings of foundation blocks, equipment grouting, supply and fixing of supports etc. on walls, foundations; floor and trenches will be done by successful bidder.

1.1.15 Erection and commissioning of compressed air system.

2.0 TERMINAL POINTS:

2.1 Bidder will terminate compressed air piping at common IA header and common SA header downstream of air receiver with isolation valve as per enclosed tender drawing.

2.2 250 Nb Cooling water supply pipeline connection will be provided by the purchaser outside the compressor house (at 10.0 m from compressor house building). The return hot water shall be terminated by the contractor at the same location. Further interconnection from these terminal points shall be in bidder's scope. Refer enclosed tender drawing.

3.0 EXCLUSIONS:

3.1 HT motors for Air compressors. HT motors are not in bidder's scope of supply, bare motors only shall be supplied as free issue by BHEL to successful bidder based on motor inputs furnished by bidder, like motor rating and TS (Torque - Speed) curve. The responsibility for satisfactory operation for combined performance of compressors & motors shall rest with the bidder only as if, the drive motors also have been supplied by the bidder. Couplings, base plate, foundation bolts, any other fittings, etc. as required shall be supplied by the bidder only. BHEL shall supply motors to successful bidder works for shop testing of compressors with job motors. All other motors (mandatory spare) shall be dispatched by BHEL directly to project sites.

3.2 MCC/Switchgear for power supply to Air Compressors and other drives and panels.

3.3 Civil works including construction of compressor house, foundation of all compressor, air dryer and air receiver, pipe / cable trenches.

3.4 Lighting and ventilation of compressor house.

3.5 Monorail hoists/Cranes as necessary for handling of equipment after erection.

3.6 Compressed Air Distribution Piping running from isolation valve of the IA & SA header after the air receivers outside the compressor house.

4. SUB-VENDOR ITEMS

The tentative make of Sub-vendor items shall be generally as per Annexure-I, Section IA enclosed which is subject to customer approval during detail engineering.

5. DRAWINGS AND DOCUMENTS TO BE SUBMITTED WITH THE BID

The drawings and documents to be submitted with the bid shall strictly be as mentioned under Section IIIA. Any documents other than those indicated in Section IIIA will not be reviewed and will not form part of contract.

6. DRAWINGS/ DOCUMENTS REQUIRED DURING DETAIL ENGINEERING

List of drawing / document required to be submitted during detail engineering is attached in Annexure-III, Section IA. Any other drawings and documents as required by BHEL / Customer / Consultant shall be



COMPRESSED AIR SYSTEM

1X 660MW PANKI TPS EXTN

DOCUMENT NO.: **PE-TS-426-555-A001**

SCOPE OF SUPPLY, EXCLUSION & TP.

SECTION-IA

REV. 01

DATE: 17.06.2019

furnished by the successful bidder during detail engineering stage for which no implication shall be entertained by BHEL.

7. DRAWINGS DISTRIBUTION SCHEDULE

Drawing/document needs to be submitted by successful bidder during detail engineering shall be as per Annexure-II, Section IA.

8. DRAWINGS ENCLOSED WITH THE SPECIFICATION

Drawings as per Annexure-IV, Section IA enclosed will form part of the specification.

The P&I diagrams are indicative and show the minimum requirement to be followed including minimum requirement of instruments. Any other item and instruments required (within the terminal points) to make the system complete in all respect and for satisfactory operation of the system shall also deemed to have been included by the bidder in their scope. The detailed P&I diagrams for compressed air system in line with specification requirement shall be developed by the vendor during detail engineering for customer's approval and without any commercial implication to customer. Bidder to note that the while preparing PIDs after placement of order, successful bidder shall incorporate line numbers, Instrument tag nos., KKS Numbering, equipment no, Line Spec, Line MOCs, legend / symbol chart, equipment capacity, relief valve capacity and set pressure, control valve capacity, range, fail position etc. in these drawing and same are subject to the customer approval.

9. MANDATORY SPARES

General requirement of mandatory spares will be as per the list enclosed under Annexure-V, Section IA. The successful bidder immediately after approval of PID, Layout & equipment/ instrument data sheets /GA will prepare detailed list of mandatory spares with regard to their exact quantities, applicability/ non applicability; supply of alternate items against non-applicable items etc. This list will be submitted to customer for getting their approval. The successful bidder will proceed for ordering only after approval of the list. BHEL reserves the right to buy any or all the mandatory spares parts as mentioned in the list.

10. GUARANTEED POWER CONSUMPTION

Bidder to furnish the Guaranteed power consumption (GPC) as per the format attached at Section IIIF of this specification. Bidder to furnish GPC along with its technical bid and not in sealed priced bid.

11. OTHER REQUIREMENTS

- Detailed erection manual for each of the equipment as well as complete system supplied under this contract at least 2 months before the scheduled erection of the concerned equipment / component or along with supply of concerned equipment / component whichever is earlier.
- The O&M Manual to be submitted by the successful bidder will necessarily address the following:
 - a. Complete System Description along with PIDs, write up on electrical philosophy and safety/process interlocks etc.
 - b. Instructions for plant operation
 - c. Commissioning procedure of the system
 - d. Chapter on precautions to be taken during:
 - Operation
 - Idle time



COMPRESSED AIR SYSTEM

1X 660MW PANKI TPS EXTN

DOCUMENT NO.: **PE-TS-426-555-A001**

SCOPE OF SUPPLY, EXCLUSION & TP.

SECTION-IA

REV. 01

DATE: 17.06.2019

- Long shutdown
- e. Chapter on trouble shooting during plant operation covering:
 - Safely aspects
 - Do's and do not's
 - Maintenance schedule
 - Schedule of lubricants & consumables
- f. O & M instruction for all individual equipment which shall invariably contain but not necessarily limited to the following:
 - Equipment description/interdiction
 - Data sheet, Equipment GA & Cross Section Drawing
 - Catalogue of each equipment
 - DO's & DON'T's
 - Duty Conditions
 - Installation & Safety Recommendation
 - Start-up & shut down procedure
 - Instructions for testing and adjustment of system parameters
 - Disassembly & Assembly Instructions giving sequence no. of each component
 - List of Replacement/ Spare parts along with their drawing and catalogues and procedure for ordering spares.
 - Reason & Remedy Chart for any problem
 - Maintenance Schedules- Daily, Weekly, Monthly, Half Yearly and Annual indicating clearly the spares part and man-hour requirement for each stage.
 - Detailed specification/ Schedule of all the consumables including lubricant oils, greases, chemicals etc. required for the complete system
 - Commission procedure for equipment.
- 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.
- In case vendor submits revised drawing/doc after approval of the corresponding drawing/doc, 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.
- Bidder to note that during detail engineering, successful bidder to submit the drg/doc through web based Document Management System in addition to hard copies to be submitted as per dwg/ document distribution schedule. Bidder would be provided access to the DMS for drg/doc approval and adequate training for the same. Detailed methodology would be finalized during the kick-off meeting. Bidder to ensure following at their end.



COMPRESSED AIR SYSTEM

1X 660MW PANKI TPS EXTN

DOCUMENT NO.: **PE-TS-426-555-A001**

SCOPE OF SUPPLY, EXCLUSION & TP.

SECTION-IA

REV. 01

DATE: 17.06.2019

- Internet explorer version – Minimum Internet Explorer 7
 - Internet speed – 2 mbps (Minimum preferred)
 - Pop ups from our external DMS IP (124.124.36.198) should not be blocked
 - Vendor's Internal proxy setting should not block DMS application's link (<http://124.124.36.198/wrenchwebaccess/login.aspx>)"
- DMS user manuals to be used by BHEL PEM vendors for uploading, viewing, revising, commenting and tracking documents on PEM's DMS have been uploaded on PEM internet website (www.bhelpem.com) under the Vendor session.
For quick access bidder may refer the link <http://bhelpem.com/DMSManuals/DMSManuals.html>
- Final Electrical Load list will be submitted by the successful bidder as per agreed drawing/ doc submission schedule. Thereafter any change in the electrical load list shall be entertained only subject to its feasibility, and BHEL reserves the right to debit the vendor cost of any changes necessitated in the switch gear /MCC on account of changed loads.
 - Wherever CIVIL works is excluded from the bidder's scope, successful bidder shall furnish civil assignment drawings. The corresponding CIVIL drawing prepared by BHEL / CIVIL agency, based on civil assignment drawing of bidder will be furnished to the successful bidder for concurrence. In case any modification is required in the civil work already carried out based on final civil inputs given by vendor, BHEL reserves the right to debit cost of such rework to vendor".
 - If any deviation is there then same to be indicated separately under the heading "Schedule of Technical Deviation" enclosed as per Volume III of the Technical Specification along with Cost of Withdrawal. In case nothing is mentioned under the column Cost of withdrawal then during bid evaluation no price implication will be admissible for withdrawal of deviations. Bidders shall also note that the deviation in any other form except above is not acceptable (i.e. in data sheet or other Annexure or elsewhere in the offer) and same shall not be considered for review/evaluation purpose/comments and it would be assumed that the system/material/equipment has been offered strictly in line with specifications/requirements.

12 BIDDER TO NOTE THE FOLLOWING INFORMATION:

- 12.1 Bidders to indicate offered model in their offer and to submit backup document (e.g. performance test, etc.) matching FAD calculation along with the catalogue of the offered model to justify selection.
- 12.2.1 Compressor and air dryer shall be designed for cooling water (from passivated DM water) with inlet temp of thermal 38 deg C and terminal pressure 10 kg/sqcm(g). Bidder to restrict the temperature rise to 10 deg C and pressure drop across Compressed Air System within terminal points to 10 MWC. Qty of cooling water shall be 320 cum/hr (Maximum) considering working equipment only.
- 12.3 Design Inlet conditions for Compressor
- a) Temp : 45.0 Deg C
 - b) Relative humidity : 75%
 - c) Altitude : 126.0 m above MSL
- 12.4 Design, all calculations, equipment selection criterion, layout drawings/schemes/G.A. drg and documents like data sheet/Technical particulars etc. shall be prepared by successful bidder and shall be subjected to Customer & BHEL approval during detail engineering stage.



COMPRESSED AIR SYSTEM

1X 660MW PANKI TPS EXTN

DOCUMENT NO.: **PE-TS-426-555-A001**

SCOPE OF SUPPLY, EXCLUSION & TP.

SECTION-IA

REV. 01

DATE: 17.06.2019

- 12.5 The maximum velocity to be considered in compressed air shall be 10.0 m/s (under Average pr. & Temp. Conditions).
- 12.6 All drawings and documents shall be computer based.
- 12.7 All commissioning spares & consumables for trouble free operation shall be provided, with minimum to what specified elsewhere in the specification.
- 12.8 Bidder to clearly note that the instruments, valves etc as shown in the P&I Diagram is the bare minimum and any additional instruments/valves required to complete the system in terms of safety, trouble free operation of equipment's & system as a whole and isolation of individual equipment for maintenance, then same shall be supplied by the bidder without any commercial implication to BHEL.
- 12.9 Grouting of equipment's, like Air receiver, Air dryer & foundation bolts etc. are in the scope of the bidder.
- 12.10 Performance test for compressors shall be carried out at shops with job motor only.
- 12.11 All the instruments as required for performance testing shall be arrange by bidder. Instrument for testing shall be calibrated from government certified labs & this is in the bidder scope. Bidder to ensure validity of such reports before the performance tests.
- 12.12 The height of two number, 10 cum, unit air receivers, to be located inside TG Hall, shall be limited to 4M.
- 12.13 Access platform required for the maintenance of instruments/valves on the towers of HOC type air drier shall be in bidder's scope of work.
- 12.14 Only KKS tagging shall be used in all document/drawings and in the field for all items/equipment/signals etc. No other tagging method is acceptable. The successful bidder shall provide detailed drawing with KKS only. Operational write up of the system should strictly contain KKS code for identification and description.

1X660 MW PANKI TPS

COMPRESSED AIR SYSTEM

SECTION IA

(TECHNICAL REQUIREMENT - MECHANICAL)



BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR PROJECT ENGINEERING MANAGEMENT
NOIDA-INDIA

	1X660 MW PANKI TPS EXTN. COMPRESSED AIR SYSTEM	BHEL Doc. No: PE-TS-426-555-A001	
		REV	01
		DATE	17.06.2019
		Section IA	

1.

SYSTEM DESCRIPTION

1.1.1

Compressed air system is provided in the power plant to supply compressed air through the distribution network to various user points.

1.1.2

The compressed air system shall comprise of the instrument air system and the plant/service air system. Instrument air is required for the various pneumatically operated valves and instruments in the power plant, while plant air is required for general plant services.

1.2

Compressed Air System includes the following

1.2.1

Three (3) nos. (2 working + 1 standby) Instrument air compressors and three (3) nos. Plant air compressor (2 working + 1 standby), including drives, intercoolers, after coolers, step up gearbox, silencer and other accessories.

1.2.2

Three (3) nos. (2 working + 1 standby) air-drying plants (ADP) each suitable for connecting to individual instrument air compressor.

1.2.3

Intake air filters.

1.2.4

Six (06) nos. air receivers, (3 nos. for instrument air service and 3 nos. for plant air service) near compressor house, two (2) nos as Unit air receiver in TG Hall (for instrument air service), Two (2) nos for DM Plant (1 no. for instrument air service and 1 no. for plant air service), one (1) no for FGD (instrument air service) and one (1) no for CHP (service air service).

1.2.5

Interconnecting piping, valves, fittings, supports/hangers, control air tubing (complete with valves and fittings between air receivers, compressor and local panel for each compressor), cooling water piping & valves for safe and satisfactory operation of air compressors.

1.2.6

Instruments including the electronic on line dew point meter with suitable sampling connection and isolation valve at the outlet of each Air Drying Plant shall be provided.

2.

DESIGN INPUTS/ CRITERIA

3.1

AIR COMPRESSORS

2.1.1

The capacity of each instrument air compressor shall be 40.0 NM³/min. Delivery pressure will be 8.5 Kg/cm² (g) at compressor outlet while 8.0 Kg/cm² (g) at ADP outlet. Each compressor will be designed to deliver the nominal capacity at the required delivery pressure. (Refer compressor sizing calculation).

2.1.2

The capacity of each plant air compressor shall be 40.0 NM³/Min. Delivery pressure will be 8.5 Kg/cm² (g) at outlet of SA compressor. (Refer compressor sizing calculation).

2.1.3

Air compressors will be multi stage oil free, screw type.

2.1.4

The compressors' capacity will be designed for 45⁰ C DBT and 75% RH at atmospheric pressure at site & at 193.0m above mean sea level (MSL).

2.1.5

Testing of compressor shall be as per ISO 1217.

2.1.6

Air compressors will be designed for continuous operation with high efficiency to satisfy the performance requirement.

2.1.7

The maximum continuous motor ratings shall be arrived at considering 15% margin over the duty point input.

2.1.8

Satisfactory operation in parallel will be ensured without any uneven load sharing, undue vibration, noise etc.

	1X660 MW PANKI TPS EXTN. COMPRESSED AIR SYSTEM	BHEL Doc. No: PE-TS-426-555-A001	
		REV	01
		DATE	17.06.2019
		Section IA	

2.1.9	Noise level shall not exceed 85 dBA plus tolerances as per ISO standard when measured at a distance of 1.5 meter above the floor and 1.0 meter from the compressor under free field conditions. Acoustic enclosure, if required, shall be provided to meet the above condition.
2.1.10	The compressed air velocity shall be limited to 10 m/s for pipe sizing.
2.1.11	The material of construction for the Air Compressor shall be as mentioned in attached customer specification.
2.2	ROTOR.
2.2.1	Rotors will be one-piece construction with a suitable forged carbon steel or stainless steel coated with corrosion resistant material to minimise leakage and wear.
2.2.2	The rotors will have an asymmetric profile, so as to keep leakage losses to a minimum and ensure high efficiency.
2.2.3	Highly precise timing gears will be mounted on the rotor shafts to maintain the rotors in correct relative position.
2.2.4	These gears will be designed to counteract the axial forces incurred in compression.
2.2.5	Rotors shall be dynamically balanced.
2.3	AIR DRYING PLANT.
2.3.1	Air-drying plant shall be of heat of compression desiccant type (rotary drum type or conventional twin tower type), drying by adsorption method. Capacity of each ADP shall be 44.0 Nm³/min (i.e. 1.1 times the compressor capacity).
2.3.2	Quality of outlet air from ADP shall be in accordance to Instrument Society of American Standard S7.3 "Quality Standard for Instrument Air" as follows. a) Dew point at outlet of the air drying plant will be minus (-) 40° C at atmospheric pressure. b) Dust particle size in instrument air will be less than two (2) micron.
2.3.3	Desiccant shall be activated alumina for conventional twin tower type ADP. For rotary drum type ADP silica gel impregnated inorganic fibre rotor as per manufacturer standard shall be used.
2.4	AIR RECEIVER.
2.4.1	The capacity of 06 nos. air receivers provided near to compressor house shall be 15 m³ (nominal) and for 02 nos. air receivers provided in TG hall as unit air receiver shall be 10 m³ (nominal). Capacity of 02 nos are receivers provided in DM plant shall be 2 m³ and 5m³ (nominal). Air receivers provided in for CHP and FGD areas shall be of 5 m³ (nominal) capacity.
2.4.2	The air receivers shall be vertical self-supporting cylindrical vessels with supporting legs for resting on their foundation.
2.4.3	Design Pressure & Temperature for the air receiver shall be 1.5 times compressor discharge pressure & 80° C respectively. Air receivers shall be designed as per ASME Section VIII or IS: 2825.
2.4.4	The material of construction of shell, dished ends, flanges etc. of the air receivers shall be of carbon steel as per IS: 2062 / equivalent.
2.4.5	Air receiver shall be provided with nozzles, air release vents, safety valve, pressure gauge, temperature gauge, minimum 500 mm dia. manhole for inspection.
2.5	INTAKE FILTER
2.5.1	Dry type suction air filters will be provided at the compressor inlet to prevent dust and dirt from entering the compression chambers of compressors. The filtering efficiency

	1X660 MW PANKI TPS EXTN. COMPRESSED AIR SYSTEM	BHEL Doc. No: PE-TS-426-555-A001	
		REV	01
		DATE	17.06.2019
		Section IA	

shall be 99.0 %, down to 2 microns. Sound suppressing characteristics will be considered in the filter design.

2.6 PIPING AND VALVES (WITHIN COMPRESSOR HOUSE)

2.6.1 All interconnecting compressed air piping shall conform to ASTM A-53 type E grade B / IS 1239 heavy galvanised / IS 3589 Gr 410 galvanised. All cooling water piping will be IS-3589 Gr.410/ IS-1239 Heavy grade. Oil Piping shall be API 5L. The fittings shall be conforming to relevant BIS standard and Grade equivalent that of parent pipe Grade. Compressed air piping handling hot air will be suitably insulated so as to restrict surface temperature to 60 deg. C. The compressed air pipe joints will be screwed type. Cooling water lines of 65 Nb and above shall be joined by butt welding and 50 Nb and below by socket welding.

2.6.2 Necessary auto drain shall also be provided at strategic points in compressed air line.

2.6.3 VALVES

3.6.3.1 Compressed Air service.

a) All airline valves shall be ball valve type. For compressed air application, valve body material shall be stainless steel.

3.6.3.2 Water service

a) Cooling water / drain water application valve shall be gate / globe / ball valve type. Valve material shall be Cast iron for size 65 Nb and above; gun metal / forged carbon steel for sizes 50 Nb and below.

3.6.3.3 End connections shall be screwed or flanged as required.

2.7 LAYOUT CONSIDERATION

2.7.1 Air compressors will be located indoor in a separate compressor room; compressor room layout is attached with this specification. Bidder to accommodate compressor and dryers in the space allocated in compressor room.

2.7.2 The air receivers will be located outdoors and adjacent to the compressor room.

2.7.3 Complete ADP equipment shall be preferably mounted on a skid and located indoor.

3. OPERATION & CONTROL PHILOSOPHY

3.1 The necessary instrumentation and control shall be provided for safe and trouble free operation of compressed air system.

3.2 Individual compressor control shall be through microprocessor based control system in line with requirements mentioned in attached customer specification and C&I specification.

3.3 Overall controls of the Compressors like, load, unload, field instruments shall be through main plant DDCMIS.

1X660 MW PANKI TPS

COMPRESSED AIR SYSTEM

SECTION IA

(CUSTOMER SPECIFICATION)



BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR PROJECT ENGINEERING MANAGEMENT
NOIDA-INDIA

23.0 COMPRESSED AIR SYSTEM

23.1 INTENT OF SPECIFICATION

23.1.1 This specification is intended to cover the Design, Engineering, Manufacture, Fabrication, Assembly, Inspection, Testing at Manufacturer's works, Packing, Transportation, Delivery, Receipt, Unloading, Storage and handling at site, supervision of Erection, Testing, Commissioning and Field Acceptance / Performance Guarantee test of Compressed Air System consisting of air compressors and their motor drives, receivers and air drier units with all associated accessories and auxiliaries as specified herein after and as required for safe trouble free operation and maintenance for 1x660 MW Panki Thermal Power Station, Kanpur, Uttar Pradesh.

23.1.2 Since the project is being implemented on turnkey concept of engineering, procurement and construction (EPC) with single point responsibility with the successful bidder, it not intended to specify completely herein, all details of design and construction of equipments. However, the equipment shall conform in all respects to high standards of engineering, design and workmanship and be capable of performing in continuous commercial operation up to the vendor's guarantee in a manner acceptable to the owner. The owner will interpret the meaning of drawings and specifications and shall be entitled to reject any work of material which in his judgment is not in full accordance therewith.

23.1.3 Compressed Air is mainly required in the following areas :

- a. Pulveriser coal sampling.
- b. APH soot blowing.
- c. Turbine Generator (TG) and Auxiliaries.
- d. CPU Area
- e. DM Plant & Water system area.
- f. TG & SG area cleaning and maintenance.
- g. Fuel oil pump house area
- h. LDO atomization
- i. Station C & I area
- j. CHP area
- k. AHP Area
- l. ETP area
- m. Any other area (if required) which is not covered above.

Besides, dedicated Compressed Air Systems (as described in respective Chapters) shall be provided for each of the following areas:

- (a) CHP area
- (b) AHP area
- (c) Mill Reject handling system

23.2 System Description

- 23.2.1 The compressed air system shall consist of Instrument Air compressors & their motor drives, Air Drying (ADPs) Plants. Service Air compressors & their motor drives, air receivers for each Air compressors, instrumentation and control, control panels, interconnection compressed air piping in the compressor house, instrument air piping network, service air piping network and unit instrument air receiver.
- 23.2.2 The air compressors & drives, instruments, control panels and ADP's shall be located indoor inside the compressor house and the air receivers shall be located outside the compressor house. The compressor house shall be provided with an electrically (with pendent control for long traveling, Cross travel and lifting) operated, overhead traveling type (EOT) crane as specified elsewhere in tender specification.
- 23.2.3 In addition to the air receivers mentioned above Unit air receivers for instrument air system shall be provided to cater to the requirements of SG (Steam Generator & Auxiliaries) and TG (Turbine Generator and its auxiliaries). The unit air receivers shall be located in BC bay of TG building area.
- 23.2.4 Further a dedicated air receiver shall be provided near DM plant to meet the instrument air requirement of water treatment plant.
- 23.2.5 The compressed air system comprises of Instrument Air (IA) air system and Service Air (SA) system.
- 23.2.6 The IA system shall supply required quality air to various pneumatically operated valves and instruments of SG, TG and all BOP systems and SA system shall meet the service air requirement of the proposed Unit.
- 23.2.7 The compressors shall be arranged such that all the service air compressors shall be able to supply air upstream of each ADP through an isolation valve and a non-return valve and control valve so that in event of failure of instrument air compressor, instrument air is ensured continuously from service air compressor. The valves and piping arrangement for such interconnection shall also be provided as preliminary indicated in the flow diagram enclosed with the specification.
- 23.2.8 All the piping works for IA & SA system including all accessories shall be provided.

Air from Instrument air compressors shall be dried in respective Air Drying Plants in compressor house and delivered to the Air receivers. From the Compressed air piping header at the downstream of Air receivers, one instrument air piping header for each unit of main plant and one for balance of plant shall be provided. Distribution of instrument air network shall be provided as per the tender drawing

A separate service air header shall be tapped off from the pipe header at Service Air receiver outlet and distributed as per the tender drawing

23.3 Codes & Standards

The equipment to be provided under this section shall specifically conform to the following codes, standards, specifications and regulations as applicable, including all its latest amendments subsequent to the year of publication as mentioned below:

- BS-726 : Measurement of Air Flow for Compressor
- IS-2825 : Code for unfired pressure vessels.
- IS-4503 : Shell and Tube Type Heat Exchanger
- IS-5456 : Code of Practice for testing of positive displacement type air Compressors and exhausters.
- IS-5727 : Glossary of terms relating to compressors and exhausters.
- IS-1239 Part-1 : Mild Steel tubes, tubulars and other wrought steel pipes.
- IS-1239 Part-2 : Mild steel tubes, tubulars and other wrought steel fittings.
- IS-6206 : Guide for selection, installation and maintenance of air compressors / plants with operating pressure up to 10 bars.
- ANSI-B16.5 : Steel Pipes Flanges and Fittings.
- IS-7938 : Air Receivers for Compressed Air Installations.
- IS-10431 Part-I : Measurement of Air Flow of Compressor and Exhausters by nozzles.
- ASME PTC-9 : Performance Test Codes for Displacement Compressors, Vacuum Pumps and Blowers.
- BS-5169/1975 : Fusion Welded Steel Air Receiver.
- ISO-7183 : Compressed Air Dryers - Specification and Testing.
- ISO-7183 (Part-II) : Compressed Air Dryers - Performance rating.
- IS-12258 : Technical supply condition for Screw Air Compressor.
- BS-1571 : Simplified Acceptance Test for Air Compressor and Exhausters.
- IS-2062 : Steel for General Structural Purpose- Specification.
- IS-11989 : Compressed air dryer.
-
- ISO 8753.1 : Filter quality classes.

23.4 Design Requirements & Performance Guarantee:

23.4.1 Air Compressors shall be identical and all equipments shall be designed for continuous operation with high efficiency to satisfy the performance requirements as specified in Data Sheet enclosed with this section. Frequent start/ stop of the system shall not result deterioration in performance nor damage to the equipment.

23.4.2 The compressors and Air Drying Plants shall operate under the following ambient conditions.

- a) Minimum Temperature 2 Deg C
- b) Maximum Temperature 50 Deg C
- c) Design Condition (Temp & RH) 45 Deg C & 75%

- 23.4.3 The capacity of each IA compressor and SA compressor shall be 40 NM³/min (minimum) or as computed by procedure for capacity determination of IA and SA in clause no. 23.4.10 below, whichever is higher. The discharge pressure at the outlet of after cooler shall not be less than 8.5 Kg/cm² (g).
- 23.4.4 The Compressed Air System shall ensure a reliable supply of adequate quantity and quality of oil free dry air on continuous and intermittent basis. It consists of two sub systems namely,
- i) Instrument Air (IA) for Instrumentation and Control purposes.
 - ii) Service Air (SA) for some boiler equipment, general house cleaning and other miscellaneous usage.
- 23.4.5 The normal pressure of Instrument Air supply at the outlet of Air Dryer shall be 8.0 kg/cm² (g) (minimum). Corresponding to the normal pressure at the outlet of dryer, the rated discharge pressure of IA compressor shall be worked out, allowing for pressure drops in system piping, equipment and all other accessories. The rated discharge pressure of IA compressor shall be computed as per guidelines specified above or 8.5 kg/cm² (g) (minimum) at the outlet of after cooler, whichever is higher. Each Service Air compressor shall be designed to deliver service air at a rated discharge pressure equal to the rated discharge pressure of each Instrument Air Compressor. The maximum expected pressure in the system shall be computed by considering 20% overpressure over and above the rated discharge pressure of each air compressor as computed above.
- 23.4.6 Noise level shall not exceed 85 dBA when measured at a distance of 1.0 meter from the compressor. Acoustic enclosures as required shall be provided to meet the above condition. The discharge blow-off silencer and intake silencers shall be designed to meet the above noise limitation level.
- 23.4.7 Service air compressors and instrument air compressors shall be interconnected for flexibility in operation, designed for continuous operation with high efficiency to satisfy the system requirements. The compressors shall be of indoor duty complete with air coolers necessary valves with vent pipe work ducted to a safe discharge outlet. The air pipe work shall be of ERW pipes to IS: 3589/1239 heavy quality construction.
- 23.4.8 Compressors shall be identical oil free, rotary, dry screw type, water cooled, horizontal and multistage. Each compressor shall have an inlet filter and silencer unit having inlet area large enough to ensure that frequent filter changes are not required. The silencer unit shall comply with the statutory noise requirements specified for which necessary acoustic enclosure shall be provided for housing the compressors. Drive motor shall comply with standard specification for induction motors enclosed with the specification and shall be connected directly to the gear box of the compressor.

- 23.4.9 Each air compressor shall have its own control panel with indication lights for power on; service hour-run meter; load hour-run meter; inlet air filter differential pressure high; outlet air pressure & temperature (analogue gauge); oil filter differential pressure high; separator element differential high; motor overload; low oil level; compressor temperature high; oil temperature before and after oil cooler (analog gauge). The compressor should trip on motor overload; low oil level; and compressor temperature high.
- 23.4.10 The total Instrument Air requirements shall be assessed by the following guideline :

$$Z = \{(A+B)+C+D\} \times [1 + (mw+ml)/100]$$
where,
A = Instrument Air requirement for SG & auxiliaries (continuous).
B = Instrument Air requirement (continuous) for TG & auxiliaries
C = Instrument Air requirement (continuous) for Water treatment plant and other facilities
D = Station C&I requirement (continuous).
mw = Wear & tear margin (10%)
ml = Leakage margin (10%)
Z = Total Instrument Air requirement
- The total Service Air requirement shall be assessed by considering the following guideline:

$$Y = \{(E+F)+G+H\} \times [1 + (mw+ml)/100]$$
where
Y = Total service air requirement (continuous)
E = Service Air requirement (continuous) for SG, TG & auxiliaries.
F = Service Air requirement (continuous) for Water treatment plant and other facilities. **F = 2.5 NM³/min (minimum)**
G= Service Air Requirement for AHP
H= Service Air Requirement for CHP
mw = Wear & tear margin (10%)
ml = Leakage margin (10%)
Each Service Air Compressor shall have capacity identical to that of each IA compressor but in no case less than the value Y as computed above.
- While calculating the air requirement of bidder's equipment/ plant/ systems for continuous requirement of service air, no diversity factor shall be considered and they are assumed to be of "Simultaneous Requirements". The intermittent requirement of service air, if any, shall be converted into continuous requirement by considering frequency of such requirements or selecting an appropriate diversity factor and such diversity factor shall not be less than 0.6.
- 23.4.11 Compressed air system shall comprise one (1) IA group and one (1) SA group of compressors.
- 23.4.12 Equipment operating on Instrument Air and Service Air System shall be designed for a pressure of 120% of rated discharge pressure of each air compressor.

-
- 23.4.13 The delivered compressed air shall not contain any trace of oil, grease or any other impurities. Size of particles in the delivered air shall not exceed 1 Microns.
- 23.4.14 Compressed air system equipment requiring DMCW cooling water shall be capable of operation at design capacity with DMCW cooling water inlet temperature subject to a maximum of 38°C (Indicative). The above equipment shall also be capable to withstand a pressure not less than the shut off head of each DMCW pump.
- 23.4.15 The temperature of air at outlet of after cooler shall not exceed 8°C above the cooling water inlet temperature.
- 23.4.16 As more than one (1) compressor with drive is specified, satisfactory operation in parallel shall be ensured without any uneven load sharing, undue vibration, and keeping noise level within permissible limits for the number of compressors working simultaneously.
- 23.4.17 Each Air Receiver shall be so sized that even in the event of total stoppage of air inflow to the same, the pressure in the Air Receiver shall not fall below 5.5 kg/cm² (g) within two (2) minutes of such stoppage, while maintaining an out flow of air at a rate equal to the rated capacity of a single compressor, during the aforesaid period. In no case, the size of each Air Receiver shall be less than that arrived from IS 7938.
- 23.4.18 Air receivers shall be provided for service air and instrument air separately as shown in the flow diagram.
- 23.4.19 Air receivers shall be designed in accordance with ASME Section-VIII or IS: 2825. Corrosion allowance of minimum 3 mm shall be considered for the design. The air receiver shall be of vertical cylindrical design with dished ends.
- 23.4.20 Air receivers shall be designed for minimum 1.5 times compressor discharge pressure.
- 23.4.21 The air receiver shall have inlet / outlet connections, safety relief valves, fusible plugs, pressure gauges, pressure switches, temperature gauges, flanged pipe connections, inspection manholes with automatic drain traps. The air receiver shall have access platforms for maintenance of safety relief valves and instruments.
- 23.4.22 Three (3) HOC type air drying plants shall be provided (2W +1S) and shall be designed to deliver continuous instrument air. The capacity of each air drying plant shall be provided to match the corresponding 1.10 times capacity of each Instrument air compressor. Discharge pressure available at the outlet of Air Drying Plant shall be minimum 8.00Kg/cm² (g) or more as per requirement of contractor.
- 23.4.23 The air drying plants receiving compressed air saturated with moisture shall be capable of operating continuously to provide reliable moisture free compressed air. Dew point of the outlet air measured at the stated operating pressure shall be as mentioned in Data Sheet or lower
-

- throughout the operation. For calculating moisture load, relative humidity and dry bulb temperature at ADP inlet shall be taken as 100% & 50°C respectively.
- 23.4.24 The drying process shall employ heat of compression type air drying plant using adsorption process through a desiccant medium drying to remove moisture from air. The air drying plant shall be considered to remove the moisture and dry air shall have following quality:
- (a) Dew point at atmospheric pressure (-) 40° C.
 - (b) Oil content 0.01 ppm (maximum tolerable) or oil free.
 - (c) Dust – Practically dust free but maximum particle size 1 micron. Air quality after air drying plant shall be in accordance with ISA – 57.3 (Instrument Society of America) quality standards for instrument air.
 - (d) Contaminants - No corrosive hazardous, toxic or flammable materials.
- 23.4.25 Air Driers shall be suitable for part load operation while maintaining the outlet air dew point as specified above. Necessary instruments and controls shall be provided to ensure that the specified dew point is maintained irrespective of input variations.
- 23.4.26 Air Dryers shall include at least the following:
- a) Pre-filters with condensate discharge trap stations.
 - b) After-filters with condensate discharge trap station.
 - c) Inter connecting piping, fittings, specialties, drain trap station etc. complete with isolation valves, solenoid valves, check valves, pressure relief valves etc. Including all drain piping as required.
 - d) Complete control and instrumentation including control cabling from instrument to junction boxes including junction boxes, tubing, wiring inside plant.
 - e) Terminal counter flanges with nuts, bolts, gaskets, etc.
- 23.4.27 The contractor shall assume full responsibility in the operation of the air drying plant as a whole.
- 23.4.28 For the air drying capacity and all other relevant details pertaining to Air Drying Plant, Data Sheet shall be referred to.
- 23.4.29 Compressed air piping shall be sized for minimum pressure drops and considering velocity range as specified in Chapter 34, Volume III as per IS: 6206. All pipelines shall have butt welded connections with minimum flange joints for connection to vessels and equipment. All pipelines shall be suitably supported and routed such that there shall be minimum hindrance for the operating personnel.

23.5 Scope of Supply & Works

23.5.1 The Instrument Air System shall include but not limited to the following:

- a. Three (3) (2W+1S), oil free, dry screw type, water cooled, horizontal multistage rotary screw compressors. Each IA compressor capacity shall be $40 \text{ Nm}^3/\text{min}$ (minimum) or as computed by procedure for capacity determination of IA and SA in clause no. 23.4.10 above, which ever is higher, at pressure $8.5 \text{ kg/cm}^2 \text{ (g)}$ (minimum) at the outlet of after cooler.
- b. Shell and tube type water cooled Inter cooler and After cooler with moisture separators and drain traps
- c. Suction filter along with blow off valve and silencer
- d. Three (3) (2W+1S) HOC type Air Drying Plants along with Pre-filter & After-filter in the air inlet & outlet of Air Dryer respectively to ensure dry moisture free Instrument quality air. Capacity of each drier shall be 1.10 times to capacity of each IA compressor.
- e. All instruments as required including pressure switches, temperature switches, pressure gauges, temperature gauges, mass flow meters, control panels etc.
- f. Three (3) vertical Air Receivers [of capacity $15 \text{ M}^3 \text{ (min)}$] complete with supporting structure, pressure gauges and switches, safety valves, drain traps etc.
- g. Microprocessor based control panel for individual compressor, DCS (BHEL scope) based control system for control and monitoring of the overall CAS.
- h. Minimum three (3) Unit Air Receivers, two in main plant area and one in DM plant area. Capacity of each unit air receiver in main plant area shall be shall be minimum 10 NM^3 and for DM plant area it shall be minimum 2 NM^3 .
- i. Instrument air distribution piping as required with all valves and instrumentation.

23.5.2 The Service Air System shall include but not limited to the following:

- a. Three (3) (2W+1S), oil free, dry screw type, water cooled, horizontal multistage rotary screw compressors. Each SA compressor capacity shall be $40 \text{ Nm}^3/\text{min}$ (minimum) or as computed by procedure for capacity determination of IA and SA in clause no. 23.4.10 above, which ever is higher., at pressure $8.5 \text{ kg/cm}^2 \text{ (g)}$ (minimum) at the outlet of after cooler.
- b. Shell and tube type water cooled Inter cooler and After cooler with moisture separators and drain traps
- c. Suction filter along with blow off valves and silencer
- d. All instruments as required including pressure switches, temperature switches, pressure gauges, temperature gauges, control panels
- e. Three (3) nos. vertical Air Receivers [of capacity $15 \text{ M}^3 \text{ (min)}$] complete with welded supporting stand and foundation bolt, pressure gauge and switch, safety valves, drain cock as minimum.
- f. Microprocessor based control panel for individual compressor, DCS (BHEL scope) based control system for control and monitoring of the overall CAS.
- g. Service air distribution piping as required with all valves and instrumentation.

23.5.3 Handling arrangement of air compressors shall be as detailed in Chapter-28 (Cranes & Hoists) of this volume.

23.6 Design & Construction:

The minimum requirements of design and construction features of various components of compressed air system are described below.

The motor drives shall be as per electrical specification.

23.6.1 Air Compressors

Compressors shall be multi stage oil free screw type.

Multiple compression chambers shall be designed to ensure minimum unbalance and arranged in compact manner suitable for easy accessibility and maintenance of the compressors.

The compression chamber, housing two precision made screw type rotors, for each stage shall be designed with large port for fast filling and low velocities.

The stator (casing) shall be of Cast- Iron (IS- 210 grade) construction with integral jacket cooling. Suitable arrangement for cleaning of the cooling jackets during maintenance of compressor shall be provided.

The Rotors and shaft shall be of single piece of construction made of forged steel (AISIC 1141 or equivalent) Rotors shall be dynamically balanced, design with asymmetric profile, to keep leakage losses to a minimum and ensure high efficiency.

Highly precise timing gears to maintain rotors in correct relative position shall be shaft mounted, oil lubricated and designed to counteract the axial forces incurred in compression.

Bearing shall be high precision antifriction type IS-25 Grade 84. The axial thrust load shall be minimized by dividing the axial load of compression on the main and auxiliary bearings through suitable balancing arrangement and minimum operating life of 40000 running hours.

Shaft seals of floating restrictive ring type design to prevent air and oil leakage along the shaft into the elements. The shaft seals rings and retainers shall be of stainless steel construction and be free for radial self-adjustment on the rotor shafts.

The safety valves shall be provided on low pressure and high pressure stages to safeguard low pressure & high pressure circuit. Inlet throttle valve shall be provided to throttle the incoming air during idling period. A direct shaft driven positive displacement type oil pump or a separate motor driven oil pump shall be provided. The lubrication system shall consist of lube oil reservoir, lube oil pumps, suction strainers for pumps, supply & return system, oil cooler and twin two full-flow (2 x 100%) of

filters, required instruments etc. the filters with replacement and re-pressurizing during operations.

The motor rating (at the design ambient temperature specified for the electric drive in the electrical specification) shall be sized as specified in the electrical volume.

Couplings shall be of non-lubricated flexible element spacer type and coupling guards shall be provided.

The inlet air filter & silencer shall be located at the downstream of discharge blow off valve.

The instrumentation controls and panels shall conform to the requirements specified in the control & instrumentation volume.

The intercoolers, after coolers, oil coolers shall conform to the requirements specified in subsequent clauses of this chapter.

Each compressor shall be provided with name plate, base plate, anchor bolts and shim packs, anti-vibration pads, eye bolts, operation & maintenance tools.

The material of construction of compressors shall be as per the enclosed datasheet.

23.6.2 Lubrication System

The compressor package shall include a lubricant management system which shall lubricate the bearings and seal and the compressor chamber (screw rotor housing) shall be totally separated from bearing/ gear chamber.

The lubricant pump shall be shaft driven. An auxiliary motor driven pump shall be provided, if required by the manufacturer to supply pre start and shut down system. All lube oil pumps shall be rotary positive displacement type, having stainless steel rotors and steel casing. The pump discharge system shall be protected by a relief valve.

The heat exchanger of the lube oil cooler shall be water cooled. The heat exchanger shall be located within the compressor skid.

The fouling factors shall be considered as per recommendation of TEMA.

The lube oil cooler shall be designed for a heat duty corresponding to the peak power demand of the compressors.

The cooler shall be designed in accordance with the requirement of IS 2825.

Due consideration for the differential expansion of shell and tube shall be given in the design of the coolers.

23.6.3 Gear Box

Speed increasing gears between the motor and compressor stages shall consist of a common helical gear driving pinion of each stage. Helical timing gears shall be mounted on the rotor shafts to maintain accurate relative rotor position. Gears shall have rating of AGMA-12 rating or equivalent.

23.6.4 Intercoolers, Aftercoolers & oil Coolers

Intercoolers, aftercoolers and oil coolers shall be of water cooled & shell and tube type with water on the tube side. Intercoolers & aftercoolers shall be designed in accordance with Section VIII of ASME code or equivalent.

Outlet temperature of air from intercooler shall be suitable to suit the equipment and outlet temperature of air from compressor house outlet header shall be limited to 45 Deg C. However, the instruments or the pneumatic devices requires air temperature less than 45 Deg C, the same shall be achieved at the outlet header.

Coolers shall be provided with removable tube bundle design in accordance with design code TEMA Class C and shall be constructed with removable shell cover.

The coolers shall be constructed and arranged to allow removal of tube bundles without dismantling piping or compressor components.

Oil coolers shall be equipped with vent & drain connections on oil and water sides. Oil temperature control valve with manual override feature or bypass construction shall be provided to maintain constant temperature. Vent & drain connections for intercoolers and after coolers shall be provided.

Design pressure shall be 8 kg/cm²(g) based on shut off head of DMCW pumps.

The coolers shall be designed for maximum heat load and at least 10% design margin shall be provided in the number of tubes.

Adequately sized safety valves shall be provided for both intercoolers and after coolers.

Each intercooler and after cooler shall be provided with moisture separator units with suitable baffling. Moisture separator units shall be equipped with a level gauge with isolating cock.

Electrically operated automatic drain trap stations with bypass and isolating valves shall be provided for moisture separators for automatically draining of condensed moisture. The drain trap may be of full bore ball valve operated by capacitance type level switch. Manual draining facility shall also be provided in the drain trap.

Cooler shells, channels and covers shall be of steel (SA 285 Gr or Equivalent). Tube sheet shall be of Brass or SS and the tubes shall be of admiralty brass or Aluminium brass or Copper or SS 304.

23.6.5 Air Receivers

There shall be one air receiver for each compressor near compressor house, one instrument air receiver for DM Plant (min. 2 cum) and two unit instrument air receiver near main plant (min 10 cum capacity, each).

Capacity of each of the air receivers in the compressor house shall be of minimum 15 cum (nominal). The capacity of the unit instrument air receiver near main plant shall be min 10NM³ or to suit emergency storage requirement, whichever is higher.

Receivers other than unit air receivers shall be outdoor located and vertical cylindrical vessels with dished ends.

The design pressure and temperature shall be minimum 10 kg/cm²(g) and 50 Deg C respectively. Receivers shall be designed in accordance with Section VIII, Division 1 of ASME code or equivalent.

Air receivers are to be provided with gasketed inspection manhole of minimum 500 mm diameter with cover plate, lifting handle, davit cap etc. Opening shall not pierce any seam & shall be as far as possible away from any welded seam.

Receivers shall be of welded construction with minimum number of joints. Longitudinal seam in adjacent sections shall not be in same line. Welding shall be as per relevant codes. Filler material to have composition and structure as that of the material welded. Welding electrodes shall be approved by owner. Electrodes to be dried before use.

Relief valves shall be provided to suit compressor capacity and set pressure of the same shall be at least 10% above working pressure. The spring in relief valve shall not reset for any pressure more than 10% above or below the design set pressure.

Each air receiver shall be provided with drain connection with electrically operated automatic drain trap arrangement with isolation and bypass valve.

The material of construction of shell, dished ends, flanges etc. of the air receivers shall be of carbon steel as per IS 2062 or equivalent.

23.6.6 Intake Air Filter & Silencer

Filters with multiple elements and quick removal type for easy cleaning to be provided at suction of each air compressor and shall also be of heavy duty dry type.

The filters shall be complete with integral silencers. Separate silencers, if specified shall be provided and all other accessories. The filtering elements shall be easily removable for cleaning or for replacement.

The filters shall be designed for an efficiency of not less than 99% for particles 2 microns and larger.

The silencer shall be of very high efficiency type to adequately dampen the operating noise as per the requirement.

Pulsation dampener of approved design shall be provided on the compressor suction and discharge manifold.

23.6.7 Air Drying Plants

One number air drying plant shall be provided for each instrument air compressor. Three (3) HOC type air drying plants shall be provided (two working and one standby) for instrument air. The capacity of each air drying plant shall be 1.10 times of the Instrument air compressors.

23.6.7.1 Codes And Standards

The design, manufacture, testing and performance of the various components of Air Drying Plant shall comply with at least the requirements of one or more of the following codes, as applicable:

i)	IS-11989	:	Specification for Air Dryers.
ii)	IS-2825	:	Code for Unfired Pressure Vessels.
iii)	IS-11327	:	HOC type units.
iv)	ISO 8753.1	:	Filter quality classes.

23.6.7.2 Technical requirements

The capacity of air drying plant shall be equal to the 1.10 times capacity of the individual air compressors. The Air drying plant, at its rated capacity, shall be designed to deliver continuously air at dew point of minus (-) 40 deg C at atmospheric pressure and the Quality of dry outlet air to conform to Instrument Society of American Standard S7.3"Quality Standard for Instrument Air".

Discharge pressure available at the outlet of Air drying Plant shall be minimum 8.0 Kg/cm² (g) or more as per the requirement of Contractor

The compressors and Air Drying plants shall operate under the following ambient conditions.

(i)	Minimum temperature	2 deg.C
(ii)	Maximum temperature	50 deg. C

(iii) Design condition (temperature & Relative humidity)	45 deg.C& 75% RH
(iv) Height above MSL (m) information	As given in Plant

One number Air drying plant shall be provided for each Instrument air compressor.

Drying shall be by adsorption process through a desiccant medium.

Air Drying (ADP) Plant shall be of "Heat of Compression (HOC) type".

Regeneration of desiccant shall be achieved by "Heat of compression" method without any air purge loss.

Hot unsaturated compressed air shall be used for regeneration of exhausted desiccant in "Heat of compression type ADP".

Each ADP shall be provided with two adsorber towers each sized for design drying cycle of minimum 8 hours. After this period the adsorber tower which was under drying mode shall be put under regeneration/reactivation mode while the other tower will take over the drying duty. The change of drying mode to reactivation mode or vice-versa shall be automatic with provision for manual operation also. The change over from one mode to another shall be through automatic solenoid operated valves.

In case of HOC type drier, the reactivation shall be achieved by the heat of the compressed air itself. The hot unsaturated compressed air from the outlet of last stage of compressor shall be passed through the adsorber tower. The moist air shall be cooled in dehumidifier and passed through the second adsorber for final drying. The design reactivation cycle/period of the tower shall be less than 8 hours including cooling period for desiccant for both the types of ADP.

Each ADP shall be provided with 2 numbers of 100 percent capacity pre-filters and 2 numbers of 100 percent capacity after-filters at the upstream & downstream of towers. The filtering media shall be of ceramic candle type elements designed to withstand at least 50% of static pressure as differential pressure. The pre-filters shall be provided with automatic electrically operated drain trap arrangement with isolation and bypass valves.

The adsorber tower shall be designed with sufficient cross sectional area resulting low air velocity and pressure drop. Minimum 20% of desiccant depth shall be provided as free board in adsorber vessels. Adsorber vessels to be provided with suitable number of inspection/sightwindows of "Persplex" for observation of adsorbent condition. Desiccant filling and removal connections shall be provided for the adsorber vessels.

The coolers/heat exchangers/ dehumidifiers of ADP shall be designed & constructed as per the requirements specified for "Intercoolers, after coolers & Oil coolers" above.

Required sample connections to piping be provided for sampling of air at desired locations.

Non lubricated two way/ three way/ four way ball valves with pneumatic actuators be provided.

All pressure vessels such as pre-filters, after-filters, adsorber vessels, heaters, heat exchangers/de-humidifiers/coolers etc associated with ADP shall be designed in accordance with Section VIII, Division 1, of ASME Code or equivalent. The pressure vessels shall be provided with air tight gasketed manholes/handholes and relief valves

Quantity of desiccant to be calculated shall take into account residual moisture content at the end of regeneration cycle.

Adsorption capacity and density to be considered for silica gel shall not be more than 10% and 550 kg/m³ respectively. In case of activated alumina the same shall be 8% (max) and 900 kg/m³ (max) respectively.

In case of Heat of compression type, adsorbers shall be sized so that even when the compressor is operating at part load, complete regeneration shall be achieved within the cycle time and quality of air (dew point) shall be maintained throughout the design cycle period.

Complete ADP equipment's shall preferably be mounted on a skid.

Required sample connections in piping are provided for sampling of air at desired locations.

Non-lubricated two way / three way/ four way valves ball valves with pneumatic actuators be provided.

The material of Construction for various components of ADP shall be as follows:-

(a)	Adsorber vessel	Carbon steel
(b)	All internals of adsorber vessels	SS 304
(c)	Cooler shells, channels and covers Cooler Tube sheet & tubes	Same as that in intercoolers/after coolers
(d)	Relief valves	Brass or SS
(e)	Desiccant	Silica gel or Activated Alumina
(f)	Air piping	Galvanized steel
(g)	Valves in Air Line	CI or Cast steel or Forged steel body with stainless steel trim
(j)	Valves in water pipe lines	SS/Bronze/Gunmetal

HOC dryers of single rotating drum type design using packed dessicant with in – built regeneration and adsorption compartments are also acceptable in place of specified twin-tower type dryers, if the design ensures specified performance guarantee. In case, the Contractor offers such a type, the same shall be of proven design. The control & instrumentation requirements specified are applicable for such design also.

23.6.8 Interconnecting Piping, Fittings and Valves

The interconnecting piping & valves within compressor house for compressed air & cooling water etc. shall be designed in line with layout requirements indicated in Chapter33: Layout Requirement of Volume III.

23.6.9 Moisture Separator

Moisture separator shall be of high efficiency design and provided with vent nozzle and auto drain trap system.

23.6.10 Solenoid Valves & Multiway Valves

The solenoid valve shall be of approved make. The solenoid valves shall have heavy duty, double impregnated tropicalised coils (single or double solenoid as required) and shall be suitable for the operating temperature and for operation continuously energised in a tropical climate.

The solenoid valves shall be of bronze body with stainless steel trim. The coil shall be of continuous duty and of epoxy moulded type, Class F. The enclosure shall be water tight, dust tight weather proof and shall conform to NEMA 4X standard. The valves shall be suitable for mounting in any position. Solenoid coils shall be Class H high temperature construction and shall be suitable for continuous operation. Type of operation and electrical ratings shall be subject to owner's approval.

23.6.11 VOID

23.7.0 Control Philosophy

23.7.1 General

The minimum requirements are specified herein and the same shall be elaborated by the bidder. The bidder shall include controls & instrumentation to facilitate safe, reliable and efficient operation of the system. The controls, protection, interlock and instrumentation system offered by the bidder shall be subjected to approval of the owner during post award engineering stage. For details of Control & Instrumentations, refer to C&I specification

Any of the compressor and air drying plant may be selectable for "shutdown", "working" or "standby" duty.

On tripping of working equipment the standby equipment shall come into operation automatically in case of very low air pressure in the system.

All abnormal conditions used for tripping the compressor or any other equipment shall be provided with pre-trip audio visual indication/annunciation in the control panel.

An electrically operated automatic valve shall be provided on cooling water supply line of each compressor & dryer (if applicable) which will automatically shut off the cooling water supply in case any of the compressor/ dryer is not running for more than the set time duration. Suitable interlock shall also be provided for opening the valve before starting of any of the compressor.

The following indications shall be made available in the control panels for repeating the same in main plant control system/ panels.

- a. Status of each compressor
- b. Instrument air pressure low/ high
- c. Service air pressure low/ high
- d. Dew point of instrument air
- e. Status of each ADP

Lube oil pressure and temperature on the oil circuit of compressor shall be automatically controlled.

Unless otherwise mentioned in the relevant electrical volume, automatic motor overload control system shall be included to permit continuous operation of compressors at minimum ambient air without exceeding the name plate rating of the motor.

23.7.2 Screw Compressors

- 23.7.2.1 Each compressor shall be in the control panel to operate either in base duty (Auto Load/ unload) or Standby duty (Auto On – Off) mode.
- 23.7.2.2 In “Base duty”, whenever air supply from compressors exceeds the demand, control system shall operate the load-unload circuit at a predetermined set pressure, throttle the inlet valve and open the blow off valve. The compressor shall run in unload condition. When system pressure drops due to more demand, the load – unload circuit shall operate again to bring the compressor to 100% load after closing the blow off valve.
- 23.7.2.3 In “Standby” mode the compressor shall automatically assist base load compressors during periods of peak air demand. When air pressure in the system reaches a preset lower limit, the compressor shall be started in unloaded condition and the compressor shall be fully loaded. When the pressure in the system rises to preset high value, the compressor shall be unloaded and shall run in idling mode for a specific period (set by timer). The compressor may be loaded to full load in case of drop in system pressure or compressor may be stopped in case the system pressure does not drop and compressor continues to idle for more than a preset time.

23.7.2.4 The control system shall provide warning to the operator that a hot start condition exists for the motor driver and adequate cool down period has not occurred after the motor was shut down.

23.7.2.5 The alarms and shutdown scheme mentioned below are suggestive and shall be provided as per manufacturer's standard practice meeting the safe operational requirement of the equipment/ system of each compressor :

- a. "Air temperature high" at inlet stage - Alarm & trip
- b. Low Lube Oil Pressure - Alarm & trip
- c. High Lube Oil Supply temperature - Alarm & trip
- d. High Oil filter differential pressure - Alarm & trip
- e. Low Lube oil level in lube oil sump - Alarm & trip
- f. High inlet air filter differential pressure - Alarm & trip
- g. Low cooling water flow to air compressors - Alarm & trip

23.7.3 Air Drying Plant

23.7.3.1 The control system shall provide the (as minimum) alarms, "High Reactivation air temperature", "Low Reactivation air Temperature", "Low Cooling Water Flow", "Low Air pressure at the outlet of ADP" and " High dew point at the outlet of ADP". Adequate number of temperature elements etc. shall be provided for measurement and monitoring the same.

DATA SHEET-A

SCREW TYPE AIR COMPRESSOR AND AUXILIARIES

SR. NO.	ITEM		DETAIL
1.0	PERFORMANCE DATA		
1.1	Free Air Delivery	:	Bidder to compute and indicate as per guidelines specified in this section.
1.2	Capacity	:	40 Nm ³ /min (minimum), 8.5 Kg/cm ²
1.3	Noise level near compressors	:	Noise level shall not exceed 85 dBA when measured at a distance of 1.0 meter from the compressor. Acoustic enclosures as required shall be provided to meet the above condition.
1.4	Vibration limit (measured at top and bottom of main bearing)	:	40 microns
1.5	Guaranteed Power consumption at motor input terminals at rated condition	:	Bidder to indicate
2.0	CONSTRUCTION FEATURES		
2.1	Location	:	Indoor
2.2	Number of compressors	:	Three (3) IA compressors (2W+1S) and Three (3) SA compressors (2W+1S) connected on a common discharge manifold
2.3	Type	:	Oil-free, dry screw type, water cooled, horizontal, two (2) stage, rotary screw compressors
2.4	Service	:	Instrument Air and Service Air
2.5	Duty	:	Continuous
2.6	Type of Drive	:	Electric Motor
2.7	Design ambient temperature for drive	:	50°C
2.8	Number of starts per hour	:	8 (equally spreaded)
2.9	Type of transmission	:	Gear
2.10	Ant vibration arrangement required	:	Yes

SR. NO.	ITEM		DETAIL
2.11	Maximum temperature for any step during the cycle	:	Bidder to indicate
2.12	Type of control	:	Dual i.e. both load-unload and auto start/ stop
2.13	Type of Annunciation	:	Audio-visual
2.14	Flange standard	:	ANSI B-16.5/equivalent
3.0	MATERIALS OF CONSTRUCTION		
3.1	Compressor chamber	:	Cast iron coated with corrosion resistant material
3.2	Rotors	:	Forged carbon steel coated with corrosion resistant material, 2 nd stage Stainless steel
3.3	Bearing	:	Oil lubricated Antifriction type suitable for at least 40,000 running hours.
3.4	Timing Gear	:	Low alloy steel
3.5	Base Plate	:	MS
3.6	Inlet throttle valve & housing	:	Aluminium / Stainless steel
3.7	Shaft seals	:	Stainless Steel
3.8	Safety valves	:	Brass
3.9	Water separator	:	Cast Iron
3.10	Blow off valve	:	Stainless Steel
3.11	Unloading Cylinder header	:	Aluminium
3.12	Tube of oil cooler	:	Stainless Steel type SS-304
3.13	Outer casing of coolers	:	Carbon Steel / SG Iron
3.14	Non Return Valve (NRV)		Stainless steel spring loaded type.
3.15	Gear Box	:	Cast Iron GGG 40 (DIN 1693) /SG Iron
3.16	Gears	:	Alloy Steel
4.0	SUPPLY OF ACCESSORIES & SERVICES		
4.1	Intake air filters with silencers	:	Yes

SR. NO.	ITEM		DETAIL
4.2	Intercoolers	:	Yes
4.3	After coolers with moisture separators	:	Yes
4.4	All instruments as specified, as shown in tender drawing and as required for safe and trouble- free operation of the system	:	Yes
4.5	Coupling guards	:	Yes
4.6	Air receivers	:	Yes
4.7	Foundation bolts, nuts, sleeves, inserts etc.	:	Yes
4.8	All interconnecting air and cooling water piping, complete with valves, fittings as shown in relevant tender drawings and as required for reliable and smooth operation of the system	:	Yes
4.9	Eye bolts, lifting tackle, tools, etc.	:	Yes
4.10	Control panels complete with all accessories	:	Yes
4.11	Instrument gauge panels complete with all accessories	:	Yes
5.0	DM COOLING WATER DATA		
5.1	Quality	:	DM Water
5.2	Design inlet temperature	:	38°C (maximum
5.3	Design pressure	:	Bidder to indicate. Shall not be less than the shut off head of DMCW pump.
5.4	Normal inlet pressure	:	Bidder to indicate. Shall be equal to the rated TDH of DMCW pump
5.5	pH value	:	8.5 to 9.5
5.6	Maximum pressure drop allowable between inlet and outlet points	:	6.0 to 8.0 MWC
6.0	TESTING AND INSPECTION		
6.1	Material Testing and identification	:	Required
6.2	Dye Penetration test	:	Yes

SR. NO.	ITEM		DETAIL
6.3	Type of performance test to be conducted	:	Routine test/Type test as per relevant clause
6.4	Bend Test as per BS 5169	:	Yes
6.5	Field performance test	:	Yes
6.6	Shop performance test	:	Yes
6.7	MPI and UT tests	:	Yes
6.8	Spot Radiography for all circumferential and longitudinal butt joints	:	Yes
6.9	All other specific tests as specified in relevant Clause of this section		Yes
7.0	DRIVE MOTOR		
7.1	Electric motor	:	Drive motor for compressor shall comply with the requirements of relevant Clause of this section and concerned electrical volume of this Specification.
8.0	COMPRESSOR ACCESSORIES		
8.1	INTAKE AIR FILTER	:	
8.1.1	Numbers required	:	One (1) with each compressor
8.1.2	Location	:	Indoor, at the suction of each air compressor
8.1.3	Type	:	Dry type
8.1.4	Silencer	:	Yes
8.1.5	Air flow rate	:	To suit compressor rating
8.1.6	Particle removing efficiency	:	99.9% up to particle size of 2 Micron
8.1.7	Maximum allowable pressure drop at stated air flow rate in new condition of filter (viscosity of air at normal ambient temperature)	:	150 mm WG
8.1.8	Test requirement	:	No separate test. Compressor performance testing shall include the filters in test set up. Capacity, pressure drop and efficiency shall be measured.

SR. NO.	ITEM		DETAIL
8.2	AIR RECEIVER		
8.2.1	Numbers required	:	One (1) for each IA compressor + (1) for each SA compressor at the Compressor Outlet. Further, dedicated receivers at specified locations as per Flow diagram shall also be provided.
8.2.2	Installation	:	Outdoor
8.2.3	Type	:	Vertical cylindrical with torispherical dished ends.
8.2.4	Design pressure / Temperature	:	Minimum 1.5 times compressor discharge pressure (or 12.75 kg/cm ² (g) minimum) / 80° C (minimum)
8.2.5	Hydraulic test Pressure	:	150 % design pressure.
8.2.6	Design code	:	ASME Sec-VIII or IS-2825/IS-7938/ Approved equal
8.2.7	Capacity of each air receiver	:	Bidder to compute. However, the water filled volume shall not be less than 15 m ³ under any circumstances for receivers at Compressor Outlet
8.2.8	Material of construction of shell	:	MS to IS-2062
8.2.9	Material of construction of dished ends	:	MS to IS-2062
8.2.10	Material of construction of flanges	:	MS to IS-2062
8.2.11	Corrosion allowance		3.0 mm (minimum)
8.2.12	Supply of Accessories & Services	:	
8.2.12.1	Flanges with nuts, bolts and gaskets	:	Yes
8.2.12.2	Pressure gauge with snubber	:	Yes
8.2.12.3	Pressure Transmitter	:	Yes
8.2.12.4	Temperature gauge	:	Yes
8.2.12.5	Relief valve	:	Yes, set pressure shall be at least 10% above working pressure
8.2.12.6	Trap station	:	Yes
8.2.12.7	Level gauge	:	NA
8.2.12.8	Vent valve/plug	:	Yes

SR. NO.	ITEM		DETAIL
8.2.12.9	Level Transmitter	:	NA
8.2.12.10	Supporting stand with necessary foundation bolts, nuts, sleeves etc	:	Yes
8.2.12.11	Eye bolts, lifting tackle etc.	:	Yes
8.2.12.12	Automatic Drain Trap		Yes
8.2.12.13	Painting	:	
A	External	:	Two coats of epoxy Primer and two finish coats of epoxy paints.
B	Internal	:	Cleaned and one coat of black bituminous paint applied.
8.2.12.14	Inspection and Testing		
A	Material testing and identification	:	Yes
B	Bend test as per BS-5169	:	Yes
C	Spot radiography of circumferential and longitudinal butt welds	:	Yes
D	Field performance test	:	Yes
E	D.P. test where radiography cannot be done	:	Yes
F	Hydraulic Test	:	Yes
G	Other specific tests as specified in relevant Clause of this specification	:	Yes
8.3	INTERCOOLER, AFTERCOOLER, MOISTURE SEPARATOR, PIPING, VALVES ETC:		
8.3.1	After cooler :		
A	Installation	:	Indoor
B	Type	:	Shell and Tube
C	Relief Valve	:	Yes
D	Moisture Separator	:	Yes
E	Trap Station	:	Yes
F	Temperature Indicator	:	Yes

SR. NO.	ITEM		DETAIL
G	Temperature Switch	:	Yes
H	Temperature Transmitter	:	Yes
I	Level Gauge	:	Yes
8.3.2	Intercooler :		
A	Installation	:	Indoor
B	Type	:	Shell and Tube
C	Relief Valve	:	Yes
D	Trap Station	:	Yes
E	Pressure Gauge	:	Yes
F	Temperature Indicator	:	Yes
G	Temperature Switch	:	Yes
H	Temperature Transmitter	:	Yes
I	Moisture Separator	:	Yes
8.3.3	Supply of Accessories and Services	:	
A	Supporting stands with bolts, nuts and gaskets	:	Yes
B	Eye bolts, lifting tackle etc with tools and tackle	:	Yes
C	Flanged connections for supply and return of cooling water	:	Yes
8.3.4	Material of Construction :		
A	Tube	:	Stainless steel within star profile
B	Shell	:	Mild Steel
C	Tube Sheet	:	IS 2002 Gr 2
D	Baffles	:	IS 2062
E	Flanges	:	IS 2062
8.3.5	Cooling Water Data	:	Same as mentioned earlier

SR. NO.	ITEM		DETAIL
8.3.6	Piping, Valves and Fittings for Compressed Air System :		
A	Pipes for cooling water line	:	IS-1239 (Heavy grade) upto 150 NB. IS-3589 for sizes above 150 NB with minimum pipe thickness of 6 mm.
B	Pipes for compressed air line & interconnecting air line	:	ASTM A-53 type E Gr. B galvanized /IS 1239 heavy galvanized/IS 3589 Gr 410 Galvanized to IS-4736 or equivalent.
8.3.7	Fittings		
A	Fittings for cooling water line	:	ASTM A-234 Gr. WPB for sizing including 65 NB and above. And ASTM A105 for sizes up to 50 NB
B	Fittings for compressed air piping & interconnecting air piping	:	IS-1239 Part-2 galvanized to IS-4736 or equivalent. /ANSI B16.5 galvanized to IS-4736 or equivalent.
C	Valves for air line	:	Stainless Steel
D	Testing and inspection	:	As per relevant clause of this section.
E	Valves for cooling water line	:	As per respective volume in LP Piping

DATA SHEET-B

AIR DRYING PLANT AND AUXILIARIES

<u>SR. NO.</u>	<u>ITEM</u>		
1.0	<u>GENERAL INFORMATION</u>		
1.1	Numbers of Air drying Plant	:	Three (3) (2W + 1S) One (1) for each IA compressor
1.2	Duty	:	Continuous
1.3	Operation	:	Fully Automatic
1.4	Service	:	Instrument Air
1.5	Installation	:	Indoor
1.6	Type	:	HOC
1.7	Outlet dew point	:	At least (-) 40 °Cat atmospheric pressure
1.8	Annunciation	:	Local and remote
1.9	Location	:	Indoor skid mounted
2.0	<u>MATERIAL OF CONSTRUCTION</u>		
2.1	Adsorber vessel		Carbon steel
2.2	All internals of adsorber vessels		SS 304
2.3	Cooler shells, channels and covers Cooler Tube sheet & tubes		Same as that in intercoolers/after coolers
2.4	Relief valves		Brass or SS
2.5	Desiccant		Silica gel or Activated Alumuna
2.6	Air piping		Galvanized steel
2.7	Valves in Air Line		CI or Cast steel or Forged steel body with stainless steel trim
2.8	Valves in water pipilines		SS/Bronze/Gunmetal
3.0	<u>PERFORMANCE SPECIFICATION</u>		
3.1	Air drying capacity	:	1.10 times the instrument air compressor capacity

<u>SR. NO.</u>	<u>ITEM</u>		
3.2	Inlet air pressure	:	To suit compressor rating
3.3	Air flow (Free Air delivery)	:	To suit compressor rating
3.4	Inlet air temperature	:	Refer met data in Volume II, However, shall be suitable to handle air inlet temperature of 60 °C.
3.5	Maximum allowable air pressure drop	:	0.5 kg/cm ²
3.6	Design Requirement	:	(-) 40 °C dew point at outlet (at atmospheric pressure). Dust laden, not more than 0.1 ppm, oil free
4.0	<u>SUPPLY OF ACCEESSORIES AND SERVICES FOR EACH ADP</u>		
4.1	Pre-filters and After Filters	:	2 x 100% with automatic drain trap filter arrangement & with ceramic candle type
4.2	Dew point indicator on line	:	Yes
4.3	Instruments as per specification, Tender drawing and as required for safe and trouble free operation	:	Yes
4.4	Control panel with accessories	:	Yes
4.5	Tools and tackle	:	Yes
4.6	Spare parts	:	Yes
4.7	All interconnecting piping complete with fittings, valves etc.	:	Yes
4.8	Insulation	:	Yes
4.9	Base frame, foundation bolts, nuts, sleeves etc.	:	Yes
4.10	Vessel internal paint	:	Anti-corrosive
4.11	<u>SHOP PAINTING</u>		
4.11.1	Internal	:	Anti-corrosive heat resistant paint. Epoxy based
4.11.2	External	:	2 coats of epoxy primer
5.0	<u>INSPECTION AND TESTING</u>		
5.1	Non-destructive material test	:	Yes
5.2	Hydrostatic test	:	Yes

<u>SR. NO.</u>	<u>ITEM</u>		
5.3	Performance tests at shop	:	Yes
5.4	Performance tests at site	:	Yes
5.5	Spot Radiography of welds parts to be tested	:	All pressure parts and vessels
5.6	Dye Penetration test	:	Yes
6.0	POWER SUPPLY	:	415 V / 3 phase (3 wire) / 50 Hz $\pm$ 5 %
6.1	Variation in supply voltage	:	$\pm$ 10%
7.0	Air flow variations	:	0 to 100%
8.0	Condensate removal	:	Automatic without air loss
9.0	Maximum operating air pressure	:	16 bar (g)
10.0	Auto drain trap	:	No air loss type

1X660 MW PANKI TPS

COMPRESSED AIR SYSTEM

SECTION IA

(GENERAL TECHNICAL REQUIREMENT INCLUDING LP PIPING)



BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR PROJECT ENGINEERING MANAGEMENT
NOIDA-INDIA

CHAPTER 5 : GENERAL TECHNICAL REQUIREMENTS**1.0 INTRODUCTION**

This part covers technical requirements, which will form an integral part of the Contract. The following provisions shall supplement all the detailed technical requirements brought out in the Technical Specifications and the Technical Data Sheets.

2.0 BRAND NAME

Whenever a material or article is specified or described by the name of a particular brand, manufacturer or vendor, the specific item mentioned shall be understood to be indicative of the function and quality desired, and not restrictive; other manufacturer's products may be considered provided sufficient information is furnished to enable the Owner to determine that the products proposed are equivalent or superior to those named.

3.0 BASE OFFER & ALTERNATE PROPOSALS

The Bidder's proposal shall be based upon the use of equipment and material complying fully with the requirements specified herein. It is recognized that the Bidder may have standardized on the use of certain components, materials, processes or procedures different than those specified herein. Alternate proposals offering similar equipment based on the manufacturer's standard practice may also be considered, provided the base offer is in line with technical specifications and such proposals meet the specified design standards and performance requirement and are acceptable to the Owner. Sufficient amount of information for justifying such proposals shall be furnished to Owner along with the bid to enable the Owner to determine the acceptability of these proposals.

4.0 COMPLETENESS OF FACILITIES

- 4.1 Bidders may note that this is a contract inclusive of the scope as indicated elsewhere in the specification. Plant shall be engineered and designed in accordance with the specification requirement. All engineering and associated services are required to ensure that a completely engineered plant is provided.
- 4.2 All equipments furnished by the Bidder shall be complete in every respect, with all mountings, fittings, fixtures and standard accessories normally provided with such equipment and/or those needed for erection, completion and safe operation & maintenance of the equipment and for the safety of the operating personnel, as required by applicable codes, though they may not have been specifically detailed in the respective specifications, unless included in the list of exclusions.
- 4.3 All similar standard components/ parts of similar standard equipment provided shall be interchangeable with one another.

5.0 Codes & Standards

- 5.1 In addition to the codes and standards specifically mentioned in the relevant technical specifications for the equipment / plant / system, all equipment parts, systems and works covered under this specification shall comply with all currently applicable statutory regulations and safety codes of the Republic of India as well as of the locality where they will be installed, including the following:



- (a.) Bureau of Indian Standards (BIS)
- (b.) Indian Electricity Act (2003)
- (c.) Indian Electricity Rules
- (d.) Indian Explosives Act
- (e.) Indian Factories Act and State Factories Act
- (f.) Indian Boiler Regulations (IBR)
- (g.) Regulation of Central Electricity Authority
- (h.) Regulations of the Central Pollution Control Board, India
- (i.) Regulations of the Ministry of Environment & Forest (MoEF), Government of India
- (j.) Pollution Control Regulations by Department of Environment, Government of India
- (k.) State Pollution Control Board.
- (l.) Building and other construction workers (Regulation of Employment and Conditions of services) Central Rules, 1998
- (m.) Explosive Rules, 1983
- (n.) Petroleum Rules, 1976,
- (o.) Gas Cylinder Rules, 1981
- (p.) Static and Mobile Pressure Vessels (Unified) Rules, 1981
- (q.) Workmen's Compensation Rules, 1924
- (r.) Rules for Electrical installation by Tariff Advisory Committee (TAC) and appropriate Electrical Inspectorate.
- (s.) Owner's Safety Policy
- (t.) Any other statutory codes / standards / regulations, as may be applicable.

5.2 Unless covered otherwise by Indian codes & standards and in case nothing to the contrary is specifically mentioned elsewhere in the specifications, the latest editions (as applicable as on date of bid opening), of the codes and standards given below shall also apply:

- (a.) British Standards (BS)
- (b.) Japanese Industrial Standards (JIS)
- (c.) American National Standards Institute (ANSI)
- (d.) American Society of Testing and Materials (ASTM)
- (e.) American Society of Mechanical Engineers (ASME)
- (f.) American Petroleum Institute (API)
- (g.) Standards of the Hydraulic Institute, U.S.A.
- (h.) International Organisation for Standardization (ISO)
- (i.) Tubular Exchanger Manufacturer's Association (TEMA)
- (j.) American Welding Society (AWS)
- (k.) Cooling Tower Institute (CTI)
- (l.) National Electrical Manufacturers Association (NEMA)
- (m.) National Fire Protection Association (NFPA)
- (n.) International Electro-Technical Commission (IEC)
- (o.) Expansion Joint Manufacturers Association (EJMA)
- (p.) Heat Exchange Institute (HEI)
- (q.) IEEE standard
- (r.) JEC standard

5.3 Other International/ National standards such as DIN, VDI, BS, etc. shall also be accepted for only material codes and manufacturing standards, subject to the Owner's approval, for which the Bidder shall furnish, along with the offer, adequate information to justify that these standards are equivalent or superior to the standards mentioned above. In all such cases the Bidder shall furnish



specifically the variations and deviations from the standards mentioned elsewhere in the specification together with the complete word to word translation of the standard that is normally not published in English.

- 5.4 As regards highly standardized equipments such as Steam Turbine and Generator, National /International standards such as JIS, DIN, VDI, ISO, SEL, SEW, VDE, IEC & VGB shall also be considered as far as applicable for Design, Manufacturing and Testing of the respective equipment. In addition, these standards shall be referred for the design of machine foundations, wherever specifically mentioned in the specifications. However, for those of the above equipment not covered by these National / International standards, established and proven standards of manufacturers shall also be considered.
- 5.5 In the event of any conflict between the codes and standards referred to in the above clauses and the requirement of this specification, the requirement of Technical Specification shall govern.
- 5.6 Two (2) English language copies of all-national and international codes and/or standards used in the design of the plant, equipment, civil and structural works shall be provided by the Bidder to the Owner within two calendar months from the date of the Notification of Award.
- 5.7 In case of any change in codes, standards & regulations between the date of bid opening and the date when vendors proceed with fabrication, the Owner shall have the option to incorporate the changed requirements or to retain the original standard. It shall be the responsibility of the Bidder to bring to the notice of the Owner such changes and advise Owner of the resulting effect.

6.0 EQUIPMENT FUNCTIONAL GUARANTEE

- 6.1 The Equipment and Auxiliaries shall be capable of continuous operation in frequency range of 47.5 to 51.5 Hz.
- 6.2 The functional guarantees of the equipment under the scope of the Contract shall be as per "Chapter 8 - Functional Guarantee & LD", Volume-II. These guarantees shall supplement the general functional guarantee provisions covered under General Conditions of Contract.
- 6.3 Liquidated damages for shortfall in meeting functional guarantee(s) during the performance and guarantee tests shall be assessed and recovered from the Bidder as specified elsewhere in this specification.

7.0 DESIGN OF FACILITIES / MAINTENANCE & AVAILABILITY CONSIDERATIONS

7.1 Design of Facilities

- 7.1.1 All the design procedures, systems and components proposed shall have already been adequately developed and shall have demonstrated good reliability under similar conditions elsewhere.
- 7.1.2 The Bidder shall be responsible for the selection and design of appropriate equipments to provide the best co-ordinate performance of the entire system. The basic requirements are detailed out in various clauses of the Technical Specifications. The design of various components, assemblies and subassemblies shall be done so that it facilitates easy field assembly and dismantling. All the



rotating components shall be so selected that the natural frequency of the complete unit is not critical or close to the operating range of the unit.

7.2 Maintenance and Availability Considerations

- 7.2.1 Equipment/facilities offered shall be designed for high availability, low maintenance and ease of maintenance. The Bidder shall specifically state the design features incorporated to achieve high degree of reliability/ availability and ease of maintenance. The Bidder shall also furnish details of availability records in the reference plants stated in his experience list.
- 7.2.2 Bidder shall state in his offer the various maintenance intervals, spare parts and man-hour requirement during such operation. The intervals for each type of maintenance namely inspection of the furnace, inspection of the entire hot gas path and the minor and major overhauls shall be specified in terms of fired hours, clearly defining the spare parts and man-hour requirement for each stage.
- 7.2.3 Lifting devices i.e. hoists and chain pulley jacks, etc. shall be provided by the Bidder for handling of any equipment or any of its part having weight in excess of 500 Kgs during erection and maintenance activities.
- 7.2.4 Lifting devices like lifting tackles, slings, etc. to be connected to hook of the hoist / crane shall be provided by the Bidder for lifting the equipment and accessories covered under the specification.

8.0 DOCUMENTS, DATA AND DRAWINGS TO BE FURNISHED BY BIDDER

- 8.1 Plant and equipment shall be fully integrated, engineered and designed to perform in accordance with the technical specification. All engineering and technical services required ensuring a completely engineered plant shall be provided in respect of mechanical, electrical, control & instrumentation, civil & structural works as per the scope.

The Contractor shall furnish engineering data/drawings in accordance with the schedule of information as specified in Technical Specification and data sheets.

A comprehensive engineering and quality coordination procedure shall be finalized with the successful bidder covering salient features as described in this section of specifications.

- 8.2 The number of copies/prints/CD-ROMs/manuals to be furnished for various types of documents is given in Annexure-I attached with Chapter 5, Volume-II.
- 8.3 The documentation that shall be provided by the Bidder is indicated in various sections of specification. The documentation shall include but not be limited to the following:

8.3.1 Basic Engineering Documentation

Prior to commencement of the detailed engineering work, the Bidder shall furnish a Plant Definition Manual within 4-6 weeks from the date of the Notification of Award. This manual shall contain the following as a minimum:-

- 1) System description of all the mechanical, electrical, control & instrumentation & civil systems.



- 2) Technology scans for each system / sub-system & equipment.
- 3) Selection of appropriate technology / schemes for various systems/ subsystems including techno-economic studies between various options.
- 4) Optimization studies including thermal cycle optimization.
- 5) Sizing criteria of all the systems, sub-systems including various piping systems/ equipments/ structures/ equipment foundations along with all calculations justifying and identifying the sizing and the design margins.
- 6) Schemes and Process & Instrumentation diagrams for the various systems/ sub-system with functional write-ups.
- 7) Operation Philosophy and the control philosophy of the Main Plant and other plants.
- 8) General Layout plan of the power station incorporating all facilities in Bidder's as well as those in the Owner's scope. This drawing shall also be furnished in native (Word, Excell, ACAD etc) in the form of CD discs to the Owner for engineering of areas not included in Bidder's scope.
- 9) Basic layouts and cross sections of the main plant building (various floor elevations), boiler, fuel oil area and other areas included in the scope of the Bidder.
- 10) Documentation in respect of Quality Assurance System as listed out elsewhere in this specification.

The successful bidder shall furnish within three (3) weeks from the date of Notification of Award, a list of contents of the Plant Definition Manual (PDMs) including techno-economic studies, which shall then be mutually discussed & finalised with the Owner.

After approval of Plant Definition Manual / Design Basis Report, Bidder shall furnish detailed technical specification of all system / packages of the Plant.

8.3.2 Detailed Engineering Documentation

- 1) Layouts, general arrangements, elevations and cross-sections drawings for all the equipment and facilities of the plant.
- 2) Flow diagrams, Process & Instrumentation Diagrams along with write-up and system description.
- 3) Start-up curves for turbine, boiler and both turbine and boiler combined together as a unit for various start-ups, viz. cold, warm and hot start-up.
- 4) Piping isometric, composite layout and fabrication drawings.
- 5) Piping engineering diagrams, pipe and fittings schedules, valve schedules, hanger and support schedules, insulation schedules.
- 6) Technical data sheets for all bought out and manufactured items. Bidder shall use the specifications as a base for placement of orders on their sub-vendors.



- 7) Detailed design calculations for components, system/sub-system, piping etc., wherever applicable including sizing calculations for all auxiliaries as per criteria specified elsewhere in specification.
- 8) Boiler pressure part schedule and sizing calculations. Boiler performance data and boiler design dossier.
- 9) Transient, hydraulic and thermal stress analysis of piping and system wherever applicable & input and output data along with stress analysis isometrics showing nodes.
- 10) Thermal cycle information (heat balance diagrams, boiler performance calculations, condenser and heat exchanger thermal calculations etc.).
- 11) Characteristic Curves/ Performance Correction Curves. Hydraulic & Mechanical design calculations for condensers & heaters.
- 12) Model Studies/ CFD analysis for ESP, CW sump etc and furnishing report with recommendations.
- 13) Characteristic Curves/ Performance Correction Curves and thermal design calculations for Cooling Tower.
- 14) Composite Water Balance for total Plant.
- 15) Hydraulic calculation/profile for Water Treatment Plant.
- 16) Comprehensive list of all terminal points which interface with Owner's facilities giving details of location, terminal pressure, temperature, fluid handled & end connection details, forces, moments etc.
- 17) Power supply single line diagram, block logics, control schematics, electrical schematics, etc.
- 18) Protection systems diagrams and relay settings. Load Flow study.
- 19) Interconnection diagrams.
- 20) Cable routing plan.
- 21) Instrument schedule, measuring point list, I/O list, Interconnection & wiring diagram, functional write-ups, installation drawings for field mounted instruments, logic diagrams, control schematics, wiring and tubing diagrams of panels and enclosures etc. Drawings for open loop and close loop controls (both hardware and software). Motor list and valve schedule including type of actuator etc.
- 22) Alarm and annunciation list and alarms & trip set points.
- 23) Sequence and protection interlock schemes.
- 24) Type test reports and power system stability study report.
- 25) Control system configuration diagrams and card circuit diagrams and maintenance details.



- 26) Detailed software manuals & source software listing.
- 27) Detailed flow chart for digital control system.
- 28) Mimic diagram layout.
- 29) Civil Task drawings (for the Engineering by Owner), Design and Drawings for the Civil & Structural works in the scope of the Bidder.
- 30) Model study reports wherever applicable.
- 31) Functional & guarantee test procedures and test reports.
- 32) Documentation in respect of Quality Assurance System as listed out elsewhere in this specification.
- 33) Documentation in respect of commissioning as listed out elsewhere in this specification.

The Bidder while submitting the above documents / drawings for approval / reference as the case may be, shall mark on each copy of submission the reference letter along with the date vide which the submissions are made.

8.3.2 Instruction Manuals

The Bidder shall submit to the Owner, draft Instruction Manuals for all the equipments covered under the Contract by the end of one year from the date of his acceptance of the Letter of Award. The Instruction manuals shall contain full details required for erection, commissioning, operation and maintenance of each equipment. The manual shall be specifically compiled for this project. After finalization and approval of the Owner the Instruction Manuals shall be submitted as indicated in Annexure-IV. The Contract shall not be considered to be completed for purposes of taking over until the final Instructions manuals have been supplied to the Owner. The Instruction Manuals shall comprise of the following.

A) Erection Manuals

The erection manuals shall be submitted at least three (3) months prior to the commencement of erection activities of particular equipment/system. The erection manual should contain the following as a minimum.

- 1) Erection strategy.
- 2) Sequence of erection.
- 3) Erection instructions.
- 4) Critical checks and permissible deviation/tolerances.
- 5) List of tool, tackles, heavy equipments like cranes, dozers, etc.
- 6) Bill of Materials
- 7) Procedure for erection.



- 8) General safety procedures to follow during erection/installation.
- 9) Procedure for initial checking after erection.
- 10) Procedure for testing and acceptance norms.
- 11) Procedure / Check list for pre-commissioning activities.
- 12) Procedure / Check list for commissioning of the system.
- 13) Safety precautions to be followed in electrical supply distribution during erection

B) Operation & Maintenance Manuals

- a) The manual shall be a two rim PVC bound stiff sided binder able to withstand constant usage or where a thicker type is required it shall have locking steel pins, the size of the manual shall not be larger than international size A3. The cover shall be printed with the Project Name, Services covered and Volume / Book number Each section of the manual shall be divided by a stiff divider of the same size as the holder. The dividers shall clearly state the section number and title. All written instructions within the manual not provided by the manufacturers shall be typewritten with a margin on the left hand side.

- b) The arrangement and contents of O&M manuals shall be as follows :

1) Chapter 1 - Plant Description :

To contain the following sections specific to the equipment/system supplied

- i.) Description of operating principle of equipment / system with schematic drawing / layouts.
- ii.) Functional description of associated accessories / controls. Control interlock protection writes up.
- iii.) Integrated operation of the equipment alongwith the intended system. (The is to be given by the supplier of the Main equipment by taking into account the operating instruction given by the associated suppliers).
- iv.) Exploded view of the main equipment, associated accessories and auxiliaries with description. Schematic drawing of the equipment alongwith its accessories and auxiliaries.
- v.) Design data against which the plant performance will be compared.
- vi.) Master list of equipments, Technical specification of the equipment/ system and approved data sheets.
- vii.) Identification system adopted for the various components, (it will be of a simple process linked tagging system).

- viii.) Master list of drawings (as built drawing - Drawings to be enclosed in a separate volume).

2) Chapter 2.0 - Plant Operation:

To contain the following sections specific to the equipment supplied

- i.) Protection logics provided for the equipment alongwith brief philosophy behind the logic, Drawings etc.
- ii.) Limiting values of all protection settings.
- iii.) Various settings of annunciation/interlocks provided.
- iv.) Start-up and shut down procedure for equipment alongwith the associated systems in step mode.
- v.) Do's and Don'ts related to operation of the equipment
- vi.) Safety precautions to be taken during normal operation. Emergency instruction on total power failure condition/lubrication failure/any other conditions.
- vii.) Parameters to be monitored with normal value and limiting values.
- viii.) Equipment isolating procedures.
- ix.) Trouble shooting with causes and remedial measures.
- x.) Routine testing procedure to ascertain healthiness of the safety devices alongwith schedule of testing.
- xi.) Routine Operational Checks, Recommended Logs and Records
- xii.) Change over schedule if more than one auxiliary for the same purpose is given.
- xiii.) System/plant commissioning procedure.
- xiv.) Preservation procedure on long shut down.

3) Chapter 3.0 - Plant Maintenance

To contain the following sections specific to the equipment supplied

- i.) Exploded view of each of the equipments. Drawings alongwith bill of materials including name, code no. & population.
- ii.) Exploded view of the spare parts and critical components with dimensional drawings (In case of Electronic cards, the circuit diagram to be given) and spare parts catalogue for each equipment
- iii.) List of Special T/ P required for Overhauling /Trouble shooting including special testing equipment required for calibration etc

- iv.) Stepwise dismantling and assembly procedure clearly specifying the tools to be used, checks to be made, records to be maintained etc. Clearance to be maintained etc.
- v.) Preventive Maintenance schedules linked with running hours/calendar period alongwith checks to be carried out
- vi.) Overhauling schedules linked with running hours/calendar period alongwith checks to be done
- vii.) Long term maintenance schedules
- viii.) Consumables list alongwith the estimated quantity required during normal running and during maintenance like Preventive Maintenance and Overhauling
- ix.) List of lubricants with their Indian equivalent, Lubrication Schedule including charts showing lubrication checking, testing and replacement procedure to be carried daily, weekly, monthly & at longer intervals to ensure trouble free operation and quantity required for complete replacement
- x.) Tolerance for fitment of various components
- xi.) Details of sub vendors with their part no. in case of bought out items
- xii.) List of spare parts with their Part No, total population, life expediency & their interchange ability with already supplied spares to OWNER.
- xiii.) List of mandatory and recommended spare list along with manufacturing drawings, material specification & quality plan for fast moving consumable spares.
- xiv.) Lead time required for ordering of spares from the equipment supplier, instructions for storage and preservation of spares
- xv.) General information on the equipment such as modification carried out in the equipment from its inception, equipment population in the country / foreign country and list of utilities where similar equipments have been supplied.

8.3.2.2 After finalization and approval of the Employer, the O & M Manuals shall be submitted as indicated in Annexure-VI. The Contract shall not be considered to be completed for purposes of taking over until the final Instructions manuals (both erection and O & M manuals have been supplied to the Employer.

8.3.2.3 If after the commissioning and initial operation of the plant, the instruction manuals (Erection and /or O&M manuals) require modifications/additions/changes, the same shall be incorporated and the updated final instruction manuals shall be submitted by the Contractor to the Employer for records and number of copies shall be as mentioned in Annexure-VI.

8.3.3 Plant Handbook and Project Completion Report



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001

Page 65 of 429



8.3.3.1 Plant Handbook

The Bidder shall submit to the Owner a preliminary plant hand book preferably in A-4 size sheets which shall contain the design and performance data of various plants, equipments and systems covering the complete project including

- 1) Design and performance data.
- 2) Process & Instrumentation diagrams.
- 3) Single line diagrams.
- 4) Sequence & Protection Interlock Schemes.
- 5) Alarm and trip values.
- 6) Performance Curves.
- 7) General layout plan and layout of main plant building and auxiliary buildings.
- 8) Important Do's & Dont's

The plant handbook shall be submitted within twelve (12) months from the date of award of contract. After the incorporation of Owner's comments, the final plant handbook complete in all respects shall be submitted three (3) months before start-up and commissioning activities.

8.3.3.2 Project Completion Report

The Bidder shall submit a Project Completion Report at the time of handing over the plant.

8.3.4 Drawings

- a)
 - i) All the plant layouts shall be made in computerised 3D modelling system. The Employer reserves the right to review the 3D model at different stages during the progress of engineering. The layout drawings submitted for Employer's review shall be fully dimensioned and extracted from 3D model after interference check.
 - ii) All documents submitted by the Contractor for Employer's review shall be in electronic form (soft copies) along with the desired number of hard copies as per Annexure-VI (GTR)-Vol-II.

The soft copies of identified drawings/documents shall be in pdf format, whereas the attachments/reply to the submitted document(s) can be in .doc, .xls, .pdf, .dwg or .std formats.
 - iii) Final copies of the approved drawings along with requisite number of hard copies shall be submitted as per Annexure-VI (GTR), Vol-II.
 - iv) The completed plant documentation including integrated 3-D model with equipment drawings, data sheets, P&ID, BOQ, schematics, logic diagrams, test reports and quality plan, etc. attached to the respective equipments / systems in the 3D model shall be furnished to Employer,



along with the design review software (network ready) which shall include interference check, walk-through animation, simulation, visual effect, photo realism etc. loaded on a server with four (4) work stations (latest configuration for server & workstation) with one A4 size colored laser printer and one A0 size colored plotter. The software shall include facility for obtaining hard copies of all the drawings/documents on standard plotter / printer.

The requisite hardware and software shall be supplied and commissioned by the Contractor at Employer's Head Office at Lucknow & Site Office at Panki as per mutually agreed schedule.

All softwares provided shall necessarily include the cost for perpetual license(s) for use on all the machines and an Annual Maintenance Contract (AMC) which shall include software upgrades as & when released by the software agency for a period of three (3) years after warranty/guarantee period.

- b) All documents/text information shall be in latest version of MS Office or MS Excel as applicable.
- c) All drawings submitted by the Contractor including those submitted at the time of bid shall be in sufficient detail indicating the type, size, arrangement, weight of each component for packing and shipment, the external connection, fixing arrangement required, the dimensions required for installation and interconnections with other equipments and materials, clearance and spaces required between various portions of equipment and any other information specifically requested in the drawing schedules.
- d) Each drawing submitted by the Contractor (including those of sub vendors) shall bear a title block at the right hand bottom corner with clear mention of the name of the Employer, the system designation, the specifications title, the specification number, the name of the Project, drawing number and revisions. If standard catalogue pages are submitted the applicable items shall be indicated therein. All titles, notings, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.
- e) The drawings submitted by the Contractor (or their subvendor) shall bear Employer's drawing number in addition to contractor's (their sub-vendor's) own drawing number. Employer's drawing numbering system shall be made available to the successful bidder so as to enable him to assign Employer's drawing numbers to the drawings to be submitted by him during the course of execution of the Contract.
- f) The Contractor shall also furnish a "Master Drawing List" which shall be a comprehensive list of all drawings/ documents/ calculations envisaged to be furnished by him during the detailed engineering to the Employer. Such list should clearly indicate the purpose of submission of these drawings i.e. "FOR APPROVAL" or "FOR INFORMATION ONLY".
- g) Similarly, all the drawings/ documents submitted by the Contractor during detailed engineering stage shall be marked "FOR APPROVAL" or "FOR INFORMATION" prior to submission. Further, space shall be identified on each drawing for Approval stamp and electronic signature



- h) The furnishing of detailed engineering data and drawings by the Contractor shall be in accordance with the time schedule for the project. The review of these documents/ data/ drawings by the Employer will cover only general conformance of the data/ drawings/ documents to the specifications and contract, interfaces with the equipments provided by others and external connections & dimensions which might affect plant layout. The review by the Employer should not be construed to be a thorough review of all dimensions, quantities and details of the equipments, materials, any devices or items indicated or the accuracy of the information submitted. The review and/ or approval by the Employer/ Project Manager shall not relieve the Contractor of any of his responsibilities and liabilities under this contract.
- i) After the approval of the drawings, further work by the Contractor shall be in strict accordance with these approved drawings and no deviation shall be permitted without the written approval of the Employer.
- j) All manufacturing, fabrication and execution of work in connection with the equipment / system, prior to the approval of the drawings, shall be at the Contractor's risk. The Contractor is expected not to make any changes in the design of the equipment /system, once they are approved by the Employer.
- k) However, if some changes are necessitated in the design of the equipment/system at a later date, the Contractor may do so, but such changes shall promptly be brought to the notice of the Employer indicating the reasons for the change and get the revised drawing approved again in strict conformance to the provisions of the Technical Specification.
- l) Drawings shall include all installations and detailed piping layout drawings. Layout drawings for all piping of 65 mm and larger diameter shall be submitted for review/ approval of Owner prior to erection. Small diameter pipes shall however be routed as per site conditions in consultation with site authority/representative of Owner based on requirements of such piping indicated in approved / finalized Flow Scheme / Process & Instrumentation Diagrams and/or the requirements cropping up for draining & venting of larger diameter piping or otherwise after their erection as per actual physical condition for the entire scope of work of this package.
- m) Assessing & anticipating the requirement and supply of all piping and equipment shall be done by the Bidder well in advance so as not to hinder the progress of piping & equipment erection, subsequent system charging and its effective draining & venting arrangement as per site suitability.
- n) As Built Drawings**
After final acceptance of individual equipment/system by the Owner, the Bidder will update all original drawings and documents for the equipment/ system to "as built" conditions in requisite number.
- o) Drawings must be checked by the Bidder in terms of its completeness, data adequacy and relevance with respect to engineering schedule prior to submission to the Owner. In case drawings are found to be submitted without proper endorsement for checking by the Bidder, the same shall

not be reviewed and returned to the Bidder for re-submission. The Bidder shall make a visit to site to see the existing facilities and understand the layout completely and collect all necessary data/drawings at site which are needed as an input to the engineering. The Bidder shall do the complete engineering including interfacing and integration of all his equipment, systems & facilities within his scope of work as well as interface engineering & integration of systems, facilities, equipment & works under Owner's scope and submit all necessary drawings/documents for the same.

- p) The Bidder shall submit adequate prints of drawing/data/document for Owner's review and approval. The Owner shall review the drawings and return one (1) copy to the Bidder authorizing either to proceed with manufacture or fabrication, or marked to show changes desired. When changes are required, drawings shall be re-submitted promptly, with revisions clearly marked, for final review. Any delays arising out of the failure of the Bidder to submit/rectify and resubmit in time shall not be accepted as a reason for delay in the contract schedule.
- q) All engineering data submitted by the Bidder after final process including review and approval by the Project Manager/Owner shall form part of the contract documents and the entire works covered under these specification shall be performed in strict conformity with technical specifications unless otherwise expressly requested by the Project Manager in writing.

8.4 Engineering Information Submission Schedule

Prior to the award of Contract, a Detailed Engineering Information Submission Schedule shall be tied up with the Owner. For this, the bidder shall furnish a detailed list of engineering information alongwith the proposed submission schedule. This list would be a comprehensive one including all engineering data / drawings / information for all bought out items and manufactured items. The information shall be categorised into the following parts.

- a) Information that shall be submitted for the approval of the Owner before proceeding further, and
- b) Information that would be submitted for Owner's information only.

The Master Drawing List (MDL) shall be updated periodically and submitted to the employer, highlighting the changes made in MDL.

The schedule should allow adequate time for proper review and incorporation of changes/ modifications, if any, to meet the contract without affecting the equipment delivery schedule and overall project schedule. The early submission of drawings and data is as important as the manufacture and delivery of equipment and hardware and this shall be duly considered while determining the overall performance and progress.

8.5 Engineering Progress and Exception Report

8.5.1 Report giving the status of each engineering information including

- a) A list of drawings/engineering information which remains unapproved for more than four (4) weeks after the date of first submission



- b) Drawings which were not submitted as per agreed schedule including those for revision after commenting last revision .
- 8.5.2 The draft format for this report shall be furnished to the Owner within four (4) weeks of the award of the contract, which shall then be discussed and finalized with the Owner.

8.6 Engineering Co-ordination Procedure

- 8.6.1 The following principal coordinators will be identified by respective organizations at time of award of contract:

Project Manager (UPRVUNL EC):

Name :
Designation :
Address
a) Postal :
b) Telegraphic /e-Mail :
c) FAX : TELEPHONE (Land & Mobile):

Contractor's/ Vendor's Engineering Coordinator (VENDOR EC):

Name :
Designation :
Address :
a) Postal :
b) Telegraphic /e-Mail :
c) FAX : TELEPHONE(Land & Mobile) :

- 8.6.2 All engineering correspondence shall be in the name of above coordinators on behalf of the respective organizations.

- 8.6.3 Contractor's/Vendor's Drawing Submission and Approval Procedure:

- a) All data/information furnished by Vendor in the form of drawings/ documents/catalogues or in any other form for OWNER'S information/ interface and or review and approval are referred by the general term "drawings".
- b) The 'Master drawings list' indicating titles, Drawing Number, Date of submission and approval etc. shall be finalised mutually between Contractor and Owner before the award of contract. This list shall be updated if required at suitable interval during detailed engineering.
- c) All drawings (including those of subvendor's) shall bear at the right hand bottom corner the 'title plate' with all relevant information duly filled in. The Contractor shall furnish this format to his subvendor along with his purchase order for subvendor's compliance.
- d) Owner shall intimate the contractor, OWNER drawing number procedure. Vendor, thereafter, shall indicate OWNER drawing number in MDL and in subsequent Submission of drawing, in the space provided for this purpose in



title plate, in addition to his own drawing number, if any.

- e) The contractor shall make a visit to site to see the existing facilities and understand the layout completely and collect all necessary data / drawings at site which are needed as an input to the engineering. The contractor shall do the complete engineering including interfacing and integration of all his equipment, systems & facilities within his scope of work as well as interface engineering & integration of systems, facilities, equipment & works under Owner's scope and submit all necessary drawings/ documents for the same.
- f) Drawings must be checked by the Contractor in terms of its completeness, data adequacy and relevance with respect to engineering schedule prior to submission to the Owner. In case drawings are found to be submitted without proper endorsement for checking by the Contractor, the same shall not be reviewed and returned to the Contractor for re-submission.
- g) The Contractor shall submit adequate prints of drawing / data / document for Owner's review and approval. The drawings submitted by the Contractor/vendor shall be reviewed by OWNER and their comments shall be forwarded within four (4) weeks of receipt of drawings. Upon review of each drawing, depending on the correctness and completeness of the drawing, the same will be categorized and approval accorded in one of the following categories/action:

CATEGORY/Action - 1 : Distributed
CATEGORY/Action - 2 : Approved

CATEGORY/Action - 3 : Approved, subject to incorporation of comments/ modification as noted. Forward final drawing Resubmit revised drawing incorporating the comments

CATEGORY/Action - 4 Approved, subject to incorporation of comments/ modification as noted. Resubmit revised drawing incorporating the comments

CATEGORY/Action - 5: Not approved. Resubmit revised drawings for approval after incorporating comments/ modification as noted in accompanying memo.

CATEGORY/Action - 6 : For information and records.

- h) Contractor shall resubmit the drawings marked/stamped under Category/Action 3,4 & 5 within two(2) weeks of receipt of comments on the drawings, incorporating all comments. Every revision of the drawing shall

bear a revision index wherein such revisions shall be highlighted in the form of description or marked up in the drawing identifying the same with relevant revision Number enclosed in a triangle (e.g. 1, 2, 3 etc). Contractor shall not make any changes in the portions of the drawing other than those commented. If changes are required to be made in the portions already approved, the Contractor shall resubmit the drawing identifying the changes for Owner's review and approval. **Drawings resubmitted shall show clearly the portions where the same are revised marking the relevant revision numbers and Owner shall review only such revised portion of documents.**

- i) In case, the Contractor/ Vendor does not agree with any specific comment, he shall furnish the explanation for the same to OWNER for consideration. In all such cases the Contractor shall necessarily enclose explanations along with the revised drawing (taking care of balance comments) to avoid any delay and/or duplication in review work.
- j) It shall be the responsibility of the Contractor/ Vendor to get all the drawings approved as the case may be and complete the engineering activities within the agreed schedule. Any delay arising out of submission and modification of drawings shall not alter the contract completion schedule.
- k) If Contractor/ Vendor fails to resubmit the drawings as per the schedule, construction work at site will not be held up and work will be carried out on the basis of comments furnished on previous issues of the drawing.
- l) These comments will be taken care by the contractor while submitting the revised drawing.
- m) The contractor shall use a single transmittal for drawings Submission. This shall include transmittal numbers and date, number of copies being sent, names of the agencies to whom copies being sent, drawing number and titles, remarks or special notes if any etc.

9.0 Technical Co-Ordination Meetings

- 9.1 The Bidder shall be called upon to organize and attend monthly Design/ Technical Co-ordination Meetings with the Owner / Owner's representatives / OWNER Consultant during the period of contract. The Bidder shall attend such meetings at his own cost at mutually agreed venue as and when required and fully co-operate with such persons and agencies involved during the discussions.
- 9.2 The Contractor should note that Time is the essence of the contract. In order to expedite the early completion of engineering activities, the Bidder shall submit all drawings as per the agreed Engineering Information Submission Schedule. The drawings submitted by the Bidder will be reviewed by the Owner as far as practicable within three (3) weeks from the date of receipt of the drawing .The comments of the Owner shall then be discussed across the table during the above co-ordination Meetings wherein best efforts shall be made by both sides to ensure the approval of the drawing.



- 9.2.1 The Contractor shall ensure availability of the concerned experts / consultants/ personnel who are empowered to take necessary decisions during these meetings. The Bidder shall be equipped with necessary tools and facilities so that the drawings/documents can be resubmitted after incorporating necessary changes and approved during the meeting itself.
- 9.2.2 Should any drawing remain unapproved for more than six (6) weeks after it's first submission, this shall be brought out in the monthly Engineering Progress and Exception Report with reasons thereof.
- 9.3 Any delays arising out of failure by the Bidder to incorporate Owner's comments and resubmit the same during the TCM shall be considered as a default and in no case shall entitle the Bidder to alter the Contract completion date.

10.0 Design Improvements

The Owner or the Contractor may propose changes in the specification of the equipment or quality thereof and if the parties agree upon any such changes the specification shall be modified accordingly.

If any such agreed upon change is such that it affects the price and schedule of completion, the parties shall agree in writing as to the extent of any changing the price and/or schedule of completion before the Bidder proceeds with the change. Following such agreement, the provision thereof, shall be deemed to have been amended accordingly.

11.0 Equipment Bases

A cast iron or welded steel base plate shall be provided for all rotating equipment which is to be installed on a concrete base, unless otherwise specifically agreed to by the Owner. Each base plate which support the unit and its drive assembly, shall be of a neat design with pads for anchoring the units, shall have a raised lip all around, and shall have threaded drain connections.

12.0 Protective Guards

Suitable guards shall be provided for protection of personnel on all exposed rotating and/or moving machine parts. All such guards shall be designed for easy installation and removal for maintenance purpose.

13.0 Lubricants, Servo Fluids and Chemicals

- 13.1 The Bidder's scope includes all the first fill and one year's topping, requirements of consumables such as oils, lubricants including grease, servo fluids, gases and essential chemicals etc. Consumption of all these consumables during the initial operation and final filling after the initial operation shall also be included in the scope of the Bidder. Bidder shall also supply a quantity not less than 10% of the full charge of each variety of lubricants, servo fluids, gases, chemicals etc. used which is expected to be utilised during the first year of operation. This additional quantity shall be supplied in separate Containers.
- 13.2 As far as possible lubricants marketed by the Indian Oil Corporation shall be used. The variety of lubricants shall be kept to a minimum possible.



Detailed specifications for the lubricating oil, grease, gases, servo fluids, control fluids, chemicals etc. required for the complete plant covered herein shall be furnished. On completion of erection, a complete list of bearings/ equipment giving their location and identification marks shall be furnished to the Owner along with lubrication requirements.

14.0 Lubrication & Chemicals

Equipment shall be lubricated by systems designed for continuous operation. Lubricant level indicators shall be furnished and marked to indicate proper levels under both standstill and operating conditions.

14.1 Chemicals for Water System

Bidder's scope include Chemical required for complete water system up to final handing over EPC package and further two (2) months plant operational requirement.

15.0 Material of Construction

All materials used for the construction of the equipment shall be new and shall be in accordance with the requirements of this specification. Materials utilized for various components shall be those which have established themselves for use in such applications.

16.0 Rating Plates, Name Plates & Labels

- 16.1 Each main and auxiliary item of plant including instruments shall have permanently attached to it in a conspicuous position, a rating plate of non-corrosive material upon which shall be engraved manufacturer's name, equipment, type or serial number together with details of the ratings, service conditions under which the item of plant in question has been designed to operate, and such diagram plates as may be required by the Owner.
- 16.2 Each item of plant shall be provided with nameplate or label designating the service of the particular equipment. The inscriptions shall be approved by the Owner or as detailed in appropriate section of the technical specifications.
- 16.3 Such nameplates or labels shall be of white non-hygroscopic material with engraved black lettering or alternately, in the case of indoor circuit breakers, starters, etc. of transparent plastic material with suitably coloured lettering engraved on the back. The name plates shall be suitably fixed on both front and rear sides.
- 16.4 Items of plant such as valves, which are subject to handling, shall be provided with engraved chromium plated nameplate or label with engraving filled with epoxy. The name plates for valves shall be marked in accordance with MSS standard SP-25 and ANSI B 16.34 as a minimum.
- 16.5 Hanger/ support numbers shall be marked on all pipe supports, anchors, hangers, snubbers and restraint assemblies. Each constant and variable spring support shall also have stamped upon it the designed hot and cold load which it is intended to support. Suitable scale shall also be provided to indicate load on support/hanger.

- 16.6 Valves, steam traps and strainers shall be identified by Owner's tag number of a metal tap permanently attached to non pressure parts such as the yoke by a stainless steel wire. The direction of flow shall also be marked on the body.
- 16.7 Safety and relief valves shall be provided with the following:
- a) Manufacturer's identification.
 - b) Nominal inlet and outlet sizes in mm.
 - c) Set pressure in Kg/cm² (abs).
 - d) Blowdown and accumulation as percentage of set pressure.
 - e) Certified capacity in Kg of saturated steam per hour or in case of liquid certified capacity in litres of water per minute.
- 16.8 All such plates, instruction plates, etc. shall be bilingual with Hindi inscription first, followed by English. Alternatively, two separate plates one with Hindi and the other with English inscriptions may be provided.
- 16.9 All segregated phases of conductors or bus ducts, indoor or outdoor, shall be provided with coloured phase plates to clearly identify the phase of the system

17.0 Tools and Tackles

The Bidder shall supply with the equipment one complete set of all special tools and tackles and other instruments required for the erection, assembly, disassembly and proper maintenance of the plant and equipment and systems (including software). These special tools will also include special material handling equipment, jigs and fixtures for maintenance and calibration / readjustment, checking and measurement aids etc. A list of such tools and tackles shall be submitted by the Bidder alongwith the offer.

The price of each tool / tackle shall be deemed to have been included in the total bid price. These tools and tackles shall be separately packed and sent to site. The Bidder shall also ensure that these tools and tackles are not used by him during erection, commissioning and initial operation. For this period the Bidder should bring his own tools and tackles. All the tools and tackles shall be of reputed make acceptable to the Owner.

18.0 Welding

- 18.1 If the manufacturer has special requirements relating to the welding procedures for welds at the terminals of the equipments to be performed by others the requirements shall be submitted to the Owner in advance of commencement of erection work.

19.0 Colour Code for all Equipments/ Pippings/ Pipe Services

- 19.1 All equipment/ piping/ pipe services are to be painted by the Bidder in accordance with Owner's standard colour coding scheme, which will be furnished to the Bidder during detailed engineering stage.

20.0 Protection and Preservative Shop Coating



20.1 Protection

All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either metallic or a non-metallic protection device. All ends of all valves and piping and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage. The parts which are likely to get rusted, due to exposure to weather, should also be properly treated and protected in a suitable manner. All primers/paints/coatings shall take into account the hot humid, corrosive & alkaline, subsoil or over ground environment as the case may be. The requirements for painting specification shall be complied with as detailed out in Chapter 9, Volume II.

20.2 Preservative Shop Coating

- 20.2.1 All exposed metallic surfaces subject to corrosion shall be protected by shop application of suitable coatings. All surfaces which will not be easily accessible after the shop assembly, shall be treated beforehand and protected for the life of the equipment. All surfaces shall be thoroughly cleaned of all mill scales, oxides and other coatings and prepared in the shop. The surfaces that are to be finish-painted after installation or require corrosion protection until installation, shall be shop painted with at least two coats of primer.
- 20.2.2 Transformers and other electrical equipments if included shall be shop finished with one or more coats of primer and two coats of high grade epoxy. The finished colours shall be as per manufacturer's standards, to be selected and specified by the Owner at a later date.
- 20.3 Shop primer for all steel surfaces which will be exposed to operating temperature below 95 degrees Celsius shall be selected by the Bidder after obtaining specific approval of the Owner regarding the quality of primer proposed to be applied. Special high temperature primer shall be used on surfaces exposed to temperature higher than 95 degrees Celsius and such primer shall also be subject to the approval of the Owner.
- 20.4 All other steel surfaces which are not to be painted shall be coated with suitable rust preventive compound subject to the approval of the Owner.
- 20.5 All piping shall be cleaned after shop assembly by shot blasting or other means approved by the Owner. Lube oil piping or carbon steel shall be pickled.
- 20.6 Painting for Civil structures shall be done as per relevant part of technical specification.

21.0 QUALITY ASSURANCE PROGRAMME

To ensure that the equipment and services under the scope of contract whether manufactured or performed within the Contractor's works or at his sub-contractor's premises or at the Employer's site or at any other place of work are in accordance with the specifications, the Contractor shall adopt suitable quality assurance program to control such activities at all points, as necessary. Such programs shall be outlined by the Contractor and shall be finally accepted by the Employer/authorised representative after discussions before the award of the contract. The QA program shall be generally in line



with ISO-9001/IS-14001. A quality assurance program of the contractor shall generally cover the following:

- a) His organization structure for the management and implementation of the proposed quality assurance program
- b) Quality System Manual
- c) Design Control System
- d) Documentation and Data Control System
- e) Qualification data for bidder's key personnel.
- f) The procedure for purchase of materials, parts, components and selection of sub-Bidder's services including vendor analysis, source inspection, incoming raw-material inspection, verification of materials purchased etc.
- g) System for shop manufacturing and site erection controls including process, fabrication and assembly.
- h) Control of non-conforming items and system for corrective actions and resolution of deviations.
- i) Inspection and test procedure both for manufacture and field activities.
- j) Control of calibration and testing of measuring testing equipment.
- k) System for Quality Audits.
- l) System for identification and appraisal of inspection status.
- m) System for authorising release of manufactured product to the Owner.
- n) System for handling, storage and delivery.
- o) System for maintenance of records, and
- p) Furnishing of quality plans for manufacturing and field activities detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of equipment/component as per formats enclosed as Annexure-I and Annexure-II respectively.

22.0 General Requirements - Quality Assurance

22.1 All materials, components and equipment covered under this specification shall be procured, manufactured, erected, commissioned and tested at all the stages, as per a comprehensive Quality Assurance Programme. An indicative programme of inspection/tests to be carried out by the Bidder for some of the major items is given in the respective technical specification. This is, however, not intended to form a comprehensive programme as it is the Bidder's responsibility to draw up and implement such programme duly approved by the Owner. The detailed Quality Plans for manufacturing and field activities shall be drawn up by the Bidder and will be submitted to Owner for approval. Schedule

of finalisation of such quality plans will be finalised before award. Monthly progress reports on MQP/FQP submission/approval shall be furnished.

- 22.2 Manufacturing Quality Plan will detail out for all the components and equipment, 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/ Sub-Bidder's/ sub-supplier's Quality Control Organisation, the relevant reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and final testing/performance testing. The Quality Plan shall be submitted on electronic media e.g. CD or E-mail in addition to hard copy, for review and approval. After approval the same shall be submitted in compiled form on CD-ROM.
- 22.3 Field Quality Plans will detail out for all the equipment, the quality practices and procedures etc. to be followed by the Bidder's "Site Quality Control Organisation", during various stages of site activities starting from receipt of materials/equipment at site.
- 22.4 The Bidder shall also furnish copies of the reference documents/plant standards/acceptance norms/tests and inspection procedure etc., as referred in Quality Plans along with Quality Plans. These Quality Plans and reference documents/standards etc. will be subject to Owner's approval without which manufacturer shall not proceed. These approved documents shall form a part of the contract. In these approved Quality Plans, Owner shall identify customer hold points (CHP), i.e. test/checks which shall be carried out in presence of the Owner's Project Manager or his authorised representative and beyond which the work will not proceed without consent of Owner in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and referred to Owner along with technical justification for approval and dispositioning.
- 22.5 No material shall be despatched from the manufacturer's works before the same is accepted, subsequent to predespatch final inspection including verification of records of all previous tests/inspections by Owner's Project Manager/Authorised representative and duly authorised for despatch by issuance of Material Despatch Clearance Certificate (MDCC).
- 22.6 All material used for equipment manufacture including casting and forging etc. shall be of tested quality as per relevant codes/standards. Details of results of the tests conducted to determine the mechanical properties; chemical analysis and details of heat treatment procedure 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.
- 22.7 The Bidder shall submit to the Owner Field Welding Schedule for field welding activities in the format enclosed at Annexure-V. The field welding schedule shall be submitted to the Owner along with all supporting documents, like welding procedures, heat treatment procedures, NDT procedures etc. at least ninety days before schedule start of erection work at site.
- 22.8 All welding and brazing shall be carried out as per procedure drawn and qualified in accordance with requirements of ASME Section IX/BS-4870 or other International equivalent standard acceptable to the Owner.

- 22.9 All welding/brazing procedures shall be submitted to the Owner or its authorised representative for approval prior to carrying out the welding/brazing.
- 22.10 All brazers, welders and welding operators employed on any part of the contract either in Bidder's/sub-Bidder's works or at site or elsewhere shall be qualified as per ASME Section-IX or BS-4871 or other equivalent International Standards acceptable to the Owner.
- 22.11 Welding procedure qualification & Welder qualification test results shall be furnished to the Owner for approval. However, where required by the Owner, tests shall be conducted in presence of Owner/authorised representative.
- 22.12 For all pressure parts and high pressure piping welding, the latest applicable requirements of the IBR (Indian Boiler Regulations) shall also be essentially complied with. Similarly, any other statutory requirements for the equipment/systems shall also be complied with. On all back-gauged welds MPI/LPI shall be carried before seal welding.
- 22.13 Unless otherwise proven and specifically agreed with the Owner, welding of dissimilar materials and high alloy materials shall be carried out at shop only.
- 22.14 No welding shall be carried out on cast iron components for repair.
- 22.15 All the heat treatment results shall be recorded on time temperature charts and verified with recommended regimes.
- 22.16 All non-destructive examination shall be performed in accordance with written procedures as per International Standards, The NDT operator shall be qualified as per SNT-TC-IA (of the American Society of non-destructive examination). NDT shall be recorded in a report, which includes details of methods and equipment used, result/evaluation, job data and identification of personnel employed and details of co-relation of the test report with the job.
- 22.17 All plates of thickness above 40mm & all bar stock/Forging above 40mm dia shall be ultrasonically tested. For pressure parts, plate of thickness equal to or above 25mm shall be ultrasonically tested.
- 22.18 The Bidder shall list out all major items/ equipment/ components to be manufactured in house as well as procured from sub-contractors bought out items (BOI). All the sub-Bidder proposed by the Bidder for procurement of major bought out items including castings, forging, semi-finished and finished components/equipment etc., list of which shall be drawn up by the Bidder and finalised with the Owner, shall be subject to Owner's approval. The Bidder's proposal shall include vendor's facilities established at the respective works, the process capability, process stabilization, QC systems followed, experience list, etc. along with his own technical evaluation for identified sub-contractors enclosed and shall be submitted to the Owner for approval within the period agreed at the time of pre-awards discussion and identified in review category prior to any procurement. Monthly progress reports on sub-Bidder detail submission / approval shall be furnished. Such vendor approval shall not relieve the Bidder from any obligation, duty or responsibility under the contract.
- 22.19 For components/equipment procured by the contractors for the purpose of the contract, after obtaining the written approval of the Owner, the Bidder's

purchase specifications and inquiries shall call for quality plans to be submitted by the suppliers. The quality plans called for from the sub-Bidder shall set out, during the various stages of manufacture and installation, the quality practices and procedures followed by the vendor's quality control organisation, the relevant reference documents/standards used, acceptance level, inspection of documentation raised, etc. Such quality plans of the successful vendors shall be finalised with the Owner and such approved Quality Plans shall form a part of the purchase order/contract between the Bidder and sub-Bidder. Within three weeks of the release of the purchase orders /contracts for such bought out items /components, a copy of the same without price details but together with the detailed purchase specifications, quality plans and delivery conditions shall be furnished to the Owner on the monthly basis by the Bidder along with a report of the Purchase Order placed so far for the contract.

- 22.20 Owner reserves the right to carry out quality audit and quality surveillance of the systems and procedures of the Bidder's or their sub-Bidder's quality management and control activities. The Bidder shall provide all necessary assistance to enable the Owner carry out such audit and surveillance.
- 22.21 The Bidder shall carry out an inspection and testing programme during manufacture in his work and that of his sub-Bidder's and at site to ensure the mechanical accuracy of components, compliance with drawings, conformance to functional and performance requirements, identity and acceptability of all materials parts and equipment. Bidder shall carry out all tests/inspection required to establish that the items/equipment conform to requirements of the specification and the relevant codes/standards specified in the specification, in addition to carrying out tests as per the approved quality plan.
- 22.22 Quality audit/surveillance/approval of the results of the tests and inspection will not, however, prejudice the right of the Owner to reject the equipment if it does not comply with the specification when erected or does not give complete satisfaction in service and the above shall in no way limit the liabilities and responsibilities of the Bidder in ensuring complete conformance of the materials/equipment supplied to relevant specification, standard, data sheets, drawings, etc.
- 22.23 For all spares and replacement items, the quality requirements as agreed for the main equipment supply shall be applicable.
- 22.24 Repair/rectification procedures to be adopted to make the job acceptable shall be subject to the approval of the Owner/ authorised representative.

22.25 Environmental Stress Screening

All solid state electronic system / equipment / sub assembly shall be free from infant mortile components. For establishing the compliance to this requirement, the contractor / sub – contractor should meet the following

- 1) The Contractor / Sub – contractor shall furnish the established procedure being followed for eliminating infant mortile components. The procedure followed by the Contractor / Sub – contractor should be substantiated along with the statistical figures to validate the procedure being followed. The necessary details as required under this clause shall be furnished at the stage of QP finalization.



OR

In case the Contractor / Sub – contractor do not have any established procedure to eliminate infant mortile components then two number or 10% whichever is less, most densely populated Panels shall be tested for Elevated Temperature Cycle Test as per the following procedure.

Elevated Temperature Test Cycle

During the elevated temperature test which shall be for 48 hours of the total 168 hours of testing, the ambient temperature shall be maintained at 50 deg.C. The equipment shall be interconnected with devices which will cause it to repeatedly perform all operations it is expected to perform in actual service with load on various components being equal to those which will be experienced in actual service.

During the elevated temperature test the cubicle doors shall be closed (or shall be in the position same as they are supposed to be in the field) and inside temperature in the zone of highest heat dissipating components/modules shall be monitored. The temperature rise inside the cubicle should not exceed 10 deg.C above the ambient temp. at 50 deg.C.

In case of any failure during the test cycle, the further course of action should be mutually discussed for demonstrating the intent of the above requirement.

2) Burn in Test Cycle

The 48 hours elevated temperature test shall be followed by 120 hours of burn in test as above except that the temperature shall be reduced to the ambient temperature prevalent at that time.

During the above tests, the process I/O and other load on the system shall be simulated by simulated inputs and in the case of control systems, the process which is to be controlled shall also be simulated. Testing of individual components or modules shall not be acceptable.

In case the Bidder/ sub-Bidder is having any alternate established procedure of eliminating infant mortile components, the detail procedures followed by the Bidder/ sub- Bidder along with the statistical figures to validate the alternate procedure to be forwarded.

- 22.26 The Bidder/Sub-Bidder shall carry out routine test on 100% item at Bidder/sub-Bidder's works. The quantum of check/test for routine & acceptance test by Owner shall be generally as per criteria/sampling plan defined in referred standards. Wherever standards have not been mentioned quantum of check/test for routine / acceptance test shall be as agreed during detailed engineering stage.

23.0 QA Documentation Package

- 23.1 The Bidder shall be required to submit the QA Documentation in two hard copies and two CD ROMs, as identified in respective quality plan with tick (√) mark.



- 23.1.1 Each QA Documentation shall have a project specific Cover Sheet bearing name & identification number of equipment and including an index of its contents with page control on each document.

The QA Documentation file shall be progressively completed by the Supplier's sub-supplier to allow regular reviews by all parties during the manufacturing.

The final quality document will be compiled and issued at the final assembly place of equipment before despatch. However CD-Rom may be issued not later than three weeks.

- 23.2 Typical contents of QA Documentation are as below:-

- a) Quality Plan
- b) Material mill test reports on components as specified by the specification and approved Quality Plans.
- c) Manufacturer / works test reports/results for testing required as per applicable codes and standard referred in the specification and approved Quality Plans.
- d) Non-destructive examination results /reports including radiography interpretation reports. Sketches/drawings used for indicating the method of traceability of the radiographs to the location on the equipment.
- e) Heat Treatment Certificate/Record (Time- temperature Chart)
- f) All the accepted Non-conformance Reports (Major/Minor) / deviation, including complete technical details / repair procedure).
- g) CHP / Inspection reports duly signed by the Inspector of the Owner and Bidder for the agreed Customer Hold Points.
- h) Certificate of Conformance (COC) wherever applicable.
- i) MDCC

- 23.3 Similarly, the Bidder shall be required to submit two sets (two hard copies and two CD ROMs), containing QA Documentation pertaining to field activities as per Approved Field Quality Plans and other agreed manuals/ procedures, prior to commissioning of individual system.

- 23.4 Before despatch / commissioning of any equipment, the Supplier shall make sure that the corresponding quality document or in the case of protracted phased deliveries, the applicable section of the quality document file is completed. The supplier will then notify the Inspector regarding the readiness of the quality document (or applicable section) for review.

- a) If the result of the review carried out by the Inspector is satisfactory, the Inspector shall stamp the quality document (or applicable section) for release.
- b) If the quality document is unsatisfactory, the Supplier shall endeavor to correct the incompleteness, thus allowing to finalize the quality

document (or applicable section) by time compatible with the requirements as per contract documents. When it is done, the quality document (or applicable section) is stamped by the Inspector.

- c) If a decision is made despatch, whereas all outstanding actions cannot be readily cleared for the release of the quality document by that time. The supplier shall immediately, upon shipment of the equipment, send a copy of the quality document Review Status signed by the Supplier Representative to the Inspector and notify of the committed date for the completion of all outstanding actions & submission. The Inspector shall stamp the quality document for applicable section when it is effectively completed. The submission of QA documentation package shall not be later than 3 weeks after the despatch of equipment.

23.5 Transmission of QA Documentation

On release of QA Documentation by Inspector, one set of quality document shall be forwarded to Quality Assurance Department (@ Head Office) and other set to respective Project Site of Owner.

For the particular case of phased deliveries, the complete quality document to the Owner shall be issued not later than 3 weeks after the date of the last delivery of equipment.

24.0 Project Manager's Supervision

- 24.1 To eliminate delays and avoid disputes and litigation, it is agreed between the parties to the Contract that all matters and questions shall be referred to the Project Manager and without prejudice to the provisions of 'Arbitration' clause in Section General Conditions of Contract, the Bidder shall proceed to comply with the Project Manager's decision.
- 24.2 The work shall be performed under the supervision of the Project Manager. The scope of the duties of the Project Manager pursuant to the Contract, will include but not be limited to the following:
 - a) Interpretation of all the terms and conditions of these documents and specifications:
 - b) Review and interpretation of all the Bidder's drawing, engineering data, etc:
 - c) Witness or his authorised representative to witness tests and trials either at the manufacturer's works or at site, or at any place where work is performed under the contract :
 - d) Inspect, accept or reject any equipment, material and work under the contract.
 - e) Issue certificate of acceptance and/or progressive payment and final payment certificates
 - f) Review and suggest modifications and improvement in completion schedules from time to time, and

- g) Supervise Quality Assurance Programme implementation at all stages of the works.

25.0 Inspection, Testing and Inspection Certificates

- 25.1 The word 'Inspector' shall mean the Project Manager and/or his authorized representative and/or an outside inspection agency acting on behalf of the Owner to inspect and examine the materials and workmanship of the works during its manufacture or erection.
- 25.2 The Project Manager or his duly authorized representative and/or an outside inspection agency acting on behalf of the Owner shall have access at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection and if part of the works is being manufactured or assembled on other premises or works, the Bidder shall obtain for the Project Manager and for his duly authorized representative permission to inspect as if the works were manufactured or assembled on the Bidder's own premises or works.
- 25.3 The Bidder shall give the Project Manager/Inspector fifteen (15) days written notice of any material being ready for testing. Such tests shall be to the Bidder's account except for the expenses of the Inspector's. The Project Manager/Inspector, unless the witnessing of the tests is virtually waived and confirmed in writing, will attend such tests within fifteen (15) days of the date on which the equipment is noticed as being ready for test/inspection failing which the Bidder may proceed with test which shall be deemed to have been made in the inspector's presence and he shall forthwith forward to the inspector duly certified copies of test reports in two (2) copies.
- 25.4 The Project Manager or Inspector shall within fifteen (15) days from the date of inspection as defined herein give notice in writing to the Bidder, or any objection to any drawings and all or any equipment and workmanship which is in his opinion not in accordance with the contract. The Bidder shall give due consideration to such objections and shall either make modifications that may be necessary to meet the said objections or shall inform in writing to the Project Manager/Inspector giving reasons therein, that no modifications are necessary to comply with the contract.
- 25.5 When the factory tests have been completed at the Bidder's or sub-Bidder's works, the Project Manager /Inspector shall issue a certificate to this effect fifteen (15) days after completion of tests but if the tests are not witnessed by the Project Manager /Inspectors, the certificate shall be issued within fifteen (15) days of the receipt of the Bidder's test certificate by the Project Manager /Inspector. Project Manager /Inspector to issue such a certificate shall not prevent the Bidder from proceeding with the works. The completion of these tests or the issue of the certificates shall not bind the Owner to accept the equipment should it, on further tests after erection be found not to comply with the contract.
- 25.6 In all cases where the contract provides for tests whether at the premises or works of the Bidder or any sub-Bidder, the Bidder, except where otherwise specified shall provide free of charge such items as labour, material, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Project Manager /Inspector or his authorized representatives to carry out effectively such tests on the equipment in accordance with the

Bidder and shall give facilities to the Project Manager/Inspector or to his authorized representative to accomplish testing.

25.7 The inspection by Project Manager / Inspector and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Bidder in respect of the agreed Quality Assurance Programme forming a part of the contract.

25.8 To facilitate advance planning of inspection in addition to giving inspection notice as specified at clause no 9.05.03 of this chapter, the Bidder shall furnish quarterly inspection programme indicating schedule dates of inspection at Customer Hold Point and final inspection stages. Updated quarterly inspection plans will be made for each three consecutive months and shall be furnished before beginning of each calendar month.

25.9 All inspection, measuring and test equipment used by Bidder shall be calibrated periodically depending on its use and criticality of the test/measurement to be done. The Bidder shall maintain all the relevant records of periodic calibration and instrument identification, and shall produce the same for inspection by the Owner. Wherever asked specifically, the Bidder shall re-calibrate the measuring/test equipment in the presence of Project Manager/Inspector.

25.10 Associated document for quality assurance programme:

25.10.1 List of items requiring quality plan and sub supplier approval. (Annexure-III).

25.10.2 Status of items requiring Quality Plan and sub supplier approval (Annexure-IV)

25.10.3 Field Welding Schedule (Annexure-V).

25.10.4 Manufacturing Quality Plan (Annexure-I).

25.10.5 Field Quality Plan (Annexure-II).

25.11 TESTING OF MAJOR DESIGN FEATURES OF I&C SYSTEM:

The major design features of the system shall be demonstrated by the Contractor at the Contractor's works or any other place mutually agreed within four months from the date of LOA. These are the system function tests, which have a major impact on the detailed system design & finalization of important engineering documents like configuration, functional grouping, BOM etc., but do not require a fully engineered system for conductance. Bidder shall identify these features & include detailed test procedures in the bid, which shall be finalized during discussions with the bidder before award. The developments and any augmentation of standard features undertaken by the Bidder to fulfil the various specification requirements, shall be also be tested during these major design tests. This shall include but not be limited to the following

- A) System accuracy tests of DDCMIS for the various type of inputs identified in Part-B.
- B) Loop reaction time for sample loops/ logics
- C) SOE functionality tests
- D) Server changeover
- E) Various response times, having serious implication on operation & maintenance philosophy



- F) Duty cycle of controller/ HMIPIS with simulated load, representative of the final engineered load.
- G) Unified HMI for DDCMIS

The results of the above tests, after its acceptance by the Owner, shall be properly documented and submitted to Owner.

25.12 DEMONSTRATION OF APPLICATION ENGINEERING

2.12.1 Based on UPRVUNL inputs, the Contractor shall prepare and submit typical implemented scheme in their system (Control system & HMI) on sample basis. The typical cases to be covered shall include but not be limited to the following

i) Logics/Loops:

- a) Drive logics implementation for each type of binary drive along with its display in HMI.
- b) Sequence implementation along with its display in HMI.
- c) Single non-cascade controller implementation.
- d) Cascade loop implementation.
- e) Master slave implementation with different slave combination.
- f) Temperature & pressure compensation for flow signals & pressure compensation for level signals as applicable

ii) HMI Functions:

- a) LVS Annunciation.
- b) Graphics.
- c) HSR
- d) Logs/Reports.
- e) Calculations (Basic & Performance Calculations).

25.12.2 The above typical cases shall be finalized with the Owner through Technical Co-ordination meetings.

After review and finalization of the typical cases, the implementation of each logic & control loop shall be carried out by the Contractor based on UPRVUNL inputs. After implementation of these logics & loops, the Contractor shall test each logic /loop and record the observations in a format to be provided by the Owner and demonstrate to Owner at Owner premises during engineering finalization. Any modifications as a result of the demonstration shall be done and documented as part of the test report along with the final scheme. Similarly, HMI functions shall also be demonstrated by the Contractor at Owner premises & the results shall be documented as part of test report.

25.12.3 During the integrated testing at the Contractor's works, only sample checks shall be done by the Owner for the items covered in above application engineering demonstration.



26.0 PRE-COMMISSIONING, COMMISSIONING, TRIAL OPERATION, PERFORMANCE TEST

- 26.1 a) As soon as the facilities or part thereof has been completed operationally and structurally and before start-up, each item of the equipment and systems forming part of facilities shall be thoroughly cleaned and then inspected jointly by the Owner and the Bidder for correctness of and completeness of facility or part thereof and acceptability for initial pre-commissioning tests, commissioning and start-up at Site. The list of pre-commissioning tests to be performed shall be as mutually agreed and included in the Bidder's quality assurance programme as well as those included elsewhere in the Technical Specifications.
- b) The Bidder's pre-commissioning/ commissioning/start-up engineers, specially identified as far as possible, shall be responsible for carrying out all the pre-commissioning tests at Site. On completion of inspection, checking and after the pre-commissioning tests are satisfactorily over, the commissioning of the complete facilities shall be commenced during which period the complete facilities, equipments shall be operated integral with sub-systems and supporting equipment as a complete plant.
- c) It will be the responsibility of the Bidder to assess and furnish a list of all commissioning spars required for successful commissioning of all the equipment covered under the contract. Such a list shall be furnished by the Bidder within 12 months from the date of LOA, separately for each equipment and shall be reviewed by the Owner and discussed for mutual agreement. The commissioning spares will be so identified as not to allow the trial operation to suffer for want of such commissioning spares. The identification of commissioning spares will not in any way relieve the Bidder of any of his responsibilities of satisfactory performance under the provisions of other conditions of contract. All the commissioning spares shall be deemed to be included in scope of the Bidder as a part of the respective equipment package at no extra cost to the Owner.
- d) All piping system shall be flushed, steam blown, air blown as required and cleanliness demonstrated using acceptable industry standards. Procedures to accomplish this work shall be submitted for approval to the Owner six months prior to the respective implementations. The Owner will approve final verification of cleanliness.
- e) The time consumed in the inspection and checking of the units shall be considered as a part of the erection and installation period.
- f) The check outs during the pre - commissioning period should be programmed to follow the construction completion schedule. Each equipment/system, as it is completed in construction and turned over to Owner's commissioning (start-up) Engineer(s), should be checked out and cleaned. The checking and inspection of individual systems should then follow a prescribed commissioning documentation [SLs (Standard Check List) / TS (Testing Schedule) / CS (Commissioning Schedule)] approved by the Owner.
- g) The Bidder during initial operation and performance testing shall conduct vibration testing to determine the 'base line' of performance of all plant rotating equipment. These tests shall be conducted when the equipment is running at

the base load, peak load as well as lowest sustained operating condition as far as practicable.

26.1.1 Bidder shall furnish the commissioning organization chart for review & acceptance of Owner at least eighteen months prior to the schedule date of synchronization of 1st unit. The chart should contain:

- a) Biodata including experience of the Commissioning Engineers.
- b) Role and responsibilities of the Commissioning Organisation members.
- c) Expected duration of posting of the above Commissioning Engineers at site.

26.2 Initial Operation / Trail Operation Test

- a) On completion of all pre-commissioning activities / tests and as a part of commissioning the complete facilities shall be put on 'Initial Operation' during which period all necessary adjustments shall be made while operating over the full load range enabling the facilities to be made ready for the Guarantee Tests.
- b) The 'Initial Operation' of the complete facility as an integral unit shall be conducted for 720 continuous hours. During the period of initial operation of 720 hours, the unit shall operate continuously at full rated load for a period not less than 72 hours.

The Initial Operation Test shall be considered successful, if during the above period of initial operation, the 660MW unit shall generates a minimum of 451 million kWhrs*, as measured a generator terminals.

- c) The Initial Operation shall be considered successful, provided that each item/ part of the facility has operate continuously at the specified operating characteristics, for the period of Initial Operation with all operating parameters within the specified limits and at or near the predicted performance of the equipment/ facility.
- d) The Bidder shall intimate the Owner about the commencement of initial operation and shall furnish adequate notice to the Owner in this respect.
- e) Any loss of generation due to constraints attributable to the Owner shall be construed as Deemed Generation.
- f) An Initial Operation report comprising of observations and recordings of various parameters to be measured in respect of the above Initial Operation shall be prepared by the Bidder. This report, besides recording the details of the various observations during initial operation shall also include the dates of start and finish of the Initial Operation and shall be signed by the representatives of both the parties. The report shall have sheets, recording all the details of interruptions occurred, adjustments made and any minor repairs done during the Initial Operation. Based on the observations, necessary modifications / repairs to the plant shall be carried out by the Bidder to the full satisfaction of the Owner to enable the latter to accord permission to carry out the Guarantee tests on the facilities. However, minor defects which do not endanger the safe

operation of the equipment, shall not be considered as reasons for withholding the aforesaid permission.

(* - shall be appropriately adjusted for any generation loss attributable to Employer.)

26.3 Guarantee Tests

- a) The final test as to prove the Functional Guarantees shall be conducted at Site by the Contractor in presence of the Employer. The contractor's Commissioning, start-up and initial operation shall make the unit ready to conduct such test. Such test will be commenced, within a period of **three (3) months** after the successful completion of Initial Operations. Any extension of time beyond the above **three (3) months** shall be mutually agreed upon.
- b) These tests shall be binding on both the parties of the Contract to determine compliance of the equipment with the functional guarantee.
- c) For performance/ demonstration tests instrumentations, of accuracy class, to the approval of the Owner shall be used. The numbers and location of the instruments shall be as per the specified test codes. In addition the values of parameters shall be logged from the information system provided under Owner's Distributed Digital Control Monitoring and Information system. Test will be conducted at specified load points.
- d) Any special equipment, tools and tackles required for the successful completion of the Guarantee Tests shall be provided by the Bidder, free of cost.
- e) The Guarantee tests and specific tests to be conducted on equipments have been brought out in detail elsewhere in the specification.

27.0 TAKING OVER

Upon successful completion of Initial Operations and all the tests (including all PG test) conducted to the Employer's satisfaction, the Employer shall issue to the Contractor a Taking over Certificate as a proof of the final acceptance of the equipment. Such certificate shall not unreasonably be withheld nor will the Employer delay the issuance thereof, on account of minor omissions or defects which do not affect the commercial operation and/or cause any serious risk to the equipment. Such certificate shall not relieve the Contractor of any of his obligations which otherwise survive, by the terms and conditions of the Contract after issuance of such certificate.

28.0 TRAINING OF OWNER'S PERSONNEL

- 28.1 The scope of service under training of Owner shall include a training module in the areas of Operation & Maintenance.

Such training should cover the following areas as a minimum in order to enable these personnel to individually take the responsibility of operating and maintaining the power station in a manner acceptable to the Owner:



- a) Training for Steam Generator & ESP Equipment, TG & Auxiliaries and related equipments.
- b) Training for Electric Systems including VFD and Electric power supply system.
- c) Training for other SG/TG related C&I systems/equipments including training on Flame Monitoring System, Furnace and Flame Viewing System , Turbine Supervisory System (TSS) including vibration analyzer, vibration monitoring system axial shift, eccentricity measurements etc. for Main Turbine, BFP Turbine etc. Burner management study, control loop study, misc system for SG C&I, EHTC, Turbine stress control system, Turbine protection system, ATRS, instrumentation etc.
- d) Training for special packages for various PC based systems.
- e) Training for various C&I systems/equipment supplied includes the following:
 - i. DDCMIS - Human Machine Interface – Hardware & Operating System
 - ii. DDCMIS-Human Machine Interface System Engineering & Application Software.
 - iii. DDCMIS – Control System Hardware and Control system Application Software.
 - iv. DDCMIS – Operator Training: Use of the system at Works + at site.
 - v. DDCMIS – Specialized Network security.
- f) Training for power cycle piping/critical piping.
- g) Training for UPS systems Annunciation system, SWAS, PA system, flue gas analysers, CCTV and 24 VDC systems.
- h) Training for numerical relays & networking systems supplied under MV & LT switchgear system.
- i) Details of training modules for Mechanical, Electrical and C&I systems are given at Annexure – VII,

The exact details, extent and schedule for training shall be as finalised during detailed engineering and shall be subject to Owner's approval.

- 28.2 The scope of services under training shall also necessarily include training of Owner's Engineering personnel covering a training module as indicated in Annexure – VII. This shall cover all disciplines viz, Mechanical, Electrical, C&I, & QA etc. and shall include all the related areas like Design familiarization, training on product design features and product design softwares of major equipment and systems, engineering, manufacturing, erection, commissioning, training on operating features of equipment, quality assurance and testing, plant visits and visits to manufacturer's works, exposure to various kinds of problems which may be encountered in fabrication, manufacturing, erection, welding etc.
- 28.3 Contractor shall also arrange for training of Employer's personnel in respect of fire detection and protection systems and other Balance of Plant equipments.

- 28.4 Four (4) man month and two (2) man month training for OWNER Engineering Personnel on the offered CFD modelling code for SG & ESP including alternative geometry modeling technique shall be provided.
- 28.5 Bidder shall furnish in his offer, details of training module(s) covering above requirements which shall be subject to Owner's approval. Consolidated training period included above (Annexure – VII for O&M and Engineering) is indicative only. Owner reserves the right to reappropriate the training period between O&M and engineering depending upon the details of training module proposed by the Bidder.
- 28.6 Exact details, extent of training and the training schedule shall be finalised based on the Bidder's proposal within two (2) months from placement of award.
- 28.7 In all the above cases, wherever the training of Owner's personnel is arranged at the works of the manufacturer's (within Employer's Country) it shall be noted that the lodging and boarding of the Owner's personnel shall be at the cost of Bidder. The Bidder shall make all necessary arrangements towards the same.
- 28.8 In case the training of Owner's personnel is arranged at the works of the manufacturer's (outside Employer's Country) it shall be noted that the all the expenses including travel, air fare, application processing fees, lodging and boarding of the Owner's personnel shall be at the cost of Bidder. The Bidder shall make all necessary arrangements towards the same.
- 28.9 Take off prices (product wise) should be indicated by the Bidder in the Bid Proposal Sheets. Owner reserves the right to include or exclude these item(s) during place of Award.
- 28.10** In addition to above, the contractor shall also arrange for training of 30 Owner's Personnel at a running 660 MW unit on operation of power station, for a period of six (6) months. The training shall be conducted before commissioning of the unit. The lodging and boarding of the Owner's personnel shall be at the cost of Bidder. The Bidder shall make all necessary arrangements towards the same

Note: For training purposes, one (1) man month implies 30 working days (excluding all intervening holidays) per person.

29.0 SAFETY ASPECTS DURING CONSTRUCTION AND ERECTION

In addition to the requirements given in Erection Conditions of Contract (ECC) the following shall also cover:

- a) Working platforms should be fenced and shall have means of access.
- b) Ladders in accordance with Owner's safety rules for construction and erection shall be used. Rungs shall not be welded on columns. All the stairs shall be provided with handrails immediately after its erection.

30.0 Noise level



The equivalent 'A' weighted sound pressure level measured at a height of 1.0 m above floor level in elevation and at a distance of one (1) meter horizontally from the nearest surface of any equipment / machine, furnished and installed under these specifications, expressed in decibels to a reference of 0.0002 microbar, shall not exceed 85 dBA except for

- a) Safety valves and associated vent pipes for which it shall not exceed 105 dBA.
- b) Regulating drain valves in which case it shall be limited to 90 dBA.
- c) TG unit in which case it shall not exceed 90 dBA.
- d) For HP-LP bypass valves and other intermittently operating control valves, the noise level shall be within the limit of 85 dBA.
- e) Mill noise which will be limited to 85-90 dBA.

31.0 PACKAGING AND TRANSPORTATION

All the equipments & spares shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. Each spare shall be clearly marked or labelled on the outside of the packing with its description. When more than one spare part is packaged in a single case, a general description of the contents shall be shown on the outside of such a case and other packages must be suitably marked and numbered for the purpose of identification. All cases, containers or packages, are liable to be opened for such examination as may be considered reasonable by the Engineer. In case of equipment supplied with grease/lubricants from imported origin, the supplied shall clearly indicate the indigenous equivalent of the grease/lubricant and source of supply so as to enable the Owner to procure these items from indigenous sources. While packing all the materials, the limitation from the point of view of the sizes of railway wagons available in India should be taken account of. The Bidder shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. The Bidder shall ascertain the availability of Railway wagon sizes from the Indian Railways or any other agency concerned in India well before effecting dispatch of equipment. Before dispatch it shall be ensured that complete processing and manufacturing of the components is carried out at shop, only restricted by transport limitation, in order to ensure that site works like grinding, welding, cutting & pre-assembly to bare minimum. The Owner's Inspector shall have right to insist for completion of works in shops before dispatch of materials for transportation.

32.0 ELECTRICAL EQUIPMENTS/ENCLOSURES

All electrical equipments and devices, including insulation, heating and ventilation devices shall be designed for ambient temperature and a maximum relative humidity as specified elsewhere in the specification.

33.0 Instrumentation and Control

All instrumentation and control systems/ equipment/ devices/ components, furnished under this contract shall be in accordance with the requirements stated herein, unless otherwise specified in the detailed specifications.



- 33.1 All instrument scales and charts shall be calibrated and printed in metric units and shall have linear graduation. The ranges shall be selected to have the normal reading at 75% of full scale.

All scales and charts shall be calibrated and printed in Metric Units as follows:

a)	Temperature	-	Degree centigrade (deg C)
b)	Pressure	-	Kilograms per square centimeter (Kg/cm ²). Pressure instrument shall have the unit suffixed with 'a' to indicate absolute pressure. If nothing is there, that will mean that the indicated pressure is gauge pressure.
c)	Draught	-	Millimeters of water column (mm wc).
d)	Vacuum	-	Millimeters of mercury column (mm Hg) or water column (mmWcl).
e)	Flow (Gas)	-	Tonnes/ hour
f)	Flow (Steam)	-	Tonnes/ hour
g)	Flow (Liquid)	-	Tonnes / hour
h)	Flow base	-	760 mm Hg. 15 deg.C
i)	Density	-	Grams per cubic centimeter.

- 33.2 All instruments and control devices provided on panels shall be of miniaturized design, suitable for modular flush mounting on panels with front draw out facility and flexible plug-in connection at rear.

- 33.3 All electronic modules shall have gold plated connector fingers and further all input and output modules shall be short circuit proof. These shall also be tropicalized & components shall be of industrial grade or better.

34.0 ELECTRICAL NOISE CONTROL

The equipment furnished by the Bidder shall incorporate necessary techniques to eliminate measurement and control problems caused by electrical noise. Areas in Bidder's equipment, which are vulnerable to electrical noise shall be hardened to eliminate possible problems. Any additional equipment, services required for effectively eliminating the noise problems shall be included in the proposal. The equipment shall be protected against ESD as per IEC-801- 2. Radio Frequency interference (RFI) and Electro Magnetic Interference (EMI) protection against hardware damage and control system mal-operations/errors shall be provided for all systems.

35.0 SURGE PROTECTIONS FOR SOLID STATE EQUIPMENT

All solid state systems /equipment shall be able to withstand the electrical noise and surge as encountered in actual service conditions and inherent in a power plant and shall meet the requirements of surge protection as defined in ANSI C37.90.1-1989 on its suitable equivalent class of IEC 254-4. Details of the features incorporated and relevant tests carried out. The test certificates etc. shall be submitted by the Bidder.

36.0 Instrument Air System

The instrument air supply system as supplied by the Bidder for various pneumatic control & instrumentation devices like pneumatic actuators, power

cylinders, E/P converters, piping / tubing etc. shall be as per the details furnished elsewhere.

Each pneumatic instrument shall have an individual air shut - off valve. The pressure-regulating valve shall be equipped with an internal filter, a 50 mm pressure gauge and a built-in filter housing blow down valve.

37.0 TAPPING POINTS FOR MEASUREMENTS

Tapping points shall include probes, wherever applicable, for analytical measurements and sampling.

For direct temperature measurement of all working media, one stub with internal threading of approved pattern shall be provided along with suitable plug and washer. The Bidder will be intimated about thread standard to be adopted.

The following shall be provided on equipment by the Bidder. The standard which is to be adopted, will be intimated to the Bidder.

- a) Temperature test pockets with stub and thermowell.
- b) Pressure test pockets

38.0 SYSTEM DOCUMENTATION (DDCMIS)

The Bidder shall provide drawings, system overview & description, hardware/ software details, technical literature, functional & hardware schemes, bill of material, parts list, interconnection diagrams, data sheets, erection/ installation/ commissioning procedures, instruction/ operating manuals, etc. for each of the C&I system / sub-systems/ equipment supplied under this package. The documentation shall include complete details of the C&I systems/ sub-systems/ equipment to enable review by Owner during detailed engineering stage and to provide information to plant personnel for operation & Maintenance (including quick diagnostics & trouble shooting) of these C&I systems/ sub-systems/ equipment at site. The minimum documentation requirements for C&I systems shall be as stipulated under C&I "Technical Data Sheets" Part of specifications. In addition to this, system documentation for DDCMIS shall include as a minimum to that specified elsewhere in the Technical Specification.

The exact format, submission schedule and contents of various documents shall be as finalised during detailed engineering stage.

- 38.1 Bill of material (instrument list) for all C&I equipment/ devices shall be furnished by the bidder in standard formats as approved by the Owner.

39.0 MAINTENANCE MANUALS OF ELECTRONIC MODULES

The Contractor shall have to furnish two(2) sets of all maintenance manual of each and every electronic card/module as employed on the various systems and equipment including peripherals etc., offered by him. The Contractor will also have to furnish the data regarding the expected failure rate of various modules and other system components. Further, the contractor shall furnish a set of operating manuals which should include block diagrams, make,

model/type, details wiring and external connection drawings etc as required to do the testing and maintenance of the electronic modules.

40.0 ENVIRONMENTAL MONITORING & CONTROL MEASURES

- 40.1 The Power Plant will be developed based on the guidelines of the State Environmental Authorities and that of MoEF. Suitable provisions will be incorporated in the design of buildings, structures, and selection of equipment, so that there are no adverse effects due to emissions, noise, and contamination of soil, water and air.
- 40.2 One single flue stack of 275 meter will be provided for 660 MW unit for wider dispersion of pollutant as per environmental guidelines.

41.0 LIST OF CODES AND STANDARDS

←---	Indian Standards Title	--→	← International and international → recognized Standards
IS: 277	Galvanised steel sheets (plain or corrugated)		
IS: 655	Specification for metal air duct		
IS: 800	Code of practice for use of structural steel in general building construction 1-1952		BS 449:1969 BS 5950 ASA A57,
IS: 807	Code of practice for design, manufacture, erection and testing (Structural portion) of cranes and hoists 6588 (Issued by Standards Association of Australia) DIN 120:1936 (Sheet 1) DIN 120:1936 (Sheet 2) 327 part-I, 1951 BS 466 part-II, 1960 BS 644:1960BS 1757:1951 BS 2573:part-I:1960		Draft Revision, A.S. NO. CS.2 SAA Crane and Hoist code Doc:No. BU/4 Rev
IS:875	Code of practice for design loads (other than Canadaearthquake) for buildings and structures Leading standards (issued by Canadian Standard) DIN-1055-1955 (Issued by ASA)		National Building code of (1953)-Part-IV Design section 4.1



IS:1239 Part-I	Mild steel tubes	(ISO/R 65-1957) (ISO/R-64-1958) (ISO/R-65-1958) (BS 1387 : 1957)
IS:1239 Part-II	Mild steel tubulars and other wrought steel pipe fittings	BS 1387 : 1967 BS 1387 :1967 BS 1740 :1965
IS:2825	Code for unfired vessels	
IS:1520	Horizontal centrifugal pumps for clear cold and fresh water	
IS:1600	Code for practice for performance of constant speed IC Engines for general purpose	
IS:1601	Specification for performance of constant speed IC Engines for general Purpose	
IS:1893	Criteria for earthquake resistant design of structures	
IS1978-1971	Line Pipe April 1969.	API Standards 5L
IS:2254-1970	Dimensions of vertical shaft motor for pumps	IEC Pub 72-1 part I NEMA Pub MG 1 1954
IS:2266	Steel wire ropes for general engineering purposes	BS :302 : 1968
IS:2312	Propellant type Ventilation fans	
IS:2365	Steel wire suspension ropes for lifts and hoists	BS : 1957
IS:3346	Method for the determination of thermal conductivity of thermal insulation materials (two slab guarded hot plate method)	DIN 52612 (Deutscher Normenausschuss) ASTM C 163-1964 (American Society of Testing and materials) ASTM C 167-1974 ASTM C 177-1963
IS:3354	Outline dimensions for electric lifts.	
IS:3401	Silica gel	
IS:3588	Specification for electrical axial	

	flow fans	
IS:3589	Electrically welded steel pipes for water, gas and sewage (200mm to 2000 mm Nominal Diametre)	
IS:3677	Unbonded rock and slag wool for thermal insulation	
IS:3815	Point hook with shank for general engineering purposes	BS 482 - 1968 Doc.:67/3 1284 (Revision of BS 2903) (Issued BS)
IS:3895	Specification for monocrystallines semiconductor rectifier cells and stacks	
IS:3963	Roof extractor unit	
IS:3975	Mild steel wires, strips and tapes for armouring cables	
IS:4503	Shell and tube type heat Exchanger	
IS:4540	Specification for monocrystallines rectifier assembly equipment	
IS:4671	Expanded polystyrene for thermal insulation purpose	
IS:4736	Hot dip zinc coating on steel tubes	
IS:4894	Centrifugal fans	
IS:5456	Code of practice for testing of positive displacement type air compressors and exhauster (For Test Tolerance Only)	
IS:5749	Forged ramshorn hooks	Entwurf DIN 15402 Blett 1 Entwurf DIN 15402 BS 3017-1958
IS:6392	Steel pipe flanges	BS 4504 : 1969
IS:6524 Part-I	Code of practice for design of tower cranes Static and rail mounted	BS 2799 : 1956
IS:7098	Cross linked Polyethylene insulated PVC sheathed	Standard No. 1 to IPCEA (USA) Pub.



	cables No. 5-66-524
IS:7373	Specification for wrought aluminium and aluminium sheet and strips
IS:7938	Air receivers for compressed air installation
ISO:1217	Displacement compressor-Acceptance test
ASHRAE-33	Methods of testing for rating of forced circulation air cooling and air heating coils.
ASHRAE-52-76	Air cleaning device used in general ventilation for removing particle matter.
ASHRAE-22-72	Method of testing for rating of water cooled refrigerant condensers.
ASHRAE 23-67	Methods of testing for rating of positive displacement refrigerant compressors.
ARI-450-6	Standard for water cooled refrigerant condensers.
ARI-550	Standard for centrifugal water chilling packages.
ARI-410	Standard for forced circulation air cooling and air heating coils
ARI-430/435 BS:848 (Part-1,2)	Central station AHU/Application of Central Station AHU Fans
BS:400	Low carbon steel cylinders for the storage & transport of permanent gases.
BS:401	Low carbon steel cylinders for the storage & transport of liquefied gases.
CTI Code ACT-105	Acceptance test code for Water Cooling Tower.
ANSI-31.5	Refrigerant piping
ASME-PTC- 23-1958	Atmospheric Water Cooling Equipment
AMCA A-21C	Test Code for air moving devices
API:618	Reciprocating Compressor for general refinery services.
HYDRAULIC INSTITUTE STANDARDS.	
HYDRANT SYSTEM MANUALS OF TAC.	
TAC MANUALS OF SPRAY SYSTEM	



NFPA USA/ NSC UK/ UL USA/ FM USA STANDARDS.

INDIAN EXPLOSIVES ACT.

INDIAN FACTORIES ACT.

STANDARD OF TUBULAR EXCHANGER MANUFACTURER'S ASSOCIATION.

CODE AND STANDARD FOR CIVIL WORKS

Some of the applicable Standards, Codes and references are as follows:

Excavation & Filling

IS: 2720 (Part-II, IV TO VIII, XIV, XXI, XXIII, XXIV, XXVII TO XXIX, XL) Methods of test for soils-determination for water content etc.

IS: 4701 Code of practice for earth work on canals.

IS: 9758 Guide lines for Dewatering during construction.

IS: 10379 Code of practice for field control of moisture and compaction of soils for embankment and sub-grade.

Properties, Storage and Handling of Common Building Materials

IS: 269 Specification for ordinary Portland cement, 33 grade.

IS: 383 Specification for coarse and fine aggregates from natural sources for concrete.

IS: 432 Specification for mild steel and (Parts 1&2) medium tensile steel bars and hard-drawn steel wires for concrete reinforcement.

IS: 455 Specification for Portland slag cement.

IS: 702 Specification for Industrial bitumen.

IS: 712 Specification for building limes.

IS: 808 Rolled steel Beam channel and angle sections.

IS: 1077 Specification for common burnt clay building bricks.

IS: 1161 Specification of steel tubes for structural purposes.

IS: 1363 Hexagon head Bolts, Screws and nuts of production grade C.

IS: 1364 Hexagon head Bolts, Screws and Nuts of Production grade A & B.

IS: 1367 Technical supply conditions for Threaded fasteners.

IS: 1489 Specification for Portland-pozzolana cement:

(Part-I) Fly ash based.



(Part-II)	Calcined clay based.
IS: 1542	Specification for sand for plaster.
IS: 1566	Specification for hard-drawn steel wire fabric for concrete reinforcement.
IS: 1786	Specification for high strength deformed bars for concrete reinforcement.
IS: 2062	Specification for steel for general structural purposes.
IS: 2116	Specification for sand for masonry mortars.
IS: 2386 (Parts-I to VIII)	Testing of aggregates for concrete.
IS: 3150	Hexagonal wire netting for general purpose.
IS: 3495 (Parts-I to IV)	Methods of tests of burnt clay building bricks.
IS: 3812	Specification for fly ash, for use as pozzolana and admixture.
IS: 4031	Methods of physical tests for hydraulic cement.
IS: 4032	Methods of chemical analysis of hydraulic cement.
IS: 4082	Recommendations on stacking and storage of construction materials at site.
IS: 8112	Specification for 43 grade ordinary portland cement.
IS:8500	Medium and high strength structural steel.
IS: 12269	53 grade ordinary portland cement.
IS: 12894	Specification for Fly ash lime bricks.

Cast-In-Situ Concrete and Allied Works

IS: 280	Specification for mild steel wire for general engineering purposes.
IS: 456	Code of practice for plain and reinforced concrete.
IS: 457	Code of practice for general construction of plain & reinforced concrete for dams & other massive structures.
IS: 516	Method of test for strength of concrete.
IS: 650	Specification for standard sand for testing of cement.
IS:1199	Methods of sampling and analysis of concrete.
IS: 1791	General requirements for batch type concrete mixers.



IS: 1838 (Part-I)	Specification for preformed fillers for expansion joints in concrete pavements and structures (non-extruding and resilient type).
IS: 2204	Code of practice for construction of reinforced concrete shell roof.
IS: 2210	Criteria for the design of reinforced concrete shell structures and folded plates.
IS: 2438	Specification for roller pan mixer.
IS: 2502	Code of practice for bending and fixing of bars for concrete reinforcement.
IS: 2505	General requirements for concrete vibrators, immersion type.
IS: 2506	General requirements for concrete vibrators, screed board type.
IS: 2514	Specification for concrete vibrating tables.
IS: 2645	Specification for Integral cement water proofing compounds.
IS: 2722	Specification for portable swing weigh batches for concrete. (single and double bucket type)
IS: 2750	Specification for Steel scaffolding.
IS: 2751	Code of practice for welding of mild steel plain and deformed bars for reinforced concrete construction.
IS: 3025	Methods of sampling and test waste water.
IS: 3366	Specification for Pan vibrators.
IS: 3370 (Part I to IV)	Code of practice for concrete structures for the storage of liquids.
IS: 3414	Code of practice for design and installation of joints in buildings.
IS: 3550	Methods of test for routine control for water used in industry.
IS: 3558	Code of practice for use of immersion vibrators for consolidating concrete.
IS: 4014 (Parts I & II)	Code of practice for steel tubular scaffolding.
IS: 4326	Code of practice for earthquake resistant design and construction of buildings.
IS: 4461	Code of practice for joints in surface hydro-electric power stations.
IS: 4656	Specification for form vibrators for concrete.
IS: 4925	Specification for batching and mixing plant.



IS: 4990	Specification for plywood for concrete shuttering work.
IS: 4995 (Parts I & II)	Criteria for design of reinforced concrete bins for the storage of granular and powdery materials.
IS: 5256	Code or practice for sealing joints in concrete lining on canals.
IS: 5525	Recommendations for detailing of reinforcement in reinforced concrete work.
IS: 5624	Specification for foundation bolts.
IS: 6461	Glossary of terms relating to cement concrete.
IS: 6494	Code of practice for water proofing of underground water reservoirs and swimming pools.
IS: 6509	Code of practice for installation of joints in concrete pavements.
IS: 7861	Code of practice for extreme weather concreting. (Parts I & II)
IS: 9012	Recommended practice for shot concreting.
IS: 9103	Specification for admixtures for concrete.
IS: 9417	Recommendations for welding cold worked steel bars for reinforced concrete construction.
IS: 10262	Recommended guidelines for concrete mix design.
IS: 11384	Code of practice for composite construction in structural steel and concrete.
IS: 11504	Criteria for structural design of reinforced concrete natural draught cooling towers.
IS: 12118	Specification for two-parts poly sulphide.
IS: 12200	Code of practice for provision of water stops at transverse contraction joints in masonry and concrete dams.
IS: 13311	Method of non-destructive testing of concrete.
Part-1	Ultrasonic pulse velocity.
Part-2	Rebound hammer.
SP: 23	Handbook of concrete mixes
SP: 24	Explanatory Handbook on IS: 456-1978
SP: 34	Handbook on concrete reinforcement and detailing.

Precast Concrete Works

SP: 7(PartVI/Sec.7) National Building Code- Structural design of prefabrication and



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001
Page 102 of 429



systems building.

IS: 10297 Code of practice for design and construction of floors and roofs using precast reinforced/prestressed concrete ribbed or cored slab units.

IS: 10505 Code of practice for construction of floors and roofs using pre-cast reinforced concrete units.

Masonry and Allied Works

IS: 1905 Code of Practice for Structural Safety of Buildings-Masonry walls.

IS: 2212 Code of Practice for Brickwork.

IS: 2250 Code of Practice for Preparation and use of Masonry Mortar.

SP: 20 Explanatory hand book on masonry code.

Sheeting Works

IS:277 Galvanised steel sheets (plain or corrugated).

IS: 459 Unreinforced corrugated and semi-corrugated asbestos cement sheets.

IS: 513 Cold-rolled carbon steel sheets.

IS: 730 Specification for fixing accessories for corrugated sheet roofing.

IS: 1626 Specification for Asbestos cement building pipes and pipe fittings, gutters and gutter fittings and roofing fittings.

IS: 2527 Code of practice for fixing rain water gutters and down pipe for roof drainage.

IS: 3007 Code of practice for laying of asbestos cement sheets.

IS: 5913 Methods of test for asbestos cement products.

IS: 7178 Technical supply conditions for tapping screw.

IS: 8183 Bonded mineral wool.

IS: 8869 Washers for corrugated sheet roofing.

IS: 12093 Code of practice for laying and fixing of sloped roof covering using plain and corrugated galvanised steel sheets.

IS: 12866 Plastic translucent sheets made from thermosetting polyster resin (glass fibre reinforced).

IS: 14246 Specification for continuously pre-painted galvanised steel sheets and coils.

Fabrication and Erection of Structural Steel Work

IS: 2016	Specification for plain washers.
IS: 814	Specification for covered Electrodes for Metal Arc Welding for weld steel.
IS: 1852	Specification for Rolling and Cutting Tolerances for Hot rolled steel products.
IS: 3502	Specifications for chequered plate.
IS: 6911	Specification for stainless steel plate, sheet and strip.
IS: 3757	Specification for high strength structural bolts
IS: 6623	Specification for high strength structural nuts.
IS: 6649	High Tensile friction grip washers.
IS: 800	Code of practice for use of structural steel in general building construction.
IS: 816	Code of practice for use of Metal Arc Welding for General Construction.
IS: 4000	Code of practice for assembly of structural joints using high tensile friction grip fasteners.
IS: 9595	Code of procedure of Manual Metal Arc Welding of Mild Steel.
IS: 817	Code of practice for Training and Testing of Metal Arc Welders.
IS: 1811	Qualifying tests for Metal Arc Welders (engaged in welding structures other than pipes).
IS: 9178	Criteria for Design of steel bins for storage of Bulk Materials.
IS: 9006	Recommended Practice for Welding of Clad Steel.
IS: 7215	Tolerances for fabrication steel structures.
IS: 12843	Tolerance for erection of structural steel.
IS: 4353	Recommendations for submerged arc welding of mild steel and low alloy steels.
SP: 6 (Part 1 to 7)	ISI Hand book for structural Engineers.
IS: 1608	Method of Tensile Testing of Steel products other than sheets, strip, wire and tube.
IS: 1599	Method of Bend Tests for Steel products other than sheet, strip, wire and tube



IS : 228	Methods of chemical Analysis of pig iron, cast iron and plain carbon and low alloy steel.
IS : 2595	Code of Practice for Radio graphic testing.
IS : 1182	Recommended practice for Radiographic Examination of fusion welded butt joints in steel plates.
IS : 3664	Code of practice for Ultra sonic Testing by pulse echo method.
IS : 3613	Acceptance tests for wire flux combination for submerged Arc Welding.
IS : 3658	Code of practice for Liquid penetrant Flaw Detection.
IS : 5334	Code of practice for Magnetic Particle Flaw Detection of Welds.

Plastering and Allied Works

IS : 1635	Code of practice for field slaking of Building lime and preparation of putty.
IS : 1661	Application of cement and cement lime plaster finishes.
IS : 2333	Plaster-of-paris.
IS : 2402	Code of practice for external rendered finishes.
IS : 2547	Gypsum building plaster.
IS : 3150	Hexagonal wire netting for general purpose.

Acid and Alkali Resistant Lining

IS : 158	Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali & heat resisting.
IS : 412	Specification for expanded metal steel sheets for general purpose.
IS : 4441	Code of practice for use of silicate type chemical resistant mortars.
IS : 4443	Code of practice for use of resin type chemical resistant mortars.
IS : 4456	Method of test for chemical resistant tiles. (Part I & II)
IS : 4457	Specification for ceramic unglazed vitreous acid resistant tiles.
IS : 4832	Specification for chemical resistant mortars.
	Part I Silicate type
	Part II Resin type
	Part III Sulphur type



IS : 4860	Specification for acid resistant bricks.
IS : 9510	Specification for bitumasitc, Acid resisting grade.

Water Supply, Drainage and Sanitation

IS : 458	Specification for concrete pipes.
IS : 554	Dimensions for pipe threads, where pressure tight joints are made on thread.
IS : 651	Specification for salt glazed stoneware pipes.
IS : 774	Flushing cisterns for water closets and urinals.
IS : 775	Cast iron brackets and supports for wash basins and sinks.
IS : 778	Copperalloy gate, globe and check valves for water works purposes.
IS : 781	Cast copper alloy screw down bib taps and stop valves for water services.
IS : 782	Caulking lead.
IS : 783	Code of practice for laying of concrete pipes.
IS : 1172	Basic requirements for water supply, drainage and sanitation.
IS : 1230	Cast iron rain water pipes and fittings.
IS : 1239	Mild steel tubes, tubulars and other wrought steel fittings.
IS : 1536	Centrifugally cast (Spun) iron pressure pipes for water, gas and sewage.
IS : 1537	Vertically cast iron pressure pipes for water, gas and sewage.
IS : 1538	Cast iron fittings for pressure pipe for water, gas and sewage.
IS : 1703	Ball valves (horizontal plunger type) including float for water supply purposes.
IS : 1726	Cast iron manhole covers and frames.
IS : 1729	Sand cast iron spigot and socket, soil, water and ventilating pipes, fittings and accessories.
IS : 1742	Code of practice for building drainage.
IS : 1795	Pillar taps for water supply purposes.
IS : 1879	Malleable cast iron pipe fittings.
IS : 2064	Code of practice for selection, installation and maintenance of



	sanitary appliances.
IS : 2065	Code of practice for water supply in building.
IS : 2326	Automatic flushing cisterns for urinals.
IS : 2470 (Part-I & II)	Code of practice for installation of septic tanks.
IS : 2501	Copper tubes for general engineering purposes.
IS : 2548	Plastic seat and cover for water-closets.
IS : 2556 (Part 1 to 15)	Vitreous sanitary appliances (vitreous china).
IS : 2963	Non-ferrous waste fittings for wash basins and sinks.
IS : 3114	Code of practice for laying of cast iron pipes.
IS : 3311	Waste plug and its accessories for sinks and wash basins.
IS : 3438	Silvered glass mirrors for general purposes.
IS : 3486	Cast iron spigot and socket drain pipes.
IS : 3589	Electrically welded steel pipes for water, gas and sewage (200mm to 2000mm nominal diameter).
IS : 3989	Centrifugally cast (Spun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
IS : 4111 (Part I to IV)	Code of practice for ancillary structure in sewerage system.
IS : 4127	Code of practice for laying of glazed stone-ware pipes.
IS : 4764	Tolerance limits for sewage effluents discharged into inland-surface waters.
IS : 4827	Electro plated coating of nickel and chromium on copper and copper alloys.
IS : 5329	Code of practice for sanitary pipe work above ground for buildings.
IS : 5382	Rubber sealing rings for gas mains, water mains and sewers.
IS : 5822	Code of practice for laying of welded steel pipes for water supply.
IS : 5961	Cast iron grating for drainage purpose.
IS : 7740	Code of practice for road gullies.
IS : 8931	Cast copper alloy fancy bib taps and stop valves for water services.

IS : 8934	Cast copper alloy fancy pillar taps for water services.
IS : 9762	Polyethylene floats for ball valves.
IS : 10446	Glossary of terms for water supply and sanitation.
IS : 10592	Industrial emergency showers, eye and face fountains and combination units.
IS : 12592	Specification for precast concrete manhole covers and frames.
IS : 12701	Rotational moulded polyethylene water storage tanks.
SP: 35	Hand book on water supply and drainage.
-	Manual on Sewerage and sewage treatment (Published by CPH & EEO) As updated.

Doors, Windows and Allied Works

IS : 204	Tower Bolts
Part-I	Ferrous metals.
Part-II	Nonferrous metals.
IS : 208	Door Handles.
IS : 281	Mild steel sliding door bolts for use with padlocks.
IS : 362	Parliament Hinges.
IS : 420	Specification for putty, for use on metal frames.
IS : 1003 Part-I door	Specification for timber panelled and glazed shutters- (Part-I) shutters.
IS : 1038	Steel doors, windows and ventilators.
IS : 1081	Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators.
IS : 1341	Steel butt hinges.
IS : 1361	Steel windows for industrial buildings.
IS : 1823	Floor door stoppers.
IS : 1868	Anodic coatings on Aluminium and its alloys.
IS : 2202 (Part-II)	Specification for wooden flush door shutters (solid core type); particle board face panels and hard board face panels
IS:2209	Mortice locks (vertical type).

IS:2553	Safety glass
IS:2835	Flat transparent sheet glass.
IS:3548	Code of practice for glazing in buildings.
IS:3564	Door closers (Hydraulically regulated).
IS : 3614	Fire check doors; plate, metal covered and rolling type.
IS:4351	Steel door frames.
IS:5187	Flush bolts.
IS:5437	Wired and figured glass
IS:6248	Metal rolling shutters and rolling grills.
IS:6315	Floor springs (hydraulically regulated) for heavy doors.
IS:7196	Hold fasts.
IS:7452	Hot rolled steel sections for doors, windows and ventilators.
IS:10019	Mild steel stays and fasteners.
IS:10451	Steel sliding shutters (top hung type).
IS:10521	Collapsible gates.

Roof Water Proofing and Allied Works

IS:1203	Methods of testing tar and bitumen.
IS:1322	Specification for bitumen felts for water proofing and damp proofing.
IS:1346	Code of practice for water proofing of roofs with bitumen felts.
IS:1580	Specification for bituminous compound for water proofing and caulking purposes.
IS:3067	Code of practice for general design details and preparatory work for damp proofing and water proofing of buildings.
IS:3384	Specification for bitumen primer for use in water proofing and damp proofing.

Floor Finishes and Allied Works

IS:1237	Specification for cement concrete flooring tiles.
IS:1443	Code of practice for laying and finishing of cement concrete flooring tiles.
IS:2114	Code of practice for laying in-situ terrazzo floor finish.
IS:2571	Code of practice for laying in-situ cement concrete flooring.



IS:3462	Specification for unbacked flexible PVC flooring.
IS:4971	Recommendations for selection of industrial floor finishes.
IS:5318	Code of practice for laying of flexible PVC sheet and tile flooring.
IS:8042	Specification for white portland cement.
IS:13801	Specification for chequered cement concrete flooring tiles.

Painting and Allied Works

IS:162	Specification for fire resisting silicate type, brushing, for use on wood, colour as required.
IS:1477	Code of practice for painting of ferrous metals in buildings.
Part-I	Pretreatment.
Part-II	Painting.
IS:1650	Specification for colours for building and decorative finishes.
IS:2074	Specification for red oxide-zinc chrome, priming, ready mixed paint air drying.
IS:2338	Code of practice for finishing of wood and wood based materials.
Part-I	Operations and workmanship
Part-II	Schedules
IS:2395	Code of practice for painting concrete, masonry and plaster surfaces.
Part-I	Operations and workmanship.
Part-II	Schedule.
IS:2524	Code of practice for painting of nonferrous metals in buildings.
Part-I	Pretreatment.
Part-II	Painting.
IS:2932	Specification of synthetic enamel paint, exterior, under-coating and finishing.
IS:2933	Specification enamel paint, under coating and finishing.
IS:4759	Code of practice for hot dip zinc coating on structural steel and other allied products.
IS:5410	Specification for cement paint

IS:5411
(Part-I) Specification for plastic emulsion paint-for exterior use

IS:6278 Code of practices for white washing and colour washing.

IS:10403 Glossary of terms relating to building finishes.

Piling and Foundation

IS:1080 Code of practice for design and construction of simple spread foundations.

IS:1904 Code of practice for design and construction of foundations in Soils; General Requirements.

IS:2911 Code of practice for designs and construction of Pile foundations (Relevant Parts).

IS:2950
(Part-I) Code of practice for designs and construction of Raft foundation.

IS:2974
(Part-I TO V) Code of practice for design and construction of machine foundations.

IS:6403 Code of practice for determination of Allowable Bearing pressure on Shallow foundation.

IS:8009 Code of practice for calculation of settlement of foundation subjected to symmetrical vertical loads.

Part-I Shallow foundations.

Part-II Deep foundations.

IS:12070 Code of practice for design and construction of shallow foundations on rocks.

DIN:4024 Flexible supporting structures for machines with rotating machines.

VDI:2056 Criteria for assessing mechanical vibrations of machines.

VDI:2060 Criteria for assessing rotating imbalances in machines. Stop Log and Trash Rack

IS:4622 Recommendations for fixed - wheel gates structural design.

IS:5620 Recommendations for structural design criteria for low head slide gates.

IS:11388 Recommendations for design of trash rack for intakes.

IS:11855 General requirements for rubber seals for hydraulic gates. Roads

IRC:5 Standard specifications and Code of practice for road bridges, section-I general Features of Design.



IRC:14	Recommended practice of 2cm thick bitumen and tar carpets.
IRC:16	Specification for priming of base course with bituminous primers.
IRC:19	Standard specifications and code of practice for water bound macadam.
IRC:21	Standard specifications and Code of practice for road bridges, section-III - Cement concrete (plain and reinforced).
IRC:34	Recommendations for road construction in waterlogged areas.
IRC:36	Recommended practice for the construction of earth embankments for road works.
IRC:37	Guidelines for the Design of flexible pavements.
IRC:56	Recommended practice for treatment of embankment slopes for erosion control.
IRC:73	Geometric design standards for rural (non-urban) highways.
IRC:86	Geometric Design standards for urban roads in plains.
IRC:SP:13	Guidelines for the design of small bridges & culverts.
IRC - Publication	Ministry of Surface Transport (Roads Wing), Specifications for road and bridge works.
IS:73	Specification for paving bitumen
Loadings	
IS:875 (Pt. I to V)	Code of practice for design loads other than earthquake) for buildings and structures.
IS:1893	Criteria for earthquake resistant design of structures.
IS:4091	Code of Practice for design and construction of foundation for transmission line towers & poles.
IRC:6	Standard specifications & code of practice for road bridges, Section-II Loads and stresses.
M.O.T.	Deptt. of railways Bridge Rules.
Safety	
IS:3696 (Part I & II)	Safety code for scaffolds and ladders.
IS:3764	Safety code for excavation work.
IS:4081	Safety code for blasting and related drilling operations.
IS:4130	Safety code for demolition of buildings.

IS:5121	Safety code for piling and other deep foundations.
IS:5916	Safety code for construction involving use of hot bituminous materials.
IS:7205	Safety code for erection on structural steelwork.
IS:7293	Safety code for working with construction machinery.
IS:7969	Safety code for handling and storage of building materials
IS:11769	Guidelines for safe use of products containing asbestos.
-	Indian Explosives Act. 1940 as updated.

Architectural design of buildings

SP:7	National Building Code of India
SP:41	Hand book on functional requirements of buildings (other than industrial buildings)

Miscellaneous

IS:802	Code of practice for use of structural steel in (Relevant parts) overhead transmission line towers.
IS:803	Code of practice for design, fabrication and erection of vertical mild steel cylindrically welded in storage tanks.
IS:10430	Criteria for design of lined canals and liner for selection of type of lining.
IS:11592	Code of practice for selection and design of belt conveyors.
IS:12867	PVC handrails covers.
CIRIA	Design and construction of buried thin-wall pipes. Publication

REFERENCE CODES AND STANDARDS FOR CONTROL AND INSTRUMENTATION

The design, manufacture, inspection, testing & installation of all equipment and system covered under this specification shall conform to the latest editions of codes and standards mentioned below and all other applicable VDE, IEEE, ANSI, ASME, NEC, NEMA, ISA AND Indian Standards and their equivalents.

Temperature Measurements

1. Instrument and apparatus for temperature measurement - ASME PTC 19.3 (1974).
2. Temperature measurement - Thermocouples ANSI MC 96.1 - 1982.
3. Temperature measurement by electrical Resistance thermometers - IS:2806.
4. Thermometer - element - Platinum resistance - IS:2848.

Pressure Measurements

1. a) Instruments and apparatus for pressure measurement - ASME PTC 19.2 (1964).



- b) Electronic transmitters BS:6447.
- 2. Bourdon tube pressure and vacuum gauges - IS:3624 - 1966.
- 3. Process operated switch devices (Pr. Switch) BS-6134.

Flow Measurements

Instruments and apparatus for flow measurements - ASME PTC 19.5 (1972) Interim supplement, Part-II.

Measurement of fluid flow in closed conduits - BS-1042.

Electronic Measuring Instrument & Control Hardware / Software

1. Automatic null balancing electrical measuring instruments - ANSI C 39.4 (Rev. 1973): IS:9319.
2. Safety requirements for electrical and electronic measuring and controlling instrument - ANSI C 39.5 - 1974.
3. Compatibility of analog signals for electronic industrial process instruments - ISA - S 50.1 (1982) ANSI MC 12.1 - 1975.
4. Dynamic response testing of process control instrumentation ISA - S 26 (1968).
5. 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.
6. Printed circuit boards - IPC TM - 650, IEC 326 C.
7. General requirement and tests for printed wiring boards - IS 7405 (Part-I) 1973.
8. Edge socket connectors - IEC 130-11.
9. Requirements and methods of testing of wire wrap terminations DIN 41611 Part-2.
10. Dimensions of attachment plugs & receptacles - ANSI C 73 - 1973 (Supplement ANSI C 73 a - 1980).
11. Direct acting electrical indicating instrument - IS:1248 - 1968 (R).
12. Standard Digital Interface for Programmable Instrumentation - IEEE-488.2 - 1990.
13. Information Processing Systems - Local Area Networks - Part 2 : Logical Link Control - IEEE-802.2 - 1989.
14. Standard for Local Area Networks : Carrier Sense Multiple Access with Collision Detection - IEEE-802.3 - 1985.
15. Supplements A, B, C and E to Carrier Sense Multiple Access with Collision Detection - IEEE-802.3 - 1988.



16. Standard for Local Area Networks : Token - Passing Bus Access Method - IEEE-802.4 - 1985.
17. Standard for Local Area Networks : Token - Ring Access Method and Physical Layer Specification - IEEE-802.5 - 1985.
18. IEEE Guide to Software Requirements Specifications - IEEE-830 - 1984.
19. Hardware Testing of Digital Process Computers - ISA RP55.1 - 1983.
20. Electromagnetic Susceptibility of Process Control Instrumentation - SAMA PMC 33.1 - 1978.
21. Interface Between the Data Terminal Equipment and Data Circuit - Terminating Equipment Employing Serial Binary Data Interchange - EIA-232- D-1987.
22. Electromagnetic Compatibility for Industrial Process Measurement and Control Equipment, Part 3 : Radiated Electromagnetic Field Requirements - IEC 801-3-1984.

Instrument Switches and Contact

1. Contact rating - AC services NEMA ICS 2 - 1978 (with revision through May 1983), Part - 2-125, A6000.
2. Contact rating - DC services NEMA ICS 2-1978 Part-2 125, N600.

Enclosures

1. Type of Enclosures - NEMA ICS Part - 6 - 1978 (with Rev. 1 4/80) through 110.22 (Type 4 to 13).
2. Racks, panels and associated equipment - EIA : RS - 310 C- 1983 (ANSI C 83.9 - 1972).
3. Protection class for Enclosures, cabinets, control panels & desks - IS:2147 - 1962.

Apparatus, enclosures and installation practices in hazardous area

1. Classification of hazardous area - NFPA 70 - 1984, Article 500.
2. Electrical Instruments in hazardous dust location - ISA - 512.11, 1973.
3. Intrinsically safe apparatus - NFPA 493 1978.
4. Purged and pressurised enclosure for electrical equipment in hazardous location - NFPA 496-1982.
5. Enclosures for Industrial Controls and Systems - NEMA IS 1.1 - 1977.

Sampling System

1. Stainless steel material of tubing and valves for sampling system - ASTMA 296-82, Grade 7 P 316.
2. Submerged helical coil heat exchangers for sample coolers ASTM D11 92-1977.



3. Water and steam in power cycle - ASME PTC 19.11.
4. Standard methods of sampling system - ASTM D 1066-99.

Annunciators

1. Specifications and guides for the use of general purpose annunciators - ISA S 19.1, 1979.
2. 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
3. Damp heat cycling test - IS:2106
4. Specification for Electromagnetic Susceptibility - SAMA DMC 33, 1/78

Protections

1. Relays and relay system associated with electric power apparatus. ANSI C 37.90, 1 - 1989.
2. General requirements & tests for switching devices for control and auxiliary circuits including contactor relays - IS:6875 (Part-I) - 1973.
3. Turbine water damage prevention - ASME TDP-1-1980.
4. Boiler safety interlocks - NFPA Section 85 B - 1984, 85 C - 1991.

UPS System

1. Practices and requirements for semi-conductor power rectifiers - ANSI C 34.2, 1973.
2. Relays and relays system associated with electrical power apparatus - ANSI C 3.90 - 1983.
3. Surge withstand capability test - ANSI C 37.90 1 -1989.
4. Performance testing of UPS - IEC 146.
5. Stationary cells & Batteries Lead Acid type (with tubular positive plates) specification IS-1651-1991.
6. Recommended practice for sizing large lead storage batteries for generating stations & sub-stations - IEEE-485-1985.
7. Printed Circuit Board - IPC TM 650, IEC 326C.
8. General Requirements & tests for printed wiring boards, IS:7405 (Part-I) 1973.

Control Valves

1. Control valve sizing - Compressible & Incompressible fluids - ISA S 75.01-1985.
2. Face to face dimensions of control valves - ANSI B 16.00 - 1973.
3. ISA Hand Book of Control Valves - (ISBN : B: 1047-087664-234-2).



4. Codes for pressure piping - ANSI B 31.1
5. Control Valve leak class - ISA RP 39.6

Process Connection & Piping

1. Codes for pressure piping "power piping" - ANSI B 31.1.
2. Seamless carbon steel pipe ASTM - A - 106.
3. Forged & Rolled Alloy steel pipe flanges, forged fittings and valves and parts - ASTM - A - 182.
4. Material for socket welded fittings - ASTM - A - 105.
5. Seamless ferritic alloy steel pipe - ASTM - A - 335.
6. Pipe fittings of wrought carbon steel and alloy steel - ASTM - A - 234.
7. Composition bronze of ounce metal castings - ASTM - B - 62.
8. Seamless Copper tube, bright annealed - ASTM - B - 168.
9. Seamless copper tube - ASTM - B - 75.
10. Dimension of fittings - ANSI - B - 16.11.
11. Valves flanged and butt welding ends - ANSI - B - 16.34.

Instrument Tubing

1. Seamless carbon steel pipe - ASTM - A 106.
2. Material of socketweld fittings - ASTM - A105.
3. Dimensions of fittings - ANSI - B - 16.11.
4. Code for pressure piping, welding, hydrostatic testing - ANSI B 31.1.

Cables

1. Thermocouples extension wires/cables - ANSI MC 96.1 - 1992.
2. Requirements for copper conductor-Wiring cables for telecommunications & information processing system - VDE:0815.
3. Colour coding of single or multi-pair cables - ICEA - S - 61-402 (third edition) NEMA WCS - 1979 with revisions through 2/83.
4. Insulation & Sheathing compounds for cables : VDE 0207 (Part-4, 5 & 6).
5. Guide design and installation of cable systems in power generating stations (insulation, jacket materials) - IEEE Std. 422-1977.
6. Rules for Testing insulated cables and flexible cables : VVDE - 0472
7. Requirements of vertical flame propagation test - IEEE 383 - 1974 (R 1980)
8. Standard specification for tinned soft or annealed copper wire for electrical purpose



- ASTM B-33-81.
- 9. Oxygen index and temperature index test - ASTM D - 2863.
- 10. Smoke density measurement test - ASTM D - 2843.
- 11. Acid gas generation test - IEC - 754 - 1.
- 12. Swedish Chimney test - SEN - 4241475 (F3).
- 13. Teflon (FEP) insulation & sheath test - ASTM D - 2116.
- 14. Thermocouple compensating cables - Testing requirements & sampling plan IS:8784.
- 15. PVC insulated electric cables for working voltage upto and including 1100 V - IS:1554 (Part-I).

Cable Trays, Conduits

- 1. Guide for design and installation of cable systems in power generating station (Cable trays, support systems, conduits) - IEEE Std. 422, 1977, NEMA VE-1 1979, NFPA 70-1984.
- 2. -do- Test Standards. NEMA VE-1-1979.
- 3. Zinc coating "hot dip" on assembled products for galvanising of carbon steel cable trays - ASTM A - 386-78.

Public Address System

- 1. Specifications for loud speakers - IS:7741 (Part-I, II and III)
- 2. Code of safety requirement for electric mains operated audio amplifiers - IS:1301
- 3. Specification for Public Address Amplifiers - IS:10426.
- 4. Code of practice for outdoor installation of PA system - IS:1982.
- 5. Code of practice for installation for indoor amplifying and sound distribution system - IS:1881.
- 6. Basic environmental testing procedures for electronic and electrical items - IS:9000.
- 7. Characteristics and methods of measurements for sound system equipment - IS:9302
- 8. Code of practice of electrical wiring installations (System voltage not exceeding 650 volts) - IS:732
- 9. Rigid steel conduits for electric wiring - IS:9537 (Part-I and II)
- 10. Fittings for rigid steel conduits for electrical wiring - IS:2667
- 11. Degree of protection provided by enclosure for low voltage switchgear and control gear - IS:2147.



Vibration Monitoring System

1. API 670 - 1994
2. BS : 4675 Part-2

ANNEXURE-I

MFGR.'s LOGO	MANUFACTURER'S NAME AND ADDRESS		MANUFACTURING QUALITY PLAN				PROJECT :				REMARKS				
			ITEM :	QP NO.: REV.NO: DATE: PAGE: OF....			PACKAGE : CONTRACT NO. : MAIN-SUPPLIER :								
SL. NO	COMPONENT & OPERATIONS	CHARACTERI STICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY				
					M	C / N			M	C	N				
1.	2.	3.	4.	5.	6.		7.	8.	9.	D*	** 10.				
				LEGEND: * RECORDS, IDENTIFIED WITH "TICK" (✓) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION.** M: MANUFACTURER/SUB-SUPPLIER C: SUPPLIER/NOMINATED INSPECTION AGENCY, N: THE OWNER P: PERFORM W: WITNESS AND V: VERIFICATION. AS APPROPRIATE, CHP: THE OWNER SHALL IDENTIFIED IN COLUM "N"				  DOC. NO.: REV..... CAT.....							
MANUFACTURER / SUB-SUPPLIER		MAIN- SUPPLIER						FOR THE OWNER USE							
SIGNATURE										REVIEWED BY		APPROVED BY		APPRO VAL SEAL	

ANNEXURE-II

SUPPLIER'S LOGO		SUPPLIER'S NAME AND ADDRESS		FIELD QUALITY PLAN			PROJECT : PACKAGE : CONTRACT NO. : MAIN-SUPPLIER:				
				ITEM :	QP NO.:						
				SUB-SYSTEM :	REV.NO.:						
					DATE:						
					PAGE: OF....						
S. N O	ACTIVITY AND OPERATION	Characteristics / instruments	CLASS# OF CHECK	TYPE OF CHECK	QUANTU M OF CHECK	REFERENC E DOCUMENT	ACCEPTA NCE NORMS	FORMAT OF RECORD		REMARK S	
1.	2.	3.	4.	5.	6.	7.	8.	9.	D*	10.	
		LEGEND: * RECORDS , INDENTIFIED WITH "TICK" (✓) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION. LEGEND TO BE USED: CLASS #: A = CRITICAL, B=MAJOR, C=MINOR; 'A' SHALL BE WITNESSED BY THE OWNER FQA, 'B' SHALL BE WITNESSED BY OWNER'S ERECTION / CONSTRUCTION DEPTT. AND 'C' SHALL BE WITNESSED BY ERECTION SUPPLIER (A & B CHECK SHALL BE OWNER CHP STAGE)				 DOC. NO.: REV.....					
MANUFACTURER / SUB-SUPPLIER						MAIN- SUPPLIER		FOR THE OWNER USE			
SIGNATURE											

ANNEXURE-III

		Project : Stage :		LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB-SUPPLIER APPROVAL						DOC. NO.:	
		Package :								REV. NO.:	
		Supplier :		SUB-SYSTEM:						DATE :	
		Bidder No. :								PAGE : OF	
S. N.	Item	QP / Insp. Cat.	QP No.	QP Sub. Schedule	QP approval schedule	Proposed sub-supplier	Place	Sub-suppliers approval status / category	Sub-supplier Details submission schedule	Remarks	

LEGENDS

1. SYSTEM SUPPLIER/SUB-SUPPLIER APPROVAL STATUS CATEGORY (SHALL BE FILLED BY the Owner)

A – For these items proposed vendor is acceptable to the Owner. To be indicated with letter "A" in the list alongwith the condition of approval, if any.

DR – For these items "Detailed required" for the Owner review. To be identified with letter "DR" in the list.

NOTED – For these items vendors are approved by Main Supplier and accepted by the Owner without specific vendor approval from the Owner. To be identified with "NOTED."

2. QP/INSPN CATEGORY:

CAT-I: For these items the Quality Plans are approved by the Owner and the final acceptance will be on physical inspection witness by the Owner.

CAT-II: For these items the Quality Plans approved by the Owner. However no physical inspection shall be done by the Owner. The final acceptance by the Owner shall be on the basis review of documents as per approved QP.

CAT-III: For these items Main Supplier approves the Quality Plans. The final acceptance by the Owner shall be on the basis certificate of conformance by the main supplier.

UNITS/WORKS: Place of manufacturing Place of Main Supplier of multi units/works.

ANNEXURE-IV

[illegible]

ANNEXURE-V

		Project : Stage :		FIELD WELDING SCHEDULE (To be raised by the Bidder) Welding Code:								DOC. NO.:				
		Bidder :										REV. NO.:				
		Bidder No. :										DATE :				
		System :										PAGE : OF				
Sl. No.	DRG No. for Weld Location and Identification mark	Description of parts to welded	Matl. Spec.	Dimensions		Process of welding	Type of Weld	Electrode filler spec.	WPS. No.	Min. pre-heat	Heat treatment		NDT method / Quantum	REF		Remarks
											Temp.	Holding time		Spec. No.	ACC Norm Ref.	
NOTES:																
SIGNATURE																

ANNEXURE-VI
DOCUMENTS DISTRIBUTION SCHEDULE

S.No.	Description of Document	DESEIN				UPRVUNL			
		HO		SITE		HO		SITE	
		HC	CC	HC	CC	HC	CC	HC	CC
1.	Drawings, Data Sheets, Calculation, all equipment / Instrument Schedule, BOM etc. a) For Approval b) Resubmission c) For Information	6*	1	-	-	2	1	-	-
2.	Final Approved Documents	2	1 + 1 CD	1	1	1	1 + 2 CD	4	1 + 1 CD
3.	Drawings / Documents 'As Built'	2	1 + 1 CD	1	1	2	1 + 2 CD	4	1 + 1 CD
4.	Type Test Reports (Initial)	4*	1 + 1 CD	-	-	2	1 + 2 CD	-	-
5.	Type Test Report (Final)	2	1 + 1 CD	1	1	2	1 + 2 CD	4	1 + 1 CD
6.	Piping / Equipment Analysis (Transient) etc., Model Study Report (Draft) including Input / Output date etc.	4*	1	-	-	2	1 + 1 CD	-	-
7.	Piping / equipment Analysis (Transient) etc. Model Study Report (Final Approval) including Input / Output date	2	1 + 1 CD	-	-	2	1 + 2 CD	2	1 + 1 CD
8.	Erection Manual (Draft)	3*	1CD	-	-	1	1CD	-	-



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001

Page 125 of 429



S.No.	Description of Document	DESEIN				UPRVUNL			
		HO		SITE		HO		SITE	
		HC	CC	HC	CC	HC	CC	HC	CC
9.	Erection Manual 'Final'	1	1CD	1	-	1	1CD	2	1CD
10.	O&M Manual 'Draft'	3*	1CD	+	-	1	1CD	-	-
11.	O&M Manual 'Final'	1	1CD	1	-	1	1CD	2	2CD
12.	Commissioning Procedure 'Draft'	3*	1CD	-	-	1	1CD	-	-
13.	Commissioning Procedure 'Final'	1	1CC	1	-	1	1CD	2	1CD
14.	PG Test Procedure "Draft"	3*	1	-	-	1	1	-	-
15.	PG Test Procedure 'Final'	1	1 + 1 CD	1	-	2	1 + 1 CD	2	1 + 1 CD
16.	Progress Report	3	1CD	1	-	2	1CD	1	1CD
17.	PG Test Report for Approval	4*	1	-	-	2	1 + 1 CD	-	-
18.	Approved PG Test Report	1	1 + 1 CD	1	-	2	1 + 1 CD	4	1 CD
19.	Project Completion Report	1	1 + 1 CD	1	-	1	1CD	1	1CD
20.	Vendor Details in respect of proposed vendors including Contractor's evaluation Report	1	1CD	-	-	1	1CD	-	-
21.	Monthly Vendor / QP Approval Status	1	1	-	-	2	1	1	1
22.	Manufacturing QPs, Field QPs for review / comments	6*	1	-	-	2	1CD	-	-
23.	Manufacturing QPs, Field QP, Final	1	1CD	1	-	2	1CD	2	1CD
24.	QA documents Package for equipment / field activities etc.	1	1CD	1	-	1	1CD	1	1CD



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001
Page 126 of 429

- * - Consultant will return one (1) commented document to Vendor and CE (UPRVUNL), Lucknow
- HC - Hard Copy
- CC - Soft Copy thru e-mail
- CD - CD ROM
- HO - Head Office of Consultant / UPRVUNL



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001
Page 127 of 429



ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance Of Plant
STEAM GENERATOR	Thermal design and hydraulic circulation balance	Familiarization with various system and equipment	Manufacturing processes of pressure parts, and equipments	Control philosophy operation, notices, logic & protection schemes, O&M manual familiarization O&M issues
	Combustion and Air & gas weight calculation	Performance data collection analysis and review	Welding process	
	Pressure part calculation	O&M feed back	Testing facilities	Familiarization of special maintenance techniques.
	Pressure part and strength calculation	Operation history of various equipment and system	Product development in process	Special tool and tackles familiarization
	Tube metal temp. Calculation and selection.	Failure analysis	Future plan for technology induction	
	Performance calculation		R&D work in-progress	
	Duct design.			
	Pressure part			
	Equipment and system sizing and selection of mills, fans, airpreheater, soot blowers, dampers, valves heater, soot blowers, dampers, valves, feeders, burners start-up system, fuel firing system, draft plant			
	Flow scheme development of air & flue gas, fuel oil, auxiliary steam, main and reheat steam feed water.			

ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance Of Plant
	Layout of overall plant, steam generator area, pressure part arrangements, platforms, equipment, piping and duct, coal pipe, flue gas ducts, bunker arrangement, valves and damper, ESP area, cable & piping tressels etc.			
	Erection strategies, erection procedures			
	Performance and demonstration tests.			
MANDAYS	120	20	20	20
CFD model development and validation for Steam Generator	Familiarisation of fundamentals and basis for the development of the CFD models.			
	Solving of set of simple problems by Owner's engineers with the help of trainer.			
	Hands on experience on the development of detailed/realistic CFD models for the steam generator and ESP. The Bidder/trainer shall develop CFD models for SG & ESPs as per the Contract requirement with complete association of the Owner's engineers.			
	Validation of the above CFD model for SG & ESP by Bidder in association with the Owner's Engineers.			
MANDAYS	120 for SG and 60 for ESP	-	-	-



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001
Page 129 of 429

ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance Of Plant
TURBINE GENERATOR AND IT'S INTEGRAL AUXILIARIES	Turbine cycle optimization and turbine performance in off design condition.	Familiarization of power plants of various makes of turbines for super critical units	Manufacturing processes of turbine	
	Rotor design and strength calculation	Collection of data for analysis of availability of turbines	Assembly of turbine	
	Rotor dynamic behaviour studies wrt natural frequency, critical speed, vibration etc.	Comparative studies for integral systems of turbine	Testing of turbines	
	Blade profile/root design and blade strength design, blade vibration analysis	O&M history/problems related to turbine	Product development in process	
	Casing & diaphragm design	Failure analysis	Future plan for technology induction	
	Labyrinth seal selection & design for different turbine configurations		R&D work in progress	
	Selection of turbine type (i.e. Tandem vs. cross compounding, separate HP/IP vs. combined HP/IP, material of construction etc.)			
	Design principle for Up rating/down rating of existing design/ modules for the specific project.			
	Selection of nos., type and arrangement of bearings, load calculation on bearings, bearing oil flow calculation			
	Selection, design and control principle for Turbine governing system			



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001

Page 130 of 429



ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance Of Plant
	Performance calculation			
	Steam path audit			
	Layout principle of various equipment's of TG and its integral system			
	Latest technological advancements			
MANDAYS	45	10	10	
Boiler Feed Pumps	Techno-economic studies for Selection of BFP Configuration and its drive	Familiarization of power plants of various makes of feed pumps	Manufacturing process of various components of BFP	
	Criteria for selection of boiler Feed Pump parameters	Data collection of BFP parameters and configuration	Assembly of BFP	
	Rotor design, strength calculation and rotor dynamic behavior studies wrt critical speed, vibration etc	Collection of data for analysis of availability of BFP	Testing, capabilities of BFP at works wrt performance, NPSH, thermal shock, dry run, visual cavitation, string test, axial thrust measurement	
	Impeller design and its hydraulic behavior	O&M history/problems related to BFP	Product development in process	
	Role of critical parameters such as NPSH(R), Suction specific speed, running clearances, speed etc. in design of feed pumps	Comparative studies for various types of BFP& its features	Future plan for technology induction	
	Material selection of BFP components		R&D work in progress	
	Guiding factors for selection of BFP seals			

ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance Of Plant
	Computation of axial thrust under various flows			
	Performance calculation			
	Transient analysis in pump suction piping wrt NPSH margin			
	Latest technological trends in BFP design			
MANDAYS	20	5	10	
Condenser	Selection of condenser type and its optimization wrt temp rise across condenser, pressure drop in condenser, surface area etc.	Comparative studies of salient features	Manufacturing process of various components of condenser Assembly	
	Techno economic studies for Selection of condenser tube material and other parts depending on water quality	Collection of data for analysis of availability of Condenser	Testing capability at works	
	Condenser support selection & design	O&M history/problems related to condenser	Product development in process	
	Sizing of condenser w.r.t. super critical units		Future plan for technology induction	
	Latest technological trends in condenser arrangement and design		R&D work in progress	
	Condenser vacuum system design			
MANDAYS	10	5	5	
Feed Regenerative Equipment'	Thermal and mechanical design calculation of heaters	Comparative studies of salient features	Manufacturing process of various components of heaters	
	Basis of selecting horizontal/vertical	Analysis of data	Assembly	



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001
Page 132 of 429

ANNEXURE-VII

PRODUCT

CONTROL & INSTRUMENTATION				
DDCMIS-Man Machine Interface - Hardware & Operating System	Hardware & Software organization of the system Basis of selection of H/W memory sizing Operating system features, interface with other system, openness & inter-operability Upgradability System testing features	Operational feedback		
MANDAYS	16	6		
DDCMIS-Man Machine Interface System Engineering & Application Software	Specific system customization Various system modules & interface with OS Database organization & development Development of mimics Other application like calculations, logs historical storage functionalities & use	Operation feedback		
MANDAYS	40	6		
DDCMIS - Control System Hardware	Basic design features for system & its modules System capabilities & system design techniques Communication with MMI & other system	Operation feedback	Manufacturing processes special attention to handling of the modules Maintenance facilities	
MANDAYS	20	5	10	

ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance Of Plant
DDCMIS- Control system Application Software	Database structure Organisation & inter- face between application program & database	Operational feedback	System integration & System capabilities testing	
	Application for implementation of Control functions			
	Study of standard algorithms & development of new algorithms			
MANDAYS	12	4	4	
DDCMIS - Control Loop Study	General description of closed loop controls of thermal power plant	Specific operational feedback		
	Critical analysis of few control loops e.g., TSCS Stress Control boiler start-up control etc.			
MANDAYS	4	2		
DDCMIS- Burner Management System	Hardware logic, NFPA/ VDE requirements other safety standard	Operational feedback	Manufacturing procedure& precautions for handling the system System testing facilities	
	Flame scanner location			
MANDAYS	10	3	3	
DDCMIS - EHTC, Turbine stress control system,	Basic design concept& features	Operational feedback	Manufacturing procedure & precautions for handling for handling the system System testing facilities	
	Logics of turbine stress control system			

ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance Of Plant
Turbine protection system & ATRS	Implementation of failsafe philosophy in turbine protection system			
MANDAYS	10	3	3	
Furnace and Flame Viewing System.	Theory & principle of operation	Operational feedback		
	Details of software & methods of modification/ customisation			
Misc. systems for SG/TG C&I				
Electric Power Supply System	Theory & design features		Manufacturing/assembly process	
Wherever "DDCMIS" is indicated, it will mean SG C&I part of DDCMIS, which is in Contractor's Scope.				
QUALITY ASSURANCE & INSPECTION QA SYSTEM & PROGRAMME	Integrated QA Management System for enhanced reliability of equipments	Operational feedback Co-relationn of reliability and performance of the equipment with implementation of QA system. Appreciation of use of	Appreciation of implementation of QA Programmes in various manufacturing, assembly and testing activities. Appreciation of developmental	
	QA system in design, procurement, manufacturing, installation and operation of the equipments/ systems			
	QA system for developing and establishing new processes and vendors.			



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001

Page 136 of 429



ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance Of Plant
		structured Engg./QA documentation during Operational phase of plant and during RLA studies of plant	activities for new processes and vendors. System of prequalification of special processes	
	System of structured documentation of Engg. And test records			
MANDAYS	16	3		
PLC	Hardware organization		Manufacturing process of PLC hardware	
	Operating system features		Integration & testing facilities	
	Data base organization			
	Logic/loop algorithm			
	Development of control logic & loop s/w & MMI application development			
MANDAYS	16	-	2	
Electric Power Supply System (UPS & 24 V DC system)	Theory & design features		Manufacturing/assembly process	
			Testing methodology	
MANDAYS	10	2		
PRODUCT	AREAS OF TRAINING REQUIREMENT			
(ELECTRICAL) GENERATOR	(a) Design aspects of the following areas	- Operational feed back	(a) Manufacturing process for	



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001
Page 137 of 429

ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance Of Plant
	- Insulation system	- Familiarisation with different sub-systems	- Core	
	- Cooling medium & arrangement		- Winding bars	
	- Winding & core support systems		- Assembly	
	b) Design aspects of other auxiliary systems		(b) Testing facilities	
MANDAYS	30	15	15	
Generator Excitation System including AVR.	Design features of various sub-systems	- Operational feed back	- Manufacturing process& testing facilities for various equipment of excitation system	
	Excitor	- Familiarisation with various equipment functioning at reference plants		
	PMG			
	Transformer			
	Controllers & different limiters etc.			
	PSS & associated system studies			
400 KV Switchyard Equipments			Concepts and operational aspects for the offered equipments	
Substation Automation System				Training for site personnel for operation, maintenance & troubleshooting of total system for 5 working days at UPRVUNL site
MV AND LT Switchgear: Numerical relays & Switchgear SCADA system	Numerical relay engineering & associated training for relay software & O&M SCADA system design, engineering & associated training for SCADA & O&M			



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001
Page 138 of 429

ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance Of Plant
MDBFP motor CW motor & BWCP motor	Design criteria for the stator core and winding, rotor core & winding, Insulation system & Cooling arrangement Study of forces & vibration Diagnostic & testing of large Electrical machines	Operational feedback	Manufacturing process & testing facilities	
MANDAYS	30	15	15	
Boiler Feed pump H.T. Motor	Design Criteria for the Stator core & wdg Rotor core & wdg Insulation system Cooling arrangement	Operational feed back	Manufacturing process & test facilities	
MANDAYS	10	5	5	
CRITICAL PIPING & POWER CYCLE PIPING	Design familiarization for critical piping of supercritical Plant	Familiarization with feedback (in super critical plant) on failure analysis and vibration analysis of piping.	Cold Setting of spring hanger	
	Optimization study for sizing including pressure drop calculation and selection of single or double lead together with Owner's engineers	Study of Feed back regarding hanger setting strategies and practice	Cyclic tests carried on spring hangers.	
	Design and stress analysis of lines with Expansion Joints together with Owner's engineers		Cyclic tests carried on expansion joints	



ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance Of Plant
	Design and stress analysis of piping systems with two phase flow involving Owner's engineers		Manufacturing process of critical piping components and appreciation of their testing facilities at shop	
	Transient analysis and optimum sizing of feed suction piping together with Owner's engineers.			
	Static and dynamic analysis of critical piping including siesmic and other occassional load analysis (safety valve blowing condition). A joint activity together with Owner's engineers.			
	Study and collection of data pertaining to special welding requirements (pre and post weld heat treat ment and electrode selection criteria etc.) of materials used in high temp piping system.			
	Study and collection of data on special requirements in case of welding dissimilar metals and electrode selection criteria			
MANDAYS	45	10	10	

ANNEXURE-VII

Area	Topics	Mandays
DDCMIS-Man Machine Interface-Hardware & Operating System	Hardware & Software organization of the system	20
	Basis of selection of H/W memory sizing	
	Operating system features, interface with other system, openness & inter-operability	
	Upgradeability	
	System testing Features	
	Trouble shooting & fault analysis	
DDCMIS-Man Machine Interface System Engineering & Application Software	Specific system customization	40
	Various system modules & interface with OS	
	Database organisation & development	
	Development of mimics	
	Other application like calculation, logs historical storage functionalities & use	
	Trouble shooting & fault analysis	
DDCMIS-Control System Hardware & Control System Application Software	Basic design features for system & its modules	50
	Manufacturing process with special attention to handling of the modules Maintenance facilities	
	System capabilities & system design techniques	
	System integration & system capabilities testing	
	Communication with MMI & other system	
	Database structure Organisation & inter-face between application program & database	
	Application for implementation of Control functions	
	Study of standard algorithms & development of new algorithms	
	Trouble shooting & fault analysis	
DDCMIS- Operator Training	Use of the system at Works + at Site	20+100
DDCMIS- Specialized Network security training	To be finalized during detailed engineering.	15

UPS system	Theory & design features Manufacturing/assembly process Testing methodology	5
	Trouble shooting and fault analysis.	
24 V DC system	Theory & design features Manufacturing/assembly process	5
	Testing methodology	
	Trouble shooting and fault analysis	
SWAS	Theory & design features	5
	Trouble shooting and fault analysis	
Communication System	Theory & design features	4
	Trouble shooting and fault analysis	
PSSS System	Theory & design features	5
	Trouble shooting and fault analysis	
QA SYSTEM & PROGRAMME	Integrated QA Management system for enhanced reliability of equipments	10
	QA system in design, procurement, manufacturing, installation and operation of the equipments/ systems	
	QA system for developing and establishing new processes and vendors	
	System of structured documentation of Engg and test records	
	Appreciation of implementation of QA Programme in various manufacturing, assembly and testing activities	
	Appreciation of develop-mental activities for new processes and vendors	
	System of pre-qualification of special processes	
Controls & Instruments	Familiarization with control system and instrumentation	20
	QA System for manufacture of reliable components. Manufacturing activities for critical instruments/items	
	Implementation of testing programme to ensure reliability	
Simulator	a. System design structure and basis of design b. Hardware components and their configuration c. System Software and Simulation Software Tools d. Plant process modelling and DCS emulation e. Project specific application development, configuration and modifications including equipment modelling and interconnections of models, graphics development , configuring equations etc, f. Maintenance and troubleshooting of hardware and software components	24

PADO	Theory & design features	10
	Trouble shooting and fault analysis	
CEMS	Theory & design features	5
	Trouble shooting and fault analysis	
AAQMS	Theory & design features	5
	Trouble shooting and fault analysis	
C&I Lab Instruments	Theory & design features	6
	Trouble shooting and fault analysis	
DMS	Theory & design features	5
	Trouble shooting and fault analysis	
Station LAN & MIS	Theory & design features	5
	Trouble shooting and fault analysis	
Note	One week shall constitute of five (5) man days.	



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001
Page 143 of 429

Chapter 27: LP PIPING, VALVES & SPECIALITIES**27.0 LP PIPING, VALVES & SPECIALITIES****27.1 Equipment sizing Criteria**

- 27.1.1 All the piping systems and equipment supplied under this package shall be designed to operate without replacement and with normal maintenance for a plant service life of 30 years, and shall withstand the operating parameter fluctuations and cycling which can be normally expected during this period.
- 27.1.2 For all LP piping system covered under this specification, sizing and system design shall be to the requirements of relevant codes and standard indicated elsewhere. In addition to this, requirements of any statutory code as applicable shall also be taken into consideration.
- 27.1.3 Inside diameters of piping shall be calculated for the flow requirements of various systems. The velocities for calculating the inside diameters shall be limited to the following.

a) Water Application**Water Velocity in m/sec**

	Pipe Size	Below 50 mm	50-150 mm	200 mm & above
a)	Pump suction	-----	1.2 - 1.5	1.2 - 1.8
b)	Pump discharge and recirculation	1.2-1.8	1.8 - 2.4	2.1 - 2.5
c)	Header	----	1.5 - 2.4	2.1 - 2.4

The pipes in CW, ACW & DMCW system shall be designed to maintain a maximum velocity of 2 m/s inside the pipelines at pump discharge.

Pipe line under gravity flow shall be restricted to a flow velocity of 1 m/sec generally. Channels under gravity flow shall be sized for a maximum flow velocity of 0.6 m/sec.

WILLIAM & HAZEN formula shall be used for calculating the friction loss in piping systems with the following "C" value.

i)	Carbon steel pipe	100
ii)	CI Pipe/Ductile Iron	100
iii)	Rubber lined steel pipe	120
iv)	Stainless steel pipe	100

For calculating the required pump head for pump selection, at least 10% margin shall be taken over the pipe friction losses and static head shall be calculated from the minimum water level of the tank/sump/reservoir from which the pumps draw water.

b) Compressed Air Application

Compressed air – 10.0 m/sec. (under Average Pressure & Temp. conditions)

- 27.1.4 The pipes shall be sized for the worst (i.e. maximum flow, temp. and pressure values) operating conditions.
- 27.1.5 Based on the inside dia. so established, thickness calculation shall be made as per ANSI B 31.1 OD and thickness of pipes shall than be selected as per ANSI B 36.10/IS-1239 Heavy grade/IS-3589/ASTM-A-53/API-5L/ANSI B 36.19 as the case may be.
- 27.1.6 Corrosion allowance of 1.6 mm will be added to the calculated thickness being considered.
- 27.1.7 Bend thinning allowance/manufacturing allowance etc. shall be as per the requirement of the design code provision.
- 27.1.8 High points in piping system shall be provided with vents alongwith valves as per the system requirement. Low points shall be provided with drains alongwith drain valves as per the system requirement. Drain lines shall be adequately sized so as to clear condensate in the lines. Material for drain and vent lines shall be compatible with that of the parent pipe material.
- 27.1.9 Material of construction for pipes carrying various fluids shall be as specified elsewhere.
- 27.1.10 Compressed air pipe work shall be adequately drained to prevent internal moisture accumulation and moisture traps shall be provided at strategic locations in the piping systems.
- 27.1.11 Depending upon the size and system pressure, joints in compressed air pipe work shall be screwed or flanged. The flange shall be welded with the parent pipe at shop and shall be hot dip galvanized before dispatch to site. Alternatively, the flanges on GI pipes may be screwed-on flanges also.
- 27.1.12 Threaded joints shall be provided with Teflon sealant tapes.
- 27.1.13 Following types of valves shall be used for the system/service indicated.

System	Type of Valves					
	Butterfly	Gate	Globe	Check	Ball	Plug
Water	X	X	X	X	X	
Air		X	X	X	X	
Drains & Vents			X	X	X	
Fuel oil		X	X	X	X	X

In water service, valves above 200 NB size may be butterfly valves.

27.1.14 Recirculation pipes alongwith valves, breakdown orifices etc. shall be provided for important pumping systems as indicated in respective process and instrumentation diagrams (P&IDs). The recirculation pipe shall be sized for minimum 30% design flow of single pump operation or the recommended flow of the pump manufacturer whichever is higher.

27.1.15 All Piping 450 NB & Above shall be designated as Large dia Piping.

27.2.00 TECHNICAL SPECIFICATION

27.1.00 GENERAL

Specific technical requirements of low-pressure piping, fittings, supports, valves, specialties and tanks etc. have been covered under this Sub-section. It includes details pertaining to design and material of construction for piping, fittings, valves, equipment, etc. cleaning/surface preparation application of primer and painting on over ground piping. It also includes detailed technical requirement of laying underground/buried piping including water proofing/anti corrosive protection. It also covers design, engineering, manufacturing, fabrication, technical details of piping, valves, specialties, piping hangers/supports, tanks etc.

27.2.00 Pipes and fittings

27.2.1 All low pressure piping systems shall be capable of withstanding the maximum pressure in the corresponding lines at the relevant temperatures. However, the minimum thickness shall be adhered to. The bidder shall furnish the pipe sizing / thickness calculation as per the criteria mentioned above under LP piping equipment sizing criteria of this Technical Specification.

27.2.2 Piping and fittings coming under the purview of IBR shall be designed satisfying the requirements of IBR as a minimum.

27.2.3 Supporting arrangement of piping systems shall be properly designed for systems where hydraulic shocks and pressure surges may arise in the system during operation. Bidder should provide necessary protective arrangement like anchor blocks/anchor bolt etc. for the safeguard of the piping systems under above mentioned conditions. The requirement will be, however, worked out by the contractor and he will submit the detailed drawings for thrust/anchor block to the Employer. External, and internal, attachments to piping shall be designed so as not to cause flattening of pipes and excessive localized bending stresses.

27.2.4 Bends, loops, off sets, expansion or flexible joints shall be used as required in order to prevent overstressing the piping system and to provide adequate flexibility. Flexibility analysis (using software packages such as Caesar-II etc.) shall be carried out for sufficiently long piping (straight run more than 300M).

27.2.5 The hot lines shall be supported with flexible connections to permit axial and lateral movements. Flexibility analysis shall be carried out for pipelines which have considerable straight run as indicated above and necessary loops/expansion joint etc. shall be provided as may be necessary depending on layout.

- 27.2.6 Piping and fittings shall be manufactured by an approved manufacturer of repute. They should be truly cylindrical of clear internal diameter, of uniform thickness, smooth and strong, free from dents, cracks and holes and other defects.
- 27.2.7 For rubber lined ERW pipes, beads shall be removed.
- 27.2.8 Inspection holes shall be provided at suitable locations for pipes 800 NB and above as required for periodic observations and inspection purposes.
- 27.2.9 At all intersection joints, it is Contractor's responsibility to design and provide suitable reinforcements as per the applicable codes and standards.
- 27.2.10 For large size pipes/duct, at high point and bends/change of direction of flow, air release valves shall be provided as dictated by the system requirement and operation philosophy & tripping conditions of pumping system. Sizing criteria for air release valves shall be generally on the basis of valve size to pipe diameter ratio of 1:8. Requirement shall be decided as per relevant code.

Transient analysis / surge analysis wherever specified and required shall be conducted in order to determine the location, number and size of the Air-Release valve on certain long distance/high volume piping systems such as CW/ ACW/ Raw Water etc.

27.3.00 Material

- 27.3.1 Alternate materials offered by Bidder against those specified shall either be equal to or superior to those specified, the responsibility for establishing equality or superiority of the alternate materials offered rests entirely with the Bidder and any standard code required for establishing the same shall be in English language.
- 27.3.2 No extra credit would be given to offers containing materials superior to those specified. Likewise no extra credit would be given to offers containing pipe thickness more than specified.
- 27.3.3 All materials shall be new and procured directly from the manufacturers. Materials procured from traders or stockiest are not acceptable.
- 27.3.4 All materials shall be certified by proper material test certificates. All material test certificates shall carry proper heat number or other acceptable reference to enable identification of the certificate that certifies the material.
- 27.3.5 Material of construction for pipes carrying various fluids shall be as follows:

1	Intake Water, Raw water, Ash water, Circulating Water (CW), Aux. Cooling water (ACW), clarified Water, CW blow down, *Effluent disposal, service water, AHP Seal Water, Air Pre-Heater Wash water, Passivated DM Water and clarifier sludge.	IS-2062 Gr. B/ASTM-A-36/ASTM A-53 type 'E' Gr. B/IS-3589 Gr. 410/IS-1239 Heavy. Buried CW pipes shall be encased in 500 mm thk RCC. At road crossings live loads should be considered and this encasing thickness shall vary accordingly. 150 NB & above pipes shall be spiral welded.

2	Dematerialized water, (condenser Make up water, Boiler fill and Deaerator Fill water) & DMCW overhead tank make-up water	Stainless steel to ASTM A-312, Gr. 304 welded for sizes above 50mm NB Stainless steel to ASTM A312, Gr. 304 sch. 40 Seamless for sizes 50 mm and below
3.	*Drinking (potable) water	ASTM A-53 type E Gr. B galvanized /IS 1239 heavy galvanized/IS 3589 Gr 410 Galvanized to IS-4736 or equivalent.
4.	Instrument air & plant air.	ASTM A-53 type E Gr. B galvanized /IS 1239 heavy galvanized/IS 3589 Gr 410 Galvanized to IS-4736 or equivalent.
5.	Fuel Oil piping	API5L

NOTE: Bidder to note that for Effluent disposal system and potable water system for colony (* marked) Ductile Iron (DI) pipes conforming to IS 8329 and for fittings IS 9523 can be offered as an alternate to the mild steel/ galvanized mild steel pipes as specified above for standalone or outside plant boundary stretches. Various design aspects of DI piping has been discussed later in Annexure-I.

- 27.3.6 In water lines, pipes upto 150 mm NB shall conform to ANSI B36.10/ASTM-A-53, Type-E Gr. B/IS:1239 Gr. Heavy and minimum selected thickness shall not be less than IS: 1239 Grade heavy except for demineralised water, drinking water and condensate spill lines.
- 27.3.7 Pipes of above 150 mm NB shall be to AWWA-C200/ANSI B 36.10/ASTM A-53/IS 3589 Gr. 410. Pipe to be fabricated by the bidder shall be rolled and butt welded from plates conforming to ASTM A-53 type 'E' Gr. B/IS 2062 Gr. B/ASTM-A-36. However, larger pipes, i.e. 1000 mm NB and above shall be made from plates conforming to ASTM A 36/IS 2062 Gr. B and shall meet the requirements of AWWA-M-11(for deflection & buckling criteria considering water filled pipe as well as vacuum condition that may prevail during transient/ surge conditions, truck-load, rail-load and weight density for compacted soil or any other load as the case may be).
- 27.3.8 In demineralised water service, the pipes upto 50 NB shall be of stainless steel ASTM A 312, Gr. 304 sch. 40 Seamless. The size for these pipes shall be to ANSI B 36.19. These shall be socket welded. The material for pipe from 65 mm NB upto and including 400 NB shall be to ASTM A 312, Gr. 304 (welded). In no case the thickness of fittings shall be less than parent pipe thickness.
- Bidder/Contractor shall note that pipes offered as per a particular code shall conform to that code in all respects i.e. Dimension, tolerances, manufacturing methods, material, heat treatment, testing requirements, etc. unless otherwise mentioned elsewhere in the specification.
- 27.3.9 Instrument air, Plant (service) air lines and Drinking water lines shall be to ASTM A 53 type E grade B/ANSI B 36. 10/IS 3589, Gr. 410/IS: 1239 Heavy (in case thickness calculated is more than gr. Heavy, ANSI B 36.10 Schedule numbers shall be followed) and galvanized to IS 4736 or any equivalent

internationally reputed standard. The material of the pipes shall be to ASTM A 53 type 'E' Gr. B/IS: 3589, Gr. 410/IS: 1239 Gr. Heavy. The fittings shall be of either same as parent material or malleable iron to IS-1879 (galvanized).

- 27.3.10 Spiral welded pipes as per API-5L/IS-3589 are also acceptable for pipe of size above 150 NB. However minimum thickness of the pipes shall be as elaborated in above clauses.
- 27.3.11 Condensate lines shall be to ASTM A 106 Gr. B and dimension to ANSI B 36.10 schedule "standard" as minimum to be maintained.
- 27.3.12 If carbon steel plates of thickness more than 12 mm are used for manufacture of pipes, fittings and other appurtenances, then the same shall be control-cooled or normalized as the case may be following the guidelines of the governing code.
- 27.3.13 Buried CW Pipes/ headers shall be minimum 12 mm thick, encased in 500 mm thk RCC. However this thickness shall be reviewed for live loads at road crossings according to AWWA M11 and increased adequately, if required.

27.4.0 Piping Wall Thickness

- 27.4.1 The calculation of wall thickness required for pipelines subject to internal and/or external pressure shall be based on the formulae and recommendations as given in the applicable codes. Adequate allowances shall be made towards thinning due to bending, weakening at branch connections, threading, commercial tolerances on pipe wall thickness, corrosion and erosion, etc., and the same shall be subject to approval by Purchaser. In any case a minimum corrosion allowance of 1.6 mm shall be considered while selecting the thickness.
- 27.4.2 In case of carbon steel materials, the nominal wall thickness of pipeline shall not be less than the minimum acceptable values given below:

NB mm (inch)	15 (1/2)	30 (3/4)	25 (1)	32 (1¼)	40 (1.5)	50 (2)	65 (2.5)	80 (3)	100 (4)	125 (5)
Min. thickness, mm	3.2	3.2	3.6	3.6	3.6	3.6	3.6	4.0	4.5	5.4
NB mm (inch)	150 (6)	200 (8)	250 (10)	300 (12)	350 (14)	400 (16)	450 (18)	500 (20)	600 (24)	
Min. thickness, mm	5.4	6.35	6.35	6.35	7.1	7.1	7.1	8.0	8.0	

- > NB 600 mm to NB 900 mm - 8.0 mm
- > NB 900 mm to NB 1200 mm - 10.0 mm
- > NB 1200 mm to 1400 mm - 12.0 mm
- > NB 1400 mm to 1600 mm - 14.0 mm
- > NB 1600 mm to NB 2200 mm - 16.0 mm
- > NB 2200 mm - 18.0 mm

NOTE: For buried CW pipe with 500 mm thick RCC encasing (as detailed in cl. no. 27.3.5), the minimum acceptable thickness shall be as indicated below.

> NB 600 mm to NB 900 mm	-	8.0 mm
> NB 900 mm to NB 1200 mm	-	10.0 mm
> NB 1200 mm	-	12.0 mm

27.5.00 Piping Layout

- 27.5.1 Piping shall be grouped together where practicable and routed to present a neat appearance.
- 27.5.2 Piping routing shall be such as to provide sufficient clearance for removal and maintenance of equipment, easy access to valves, instruments and other accessories. The piping shall not encroach on the withdrawal space of various equipments.
- 27.5.3 Over head piping shall have a normal minimum vertical clearance of 2.5 meters above walkways and working areas and 8 m above roadways/railways. When several pipelines are laid parallel, flanged joints must be staggered. Welded and flanged joints should as far as possible be located at one third span from supports. If the support is situated right under the welded joints this joint must be reinforced with a strap. Flanged and welded joints must be avoided in the middle of the span. Valves should be located in such a manner so as to ensure their convenient operation from the floor or the nearest platform.
- 27.5.4 Pipelines of NB 50 size and below are regarded as field run piping. It is Bidder's responsibility to plan suitable layouts for these system insitu. Bidder shall prepare drawings indicating the layout of field run pipe work. These drawings shall be approved by Project Manager to the installation of the field run pipe work. Based on these approved layouts the Bidder shall prepare the BOQ of field run-pipe and submit to Employer for approval.
- 27.5.5 All piping shall be routed so as to avoid interference with other pipes and their hangers and supports, electrical cable trays, ventilation ducting, structural members, equipment etc.
- 27.5.6 Adequate clearance shall be ensured with respect to the above to accommodate insulation and pipe movements, if any.
- 27.5.7 Piping shall generally be routed above ground but where specifically indicated / approved by the project Manager the pipes may be arranged in trenches or buried. Pipes at working temperature above the ambient shall however not be buried.
- 27.5.8 Sufficient up stream and down stream lengths shall be provided for flow measuring devices, control valves and other specialties.
- 27.5.9 All local instruments shall be located on pipelines as to render them observable from the nearest available platforms.
- 27.5.10 Openings provided in the wall for pipelines must be closed with bricks and mortar with 10-12 mm clearance between brick work and pipe after taking care of insulation and thermal movement, if any. The clear space must be filled with felt or asbestos or approved filling compound.

27.6.00 Slope / Drains and Vents

27.6.1 Suitable slope shall be provided for all pipelines towards drain points. It is Bidder responsibility to identify the requirements of drains and vents, and supply the necessary pipe work, valves, fittings, hangers and supports etc. As per the system requirement low points in the pipelines shall be provided with suitable draining arrangement and high points shall be provided with vent connections where air or gas pockets may occur. Vent shall not be less than 15 mm size. Drains shall be provided at low points and at pockets in piping such that complete drainage of all systems is possible. Drain shall not be less than 15 mm for line size up to 150 mm, not less than 20 mm up to 300 mm and not less than 25 mm for 350 mm to 600 mm pipes and not less than 50 mm for 600 mm and above pipes.

27.6.2 Air piping shall be sloped so that any part of the system can be drained through the shut-off drain valve or drain plugs.

27.7.0 Pipe Joints

In general all water lines 65 mm NB and above, are to be joined generally by butt welding except the locations where valves/fittings are to be installed with flanged connections and 50 mm and below by socket welding unless mentioned otherwise specifically. All air lines shall be of screwed connection and rubber lined pipes of flanged connections.

27.7.1 Screwed Joints

- (a) Threading of pipes shall be carried out after bending, heat treatment etc. If not possible, threading may be done prior to these operations but proper care should be taken to protect them from damage. Threads shall be to ANSI B 2.1 (taper) NPT/IS:554 unless specified otherwise.
- (b) Galvanized pipe shall generally be joined by screwing into sockets. The exposed threaded portion on the outside of the pipes shall be given a zinc silicate coating. Galvanized pipes shall not be joined by welding. Screwed ends of GI pipes shall be thoroughly cleaned and painted with a mixture of red and white lead before jointing. For galvanized pipe sizes above 150 mm NB, screw & socket jointing as per ASTM-A-865 shall be employed for both pipe-to-pipe and pipe-to-fitting jointing. For pipe to fitting connection since no direct threading can be done on the fittings (supplied as per ASTM-A-234 Gr. WPB and ANSI B-16.9) necessary straight pipe lengths acting as match pieces shall be welded to the fitting at both ends and subsequently the free ends of the straight lengths shall be threaded as per ASTM A-865 for jointing with main pipe. Once welding of fittings with match pieces and threading of free ends of match pieces are over, the entire fabricated piece shall be galvanized, or in case match pipes and fittings are already galvanized before the above mentioned fabrication then suitable application of Zinc-Silicate paste adequately at the welded surface (both in side & out side) after welding with zinc rich electrode, alongwith the nascent threaded metal portion at both free ends given the same application of Zinc Silicate paste. Alternatively flanged jointing may be employed for pipe sizes 100 NB and above. However, the bidder shall ensure the galvanized pipe joints do not fail during hydro test.

- (c) Teflon tapes shall be used to seal out screwed joints and shall be applied to the male threads only. Threaded parts shall be wiped clean of oil or grease with appropriate solvent if necessary and allowing proper time for drying before applying the sealant. Pipe ends shall be reamed and all chips shall be removed. Screwed flanges shall be attached by screwing the pipe through the flange and the pipe and flange shall be refaced accurately.
- (d) For pipe sizes from 350 mm NB to 550 mm NB (including 350 NB & 550 NB) the GI pipes shall be of flanged connection. However, the pipes after welding of flanges shall be completely galvanized. Any site welding done on galvanized pipes shall be done with zinc-rich special electrodes and the welded surfaces whether inside or outside shall be coated with zinc-silicate pasts. Seal welding of flanges with zinc-rich electrode will be permitted only when any flange is leak-prone during hydro testing.
- (e) For pipe sizes 600 mm NB and above, the GI pipes shall be of welded connection (with zinc-rich special electrodes) followed by application of zinc silicate coating at welded surfaces both inside and outside the pipe, except for the last blank/blind flange, or, equipment connection where application of zinc-silicate paste after welding cannot be done due to inaccessibility of the inside welded surface and where galvanic protection has been impaired due to welding of pipe-to-pipe joint. Thus the last erection joint shall be flanged joint.

27.7.2 Welded Joints

- (a) For making up welded joints (butt weld or socket weld) the welding shall be performed by manual shielded metal arc process in accordance with the requirements specified elsewhere in the spec. Any welder employed for carrying butt welding shall be qualified as per ASME section IX for the type of joints he is going to weld. Jointing by butt weld, or socket weld shall depend upon the respective piping material specifications.

27.7.3 Flanged Joints

- (a) Flanged connections for pipes are to be kept to the minimum and used only for connections to vessel, equipments, flanged valves and other fittings like strainer/traps/orifices etc. for ease of connection and maintenance etc. Rubber lined pipes shall be flange joined only.
- (b) All flanged valves intended for installation on steel piping system, shall have their flanges drilled to ANSI B 16.5 (or equivalent) and according to the pressure class stated in their respective piping material specification.
- (c) Drilling on flanges of flanged valves must correspond to the drilling of flanges on the piping system on which the valves are installed.

27.8.00 Bends/elbows/mitre bends/Tees/Reducers & other fittings

27.8.1 Unless otherwise specified elbows shall be of long radius type.

- 27.8.2 For pipe sizes up to 65 Nb, long radius forged elbows or seamless pipe bends shall be used. Pipe bends, if used, shall be cold bent to a radius measured to the centre line of pipe of 3 to 5 times the pipe diameter.
- 27.8.3 For steel pipes 80 Nb and above, seamless long radius forged elbows shall be used. For pipe size 250 Nb and above mitre bends may be used for all pipes except rubber lined pipes. The bend radius shall be 1½ times the nominal pipe diameter. 90 deg. Bends (mitre) shall be in 4 pieces (3 cuts) and 45 deg. mitre bends shall be in 3 pieces 22½ deg. Fabrication of mitre bends shall be as detailed in BS 2633/BS534.
- 27.8.4 Mitre bends are not acceptable in case of rubber lined mild steel pipes.
- 27.8.5 For pipe fittings such as reducers and tees, the material shall be to ASTM-A-234 gr. WPB up to 300 NB. For pipe reducers and tees above 300 NB, the fittings may be fabricated conforming to parent pipe material. Provision of compensation pads shall be kept as per ANSI B 31.1. The fittings shall conform to the dimensional standard of ANSI B-16.9.
- However, for pipes upto 150 NB, pipe fittings may be supplied with material and dimension conforming to IS 1239 in case parent pipes also conform to IS 1239.
- For pipes, above 1200 NB, reducer and tees shall be to dimensional standard of AWWA-C-208.
- 27.8.6 Stainless steel fittings shall conform to either ASTM-A-182, Gr. 304 (316 for Sea water application, if any) or ASTM-A-403, Gr. WP 304 (316 for Sea Water application, if any) Class-S, for sizes upto and including 50 mm NB, i.e. the fitting shall be of seamless construction.
- However, for stainless steel fittings above 50mm NB, the same shall conform to ASTM-A-403, Gr. WP 304 (316 for Sea water application, if any), Class W i.e. the fittings shall be of welded construction strictly in accordance with ASTM-A-403.
- 27.8.7 In no case, the thickness of fittings shall be less than the thickness of parent pipe, irrespective of material of construction.

27.9.00 Flanges

- 27.9.1 Flanges shall be slip on type. Welding of flanges in tension is not permitted.
- 27.9.2 All flanges and flanged drilling shall be to ANSI B 16.5/BS EN-1092 of relevant pressure/temperature class. Flanges shall be fabricated from steel plates conforming to ASTM A 105/IS 2062 Gr. B. However stainless steel flanges shall be fabricated from SS plates to ASTM-A-240, Gr. 304 (316 for Sea water application, if any) or equivalent.

27.10.00 Specific technical requirement of laying buried pipe with anti corrosive treatment

The pipe in general shall be laid with the top of the pipe minimum 1.0 (one) meter below finished general ground level.

27.10.1 Trenching

- (a) The trench shall be cut true to the line and level and shall follow the gradient of the pipeline. The width of the trench shall be sufficient to give free working space on each side of the pipe. Trenches shall conform to IS 5822 or any international standard.
- (b) Free access shall be provided for the welding of the circumferential joints by increasing the width and depth of the trench at these points. There should be no obstruction to the welder from any side so that good welded joint is obtained.
- (c) The free working space shall conform to IS: 5822. The trench shall be excavated so as to provide minimum cover of 1000 mm between the top of the pipe and finished grade.
- (d) Prior to lowering and laying pipe in any trench, the bidder shall backfill and compact the bottom of the trench or excavation in accordance with IS: 5822 to provide an acceptable bed for placing the pipe.
- (e) Coating and Wrapping shall be done as under.

27.10.2 Preparation and cleaning of piping

- (a) The pipeline shall be thoroughly cleaned of all rust, grease, dirt, weld scales and weld burrs etc. moisture or other foreign matter by power cleaning method such as sand blasting, power tool cleaning, etc. Grease or heavy oil shall be removed by washing with a volatile solvent such as gasoline. Kerosene will not be permitted for cleaning. This cleaning operation shall be immediately followed by priming with the mechanical priming machine.
- (b) Certain inaccessible portions of the pipeline (which otherwise not possible to be cleaned by power cleaning methods) may be scrubbed manually with a stiff wire brush and scrapped where necessary with specific permission of the Project Manager.
- (c) On the internal surface for pipes 1000 NB and above, a coat of primer followed by a hot coal-tar enamel or coal tar epoxy painting (cold) shall be applied.
- (d) The cleaning and priming operation shall be carried out at site. The entire pipe length shall be cleaned but the ends of the pipes shall be left without coating for a distance of 230 mm for joints, which shall be coating manually at site after laying, welding and testing the pipe.

27.10.3 Coating and wrapping / Anti corrosive Protection Coal tar tape

- a. Buried piping shall be coated and wrapped, as per specification, after completion of welded and/or flanged connections, and after completion and approval of Hydro testing. Materials to be used for coating and wrapping of underground pipelines are:

- (1) Coating primer (coal tar primer)
- (2) Coating enamel (coal tar enamel)
- (3) Wrapping materials.

All primer/coating/wrapping materials and methods of application shall conform to IS: 10221 except asphalt/bitumen material. Materials (primer/coating/wrapping) as per AWWA-C-203 are also acceptable.

Protective coating shall consist of coal tar primer, coal tar enamel coating, glass fiber, tissue inner wrap followed by glass fiber or coal tar impregnated Kraft outer wrap or finish coat.

Number of coats and wraps, minimum thickness for each layer of application shall be as per IS-10221. Number of Coats and wraps shall be decided based on soil corrosivity/resistivity as indicated in IS-10221. Soil data-for this purpose shall be made available.

Total thickness of completed coating and wrapping shall not be less than 4.0 mm.

- b. Alternatively, the anti-corrosive protection for buried pipes can consist of anti-corrosive protection Coal-tar tapes. Material and application of tapes shall conform to IS 15337 or equivalent. These-tapes shall be applied hot over the cold coal tar primer in steps of 2 mm thickness so as to cover the spiral edges of the first tape by the application of second tape. The total thickness of the finished protective coating shall be 4.0 mm min.

27.10.4 Trench bed preparation and back filling

Prior to lowering and laying pipe in any excavated trench, the bottom of the trench may require to be back filled and compacted (or as the case may be) to provide an acceptable bed for placing the pipe. Bed preparation in general shall be as per IS: 5822.

27.10.5 Laying of galvanized steel (GI) pipes

All the joints shall be screwed with socket or flanged. Screwed ends of GI pipes shall be thoroughly cleaned and painted with a mixture of red and white lead before jointing. Threaded portion on either side of the socket joints shall be applied with Zinc silicate paste.

All the provisions for trenching' bed preparation' laying the pipe application of primer' coating' wrapping with tapes and back filling etc. as indicated for "laying of buried piping" and "anti corrosive protection for buried piping" are applicable for buried galvanized steel (GI) pipes also.

27.11.00 Cleaning and Flushing

- 27.11.1 All piping shall be cleaned by the Bidder before and after erection to remove grease, dirt, dust, scale and welding slag.
- 27.11.2 Before erection all pipe work, assemblies, sub-assemblies, fittings, and components, etc. shall be thoroughly cleaned internally and externally by blast cleaning or by power driven wire brushes and followed by air-blowing. The brushes shall be of the same or similar material as the metal being cleaned. Cleaning of Galvanized pipes shall be done in such a manner that the coating on MS pipe is not affected.
- 27.11.3 After erection, all water lines shall be hydro tested at 1.5 times the design pressure.
- 27.11.4 All compressed air pipe work shall be cleaned by blowing compressed air.

27.12.00 Painting of Pipes**27.12.1 Buried Piping****Internal surfaces**

- (i) Surface cleaning by sand blasting.
- (ii) Two (2) coats of epoxy primer coats. The minimum DFT of each coat shall be 35 microns.
- (iii) Finish coat-Two (2) coats of high build epoxy paint. The minimum DFT of each coat shall be 35 microns.

The total dry film thickness of 150 microns.

Tests to be carried out after application : Bond/ Adhesion test, Holiday test

External surfaces

- (i) Surface cleaning by Sand Blasting.
- (ii) Coal tar primer compatible with coal tar enamel grade. The number of coats shall be two with a DFT of 35 microns each.
- (iii) Coal tar enamel shall be applied. A single spiral inner wrap of glass fibre tissues shall be applied overlapping at least 25 mm ensuring impregnation of glass fibre tissues in the first coat. The second coat of enamel and second outer wrap of glass fibre felt, Type – I to IS: 7193-1974 will be applied in the same way confirming to Table – 10 of IS – 10221 – 1982.

The total thickness of the coating will not be less than 4.0 mm

- (iv) Alternatively Wrapping with coal tar based anticorrosion tape conforming to IS 15337: 2003 is also acceptable in lieu of s.no. (iii) above. Wrapping thickness shall be 4.0 mm.

NOTE : CW piping shall be encased in 500 mm thk RCC.

Tests to be carried out after application : Bond/ Adhesion test, Holiday test

27.12.2 Overground Piping

Internal surfaces

- (i) Surface cleaning by sand blasting.
- (ii) Two (2) coats of epoxy primer coats. The minimum DFT of each coat shall be 35 microns.
- (iii) Finish coat-Two (2) coats of high build epoxy paint. The minimum DFT of each coat shall be 35 microns.

The total dry film thickness of 140 microns (min).

External surfaces

- (i) Surface cleaning by Sand Blasting.
- (ii) Two (2) coats of epoxy primer coats. The minimum DFT of each coat shall be 35 microns.
- (iii) Finish coat-Two (2) coats of high build epoxy paint. The minimum DFT of each coat shall be 35 microns.

The total dry film thickness of 140 microns (min).

27.12.3 Other requirements

- (a) Paint manufacturers instructions shall be followed in method of application, handling, drying time etc.
- (b) The color of the finish paint shall be as per approved color-coding.
- (c) If finish paint was applied in shop, one coat of finish paint shall be applied at site.
- (d) The dry film thickness of paint shall not be less than 0.15 mm.

27.12.4 Color code for identification

The pipes shall be color painted/banded for identification as per the approved color-coding scheme and shall be generally as per IS-9404.

27.13.00 Specification for hangers and supports

27.13.1 All supports and parts shall conform to the requirement of power piping code ANSI B 31.1 or approved equivalent.

27.13.2 While designing supports for rubber lined pipes special consideration should be given. Any kind of welding on these pipes is not allowed after rubber lining.

- 27.13.3 Hanger for piping 65 mm Nb and larger and all spring support assemblies regardless of size shall be completely engineered in conformance with the provisions of power piping code ANSI B 31.1.
- 27.13.4 Hangers, saddles, supports etc. shall be fabricated from plates/pipes sections conforming to ASTM A 53/IS: 2062/IS:226/ or equivalent. They shall be designed to provide the required supporting effects and allow pipeline movements as necessary. The structural steel work shall be as per IS: 800/BS:4360. Insulation protection saddles shall be used at support point of all insulated piping.
- 27.13.5 The support shall be so interspaced as to minimize sagging of the pipes and to keep them within permissible limits where pipes are full with the conveying media.
- 27.13.6 The maximum spans of the supports of straight length shall not exceed the recommended values indicated in ANSI B 31.1.
- 27.13.7 All pipe supports shall be designed to provide an absolute minimum head room of 2.5 m from floor in passages/walkways.
- 27.13.8 At all sliding surfaces of supports suitable arrangement is to be provided to minimize sliding friction.
- 27.13.9 All components of hangers/support shall be provided with two coats of primer (red oxide paint) at shop before dispatch to site. After erection they shall be given finish coat of Long Oil Synthetic enamel to IS: 2932 of total DFT 100 to 140 microns. CLH & VLH will be primed with Epoxy Zinc rich primer of 50 micron followed by finish painting of Aliphatic Acrylic Polyurethane or equivalent of DFT 65 microns.

27.14.00 Design /Construction /Material Particulars of Gate /Globe /Check Valves /Globe Stop Valve /Butterfly Valve

27.14.1 GENERAL

- (a) All valves shall be suitable for the service conditions i.e. flow, temperature and pressure, at which they are required to operate.
- (b) General requirement of valves are as indicated below:
- (1) The valves as well as all accessories shall be designed for easy disassembly and maintenance.
 - (2) Valves to be installed outside shall be required to have the stem properly protected against atmospheric corrosion.
 - (3) All rising stem valves shall be provided with back seat to permit repacking (of glands) with valves in operation. All valves shall preferably be of outside screw and yoke type.
 - (4) All valves shall be closed by rotating the hand wheel in the clockwise direction when looking at the face of the hand wheel. In case where the hand wheel is not directly attached to the valve spindle suitable gearing shall be introduced.

- (5) All valves shall have indicators or direction clearly marked on the hand-wheel so that the valves opening/closing can be readily determined.
 - (6) Special attention shall be given to operating mechanism for large size valves with a view to obtaining quick and easy operation ensuring that a minimum of maintenance is required. For valves of size 350 mm and above either bevel or spur gearing shall be provided to facilitate manual operation.
 - (7) The valves coming in vacuum lines shall be of extended gland type and / or water sealed.
- (c) The actuator-operated valves shall be designed on the basis of the following:
- (1) The internal parts shall be suitable to support the pressure caused by the actuators.
 - (2) The valve-actuator unit shall be suitably stiff so as not to cause vibrations, misalignments, etc.
 - (3) All actuator-operated valves shall be provided with hand operated gearing mechanism also.
 - (4) All actuators operated valves shall open/close fully within time required by the process.
- (d) Valves coming under the purview of IBR shall meet IBR requirements.
- (e) Gate/slucice valves shall be used for isolation of flow. Gate valves shall be provided with the following accessories in addition to other standard items:
- (1) Hand wheel
 - (2) Position indicator (for above 50 mm NB valve size)
 - (3) Draining arrangement wherever required.
- (f) Globe valves shall be used for regulation purposes. They shall be provided with hand wheel, position indicator, draining arrangement (wherever required) and arrow indicating flow direction.
- (g) Check valves shall be used for non-return service. They shall be swing check type or double door (Dual plate) check type with a permanent arrow inscription on the valve body indicating the fluid flow direction. In long distance pipes lines with possibility of surge-occurrence, dual plate check valves are preferable for its spring controlled opening/closing of flaps/doors against flow reversals. However, dual plate check valves shall not be used for sizes more than 600 mm NB.
- (h) All gate and globe valves shall be provided with back seating arrangement to enable on line changing of gland packing.

- (i) All gate and globe valves shall be rising stem type and shall have limit switches for full OPEN and full CLOSED indication wherever required. This will include motor-operated valves also wherever required. In such cases the limit switches shall form an integral part of the valve. Stop-gap arrangement in this respect is not acceptable.
- (j) All valves shall be provided with embossed name plate giving details such as tag number, type, size etc.
- (k) Wherever required valves shall be provided with chain operator, extension spindles and floor stands or any other arrangement approved by employer so that they can be operated with ease from the nearest operating floor. Wherever necessary for safety purpose locking device shall be provided. Further, necessary small platforms for facilitating easy valve operation shall be provided by the contractor wherever necessary in consultation with project manager within the bid price at no extra cost to employer.
- (l) All valves except those with rising stems shall be provided with continuous mechanical position indicator; rising stem valves shall have only visual indication through plastic/metallic stem cover for sizes above 50 mm nominal bore.
- (m) For CI gate, globe and check valves wherever thickness of body/bonnet is not mentioned in the valves standards, thickness mentioned in IS-1538 for fitting shall be applicable.

27.14.2 VALVE BODY MATERIAL

Valve body material for various services shall be as follows:

Valve body material for water application like circulating water, Secondary circuit auxiliary cooling water of ECW system, Raw water, Ash water make-up, service water, clarified water, DM cooling water (pH corrected) & drinking water shall be cast iron for sizes 65 NB and above; gun-metal for sizes 50 NB and below.

For compressed air application, valve body material shall be cast carbon steel or forged carbon steel for sizes 65 mm NB & above and Gun metal for sizes 50 NB and below.

DM water: SS body and disc alongwith SS internals.

Condensate: Cast Carbon Steel/Forged Carbon Steel.

- 27.14.2.1 The design, material, construction, manufacture, inspection, testing and performance of valves shall comply with all currently applicable statutes, regulations and safety codes and the locality where the valves will be installed. The valves shall conform to the latest editions of applicable codes and standards as mentioned elsewhere. Nothing in this specification shall be construed to relieve the Bidder of his responsibility. Valves in general shall conform to the requirements of the following standards.

Standards and Codes

AWWA-C-504

Rubber seated butterfly valves

BS-5155/EN-593	Cast iron and steel body butterfly valves for general purpose.
IS-778	Gun-metal gate, globe and check valves for general purpose.
BS-5154	Copper alloy globe/globe stop and check and gate valves for general purpose.
IS-780	Sluice valves for water works purpose (50-300 mm size)
IS-2906	Sluice valves for water works purpose (350-1200 mm size)
IS-5150	Cast iron wedge and double disc gate for general purpose.
BS-5152	Specification for cast iron globe valves
BS-5153	Cast iron check valves for general purpose.
IS-5312	Swing check type reflux (non-return) valves
ANSI B 16.34	Standard for valves
API-594	Standard for Dual-check valves
API-600	Steel gate valves
ANSI-B-16.10	Valves face to face and other relevant dimension
API-598	Valves inspection test

27.14.2.2 End Connections

The end connections, shall comply with the following:

Socket welding (SW) – ANSI B 16.11

Butt Welding (BW) – ANSI B 16.25

Threaded (SC) – ANSI B 2.1

Flanged (FL) – ANSI B 16.5 & AWWA-C-207 (steel flanges), ANSI B 16.1 (Cast Iron flanges)

27.14.2.3 All cast iron body valves (gate, globe and non-return) shall have flanged end connections; (screwed ends for Ductile D.2NI body valves are not acceptable).

27.14.2.4 All steel and stainless steel body valves of sizes 65 mm and above shall have flanged or butt welding ends. Valves of sizes below 65mm shall have flanged or socket welded ends. Compatibility of welding between valve body material and connecting pipe material is a pre-requisite in case of butt-welded joints.

- 27.14.2.5 All gun metal body valves shall have screwed ends.
- 27.14.2.6 All flanged end valves/specialties shall be furnished alongwith matching counter flanges, fasteners, gaskets etc. as required to complete the joints

27.15.00 Check Valves

- 27.15.1 Check valves shall comply with the following characteristics:
- (a) For bore greater than 2" the valves must be swing check type or dual plate check type suitable for installation in all positions (vertical and horizontal);
 - (b) For bore smaller than or equal to 2" the valves must be of the piston type to be installed, in horizontal position.
 - (c) In the case of swing check valves, the body seat shall be inclined at such an angle from the vertical as will facilitate closing and prevent chatter.
- 27.15.2 Drilling on flanges of flanged valves must correspond to the drilling on flanges of the piping system on which the valves are to be installed.
- 27.15.3 All flanged valves intended for installation in steel piping systems shall have their flanges drilled to ANSI B 16.5 (or equivalent) and according to the pressure class.
- 27.15.4 Counter flanges to be installed on air pipes shall be screwed-on type irrespective of size.

27.16.00 Globe Valves

- 27.16.1 The globe valves shall have the following characteristics;
- Straight conveyed flow
- Right angle
- Preferably, the valves shall be of the vertical stem type.
- 27.16.2 Globe valves shall preferably have radiused or spherical seating and discs shall be free to revolve on the spindle.
- 27.16.3 The pressure shall preferably be under the disc of the valve. However, globe valves, with pressure over the disc shall also be accepted provided (i) no possibility exists that flow from above the disc can remove either the disc from stem or component from disc (ii) manual globe valves can easily be operated by hand. If the fluid load on the top of the disc is higher than 40-60 KN, bypass valve shall be provided which permits the downstream system to be pressurized before the globe valve is opened.
- 27.16.4 For the regulating valves, valves with regulating plug & parabolic outline disc type is preferred.

27.16.5 All motorized globe valves with regulating plug for which indication of percentage (%) opening are required in the control room shall be provided with necessary position transmitter.

27.17.00 Gate valves

All gate valves shall be of the full-way type, and when in the full open position the bore of the valve shall not be constricted by any part of the gate.

Gate valves shall be of the solid/elastic or articulated wedge disc and rising stem type.

27.18.00 Air Release Valve

- (a) The air release valves shall be of automatic double air valve with two orifices and two floats. The float shall not close the valve at higher air velocities. The orifice contact joint with the float shall be leak tight joint.
- (b) The valve shall efficiently discharge the displaced air automatically from ducts/pipes while filling them and admit air automatically into the ducts/pipes while they are being emptied. The valve shall also automatically release trapped air from ducts/pipes during operation at the normal working pressure.
- (c) Body material of automatic air release valves shall comply generally with BS 1452 Gr. 14/IS:210 Gr. FG 260 and spindle shall conform to high tensile brass.
- (d) Air release valves shall not have any integral isolation device within them. Each Air release valve shall be mounted, preceded by a separate isolation gate/butterfly valve.

125# ASA cast iron body, double ball construction air release valve with flanged ends to ASA B 16.10; and bolted cover to release the air. Construction materials shall be as below:

Body, cover	:	Cast iron to IS:210 Gr.FG 260
Bolts	:	Light weight leather/wooden balls
Seats	:	Bronze to ASTM-B-62
Cover packing	:	Braided asbestos
Float	:	Wood/rubber

27.19.00 Butterfly Valves**27.19.1 Design / Construction**

- (a) The valves shall be designed for the design pressure/temperature of the system on which it is installed and in accordance with AWWA-C-504, EN-593 or any other approved equivalent standard latest edition. Fabricated steel (IS: 2062 GR. B) butterfly valves instead of cast iron body valves are also acceptable for size above 300 mm nb diameter. In such a case, however, the bidder will have to necessarily submit thickness calculations, in order to establish the integrity of the fabricated valve body under the system operating pressure condition.
- (1) The valves shall be suitable for installation in any position (horizontal/vertical etc.) and shall be generally of double-flanged construction. However for sizes 600 NB and below the valves of Wafer construction are also acceptable.
 - (2) The seals, both on the body (sleeve) and on the disc shall be of the material specified. Necessary shaft seal shall be provided and adequately designed to ensure no leakage across the seal. This seal shall be designed so that they will allow replacement without removal of the valve shaft. The sealing ring on the disk shall be continuous type and easily replaceable.
 - (3) For all types of valves, the design with shaft eccentric to the disc is preferred. The shaft shall be solid type and shall pivot on bushings. Bushings/sleeve type bearings shall be contained in the hub of valve body. The bearing shall be self-lubricated type with low coefficient of friction and should not have any harmful effect on water and on valve components.
 - (4) The design of the shaft shall be such that it will safely sustain maximum differential pressure across the closed valve. The shaft and any key (taper pin etc.) for transmitting the torque between shaft and disc shall be capable of withstanding the maximum torque required to operate the valve. However, the shaft diameter shall not be less than the minimum shaft diameter specified in relevant code. Necessary Torque Calculation and the torque class selected on the basis of the same shall be furnished to the Employer for information.
 - (5) The disc shall rotate from the full open to the tight shut position. The disc shall be contoured to ensure the least possible resistance to flow and shall be suitable for throttling operation. While the disc is in the throttled position, valve shall not create any noise or vibration.
 - (6) The operating mechanism shall be mounted directly on or supported from the valve body.
 - (7) All valves shall be complete with:
 - Position indicator (located in a visible place)
 - Arrow indicating the flow direction;

Adjustable mechanical stop limiting devices to prevent over

Travel of valve disc in open/close position.

All valves shall be "tight shut off"

(8) Hand operated valves shall have the following

Local hand controls

The hand controls shall close the valve with clockwise rotation.

The hand controls shall be dimensioned to guarantee an easy maneuver under most severe conditions.

The hand controls shall be provided with locking systems suitable to avoid the disc assuming a non-desirable position during the operation.

Hand wheel shall be made of malleable iron with arms and rims of adequate strength. The hand wheel of diameters 300 mm or less shall be provided with handles for ease of operation. The pulling force required on the hand wheel rim shall not exceed 25 Kgf when operating the valve under full flow and operating pressure.

Valves-350 Nb and above shall have pressure equalizing bypass valves, wherever system parameters warrant the same.

Valves-350 Nb and above shall also be provided with gear operator arrangement suitable for manual operation. Manual operation of valve shall be through worm and gear arrangement having totally enclosed gearing with hand wheel diameter and gear ratio designed to meet the required operating torque. It shall be designed to hold the valve disc in intermediate position between full open and full closed position without creeping or fluttering. Adjustable stops shall be provided to prevent over travel in either direction.

Limit and torque switches (if applicable) shall be enclosed in water tight enclosures alongwith suitable space heaters for motor actuated valves, which may be either for On-Off operation or inching operation with position transmitter.

27.19.2 Material of Construction (Butterfly Valves)

Materials and other design details shall be as indicated below:

(a) Cast Iron Butterfly valves

Body & Disc	ASTM A48, Gr. 40 with 2% Ni/ IS: 210. Gr. FG-260, with 2% Ni and epoxy coated

Shaft	BS 970 431 S: 291/EN 57, or AISI-410 or AWWA-permitted shaft material equivalent to EN-57/AISI-410 or better.

Seat ring Seal	18-8 Stainless steel Nitrile Rubber

(b) Stainless Steel Butterfly Valves

Body & Disc	ASTM A 351, Gr. CF8M/ASTM-A-182-Gr. 304

Shaft	ASTM A 182, Gr. 316/ASTM-A-479 Gr. 316/Equivalent

Disc & Seat Rings	EPT/BUNA-N/Neoprene

(c) Carbon Steel Butterfly Valves

Body & Disc Shaft	ASTM A 216, Gr. WCB ASTM A 182, Gr. 304/ASTM-A-479 Gr. 304/Equivalent

Disc & Seat Rings	EPT/BUNA-N/Neoprene

27.19.3 Proof of Design Test (Type Test) for Butterfly Valves

Proof of Design (POD) test certificates shall be furnished by the bidder for all applicable size-ranges and classes of Butterfly valves supplied by him, in the absence of which actual POD test shall be conducted by the bidder in the presence of Employer's representative.

All valves that are designed and manufactured as per AWWA-C-504 shall be governed by the relevant clauses of POD test in AWWA-C-504. For Butterfly valves designed and manufactured to EN-593 or equivalent, the POD test methods and procedures shall generally follow the guidelines of AWWA-C-504 in all respect except that Body & seat hydro test and disc-strength test shall be conducted at the pressures specified in EN-593 or the applicable code. Actuators shall also meet requirements of POD test of AWWA-C-504.

27.20.00 MATERIAL OF CONSTRUCTION (GATE/GLOBE/CHECK VALVE)

(a) The materials shall generally comply with the following:

(1) Cast Steel Valves

Body & bonnet	ASTM A 216 Gr. WCB/ ASTM A 105
Disc for non-return Valves	ASTM A 216 Gr. WCB/ ASTM A 105
Trim.	ASTM A 182 Gr. F6 or Equivalent

(2) Stainless Steel Valves

Body & Bonnet	ASTM A 351 Gr. CF 8M/

ASTM A 182 Gr. 304

Disc -do-

Trim. ASTM 182 Gr. F. 316
/ASTM-A-479 Gr. 316 or Integral
with body**(3) Cast Iron Valves**

Body & bonnet BS 1452 Gr. 14/IS-210 Gr. FG 260

Seating surfaces and rings 13% chromium steel/13% Chrome
overlay

Disc for non-return valves BS 1452 Gr. 14/IS-210 Gr FG 260

Hinge pin for non-return valves AISI 316

Stem for gate globe valves 13% chromium steel or Equivalent

Back Seat 13% chromium steel / 13%
Chrome overlay**(4) Gun Metal Valves**

Body and bonnet IS 318 Gr. 2/Equivalent Standard

Trim -do-

- (b) Cast iron body valves shall have high alloy steel stem and seat.
- (c) Material for counter flanges shall be the same as for the piping.

27.21.00 Float Operated Valves

- (a) Valve shall automatically control the rate of filling and will shut off when a predetermined level is reached and close to prevent over flow on pre-set maximum water level. Valve shall also open and close in direct proportion to rise or fall of water level.
- (b) **DESIGN AND CONSTRUCTION FEATURES**
The following design and construction feature of the valve shall be the minimum acceptable.
- (c) Valves shall be right-angled or globe pattern.
- (d) Valves shall be balance piston type with float ball.
- (e) Leather liner shall not be provided.
- (f) The body and cover material shall be cast iron conforming to ASTM-A 126 Grade 'B' or Is: 210 Grade 200 or equivalent, and float shall be of copper with epoxy painting of two (2) coats.
- (g) Valves shall be suitable for flow velocities of 2 to 2.5m/sec.
- (h) The valves shall have flanged connections.

27.22.00 PAINTING OF VALVES:

Two (2) coats of primer followed by three (3) coats of epoxy of approved color code/shade (usually same as that of connected piping) shall be applied to all exposed surfaces except stainless steel surface, Galvanized steel surface and gun metal surface at shop as required to prevent corrosion, before dispatch. The use of grease/oil other than light grade mineral oil, for corrosion protection is prohibited. The total DFT of painting shall be 150 micron (minimum). If during transport, unloading/unpacking or erection at site any part of the painted surface gets damaged, the same shall be made good by the contractor by repainting with compatible painting primer and enamel to the satisfaction of the project manager.

27.23.00 RUBBER EXPANSION JOINTS

- 27.23.1 All parts of expansion joints shall be suitably designed for all stresses that may occur during continuous operation and for any additional stresses that may occur during installation and also during transient condition.
- 27.23.2 The expansion joints shall be single bellow rubber expansion joints. The arches of the expansion joints shall be filled with soft rubber.
- 27.23.3 The tube (i.e. inner cover) and the cover (outer) shall be made of natural or synthetic rubber of adequate hardness. The shore hardness shall not be less than 60 deg. A for outer and 50 deg. A for inner cover.
- 27.23.4 The carcass between the tube and the cover shall be made of high quality cotton duck, preferably, square woven to provide equal strength in both directions of the weave. The fabric plies shall be impregnated with age resistant rubber or synthetic compound and laminated into a unit.
- 27.23.5 Reinforcement, consisting of solid metal rings embedded in carcass shall be provided.
- 27.23.6 Expansion joints shall be complete with stretcher bolt assembly. The expansion joints shall be suitable to absorb piping movements and accommodate mismatch between pipelines.
- 27.23.7 The expansion joints shall be of heavy duty construction made of high grade abrasion-resistant natural or synthetic rubber compound. The basic fabric for the 'duck' shall be either a superior quality braided cotton or synthetic fibre having maximum flexibility and non-set characteristic.
- 27.23.8 The expansion joints shall be adequately reinforced, with solid steel rings, to meet the service conditions under which they are to operate.
- 27.23.9 All expansion joints shall be provided with stainless steel retaining rings for DM water application and IS 2062 Gr. B galvanized steel retaining rings for ordinary water for use on the inner face of the rubber flanges, to prevent any possibility of damage to the rubber when the bolts are tightened. These rings shall be split and beveled type for easy installation and replacement and shall be drilled to match the drilling on the end rubber flanges and shall be in two or more pieces.

- 27.23.10 The expansion joints shall have integral fabric reinforced full-face rubber flanges. The bolt on one flange shall have no eccentricity in relation to the corresponding bolt hole on the flange on the other face. The end rubber flanges shall be drilled to suit the companion pipe flanges.
- 27.23.11 All exposed surfaces of the expansion joint shall be given a 3 mm thick coating of neoprene. This surface shall be reasonably uniform and free from any blisters, porosity and other surface defects.
- 27.23.12 Each control unit shall consist of two (2) numbers of triangular stretcher bolt plates, a stretcher bolt with washers, nuts, and lock nuts. Each plate shall be drilled with three holes, two for fixing the plate on to the companion steel flange and the third for fixing the stretcher bolt.
- 27.23.13 Each joint shall have a permanently attached brass or stainless steel metal tag indicating the tag numbers and other salient design features.
- 27.23.14 Bidder to note that any metallic part which comes in contact with DM / Corrosive water shall be of stainless steel material.

27.24.00 STRAINERS**27.24.1 Simplex type**

The strainers shall be basket type and of simplex construction. The strainer shall be provided with plugged drain/blow off and vent connections. The free area of the strainer element shall be at least four (4) times the internal area of the connecting pipe lines. The strainer element shall be 20 mesh. Pressure drop across the strainers in new condition fitted with a removable plug. The material of construction of various parts shall be as follows:

(a)	Body	IS: 318, Gr. 2 up to 50 mm Nb, and IS: 210 Gr. FG 260 above 50 mm Nb. (For DM water/ -Body: AISI 316 or equivalent)
(b)	Strainer Element	Stainless steel (AISI 316)
(c)	End connection	Screwed upto 50 mm Nb, and flanged above 50 mm Nb

27.24.2 Duplex type

- (a) The strainers shall be basket type and of duplex construction. The strainer shall be provided with plugged drain/blow off and vent connections. The free area of the strainer element shall be at least four (4) times the internal area of the connecting pipe. The mesh of strainer element shall be commensurate with the actual service required. Pressure drop across the strainer in new condition shall not exceed 4.0 MWC at full flow.
- (b) Wire mesh (if applicable) of the strainers shall be suitably reinforced. The material of construction of various parts shall be as follows.

Body	IS: 318, Gr. 2 Up to 50 mm Nb, and IS:210,

Gr. FG 260 of ASTM-A-515 Gr. 75/IS-2062
Gr. B and internally epoxy-painted above 50 mm NB.

Strainer element Stainless steel (AISI 316)

End connection Screwed up to 50 mm Nb, and
Flanged above 50 mm Nb.
Gasket shall be of full face type

- (c) The strainer will have a permanent stainless steel tag fixed on the strainer body indicating the strainer tag number and service and other salient data.
- (d) The size of the strainer and the flow direction will be indicated on the strainer body casting.
- (e) Thickness of the strainer element should be designed to withstand the pressure developed within the strainer due to 100% clogged condition exerting shut-off pressure on the element.

27.24.3 Three shop coats of paint preceded by two coats of primer shall be applied to all exposed surfaces as required to prevent corrosion. All parts shall be adequately protected for rust prevention. The use of grease or oil other than light grade mineral oils for corrosion protection is prohibited

ANNEXURE-I**SPECIFICATION FOR DUCTILE IRON (DI) PIPES, FITTINGS & SPECIALS****1.00.00 GENERAL**

This specification covers the specific requirement of design, material, manufacture / fabrication, constructional features, inspection & testing, transportation, handling, laying, site testing and annual maintenance contract of Ductile Iron (DI) Pipes, Joints, fittings and specials.

2.00.00 CODES AND STANDARDS

The material, design, manufacture, dimensions, tolerances, mechanical properties, internal cement mortar lining, external zinc coating along with bituminous finished layer, inspection and testing of DI water pipes shall comply with the latest Indian Standard, "IS 8329 (Centrifugally cast (spun) ductile iron pressure pipes for water, gas and sewage – specification)" or equivalent international standard unless otherwise specified elsewhere in this Technical Specification.

Sl. No.	Code No.	Code Title
1	IS 8329	Centrifugally cast (spun) ductile iron pressure for water, gas and sewage - specification
2	IS 9523	Ductile iron fittings for pressure pipes for water, gas and sewage - specification
3	IS 5382	Rubber sealing rings for gas mains, water mains and sewers
4	IS 638	Specification for Sheet Rubber Jointing and Rubber Insertion Jointing
5	IS 12288	Code of practice for use and laying of Ductile Iron pipes
6	IS 11606	Methods of sampling of Cast Iron pipes and fittings
7	IS 455	Portland slag cement
8	IS 12330	Sulphate resisting Portland cement
9	IS 6452	Specification for high alumina cement for structural use
10	IS 6909	Specification for supersulphated cement
11	IS 8112	43 grade ordinary Portland cement
12	IS 1387	General requirements for supply of metallurgical materials
13	IS 1500	Methods for Brinell hardness test for metallic materials
14	IS 1608	Mechanical testing of metals – tensile testing
15	ISO 2531	Ductile iron pipes, fittings, accessories and their joints for water applications
16	ISO 4179	Ductile iron pipes and fittings for pressure and non-pressure pipelines – Cement mortar lining
17	ISO 4633	Rubber seals – Joint rings for water supply, drainage and sewerage pipelines – Specification for materials

18	ISO 8179	Ductile iron pipes – External zinc-based coating – Part 1: Metallic zinc with finishing layer
19	ISO 8179	Ductile iron pipes – External zinc coating – Part 2: Zinc rich paint with finishing layer
20	ISO 8180	Ductile iron pipelines – Polyethylene sleeving for site application
21	ISO 10802	Ductile iron pipelines – Hydrostatic testing after installation
22	ISO 10803	Design method for ductile iron pipes
23	ISO 16132	Ductile iron pipe and fittings – seal coats for cement mortar linings
24	AWWA M 41	Ductile iron pipe and fittings (guideline code for design, manufacturing, testing, jointing, laying & installation etc.)
25	BS EN 545	Ductile iron pipes, fittings, accessories and their joints for water pipelines – Requirements and test methods

3.00.0 DUCTILE IRON (DI) PRESSURE PIPES:

3.01.01 DESIGN REQUIREMENTS

Pipeline shall be sized considering C value as 140 and velocity 2-3m/sec.

3.01.01 Classification:

The class of DI pipes to be provided shall be as specified in the data sheet attached with this sub-section. The external diameter and wall thickness of socket and spigot pipes for the specified Class shall be as per IS 8329 or equivalent international standard.

3.02.00 Joints:

3.02.01 Generally push-on flexible joints shall be provided for pipe to pipe connection as per IS 8329 or equivalent international standard. However mechanical joints, flange joints and restrained joints can also be used.

3.02.02 Rubber gaskets

Rubber gasket used with push-on flexible joints shall conform to the requirements of IS: 5382 or equivalent international standard. Rubber gaskets for use with flanged joints shall conform to IS 638 or approved equivalent international standard.

4.00.00 DI FITTINGS & SPECIALS

4.01.0 Design Requirements

4.01.01 Classification

The DI fittings shall be as per IS 9523 or equivalent international standard.

4.02.00 External layer:

The DI fittings supplied shall be provided with external protection of metallic zinc coating or zinc rich paint coating with finishing layer of bituminous paint as per IS 9523 or equivalent international standard.

4.03.00 Internal lining:

The fittings shall be provided with suitable cement mortar internal lining as per IS 9523 or equivalent international standard.

4.04.00 Joints between pipe and fittings:

4.04.01 Generally , Push-on flexible joints shall be provided for pipe to fitting connection as per IS 9523 or equivalent international standard. Flange joints, wherever required, shall conform to the requirements of IS 9523 or equivalent international standard.

4.04.02 Rubber gaskets

All the DI fittings shall be provided with rubber gaskets for each socket. Rubber gasket used with push-on flexible joints shall conform to the requirements of IS: 5382/ IS 9523 or equivalent international standard.

Rubber gaskets for use with flanged joints shall conform to IS 638 or equivalent international standard.

5.00.00 TYPE TESTS

5.01.00 The contractor / manufacturer shall carry out the type tests as listed in this specification on the pipes to be supplied under this contract.

5.02.00 The type tests shall be carried out in presence of the Employer's representative, for which minimum 15 days notice shall be given by the contractor. The contractor shall obtain the Employer's approval for the type test procedure before conducting the type test. The type test procedure shall clearly specify the test set-up, instruments to be used, procedure, acceptance norms, recording of different parameters, interval of recording, precautions to be taken etc. for the type test(s) to be carried out.

5.03.00 In case the contractor / manufacturer has already conducted such specified type test(s), he may submit the type test reports to the Employer during detailed engineering for consideration of waiver of conductance of such type test(s) or otherwise as deemed fit by Employer. Such test(s) should have been either conducted at an independent laboratory or duly approved by accredited third party agency. The Employer reserves the right to waive conducting of any or all the specified type test(s) under this contract.

5.04.00 The type test shall be performed whenever a significant change is made in the design, material or process of manufacture or a new size or size range of the product is being supplied by the manufacturer.

5.05.00 THE FOLLOWING TYPE TESTS SHALL BE CARRIED OUT:

5.05.01 Joint Leak Tightness Test:

- a) Tests for joints (push-on flexible joints) shall be conducted as per the guidelines of ISO 2531 to establish adequate joint performance with respect to internal pressure, external pressure and vacuum pressure under both normal alignment of joints and deflected alignment of joints as dictated in ISO 2531.
- b) Tests for Leak tightness and mechanical resistance of flanged joints shall be conducted as per ISO 2531.

5.05.02 Cement Lining Smoothness Type Test:

The contractor / manufacturer should have carried out Cement Lining Smoothness test to establish C value (Hazen & William's constant) of the offered DI pipe as 140. Necessary certificate for the same shall be furnished to the employer.

In case the contractor / manufacturer has not carried out the test, the same shall be carried out by the contractor / manufacturer within the scope of this contract.

5.05.03 Ring bend test:

Ring bend test for 3% deflection with respect to external diameter of DI pipe offered shall be conducted by contractor / manufacturer to prove that internal cement mortar lining does not come off the substrate surface of Ductile Iron on random basis for each manufacturing lot.

If the contractor / manufacturer of pipes do not have the facility for this type test at his own works, the same can be arranged by him to conduct and demonstrate the test.

6.00.00 LAYING AND JOINTING OF DI PIPES:

6.01.00 Laying, erection and jointing of DI pipelines at field / site shall be under the direct supervision of Manufacturer (Supplier) from whom pipe is sourced / procured.

For underground laying, Special provisions in trench shall be made for accommodating socket (Bell) of each pipe, as applicable so that barrel is uniformly rested on even trench bed surface, which is well compacted as recommended in codes / standards.

6.02.00 Pipeline anchorage

Pipeline shall be securely anchored at dead ends, tees, bends, tapers and valves to resist thrust arising from internal pressure. Suitable thrust blocks made of concrete shall be designed and cast-in-situ.

7.00.00HYDRAULIC TESTING OF PIPELINES

After laying and jointing, the pipeline shall be tested for soundness and leak tightness of pipes, fittings and joints, and soundness of any construction work. The pipeline may be tested in sections.

Water and other facilities as required for such hydro testing shall be arranged by the Contractor.

7.01.00 Hydraulic Testing of Sections

The section under test shall be filled with water, taking care that all the air is displaced either through vents at the high points or by using a pig or a sphere. After filling, the pipeline shall be slightly pressurized for a period of time to achieve stable conditions.

The pipeline is then pressurized up to the full test pressure as per the relevant standard. The test pressure shall be maintained for a period of not less than 10 minutes to reveal any defects in the pipes, joints or anchorages. The test pressure shall be measured such as to ensure that the required test pressure is not exceeded at any point in the entire pipeline.

If the test is not satisfactory, the fault shall be found and rectified. Methods employed for finding faults shall be as per IS 12288.

7.02.00 Hydraulic Testing of Complete Pipeline

After all the sections have been joined together on completion of section testing, a test on the complete pipeline shall be carried out. This test shall be carried out at a pressure as specified in the data sheet attached with this sub-section. During the test, the pressure at any point in the pipeline shall not exceed the pressure as specified in the data sheet attached with this subsection.

8.00.00 DATA SHEET FOR DI PIPES, FITTINGS & SPECIALS

Sl.No.	Description	Units	Parameters
1	Pipe Material		Ductile Iron (DI) pipe internally cement mortar lined and externally coated with metallic zinc & finishing layer of bituminous paint.
2	Applicable standards		IS/ISO/AWWA/BS as listed in technical specification
3	Hazen & William's Constant		140
4	Pipe class		K7/K9 as per IS 8329 or equivalent international standard. Compatible with system pressure requirement.
5	Pipe Joint type		Push-on flexible joints as per IS 8329 / Flanged/ Restraint

6	Pipe Joint type at valves, pumps and other piping		Flange Joints as per IS 8329 & IS 9523
7	Welded-on Flange (as applicable) pressure class		Compatible with system pressure requirement.
8	DI fittings class		Compatible with system pressure requirement.
9	DI fittings flange (as applicable) class		PN 25
10	Restrain mechanism at bends, specials etc.		Thrust Blocks
11	Maximum field hydrostatic test pressure	N/mm ²	Shut-off pressure or (operating pressure+surge pressure) whichever is higher for not less than 10 minutes
	At each section (not exceeding 1000m)		
	Complete pipeline		As per IS: 12288 Table-1
12	Other requirements		As per technical specification

1X660 MW PANKI TPS

COMPRESSED AIR SYSTEM

SECTION IA

(FUNCTIONAL / PERFORMANCE / DEMONSTRATION REQUIREMENT)



BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR PROJECT ENGINEERING MANAGEMENT
NOIDA-INDIA

	TECHNICAL SPECIFICATION FOR COMPRESSED AIR SYSTEM 1X660 MW PANKI TPS	SPECIFICATION NO. PE-TS-426-555-A001	
			SECTION IA
		REVISION 01	DATE: 17.06.2019
		PAGE 2 of 3	

1.0.0 GENERAL REQUIREMENTS

- 1.1.0 After satisfactory completion of the trial operation, the performance test shall be conducted at site by the Contractor. Any preparations required for this test shall be carried out by the Contractor. 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. The PG test procedure should be submitted to the owner well in advance and got approved before the commencement of PG test. Performance Guarantee Test shall be conducted within 30 days of intimation from the Contractor about his readiness for conducting Performance Guarantee Test. These tests shall be binding on both the Owner and the Contractor to determine performance of the equipment/system with the performance guarantee data.
- 1.2.0 The tests shall be conducted at the specified load conditions or as near the specified conditions as practicable. The Owner/Contractor will apply agreed factors to compensate for deviation from the designed parameters. The suitable correction curves mutually agreed by the Owner and the Contractor shall be used.
- 1.3.0 All test instrumentation as required for the Performance Guarantee Test shall be arranged by the Contractor free of cost. Precision instruments required for Performance Guarantee Test shall, however, be arranged by the contractor. Calibration before and after test and installation of the test instrumentation for the test shall be the Contractor's responsibility. All test instrumentation shall be in accordance with the applicable code. All test instruments and calibration procedures shall be duly approved by the Owner. Batch calibration shall not be accepted. The test shall be commenced only after clearance of owner on the above vital issues.
- 1.4.0 Any special equipment, tools and tackles required for the successful completion of the performance tests shall be provided by the Contractor free of cost.
- 1.5.0 The performance guarantee figures of the equipment shall be proved by the Contractor during the Performance Guarantee Test.
- 1.6.0 Should the results of these tests show any decrease from guaranteed values, the Contractor shall modify the equipment within 90 days from the date of intimation by the owner 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 subject to grid requirements at that time. All costs of modifications including labour, material and the cost of additional testing to prove that equipment meets the guarantee shall be borne by the Contractor.
- 1.7.0 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. The details of all measuring/recording meters, test instrumentation such as class of accuracy, make etc. shall be covered in the trial operation/ performance test reports. All the list of equipment, accuracy class and test certificates to be submitted and got approved by the owner before the commencement of trial operation.
- 1.8.0 PG test to be witnessed by the consultant and the owner

	TECHNICAL SPECIFICATION FOR COMPRESSED AIR SYSTEM 1X660 MW PANKI TPS	SPECIFICATION NO. PE-TS-426-555-A001	
			SECTION IA
		REVISION 01	DATE: 17.06.2019
		PAGE 3 of 3	

2.0 PERFORMANCE GUARANTEES, PENALTIES & CAPABILITY TESTS:

- 2.1 The Contractor shall meet the Performance Guarantees as have been indicated in the Specifications.
- 2.2 The penalty for not meeting the performance guarantees during the Performance Guarantee Test shall be assessed and recovered from the Contractor. Such penalty shall be levied without limitations, in accordance with stipulations made in Technical Specification and shall be without prejudice to all the other conditions of the contract.
- 2.3 If the guarantees specified are not achieved by the Contractor within 90 days of notification by the Owner, he may at his discretion reject the equipment or accept it after levying and recovering suitable penalties.
- 2.4 In case there is shortfall in capability of equipment while demonstrating capability tests, the Contractor shall forth-with rectify his equipment within 90 days and re-perform the capability tests to Owner's satisfaction.
- 2.5 Performance parameters for compressed air system to be demonstrated are:
- Demonstration of Auxiliary power consumption for the system.
 - Free air delivery at site conditions per each compressor (Nm^3/min).
 - Power consumption at site rated parameters per each compressor (kW).
 - Max. Capacity of each air dryer at min working pressure and max. Temp at after cooler outlet (Nm^3/min).
 - Parallel operation of air compressors to be demonstrated at site.
 - Pressure drop across Air Drying Plant, Capacity and outlet dew point of each air drying plant shall be demonstrated at site.
 - Vibration level and noise level of each air compressor, blowers and any other rotating equipment of each air drying plant shall be demonstrated at site.
 - Instrument air quality

3.0 PENALTY FOR POOR PERFORMANCE:

- 3.1 Category I Guarantees: Performance guarantees penalties.
Auxiliary power consumption - Summation of power consumption of working drives at their rated capacities for compressed air system. Base auxiliary power consumption for CAS and penalties shall be as per Section III F. Bidder to furnish its guaranteed auxiliary power consumption with its technical offer (Not in sealed price).
- 3.2 Category III Guarantees: Performance Guarantee under compulsory correction.
The contractor shall make every effort to practicable to correct the deficiencies. In case the Contractor fails to meet the guarantees, the equipment / system shall be replaced with the one that shall meet the guaranteed values without any time and cost implication to the Owner. The following items are under compulsory correction:
- Capacity and discharge pressure of each air compressor. (Shall be demonstrated at shop).
 - Parallel operation of air compressors to be demonstrated at site.
 - Dew point of air at the outlet of air drying plants of instrument air compressors to be demonstrated at site.
 - Pressure drop across Air Drying Plant of air compressors to be demonstrated at site.
 - Vibration level and noise level of each air compressor, blowers and any other rotating equipment of each air drying plant shall be demonstrated at site.

1X660 MW PANKI TPS

COMPRESSED AIR SYSTEM

SECTION IA

(QUALITY ASSURANCE AND INSPECTION REQUIREMENTS)



BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR PROJECT ENGINEERING MANAGEMENT
NOIDA-INDIA

CHAPTER 11 : QUALITY ASSURANCE REQUIREMENTS**1.0 INTRODUCTION**

1.1 The minimum Quality Assurance / Quality Control (QA/QC) requirements and the services the Contractor is expected to provide to assure "Quality Assurance" are described in this section. "Quality Assurance" is defined as the entire programme adopted by the Contractor during engineering, procurement and construction to assure conformity with the contract specifications. Quality Assurance/Quality Control procedures proposed by the Contractor should address the QA/QC requirements under the following phases of the project:

- (a) Engineering
- (b) Procurement
- (c) Construction including commissioning and testing

1.2 Contractor shall submit documents to demonstrate that the Contractor and his sub-vendors possess, QA/QC programs meeting the requirements set forth in this section. Contractor shall prepare the quality assurance plans for all the offered equipments to cover the overall quality assurance requirements. Contractor shall submit a quality assurance plan along with the bid as per the format enclosed for all applicable equipment & systems.

1.3 The Contractor must submit an organization chart defining the permanent positions responsible for QA/QC accompanied by a brief description of each position's function and responsibility. A second organization chart along with a descriptive write up should also be provided outlining the proposed QA/QC program for this particular project. This chart and write up should identify the personnel responsible for the Engineering Quality Assurance Plan for the completion duration of the project.

2.0 ENGINEERING**2.1 Prior to finalization of contract**

Prior to finalization of the Contract, the Contractor shall prepare and submit a project Quality Assurance Plan that covers the engineering phase of the Works. The plan shall be designed for this project and shall address the specifics of how the Contractor will control, monitor and verify the requirements contained in this section. The Contractor shall utilize all of his QA/QC resources, manuals and procedures when preparing the plan. Purchaser shall review the plan prior to utilization and upon issue the plan shall become the basis by which Purchaser will evaluate the Contractor's engineering QA/QC activities as they relate to this project.

2.2 Purchaser's Participation

The Purchaser reserves the right to audit and verify procedures set forth in the Engineering Quality Assurance Plan. This audit right in no way relieves the Contractor from performing the control verification procedures outlined in the plan.

2.3 Engineering Quality Assurance and Quality Control Requirements

Following are the minimum Quality Assurance and Quality Control requirements for the project. The Contractor's Engineering Quality Assurance Plan shall set forth in detail the procedures to satisfy these QA/QC requirements.

2.3.1 Design Control

The Contractor shall define, document and advise the appropriate handling of the following design controls:

- (a) Establish internal as well as external discipline relationships.
- (b) Qualifications of personnel assigned for each task.
- (c) Establish audit procedures to ensure that the design conforms to the requirements.
- (d) Define and outline the number of multi-discipline design reviews.
- (e) Establish procedures for handling design changes.
- (f) Establish guidelines to handle all issues in pre-award, award and pre-fabrication with Manufacturer's and Sub-contractors.

2.3.2 Document Control

The Contractor must include in its QA/QC Plan the document control procedures defining:

- (a) Authorized use of documents
- (b) Receipt, logging and distribution of documents
- (c) Procedure for updating and implementation of additions and revisions.
- (d) Procedure for document transmittal to Purchaser. Some of the requirements for document transmittal may be covered in other parts of this specification.

2.3.3 Audits

All documents shall be audited by the Contractor for conformance with the QA/QC procedures.

The Purchaser reserves the right to review design details, either directly or through their Consultants. The Purchaser may audit detailed design related design, structural/foundation designs / piping design and other areas.

2.3.4 Engineering Sub-Contractor

The subcontracting of detailed engineering to third parties does not relieve the Contractor the responsibility for Engineering Quality Assurance.

2.4 Procurement

2.4.1 Source Quality Control

It is the Purchaser's intent that the Contractor deal only with Sub-Contractors and Manufacturers (Vendors) who have established and demonstrated effective quality assurance and quality control programs. Purchaser does require, however, that the Contractor perform such normal inspection of Sub-contractors'/Vendors' work as is necessary to obtain equipment and materials conforming to the project specifications and their supporting documents (applicable codes and industry consensus standards) and good engineering, fabrication practices as described herein. Source Quality Control is also a valuable input for confirmation of delivery performance.



Minimum inspection requirements in respect of electrical and instrumentation / control equipment and civil works are covered in their respective specifications. Prior to finalization of the contract, the Contractor shall prepare and submit a Project Quality Assurance Plan that covers Procurement and a requirement for procured items for the complete Works.

2.4.2 After Award of Subcontract

Once Sub-contractors and manufacturers are established, Purchaser and the Contractor shall review item-by-item all major engineered equipment and systems and any special fabrication/fitting to reach an agreement on the need for prefabrication/pre-inspection meetings.

2.4.3 Purchaser's Participation

2.4.3.1 The Purchaser reserves the right to audit the performance of the Sub-contractors/manufacturers and the Contractor's inspection effort. This is normally accomplished by visiting the Sub-contractors/Manufacturers with the Contractor's Inspector at pre-selected points during manufacture. Contractor shall identify notification points so that the Purchaser's can be present at particularly important stages of fabrication should the Purchaser wish to attend. The notification points are not hold points unless specifically identified as such. Should Purchaser elect not to or fail to attend, the Work shall proceed without interruption. The Purchaser reserves the right, however, to make announced spot-checks to facilitate evaluation of the Sub-Contractor and/or the Contractor's inspection effort. Purchaser may wish to hold technical meeting with the machinery Sub-Contractor during the design and fabrication of the machinery. Should Purchaser desire to hold technical meetings, the Contractor will be advised at a reasonable notice.

2.4.3.2 During audit visits to fabricator shops, Purchaser may elect to spot-check base materials and welds to verify proper metallurgy using whatever methods Purchaser may wish to utilize, but only in the presence of Contractor's Inspector unless otherwise agreed. Some of these requirements have been identified in the minimum inspection requirements listed in this section.

2.4.4 Communication

2.4.4.1 Direct, timely communication between the Contractor's Inspectors and Purchaser's auditing Inspectors is mandatory, especially in notification points and in the event of problems, Purchaser shall be advised in a timely manner of all situations where changes or compromises in specifications are considered or where non-conformances are being encountered. Suggested format for inspection request is enclosed with this section. The Contractor shall give advance notice of thirty (30) days for all overseas travel and fifteen (15) days for travel inside India.

2.4.4.2 Rejection reports shall be faxed by the Contractor's Inspector from works directly to Purchaser's Representative at the same time as faxed to the Contractor's home office. Reports shall be faxed to Contractor's home office for typing, editing and transmitting to Purchaser.

2.5 QA / QC Requirements

2.5.1 Inspection Plan



Inspection plans with detailed instructions for the Inspector's guidance shall be provided for each item. QA plans for the components indicated therein are enclosed in Tables 1 to 3 at end of this chapter. The Contractor shall develop the QA plans for all other equipment/systems on a similar basis as indicated in the Tables above. The Contractor's procurement Inspection function shall begin with the award of the purchase order and concludes when the Inspector (including inspection by client's inspector wherever applicable) has duly released the equipment in the Sub-contractor's shop.

2.5.2 Inspection Office

- 2.5.2.1 The Contractor shall identify the key inspection office located at its engineering and construction office. All inspection assignments, inspection instructions, after placement of the purchase order shall be covered from this designated office.
- 2.5.2.2 One individual in the Contractor's key inspection office shall be designated to fill the function outlined in 2.5.3 and must report to the Contractor's Manager of inspection. Additional staff may be added as necessary, provided they are under the supervision of the individual designated. This individual will hereafter be referred to as the "Quality Control Project Inspector (QCPI)".
- 2.5.2.3 For technical problems arising during manufacturing, after purchase orders are placed, the QCPI is responsible for clearing such technical problems with Engineering and/or Purchaser. All purchase orders shall have a clause requiring the Sub-Contractor to submit all questions of a technical nature concurrently to the QCPI and requisitioning Purchaser in writing through fax or letter for resolution. The QCPI shall be responsible for obtaining replies from engineering, documenting the response to the Sub-Contractor and making distribution. The assigned QCPI shall be on distribution for all other correspondence. When technical requests arise from rejection made by the Contractor's source Inspector, the source Inspector's rejection report must be attached to the Sub-Contractor's request for engineering evaluation.

2.5.3 Inspection Co-ordination and Responsibility

The QCPI shall have the overall coordination responsibility for inspection activities. The QCPI's responsibilities shall include, but not be limited to the following:

- (a) Issue assignments for source inspection.
- (b) Issue specific inspection instructions when required to the assigned source inspector.
- (c) Indicate the required type of report forms.
- (d) Coordinate and respond to questions of a technical nature.
- (e) Monitor inspection reports to determine if inspections are being performed as per written instructions.
- (f) Forward all related order correspondence to the assigned source Inspector.
- (g) Receive inspection reports from the source Inspector and make distribution as required.



- (h) Ensure that comprehensive files are maintained for each job.

2.5.4 Inspector's Qualifications

The Contractor shall submit with their QA/QC Manual resumes of contractor's inspectors detailing their experience, education and qualifications for Purchasers review/approval. The Inspectors shall have sufficient prior experience and qualifications for the equipment assigned.

2.5.5 Inspectors responsibilities

After receiving the assignment from the QCPI, the source Inspector shall review the order, conduct a pre-inspection meeting (when instructed), perform the inspections outlined, maintain field file in an organized manner and report the results to the key office and Purchaser. The following is a more detailed, but not inclusive, list of what Purchaser typically expects from the Contractor's source QCPI:

- (a) Pre-fabrication meeting – the Contractor's Inspector shall conduct a pre-fabrication meeting with the Sub-contractor prior to start of fabrication. The discussion shall include, but not be limited to a review of the following items:
 - (i) Purchase order requirements with emphasis on any special requirements (technical and quality).
 - (ii) Code Requirements.
 - (iii) Sub-contractors Quality Control Programs.
 - (iv) Fabrication Schedule.
 - (v) Major Sub-contractors.
 - (vi) Welding Procedure Specification (WPS), Procedure Qualification Record (PQR) and Welder Performance Records (WPR).
 - (vii) Non-Destructive Examination Requirements.
 - (viii) Testing – Hydrostatic and Pneumatic.
 - (ix) Manufacturer's Data Reports.
 - (x) Preservation, Packing and Shipping.
 - (xi) Extent of Purchaser / Contractor Inspection.
 - (xii) Witness Points and Hold Points and Notice requirements.
- (b) Initial inspection visit: The Inspector shall perform as a minimum, the following inspection activities prior to start of fabrication.
 - (i) Review fabrication schedule to ensure required Quality Control examinations and other intermediate tests have been included.
 - (ii) Establish approval of major Sub-contractors.



- (iii) Verify that Welding Procedures and Procedure Qualifications have been approved.
 - (iv) Verify that all welders assigned to job are qualified.
 - (v) Review Mill Test Reports to verify materials meet specifications.
 - (vi) Review Sub-contractor's Examination and Inspection Plan.
 - (vii) Review Sub-contractor's procedure for identifying and transferring material markings.
 - (viii) Make a visual examination of major materials, verify Sub-contractor's examination of all materials, and verify proper storage facilities (environment and security).
- (c) Progressive inspection visits: The following minimum activities, where applicable, shall be executed and reported upon by the Inspector:
- (i) Monitor on a random basis the transfer of material marking throughout the fabrication.
 - (ii) Initial and random inspection of edge preparation, root gap and fit up for all vessel and fabricated machinery components.
 - (iii) Initial and random witnessing of production welding to verify approved procedures, qualified welders and proper techniques are being used.
 - (iv) Ensure that welding materials are being properly controlled.
 - (v) Inspect major weld seams, nozzle and attachment welds, overlay welding and any weld repairs.
 - (vi) Perform random check of back gouging of pressure retaining welds.
 - (vii) Inspect critical/major materials from sub-Sub-contractors.
 - (viii) Check nozzles / man ways for size, rating and extension.
 - (ix) Check dimensions and workmanship of components.
 - (x) Examine gaskets and bolting against specifications.
 - (xi) Check location and attachment welds for support clips, lugs, brackets and saddles.
 - (xii) Make final visual inspection for quality of work and for damage.
 - (xiii) Make complete dimensional inspection.
 - (xiv) Witness all hydrostatic and pneumatic testing.
 - (xv) Witness routine and special testing as may be outlined in project specifications or data sheets for Electrical and Instrumentation chapters.

- (xvi) Assure electrical and instrument function and operational checks have been performed as per project specifications.
- (d) Non-destructive Examination (NDE) – The Inspector shall perform as a minimum, the following NDE activities during progressive inspections:-

(i) Radiographic examination (RE)

- Review Sub-contractor's radiography procedures for approval.
- Review all radiographs progressively through out fabrication.
- Evaluate for acceptable film quality and weld quality.

(ii) Ultrasonic examination (UE)

- Review Sub-contractor's procedures and Inspector qualifications.
- Witness at least 25% Ultrasonic examinations
- Review certified results

(iii) Magnetic particle examination (MPE)

- Review Sub-contractor's procedures and Inspector qualifications.
- Witness the initial MPE examinations and 10% minimum of all MPE examinations, as well as all examinations after repair.

(iv) Liquid penetrant examination (LPE)

- Same as for MPE

(v) Hardness testing – production welds

- Review procedure and witness initial tests
- Verify 10% of hardness values during progressive inspections.
- Review all hardness readings for acceptance per specifications and require certified results.

(e) Shipping

- (i) Verify that all shipping requirements related to cleaning, dry out, surface preparation.
- (ii) Verify that pressure equipment is appropriately code stamped and all "Manufacturer's Certified Data Reports" are complete and properly signed.
- (iii) Verify required documentation for acceptance and record is complete.

2.5.6 Inspection Reports

- 2.5.6.1 Inspection reports for interim inspection visits shall be consecutively numbered and identify non-conformance and exceptions found /corrected at that time. Final checklists should indicate all items inspected during interim inspections.
- 2.5.6.2 Inspection rejection reports shall be by telefax to the key office and Purchaser when the Sub-Contractor's proposed resolution deviates from order specifications, or would require repairing.



- 2.5.6.3 Final inspection reports shall be by check off for all major equipment and bulk piping components. The check off indicates the inspections were performed and would be covered on an interim inspection report.
- 2.5.6.4 Inspection release certificate shall be issued by the assigned Inspector only after all the requirements of the purchase order have been met. The Sub-contractor shall be given the inspection release certificate as authorization to present final billing to the Contractor and a copy of same shall be attached to the packing list to serve as notification to the job site of inspection approval.

2.6 Construction

2.6.1 Purchaser's Participation

Purchaser will have a Quality Assurance/Quality Control organization to audit the Contractor's QC effort. The assigned Purchaser's personnel will provide assurance to Purchaser's management that the Work meets specifications, however, the basic inspection and quality control responsibility is vested with Contractor.

Purchaser's auditing may include spot checks of materials including their testing in the field to ensure that inadvertent substitutions have not been made in the fabrication shops or mixing point or in field ordered materials. Purchaser's auditing shall also include testing of concrete, cement mortar, etc.

2.6.2 Communication

- 2.6.2.1 Direct, informal communication between the Contractor's field Inspectors and Purchaser's auditing Inspectors is mandatory. Further Purchaser shall be advised when major problems related to design or fabrication is uncovered.
- 2.6.2.2 Contractor's in-progress inspection reports, follow up/punch out sheets, records of radiograph inspections, etc. shall be available to Purchaser's auditing Inspectors during the course of the Works.
- 2.6.2.3 At the end of the Work, Contractor's standard inspection reports, check off sheets, radiographs, master copy of loop diagrams, electrical test data sheets, etc. shall be turned over to Purchaser in an organized, agreed upon format. Contractor shall verify that all of the required documentation of the equipment has been received and placed in the equipment files. The Contractor is responsible for obtaining any outstanding documentation from the suppliers.

2.6.3 Construction QA/QC requirements

- 2.6.3.1 It is the Purchaser's intent that the Contractor (and any Sub-contractors employed) provides sufficient qualified Inspectors to assure that facilities are installed in accordance with the plans and Purchaser's specifications and intents and that the level of quality called for therein is obtained. Prior to finalization of Contract award, the Contractor shall submit a detailed Field Quality Assurance Program for Purchaser's review. The program must be tailored to show compatibility with engineering design, compliance with applicable codes, specifications, standards, drawings, support documents, governmental regulations and this document.
- 2.6.3.2 For the construction period, the Contractor shall provide a full time, dedicated Quality Assurance Organization. As a minimum the Contractor's Construction Quality Assurance Program shall include the following: -



(a) Quality Control Program

Details of the program to be implemented, its use, control and identification of hold and inspection points shall be submitted to Purchaser for approval.

(b) Organization, Authority and Responsibility

Delineate the Contractor's Quality Control organization, responsibility and authority for performance of QC functions by discipline.

(c) Inspector Qualifications

The Contractor's Construction Assurance organization shall consist of people with qualifications similar to the requirements outlined in clause 2.5.4. The field QA organization will be a full time organization, with no other construction-related duties. As with engineering and procurement, Purchaser will review Construction QA staffing plans/

(d) Document Control

This system shall ensure that the latest issues of drawings, specifications, standards, and supporting documents shall be used for fabrication and installation and that field changes are incorporated into final "As Built" drawings.

(e) Receiving Control

Procedure for receipt of purchased items delivered at the job site initial identification, qualification and review of supporting documents shall be described. In addition, the procedure shall ensure that spare parts supplied by Contractor are properly labeled by the Sub-Contractor with description and purchase order number.

(f) Receiving inspection

This shall establish the method of notification and inspection to be performed on received items to verify the condition and conformance to the appropriate acceptance standards reference or contained in the purchased documents.

(g) Sub-contractor Non-conformance

This shall provide for documentation and disposition of non-conformances resulting from Sub-contractor errors and shipping damage to material, fabrications and equipment received at the job site. It also provides for interface with the design engineer when the non-conformance does not comply with the engineering design.

(h) Storage and Maintenance of Materials and Equipment

This system shall describe the controls and inspection performed to show that the handling, storage and preservation of materials and equipment are performed to prevent damage or harmful deterioration to the materials and equipment received at the job site.

2.6.5 Inspection, examination and testing of on-site fabrication and installation

2.6.5.1 This section shall establish the responsibility for performance and recording of examinations, tests and inspections as required by the engineering design.

2.6.5.2 Inspection of work in progress to determine conformance with drawings, specifications, any field definition agreed to shall be included. Some of the inspections are listed below:



Contractor's / Sub-Contractor / Purchaser participation to establish quality (QA/QC) requirements and how they will be met. Typical areas/disciplines may include, but not be limited to the following:

- (i) Foundations
- (ii) Field fabricated vessel
- (iii) Tanks
- (iv) Piping
- (v) Electrical
- (vi) Instrumentation
- (vii) Insulation
- (viii) Painting
- (ix) Buildings

- (i) Execute Contractor's standard quality tracking program.
- (j) Perform final check of installed facilities with Purchaser's representatives to verify completeness and accuracy in accordance with P and ID's / Engineering Flow Diagrams and other scope documents as may be required.
- (k) "Source" inspect/monitor any field award shop fabrication orders as specified.
- (l) See that proper protective procedures are employed and maintained for early installed equipment and equipment stored in offsite staging areas.

2.6.6 Non-conformances of on-site Fabrication and Installation

This section shall control on-site fabrication and installation items, which do not conform to the engineering design or for which the engineering design is incorrect.

2.6.7 Calibration of test equipment

Calibration of tools, gauges, instruments and other measuring and testing devices shall be included.

2.6.8 QA personnel qualification and certification

The qualification required of QA/QC personnel shall be outlined.

2.6.9 Quality assurance / Quality Control Records

The system, which shall ensure that all quality assurance records are maintained for ready reference and shall also provide for the accumulation, evaluation, retention and distribution of QA/QC records.

2.6.10 Interface with Statutory Authorities

Participation of statutory authorities, which require testing, witnessing and inspection, shall be provided.

2.6.11 Audits

Requirements for audits to verify implementation of the QA/QC program on a regular basis shall be included.

2.6.12 Mechanical Completion Acceptance

Contractor shall perform final inspection of the Work in accordance with the Contract documents.

- 2.6.13 Periodic reporting of QA/QC activities (once a month or earlier) as required shall be submitted.

2.7 Inspection at Works

Purchaser shall witness all the tests including performance tests of all the items like fans, pumps and all other equipment in contractor's/sub-contractor's works before dispatch.

INSPECTION REQUEST FORM			
From :			
To :			
Attn :			
Dear Sirs,			
Items detailed below are ready for inspection. Please arrange inspection and confirm the date of inspection.			
1.	Purchaser	:	
2.	Project	:	
3.	Purchaser's order reference	:	
4.	Consultant's reference	:	
5.	Sub-order reference	:	
6.	Sub-contractor's name and full address	:	
7.	Place of Inspection (full address)	:	
8.	Contact person, telephone no. and fax no.	:	
9.	Description of item and quantity	:	
10.	Nature of inspection required	:	
11.	Proposed date(s)	:	
12.	Weekly holiday	:	
We confirm that the items have been fully inspected/tested by us at all stages, of inspection as per quality plan, and all material test certificates, QC records, test Reports, calibration records of measuring/testing instruments with tractability to national level are available with us.			
Thanking you and awaiting your confirmation.			
Yours faithfully,			
Cc: Sub-contractor			

Section - M7 : Air Compressed System**1.0 AIR COMPRESSOR SYSTEM****1.1 AIR COMPRESSORS:**

- a) All pressure parts shall be hydraulically tested at not less than 150% of design pressure prior to painting and lining, if applicable. The test pressure will be maintained for 30 minutes.
- b) All other parts including inter-connecting pipings shall be hydraulically tested wherever possible, as per relevant codes.
- c) Ultrasonic testing shall be carried out on all forgings and shafts (if dia. $\geq$ 50mm) viz. Crank shaft, connecting rod, piston rod, etc. MPI/DP test will be done on machined areas of the above components.
- d) Pistons shall be subjected to DP testing.
- e) During assembly all clearances and alignments shall also be checked and recorded.
- f) Rotor shall be statically and dynamically balanced.

1.1.1 PERFORMANCE TEST (SHOP TEST) :

- a) Performance test on the compressors shall be carried out in accordance with ISO: 1217/eq. The test shall also include demonstration of loading and unloading mechanism (Capacity control) and operation of safety valves.
- b) Power consumption at motor input terminal at rated capacity as well as at fully unloaded condition of the compressor shall be measured.
- c) Vibration and noise level measurement will be done during shop performance test.
- d) Test shall be carried out on all compressors with contract drive motor where power consumption for compressors has been indicated as a guaranteed parameter
- e) Clearance on Type test requirements from Employer's Engg. Shall be reviewed prior to final clearance.

1.2 INTAKE AIR FILTER & SILENCER

- a) Test for Capacity, Pressure drop and Efficiency shall be done as per manufacturer's standard.

1.3 AIR RECEIVER, HEAT EXCHANGERS, MOISTURE SEPERATORS, AIR DRYING PLANT

- a) Each finished vessel shall be hydraulically tested to 150% of the design pressure for duration of 30 minutes.
- b) NDT on weld joints shall be as per respective code requirements or the minimum as specified below:
 - (i) 100 % DPT on root run of butt welds.
 - (ii) 100% DPT on all finished butt welds and fillet welds
 - (iii) 10% RT on butt welds which shall include all T-joints.
- c) Tube-to-Tube sheet joint of the heat exchangers shall be subject to Mock-up test as per the relevant standards.
- d) Reactivation blowers shall be tested for FAD, temp. rise, noise & vibration. Rotating parts shall be dynamically balanced.
- e) Completely assembled ADP shall be pneumatically tested at design pressure for a duration of 5 minutes. Functional and sequential operation testing of the completely assembled ADP shall be demonstrated at shop. Other accessories shall be tested as per relevant code and sections. Dew point measurement shall be done

1.4 H.O.T. CRANE :

- a) Chain pulley Blocks shall be tested as per IS: 3832.
- b) Following NDT requirements shall be met :



- i. 100% RT of Butt welds in tension and 10% RT of butt welds in compression.
- ii. DP at random on all weldments.
Deflection, load, overload & travel check on HOT crane assembly shall be carried out as per IS: 3177.

1.5 PIPINGS, VALVES, BLOWERS, TANKS & VESSELS, FITTINGS AND OTHER SPECIALITIES

Refer relevant clauses as indicated in Technical specification.

All forgings, dia 50 mm shall be Ultrasonic Tested irrespective of the type, size & rating of the valve.

CI.2. MEASURING INSTRUMENTS (PRIMARY AND SECONDARY)

MEASURING INSTRUMENTS (PRIMARY AND SECONDARY)									
TESTS ITEMS	Dimensions (R)	Make, Model, Type, Rating (R)	Process / Electrical connection (R)	Calibration (R)	Test as per standard(R)	Insulation Resistance (R)	IBR Certification (if applicable)(R)	Hydro Test(R)	Material Test certificate ®
1. PR Gauge (IS-3624)	Y	Y	Y	Y	Y				
2. Temp. Gauge (BS-5235)	Y	Y	Y	Y	Y				
3. Pr./D.P.Switch (BS-6134)	Y	Y	Y	Y	Y	Y			
4. Electronic Transmitter (IEC-770)	Y	Y	Y	Y	Y	Y			
5. Temp. Switch	Y	Y	Y	Y	Y	Y			
6. Recorder (IS-9319/ANSI C-39.4)	Y	Y	Y	Y	Y	Y			
7. Vertical indicators	Y	Y	Y	Y		Y			
8. Digital Indicators	Y	Y	Y	Y		Y			
9. Integrators	Y	Y	Y	Y					
10. Electrical Metering Instrument (IS-1248)	Y	Y	Y	Y	Y	Y			
11. Transducer (IEC-688)	Y	Y	Y	Y	Y	Y			
12. Thermocouples (ANSI-MC-96.1)	Y	Y	Y	Y	Y	Y			
13. RTD (IEC-751)	Y	Y	Y	Y	Y	Y			
14. Thermowell	Y		Y				Y	Y	Y
R-Routine Test A- Acceptance Test Y – Test applicable									
Note: 1) Detailed procedure of Burn-in and Elevated Temperature test shall be as per Quality Assurance Programme in General Technical Conditions. 2) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted along with relevant supporting documents. 3) Acceptance tests shall be carried out in presence of owner's representative.									



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



ITEMS	TESTS											
	Dimensions (R)	Make, Model, Type, Rating (R)	Process / Electrical connection	Calibration (R)	Requirement as per standard (R)	WPS approval (A)	Non-destructive testing (R)	Calculation for accuracy (R)	Insulation Resistance (R)	IBR Certification as applicable (R)	Hydro test (R)	Material test certificate (A)
15. Cold junction compensation box	Y	Y	Y	Y					Y			
16. Orifice plate(BS-1042)	Y	Y	Y	Y *	Y	Y *	Y *			Y	Y *	Y
17. Flow nozzle(BS-1042)	Y	Y	Y	Y *	Y	Y	Y			Y	Y	Y
18. Impact head type element	Y	Y	Y					Y				Y
19. Level transmitter/float type switch	Y	Y	Y	Y					Y	Y	Y	Y
20. Flue Gas analyser	Y	Y	Y	Y								
21. Dust emission monitors	Y	Y	Y	Y								
*Calibration to be carried out on one flow element of each type and size if calibration carried out as type test same shall not be repeated.												
** If applicable												
R-Routine Test A- Acceptance Test Y – Test applicable												
Note: 1) Detailed procedure of Burn-in and Elevated Temperature test shall be as per Quality Assurance Programme in General Technical Conditions 2) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted along with relevant supporting documents. 3) Acceptance tests shall be carried out in presence of owner's representative.												



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



1X660 MW PANKI TPS
COMPRESSED AIR SYSTEM

SECTION - IA
ANNEXURE - I
(SUB- VENDOR LIST)

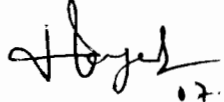


BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR PROJECT ENGINEERING MANAGEMENT
NOIDA-INDIA



**COMPRESSED AIR SYSTEM
LIST OF MAKES OF SUB-VENDOR ITEMS**

LIST OF MAKES OF SUB-VENDOR ITEMS


07.07.15
(Harish Kumar)
PEM-MACX



SUB VENDOR LIST & INSPECTION CATEGORISATION (ANNEXURE-II)

COMPRESSED AIR SYSTEM

SL No	Item	QP / Insp.Cat	Proposed Subvendor	Place of Manufacturer	Technical Limit	Remarks
1	AIR DRYING PLANT (HOC TYPE)	I	ACIL	BELGIUM	ROTARY DRUM	Testing at Atlas Copco Works Pune
			MELLCON	Delhi	Twin Tower type	
			DELAIR	Gurgaon	Twin Tower type	
			SUMMITS	Coimbtore	Twin Tower type	
			Shalcot	Noida	Twin Tower type	
2	AIR DRYING PLANT (REFRIGERANT TYPE)	I	ACIL	BELGIUM		
			MELLCON	Delhi		
			DELAIR	Gurgaon		
			SUMMITS	Coimbtore		
			Shalcot	Noida		
			Savroe	Germany		
			MTA	Italy		
			Dominic Hunter	U.K		
3	MS/GI Pipes –ERW IS 1239 / IS 3589	III	SAIL	Rourkela		1) Quantity < 200 meters Assorted sizes)
			Jindal	Ghaziabad/Hissar	upto 350NB	2) Material will be accepted on the basis of Main contractor COC supported by manufacturer TC as per relevant Code. In addition to above main contractor will certify availability of correlated identification marks on pipe wrt Manf TC and will also certify that pipes are free from rust
			Surya Roshni	Bahadurgarh	upto 400 NB	
			Tata IS 1239 Pipes	Jamshedpur	upto 150NB	
			Maharashtra seamless IS 3589	Raigad	200 to 500 NB	
			PSL	Chennai/Vizag/Kutch/Daman	Spiral Weld SAW as per IS 3589	
			Lalit Profile	Thane	Spiral Weld SAW as per IS 3589	
			Samshi Pipes Industries	Vadodara	Spiral Weld SAW as per IS 3589	
			Mukut Pipes	Rajpura	Longitudinal SAW (Single side weld) as per IS 3589	
			Indus Tubes	G B Nagar	Upto 300 NB ERW Pipes as per IS 1239/3589	
			Mann Ind	Indore	Spiral Weld SAW as per IS 3589	
			Surendra Engg	Rajpura	Spiral Weld SAW as per IS 3589	

(Signature)
07.07.15
(Harish Kumar)

SL No	Item	QP / Insp.Cat	Proposed Subvendor	Place of Manufacturer	Technical Limit	Remarks
			Pratibha Pipes & Structure Pvt Ltd	Thane	Spiral Weld SAW as per IS 3589	
			JCO Gas Pipe	Chindwara	Spiral Weld SAW as per IS 3589	
			Nukat Tanks and Vessels	Tarapur	Longitudinal SAW (Single side weld) as per IS 3589	
			DADU Pipes	Sikandrabad	Upto 300 NB ERW Pipes as per IS 1239/3589	
			Good Luck Tubes	Sikandrabad	Upto 300 NB	
			Advance Steel Tubes	Sahibabad	Upto 300 NB	
			APL APPOLO Tubes	Sikandrabad	Upto 300 NB	
			Hi Tech Pipes	Sikandrabad	Upto 300 NB	
			Ratnamani	Kutch/Ahmedabad/Chhatral	Upto 400 NB ERW Pipes as per IS 3589 and SAW as per IS 3589	
			Welspun	Anjar/Bharuch	Upto 400 NB ERW Pipes as per IS 1239/3589 and SAW as per IS 3589	
4	Forged/Formed fittings	III	EBY	Taloja		
			Siddarth & Gautam	Faridabad		
			Pipefit	Baroda		
			MS Fittings	Kolkata		
			Tube Products	Baroda		
			Bharat Forge	Pune		
			NL Hazra	Kolkata		
5	Ball Valve	I	Precision Engg	Nasik	upto 400NB 150 class	
			Microfinish Valves Ltd	Hubli		
			Weir BDK engg Industries	NEW DELHI		
			Flow chem. Industries	Ahemdabad	upto 50 NB 800 Class: 350NB 150 class	
			Audco	Chennai		
			Akay India	Hubli	upto 50NB 800 class	
			A V Valves	Agra		
			Asian Industrial valves & Instruments Ltd.	Chennai		
			ATAM Valves	Jalandhar	(1) BALL VALVES: FCS/FSS - 1/2" to 2" #800 & CCS/CSS - 2.1/2" to 4" # 150 (2) BALL VALVES: CUN METAL VALVES SIZE 15 NB TO 80 NB - UPTO PN16.0	
			GM ENGINEERING	Rajkot		
			Hawa Valves (India) Pvt. Ltd.	Navi Mumbai	Size up to 2" & #800 with MOC as FCS & FSS and for size from 65 NB to 150 NB & #150 with MOC as CCS and CSS.	


 07.07.15
 (Harish Kumar)

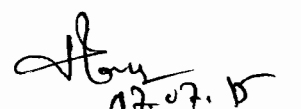
SL No	Item	QP / Insp.Cat	Proposed Subvendor	Place of Manufacturer	Technical Limit	Remarks
			INTERVALVE (INDIA) LTD.	Pune	Steel ball Valves upto 50NB, #800 and 65NB to 150NB. #150	
			NILON VALVES PRIVATE LIMITED	Ahmedabad		
			LEADER VALVES LTD.	Jalandhar	CAST STEEL UPTO 200 MM, CLASS 150/300.	
			DEMBLA VALVES LTD.	Thane		
			SURYA VALVES AND INSTRUMENTS MFG CO.	Chennai	FOR CARBON STEEL/STAINLESS STEEL UPTO SIZE 200NB.	
			UNIFLOW	Chennai		
			VALTECH INDUSTRIES	Mumbai	FORGED CARBON & ALLOY STEEL BALL VALVES, SCREWED TYPE BALL VALVES RATING 800, SIZES UPTO 50 & CC& ALLOY STEEL BALL VALVES RATING 150, SIZES 65 TO 200 FLANGED TYPE.	
			VAAS AUTOMATION	NEW DELHI		
			Belgaum Aqua Valve	Belgaum		
6	CS/FS Gate/Globe/Check valves	III	Fouress	Mumbai/ Aurangabad		
			Weir BDK	NEW DELHI		
			L & T Valves	Coimbatore/ Kancheepuram		
			Leader	Jalandhar		
			KSB	Coimbatore		
			A V Valves	Agra		
			ATAM Valves	Jalandhar	(1) Carbon Steel Gate Valves & non return valves: 15 NB to 50 NB (#800) & 65 NB to 300 NB (#150) (2) Carbon Steel Globe Valves: 15 NB to 50 NB (#800) & 65 NB to 200 NB (#150)	
			Fluidline valves	Ghaziabad		
			GM ENGINEERING	Rajkot		
			INTERVALVE (INDIA) LTD.	Pune	a) Steel Gate Valves: upto 50NB, #800 and 65NB to 150NB, #150 b) Steel Globe Valves: upto 50NB, #800 and 65NB to 100NB, #150 c) Supplier not registered for NR Valves	
			Niton Valves	Mumbai		
			NSSL Ltd.	Nagpur		
			Steel Strong valves Ltd.	Navi Mumbai		


07.07.15
(Harish Kumar)

SL No	Item	QP / Insp.Cat	Proposed Subvendor	Place of Manufacturer	Technical Limit	Remarks
			VENUS PUMPS AND ENGG. WORKS	Kolkata	CC/CSS-GATE-BBT-UPTO600NB CL UPTO300,GATE-PSBT UPTO250NB CL 1500, GLV-BBT- UPTO300NB CL UPTO600, SCNRV- BBT-UPTO600NB CL UPTO150, SCNRV-BBT- UPTO300NB CL 300, SCNRV-PSBT- UPTO150NB CL UPTO900	
			VALTECH INDUSTRIES	Mumbai	CAST CARBON & ALLOY STEEL - VALVE/RATING/SIZE- GV/150/900, GV/300/400, GV/600/300 , GV/GLV/NRV/900/250 , GLV/300/300, GLV/150/350/ , SCNRV/150/700, SCNRV/300/350, SCNRV/600/250.	
			V K Valves Ltd.	Jalandhar		
			KBL	Kondhapuri		
7	Butterfly Valve	II	KBL	Kondhapuri		
			Fouress	Bangalore		
			Audco	Chennai		
			Weir BDK	NEW DELHI		
			Tyco	Halol		
			Inter Valve	Pune		
			Advance Valves	Noida		
			Fluidline valves	Ghaziabad		
			Instrumentation Ltd.	Palakkad		
			R and D Multiples (Metal Cast) Pvt. Ltd.	Mumbai		
			SURYA VALVES AND INSTRUMENTS MFG CO.	Chennai	FOR CI , CCS & CSS UPTO SIZE 750 NB.	
			PENTAIR VALVES AND CONTROLS INDIA PRIVATE LIMITED	Navi Mumbai		
			UPADHAYA VALVES MANUFACTURERS PRIVATE LIMITED,	Kolkata	MOC-Cast Iron, size from 65 NB to 350 NB having rating of PN10 as per BS EN 593.	
			VENUS PUMPS AND ENGG. WORKS	Kolkata		

Harish
07.07.15
(Harish Kumar)

SL No	Item	QP / Insp.Cat	Proposed Subvendor	Place of Manufacturer	Technical Limit	Remarks
8	Air Receiver	I	Integrated Engineers	Mumbai		
			Diamond Fabricators	Pune		
			Parkaire	Delhi		
			Temasme Vesselex	Noida		
			United Engineering Works	Nasik		
9	Safety Relief Valve	III	LEADER	JALANDHAR		
			SPIRAX MARSHALL	PUNE		
			FISCHER SANMAR	CHENNAI		
10	Pr./Vacuum/Dp Gauges	III	Auxitrol	U.K		
			Switzer (for DP gauge)	Chennai		
			Budenburg	U.K		
			A.N.Instruments	Kolkata		
			Bells Control	Kolkata		
			Manometer India	Mumbai		
			H Guru Industries	Kolkata		
			Ashcroft India	Kalol		
			General Inst.	Mumbai/Goa		
			Gluck India	Mumbai		
			BOSE PANDA INSTRUMENTS PVT.LTD.	Kolkata		
			Forbs Marshall	Hyderabad		
			Gauge Bourdon	Mumbai		
			H Guru Instruments	Bangalore		
			Baumer Technologies	Mumbai		
11	Pr./Vacuum/DP.switch	III	Barton Inst.system	USA		* If the total Quantity is <= 10, then inspection category III. However, manufacturer TC to be submitted
			Indfoss	Ghaziabad		
			SOR	USA		
			Dressor	USA		
			Delta control	UK		
			Trafag	Ranipet		
			GiC(Gauges Bourdon)	Panvel		
			ASHCROFT INDIA PVT LTD.	USA/GERMANY		
			Switzer	Chennai		
12	Temperature Gauge	III	Budenburg	U.K		
			A.N.Instruments	Kolkata		
			Bells Control	Kolkata		
			H Guru Industries	Kolkata		
			General Inst.	Mumbai/Goa		
			H Guru Instruments	Bangalore		
			Forbs Marshall	Hyderabad		
			Goa Instruments	Goa		
			Goa Thermostatics Instruments Pvt. Ltd.	Goa		
			Gauge Bourdon	Mumbai		
			Baumer Technologies	Mumbai		


07.07.15
(Harish Kumar)

SL No	Item	QP / Insp.Cat	Proposed Subvendor	Place of Manufacturer	Technical Limit	Remarks
			Ashcroft India	Kalol		
13	Transmitters (PT, TT, DPT, LT)	II	ABB	Faridabad	PRESSURE TRANSMITTER, DP TRANSMITTER and TEMP TRANSMITTER	* If the total Quantity is <= 10, then inspection category III. However, manufacturer TC to be submitted
			Yokogawa	Bangalore		
			Emerson	Mumbai		
			(ABB) -2600T series	Faridabad/Italy		
			Pune Techtrol Pvt. Ltd.	Pune	Only for capacitance Type Level Transmitter	
			SIEMENS LIMITED	Mumbai		
			SMART INSTRUMENTS LTD, BRAZIL	Mumbai	LD-301 & T-301 TRANSMITTER FROM M/S SMART EQUIPMENTS BRAZIL.	
			SBEM PVT. LTD.	Pune	Only for capacitance Type Level Transmitter	
			TOSHNIWAL INDUSTRIES PVT. LTD.,	Ajmer		
			V. AUTOMAT & INSTRUMENTS (P) LTD.	NEW DELHI	a)DISPLACEMENT TYPE TRANSMITTERS. b)PRESSURE AND DP TRANSMITTERS	
			Honeywell Automation	NEW DELHI		
			Fuji	Japan		
			NIVO CONTROLS PVT. LTD.	Indore	For Capacitance type only	
			Moore Industries International Inc.	CALIFORNIA, USA	Indian Associate - Chemtrol	
			Endress + Hauser (India) Pvt. Ltd.,	NEW DELHI	TEMP TRANSMITTER ONLY	
14	HT Motor for Air compressor	I	CGL	Mandideep	Upto 1600 KW, 6.6 KV; Upto 1310 KW, 11 KV	
			Marathon Electric	Kolkata	Upto 6.6 KV, 750 KW	
			BHEL	Bhopal		
			SIEMENS	Germany		
			Hyosung	Korea		
			Hyundai	Korea		
15	Flow Switch	III	Switzer	Chennai		
			Levecon	Kolkata		
			DK Instruments	Kolkata		
			Delta	UK		
			ITT Barton	USA		
16	Temp Sensor	III	Pyro Electric	Mumbai		
			Detriv	Mumbai		
17	Flow Indicator	III	Sigma	Mumbai		
			Eureca	Pune		
18	Auto Drain Trap	III	Pennant	Pune		
			Forbes Marshall	Pune		
19	Dew point meter	III	GE Sensing	Ireland		

 07.07.15
 (Harish Kumar)

SL No	Item	QP / Insp.Cat	Proposed Subvendor	Place of Manufacturer	Technical Limit	Remarks
20	Flow Meter / Rota Meter	III	Michelli Instruments	UK		
			XENTAUR	USA		
			Shaw	UK		
			Trac	Hyderabad		
			Eureca	Pune	Rota Meter only	
			Flow Star Engg.	Faridabad	Rota Meter only	
			Flow Tech instruments	Vadodara	Rota Meter only	
			Instruments Engineers Pvt. Ltd.	Hyderabad	Rota Meter only	
			Scientific Devices (Bombay) Pvt. Ltd.	Mumbai	Rota Meter only	
			Emerson Process Management	singapore	Vortex Type	
			ABB Ltd.	India	Vortex Type	
			Krohne Marshall Pvt. Ltd.	India	Vortex Type	
			Endress + Hauser (I) Pvt. Ltd.	India	Vortex Type	
			Yokogawa Electric Corporation (other than high temp & h2 services)	japan	Vortex Type	
			Krohne Messtechnik GmbH & Co. Kg	Germany	Vortex Type	
21	Level Indicator/ Gauge	III	Flow Star	Faridabad		
			Scientific Devices	Mumbai		
			Gauges Bourden	Panvel		
			SBEM	Pune		
			Pune Techtrol	Pune		
			Levcon	Kolkata		
			Sigma	Mumbai		
			V-Automat	New Delhi		
			DK Instruments	Kolkata		
22	Solenoid Valve	III	HERION	GERMANY/ ITALY		
			ROTEX AUTOMATION LTD.	V V NAGAR/ BARODA		
			ASCO	CHENNAI		
			JEFFERSON	ARGENTINA		
			AVCON	MUMBAI		
23	Cable trays (max 300 meters)	III	INAR PROFILE	ANNAKAPALLI		
			ANAND UDYOG	THANE		
			MJ ENGG.	DELHI		
			INDIANA	MUMBAI		Galvanizing. At Karmatara
			TECHNO ENGG	CHANDIGARH		
			JAMUNA METAL	DELHI		


 7/7/15
 Harish Kumar

SL No	Item	QP / Insp.Cat	Proposed Subvendor	Place of Manufacturer	Technical Limit	Remarks
			INDUSTRIAL PERFORATION	KOLKATA		Galvanizing at Unistar
			VATCO	MUMBAI		Galvanizing At Sigma Mumbai
24	Cable Glands	III	SUNIL & COMPANY	KOLKATA		
			ARUP ENGG	KOLKATA		
			COMMET	MUMBAI		
			QUALITY PRECISION	KOLKATA		
25	Cable Lugs	III	DOWELLS	MUMBAI		
			CHETNA ENGG	NASIK		
			3D	VALSAD		
26	DC LEAD ACID/NI-CD BATTERY	III	AMCO SAFT INDIA LTD	BANGALORE	Ni-Cd batteries only	
			EXIDE INDUSTRIES LTD	NEW DELHI	Lead Acid batteries only.	
			HBL POWER SYSTEMS LTD	Hyderabad	NiCd and TUBULAR TYPE for Lead acid	
			HOPPECKE BATTERIEN GMBH & CO.KG,	Germany		
27	DC Battery Charger (for PLC Panel)	III	AMARA RAJA POWER SYSTEMS LIMITED	Tirupati		
			CHHABI ELECTRICALS PVT.LTD.	Jalgaon		
			CHLORIDE POWER SYSTEMS & SOLUTIONS LIMITED	Kolkata		
			DUBAS ENGG PVT LTD	BANGALORE		
			HBL POWER SYSTEMS LTD	Hyderabad		
			JEMA ENERGY	Spain	For Static SCR Type Full Wave fully Control type	
			MASS-TECH CONTROLS PVT.LTD.	Mumbai		
			STATCON POWER CONTROLS LTD	Noida		
28	INSTRUMENT FITTINGS	III	AURA INCORPORATED	NEW DELHI		
			Astec Valves & Fittings Pvt. Ltd.,	Mumbai		
			Arya Crafts & Engineering Pvt. Ltd.	Mumbai		
			Comfit & Valve Pvt. Ltd.	Nandasan-Gujarat		
			FLUIDFIT ENGINEERS PVT. LTD.	Mumbai		
			Fluid Controls Pvt. Ltd.	Mumbai		
			HP VALVES & FITTINGS INDIA PVT. LTD.	Chennai		
			PRECISION ENGINEERING INDUSTRIES	Mumbai		
			Panam Engineers,	Mumbai		
			Perfect Instrumentation Control (India) Pvt. Ltd.	Mumbai		
			VIKAS INDUSTRIAL PRODUCTS	Noida		
29	SS Pipes	III	REMI	Mumbai		
			Ratmani	Ahmedabad		
			Apex Tubes	Behror		
			Choksi	Ahmedabad		
30	UPS	III	HITACHI-HIREL	Gandhinagar		
			APC	Bangalore		
			Delta	Gurgaon		
			Emerson	Mumbai		
			DB Power	Pune		
			Aplab	Mumbai		

Handwritten signature and date:
 21/11/15
 Harish Kumar

SL No	Item	QP / Insp.Cat	Proposed Subvendor	Place of Manufacturer	Technical Limit	Remarks
31	OWS/PC	III	HP/Compaq /Dell/HCL/IBM/Lenovo			
32	Printer	III	HP/Cannon/Epson/Xerox/IBM /Lexmark			
33	PLC Based Panels	I	SIEMENS	Nasik		
			SCHNEIDER	Nasik		
			ROCKWELL	Sahibabad		
			GE Intelligent Platform	BANGALORE		
			Honeywell Automation India Limited ,	Pune		
			ABB	Bangalore		
34	Fibre Optic Cable	III	Birla Ericsson	Rewa		
			Finolex	Pune/Goa		
			Aksh Fibre	Bhiwadi		
35	Junction Box	III	AJMERA INDUSTRIAL &	Mumbai	For galvanised & FRP Junction	
			FLEXPRO ELECTRICALS	Navsari, Gujarat	Metal type Junction boxes only	
			K.S.INSTRUMENTS	Bangalore		
			SUCHITRA INDUSTRIES	Bangalore		
			Shrenik & Company,	Ahemdabad		
36	PAINTS	III	Asian Paints (I) Ltd.	Mumbai		
			Berger Paints India Ltd	Delhi		
			Goodlass Nerolac	Mumbai		
			Jenson & Nicholson (I) Ltd	Gurgaon		
			CDC carboline (I) Ltd.	Delhi		
			Shalimar Paints Ltd.	Gurgaon		
			Addison Paints Ltd	Chennai		
			Grand Polycoat	Mumbai		
			Bombay Paints	Mumbai		
			Jotun Paints	Pune		
			Hemple Paints	Singapore		

NOTES:

1) INSP CAT I : FOR THOSE ITEMS THE QUALITY PLANS ARE APPROVED BY CUSTOMER AND FINAL ACCEPTANCE WILL BE ON PHYSICAL INSPECTION WITNESS BY BHEL & CUSTOMER.

2) INSP CAT II : FOR THOSE ITEMS THE QUALITY PLANS ARE APPROVED BY CUSTOMER. HOWEVER NO PHYSICAL INSPECTION WILL BE DONE BY BHEL / CUSTOMER. THE FINAL ACCEPTANCE BY BHEL / CUSTOMER SHALL BE ON THE BASIS OF REVIEW OF DOCUMENTS AS PER QP.

3) INSP CAT III : FOR THOSE ITEMS FINAL ACCEPTANCE BY BHEL / CUSTOMER BASED ON BIDDER'S COC.

4) THE ABOVE SUB VENDOR LIST IS INDICATIVE ONLY AND IS SUBJECT TO APPROVAL/ACCEPTANCE BY CUSTOMER/BHEL . BIDDER TO PROPOSE HIS SUB VENDOR LIST WITH BACK UP DOCUMENTS (EXPERIENCE LIST, END USER CERTIFICATE AS APPLICABLE) WHICH WILL SUBJECT TO BHEL AND CUSTOMER APPROVAL DURING DETAILED ENGINEERING STAGE WITHOUT ANY TECHNICAL , COMMERCIAL AND DELIVERY IMPLICATION TO BHEL/CUSTOMER.


7/7/15
(Harish Kumar)

1X660 MW PANKI TPS

COMPRESSED AIR SYSTEM

SECTION – IA

ANNEXURE - II

(DRWG/DOC DISTRIBUTION SCHEDULE)



BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR PROJECT ENGINEERING MANAGEMENT
NOIDA-INDIA

DOCUMENTS DISTRIBUTION SCHEDULE

S.No.	Description of Document	DESEIN				UPRVUNL			
		HO		SITE		HO		SITE	
		HC	CC	HC	CC	HC	CC	HC	CC
1.	Drawings, Data Sheets, Calculation, all equipment / Instrument Schedule, BOM etc. a) For Approval b) Resubmission c) For Information	6*	1	-	-	2	1	-	-
2.	Final Approved Documents	2	1 + 1 CD	1	1	1	1 + 2 CD	4	1 + 1 CD
3.	Drawings / Documents 'As Built'	2	1 + 1 CD	1	1	2	1 + 2 CD	4	1 + 1 CD
4.	Type Test Reports (Initial)	4*	1 + 1 CD	-	-	2	1 + 2 CD	-	-
5.	Type Test Report (Final)	2	1 + 1 CD	1	1	2	1 + 2 CD	4	1 + 1 CD
6.	Piping / Equipment Analysis (Transient) etc., Model Study Report (Draft) including Input / Output date etc.	4*	1	-	-	2	1 + 1 CD	-	-
7.	Piping / equipment Analysis (Transient) etc. Model Study Report (Final Approval) including Input / Output date	2	1 + 1 CD	-	-	2	1 + 2 CD	2	1 + 1 CD
8.	Erection Manual (Draft)	3*	1CD	-	-	1	1CD	-	-

S.No.	Description of Document	DESEIN				UPRVUNL			
		HO		SITE		HO		SITE	
		HC	CC	HC	CC	HC	CC	HC	CC
9.	Erection Manual 'Final'	1	1CD	1	-	1	1CD	2	1CD
10.	O&M Manual 'Draft'	3*	1CD	+	-	1	1CD	-	-
11.	O&M Manual 'Final'	1	1CD	1	-	1	1CD	2	2CD
12.	Commissioning Procedure 'Draft'	3*	1CD	-	-	1	1CD	-	-
13.	Commissioning Procedure 'Final'	1	1CC	1	-	1	1CD	2	1CD
14.	PG Test Procedure "Draft"	3*	1	-	-	1	1	-	-
15.	PG Test Procedure 'Final'	1	1 + 1 CD	1	-	2	1 + 1 CD	2	1 + 1 CD
16.	Progress Report	3	1CD	1	-	2	1CD	1	1CD
17.	PG Test Report for Approval	4*	1	-	-	2	1 + 1 CD	-	-
18.	Approved PG Test Report	1	1 + 1 CD	1	-	2	1 + 1 CD	4	1 CD
19.	Project Completion Report	1	1 + 1 CD	1	-	1	1CD	1	1CD
20.	Vendor Details in respect of proposed vendors including Contractor's evaluation Report	1	1CD	-	-	1	1CD	-	-
21.	Monthly Vendor / QP Approval Status	1	1	-	-	2	1	1	1
22.	Manufacturing QPs, Field QPs for review / comments	6*	1	-	-	2	1CD	-	-
23.	Manufacturing QPs, Field QP, Final	1	1CD	1	-	2	1CD	2	1CD
24.	QA documents Package for equipment / field activities etc.	1	1CD	1	-	1	1CD	1	1CD

- * - Consultant will return one (1) commented document to Vendor and CE (UPRVUNL), Lucknow
- HC - Hard Copy
- CC - Soft Copy thru e-mail
- CD - CD ROM
- HO - Head Office of Consultant / UPRVUNL

1X660 MW PANKI TPS
COMPRESSED AIR SYSTEM

SECTION – IA
ANNEXURE - III
(MDL WITH SUBMISSION SCHEDULE)



BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR PROJECT ENGINEERING MANAGEMENT
NOIDA-INDIA

MDL FOR CAS PACKAGE FOR 1X660 MW PANKI TPS

Section IA, Annexure III

S. N.	DRAWING NO.	DRAWING TITLE	PURPOSE	SCHEDULED SUBMISSION, DAYS FROM LOI DATE	RESUBMISSION AFTER INCORPORATING COMMENTS (IN DAYS)
1	PE-V0-426-555-A001	QUALITY PLAN OF AIR COMPRESSOR FOR CAS	A-CUST	21	7
2	PE-V0-426-555-A002	QUALITY PLAN OF AIR DRYING PLANT FOR CAS	A-CUST	21	7
3	PE-V0-426-555-A003	QUALITY PLAN OF AIR RECEIVER FOR CAS	A-CUST	25	7
4	PE-V0-STD-555-A026	QUALITY PLAN OF VALVE FOR CAS	A-CUST	21	10
5	PE-V0-426-555-A029	SUB-VENDOR LIST & INSPECTION CATEGORISATION PLAN FOR CAS	A-CUST	15	10
6	PE-V0-426-555-A005	TDS OF INSTRUMENT AIR & SERVICE AIR COMPRESSORS	A-CUST	21	10
7	PE-V0-426-555-A006	TDS OF AIR DRYING PLANT FOR CAS	A-CUST	21	10
8	PE-V0-426-555-A008	TDS & GA OF VALVES FOR CAS	I-CUST	42	10
9	PE-V0-426-555-A010	TDS OF INSTRUMENTS FOR CAS	I-CUST	42	10
10	PE-V0-426-555-A011	GA DRAWING OF INSTRUMENT & SERVICE AIR COMPRESSOR	I-CUST	21	10
11	PE-V0-426-555-A012	GA DRAWING OF AIR DRYER FOR CAS	I-CUST	21	10
12	PE-V0-426-555-A014	GA DRAWING OF AIR RECEIVER FOR CAS	I-CUST	25	10
13	PE-V0-426-555-A015	COMPRESSOR HOUSE LAYOUT	A-CUST	30	10
14	PE-V0-426-555-A016	P & I DIAGRAM OF AIR COMPRESSOR FOR CAS	I-CUST	21	10
15	PE-V0-426-555-A017	P&I DIAGRAM OF AIR DRYER FOR CAS	I-CUST	21	10
16	PE-V0-426-555-A018	P&I DIAGRAM OF COMPRESSED AIR SYSTEM WITHIN COMPRESSOR HOUSE	A-CUST	21	10
17	PE-V0-426-555-A019	OPERATION & CONTROL PHILOSOPHY OF COMPRESSED AIR SYSTEM	A-CUST	42	10
18	PE-V0-426-555-A020	ELECTRICAL & INTERNAL WIRING DIAGRAM FOR COMPRESSOR PANEL FOR CAS	I-CUST	50	10
19	PE-V0-426-555-A025	QUALITY PLAN OF INSTRUMENTS FOR CAS	I-G-P	21	10
20	PE-V0-426-555-A026	CONTROL CABLE SCHEDULE	I-G-P	60	10
21	PE-V0-426-555-A027	I/O List for CAS system.	I-CUST	56	10
22	PE-V0-426-555-A023	PG TEST PROCEDURE FOR CAS	A-CUST	75	10
23	PE-V0-426-555-A024	O&M MANUAL-COMP AIR SYSTEM	I-CUST	90	10

NOTES

- The above drawing list is tentative and shall be finalized with the successful bidder after placement of order. While some of the drawings indicated above may not be applicable, some additional drawings may also be required based on scope of work.
- Drawings shall be prepared in Auto-Cad latest edition. Required no. of hard and soft copies (editable) of the drawings shall be furnished as per requirement specified elsewhere in the specification.
- Only manual calculation with authentic supporting literature (e.g. extracts of hand Book/ standard/codes) shall be acceptable. All design calculations and drawings shall be in SI system only.
- All the drawings and documents including general arrangement drawing, data sheet, calculation etc. to be furnished to the customer during detailed engineering stage shall include / indicate the following details for clarity w.r.t. Inspection, construction, erection and maintenance etc.:-
 - 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 labeled and included in BOQ / BOM in tabular form.
 - Painting schedule shall also be made as a part of general arrangement drawing of each equipment / items indicating at least 3 trade names.
 - All the drawings required to be furnished to customer during detailed engineering stage shall include technical parameters, details of paints and lubrication, hardness and BOQ / BOM in tabular form indicating all major components including bought out items and their quantity, material of construction indicating its applicable code / standard, weight, make etc.
 - Drawings/ documents to be submitted for purchasers 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.
 - Drawings and documents not covered above but required to check safety of machines/ system, shall be submitted during detailed engineering stage without any commercial implication.
 - All drawings shall include "B.O.M" and indicate quantity, material of construction, make along with IS/BS No., Technical parameters, dimensions, hardness, machining symbol and tolerance, requirement of radiography and hydraulic tests, painting details, elevation, side view, plan, skin section and blow-up view for clarity.
 - All drawings shall be prepared as per BHEL's title block and shall bear BHEL's drawing No.

i) 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.

j) Bidder to follow the following the drawing submission schedule:

k) 1st submission of drawings from date of LOI as per the submission schedule.

l) Every revised submission incorporating comments – within 7 days.

m) Bidder to submit revised drawings complete in all respects incorporating all comments. Any incomplete drawing submitted shall be treated as non-submission with delays attributable to bidder's account. For any clarification/ discussion required to complete the drawings, the bidder shall himself depute his personal to BHEL for across the table discussions/ finalizations/ submissions of drawings.

5. Bidder to note that during detailed engineering, drwg/doc will be submitted through web based document management system in addition to hard copies to be submitted as per drawing/document distribution schedule. Procedure for the same shall be informed after award of contract.

6. *I-G-P stands for ' internal generation purpose'.

1X660 MW PANKI TPS

COMPRESSED AIR SYSTEM

SECTION – IA

ANNEXURE - IV

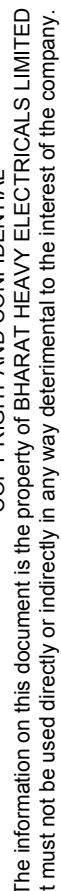
(INPUT DRAWINGS OF TENDER)



BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR PROJECT ENGINEERING MANAGEMENT
NOIDA-INDIA

List of Drawings, for tender estimation purpose only, enclosed with the technical specification

SNO	DESCRIPTION	DRG NO
1	PLOT PLAN	PE-DG-426-100-M001
2	PID OF DMCW SYSTEM	PE-DG-426-179-N001
3	PID FOR COMPRESSED AIR SYSTEM (BHEL)	PE-DG-426-555-A018
4.	PID COMPRESSED AIR SYSTEM (CUSTOMER)	14A14-DWG-M-037, REV 01
5.	COMPRESSOR HOUSE LAYOUT	PE-V0-426-555-A017, REV 2



DN D/M/A/R/D

11

10

9

8

7

6

5

4

3

2

DN D/M/A/R/D S.SEMD/ST/D

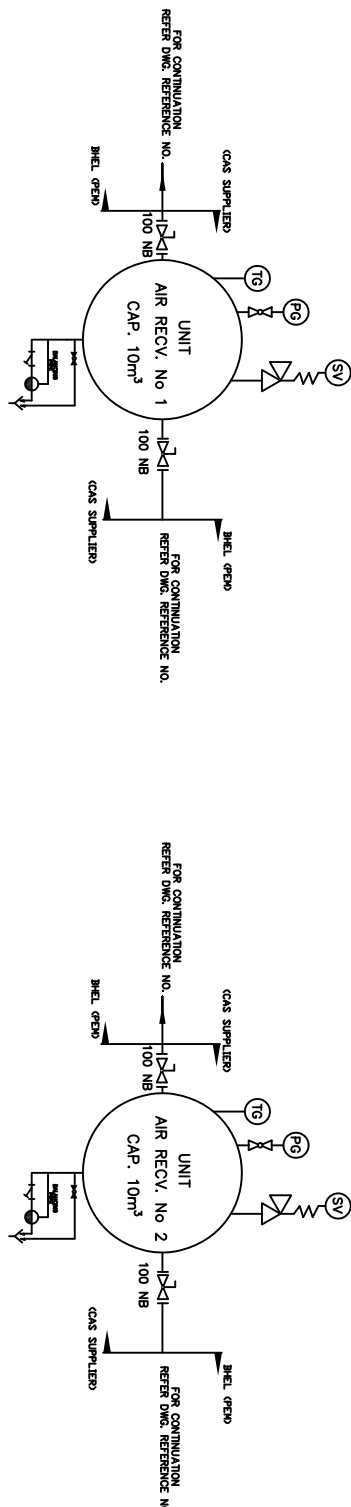
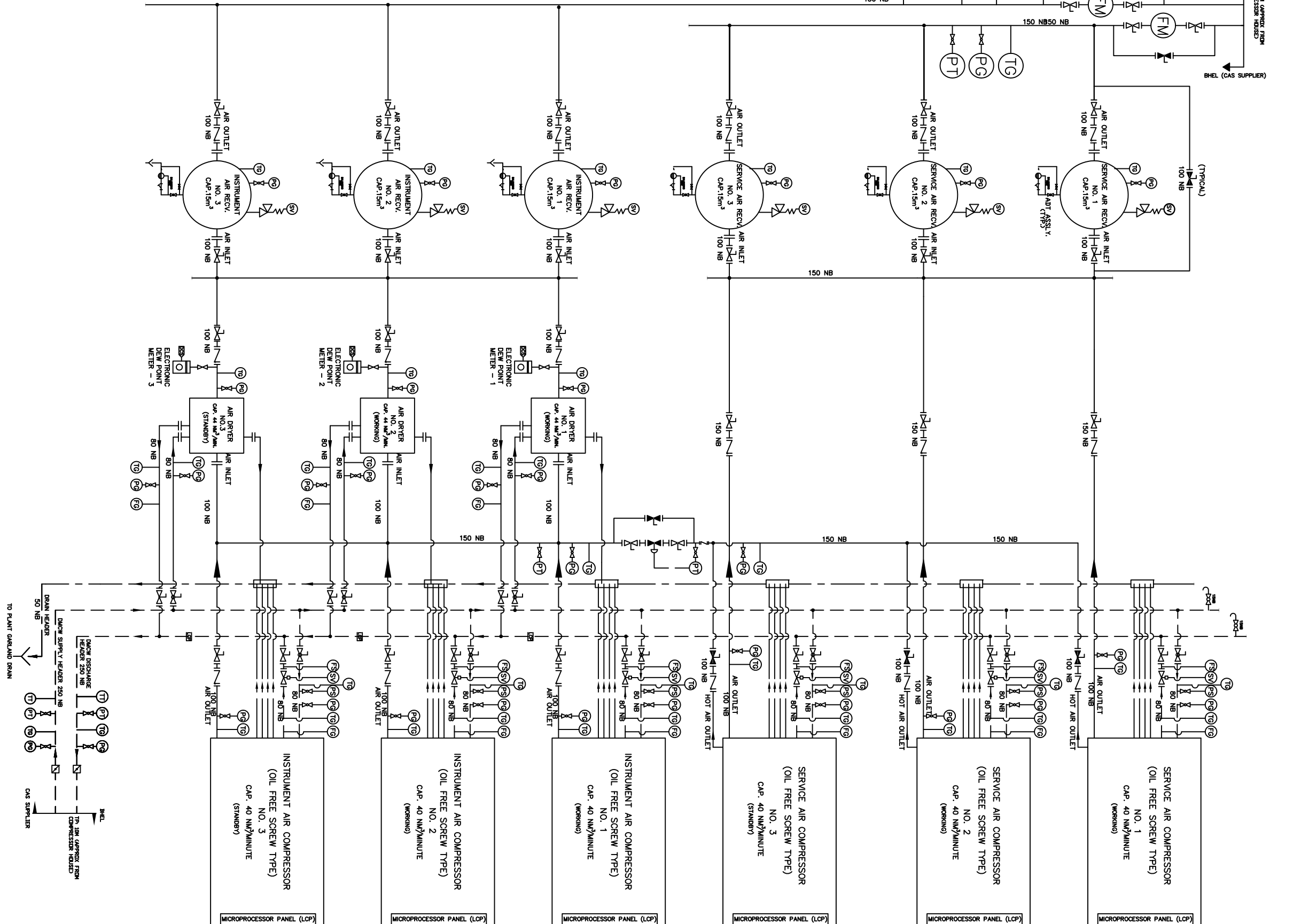
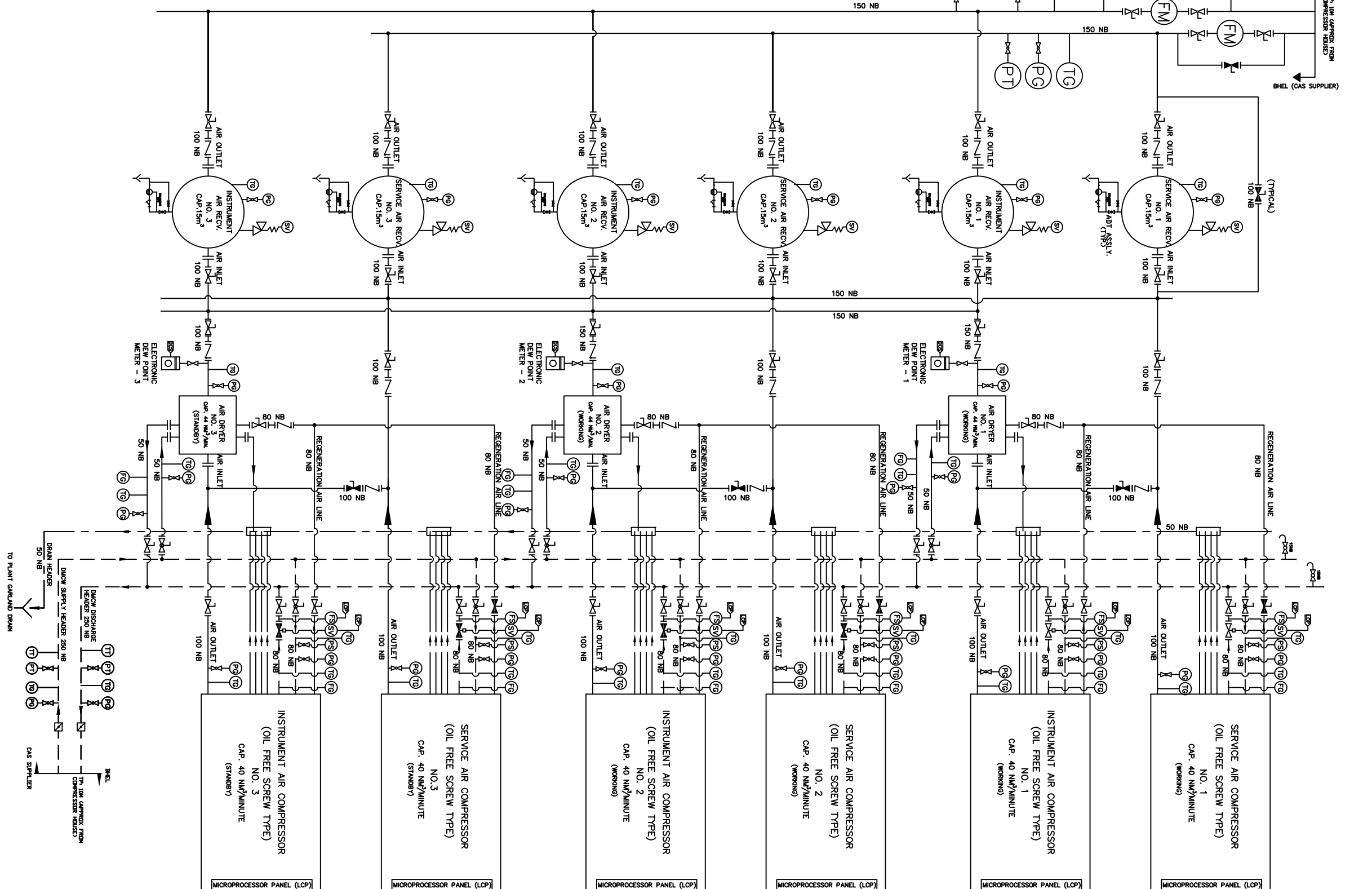
ALTERNATIVE-I: FOR HOC TYPE ROTARY DRUM DRYER

ALTERNATIVE-II: FOR HOC TYPE TWIN TOWER DRYER

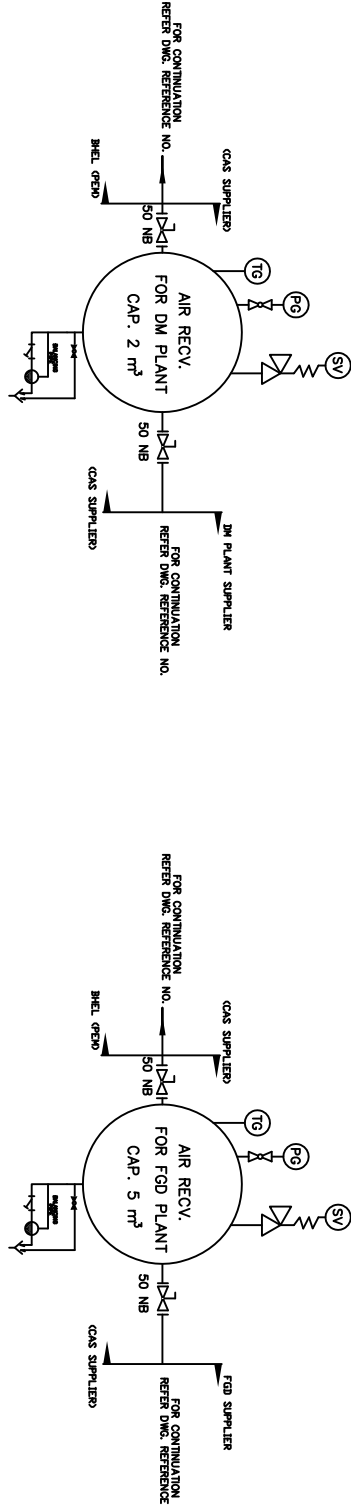
L E G E N D			
	BALL VALVE (OPEN)		SIGHT GLASS
	BALL VALVE (CLOSED)		FLOW SWITCH
	BUTTERFLY VALVE		PRESSURE TRANSMITTER
	GLOBE VALVE (OPEN)		ONLINE DEW POINT METER
	GLOBE VALVE (CLOSED)		WATER
	NON RETURN VALVE		AIR
	SOLONOID VALVE (WITH MANUAL OVERRIDE)		DRAIN
	VENT VALVE		Y TYPE FUNNEL
	PRESSURE GAUGE		RELIEF/SAFETY VALVE
	TEMP. GAUGE		Y TYPE FILTER
	FLOW INDICATOR		AUTO DRAIN TRAP WITH SOL. OPERATED ELECTRONIC TIMER
	GATE VALVE (OPEN)		GATE VALVE (CLOSE)

NOTES:-

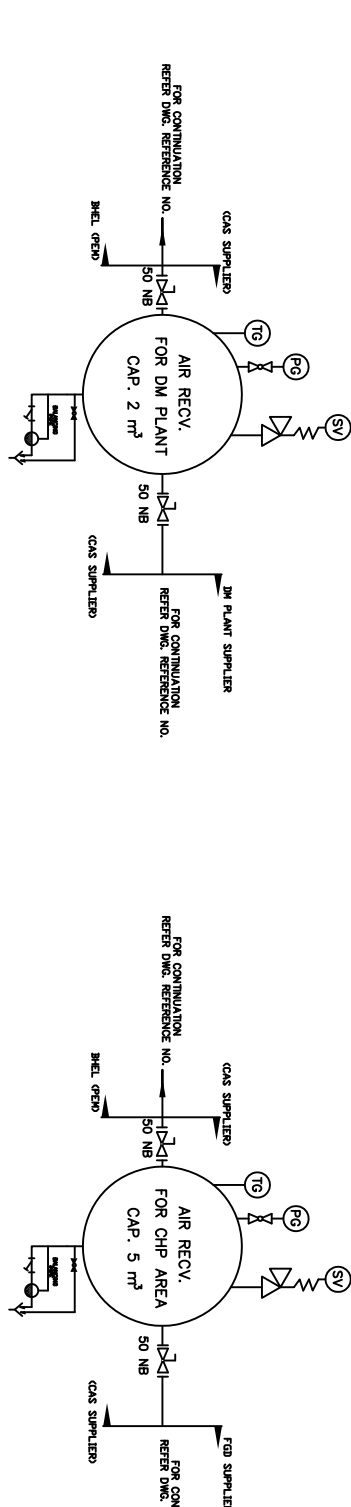
1. THE GIVEN P&I IS CONFINED TO INSTRUMENTS AND PIPING FOR COMPRESSOR HOUSE AREA ONLY
2. MOC OF PIPES AND VALVES SHALL BE AS PER TECHNICAL SPECIFICATION.
3. COMPRESSED AIR PIPING HANDLING HOT AIR WILL BE SUITABLY INSULATED SO AS TO RESTRICT SURFACE TEMPERATURE TO MAXIMUM 60 deg C.
4. ALL PRESSURE & TEMPERATURE GAUGE SHALL 150 mm DIA. TYPE.
5. MINIMUM PIPE SIZES IS MENTIONED IN THE P&I, IF AS PER SIZING CALCULATION PIPE SIZE INCREASES, SAME SHALL BE PROVIDED BY BIDDER WITHOUT ANY IMPLICATION.
6. GLOBE VALVE FOR AUTO DRAIN TRAP SHALL BE PART OF ASSEMBLY & HENCE NOT INCLUDED IN VALVE SCHEDULE.
7. ROOT VALVES FOR INSTRUMENTS SHALL BE PROVIDED ALONG WITH INSTRUMENTS.
8. 15NB VENT VALVES SHALL BE PROVIDED IN WATER HEADER.



UNT AIR RECEIVERS FOR IA APPLICATION IN MAIN PLANT AREA



AIR RECEIVERS FOR IA APPLICATION IN DM PLANT AND FGD AREA



AIR RECEIVERS FOR SA APPLICATION IN DM PLANT AND CHP AREA

1X660 MW UPRVUNL PANKI TPS EXTN.

UPRVUNL

DEVELOPMENT CONSULTANT (P) LTD., KOLKATA

426

CONTRACT

DISTRIBUTION

REV.	DATE	ALTD	CHD	APPD
1	10/10/2011			

P&I DIAGRAM FOR COMPRESSED AIR SYSTEM

DEPT.	SCALE	SIGN	DRAWING NO.
MA	CHD	MA	PE-DG-426-556-A018

12

11

10

9

8

7

6

5

4

3

LEGEND:-	
	GATE VALVE (OPEN)
	GATE VALVE (CLOSED)
	GLOBE VALVE (OPEN)
	GLOBE VALVE (CLOSED)
	NON RETURN VALVE
	BALL VALVE
	ISOLATION VALVE
	PRE FILTER
	AFTER FILTER
	FLOW SWITCH
	FLOW TRANSMITTER
	LEVEL TRANSMITTER
	PRESSURE GAUGE
	PRESSURE TRANSMITTER
	TEMPERATURE ELEMENT
	TEMPERATURE GAUGE
	FLOW GAUGE
	TEMPERATURE TRANSMITTER
	PRESSURE SWITCH
	MASS FLOW METER
	DEW POINT METER
	COMPRESSED AIR LINE
	DM COOLING WATER

NOTES:-

1. QUANTITY AND TYPE OF INSTRUMENTS/ANALYSERS SHALL BE FINALISED BY THE OWNER DURING DETAIL ENGINEERING AS PER PROCESS AND REDUNDANCY REQUIREMENTS AS STIPULATED IN IIT/TECHNICAL SPECIFICATION

2. VIBRATION MONITORING SYSTEM, BEARING RTD, & WINDING RTD SHALL BE PROVIDED FOR ALL HT MOTORS/DRIVES AND DRIVEN AUX. AS PER IIT/TECHNICAL REQUIREMENT.

FOR TENDER PURPOSE ONLY

P & ID COMPRESSED AIR SYSTEM

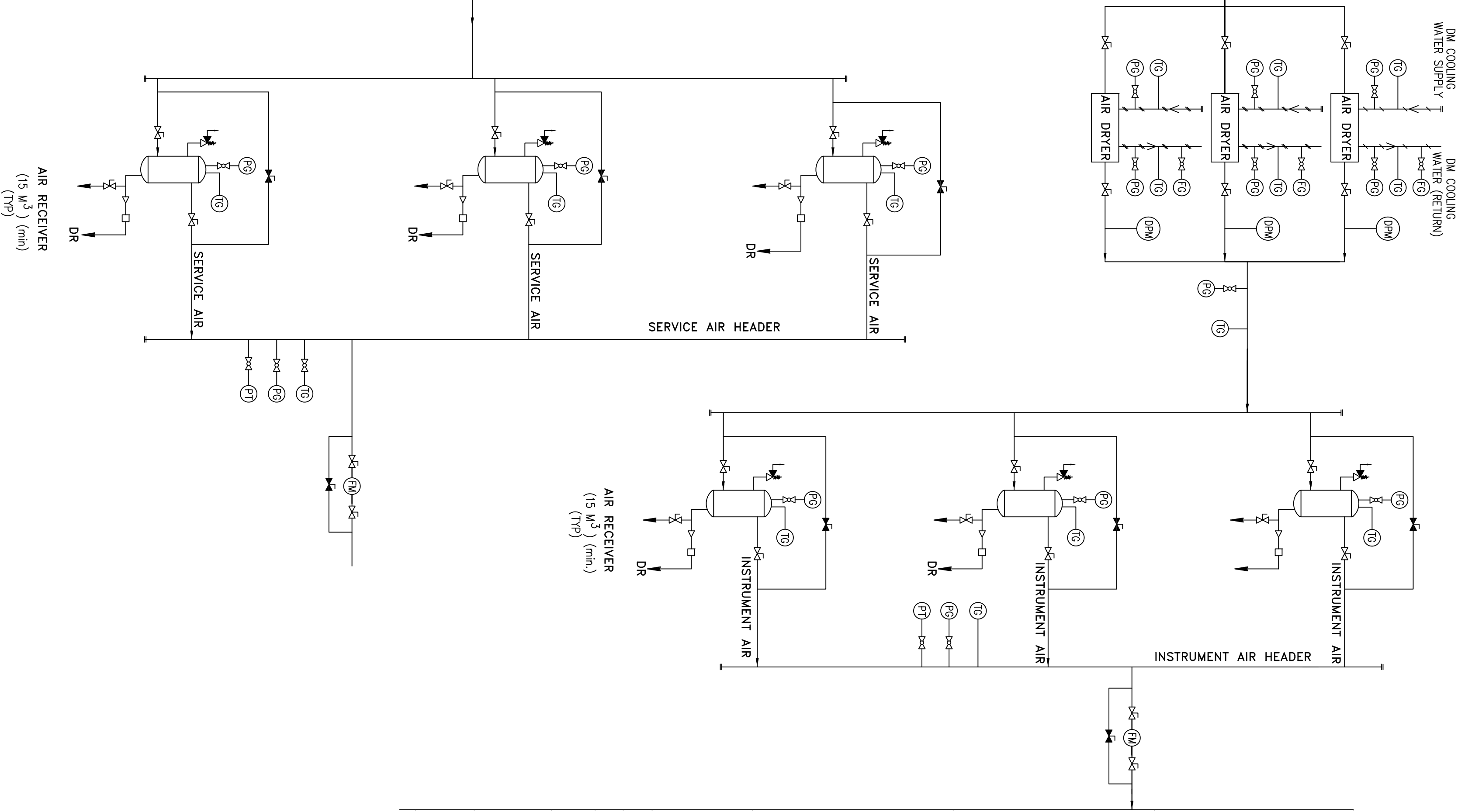
PANKI THERMAL POWER STATION
1 x 660 MW UNIT
KANPUR (UP)

UTTAR PRADESH RAJYA VIDYUT
UTPADAN NIGAM LIMITED

DEVELOPMENT CONSULTANTS PVT. LTD.
KOLKATA · MUMBAI · CHENNAI · NEW DELHI

DRAWN : SUJ D	CHECKED : S. DEY	SCALE : NIL
REVIEWED : P.G.	DATE : 30-01-15	
APPROVED : D. DE	JOB NO. : 14A14	

DWG. NO. 14A14-DWG-M-037 REV. 1



REVISIONS				APPROVALS			
NO.	DESCRIPTION	DATE	BY	NO.	DATE	BY	FOR
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.	1			PRELIMINARY
02							FOR TENDER ONLY
03							ARCHITECTURAL
04							CIVIL & STRUCTURAL
05							ELECTRICAL
06							INSTRUMENTATION
07							MECHANICAL

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

NO.	DESCRIPTION	DATE	BY
01	AS PER PROVISION FOR FUTURE INSTALLATION OF FGD & SCR	01.03.16	D.B.
02			
03			
04			
05			
06			
07			

APPROV.	REVIEWED			
	MECH.	INST.	ELEC.	SITL. ARCH.

1X660 MW PANKI TPS

COMPRESSED AIR SYSTEM

SECTION – IA

ANNEXURE - V

(MANDATORY SPARES LIST)



BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR PROJECT ENGINEERING MANAGEMENT
NOIDA-INDIA

LIST OF MANDATORY SPARES		Section IA, Annexure V
		Rev No: 01
		Date of issue: 17.06.2019
		1 x 660 MW PANKI TPS
NAME OF PROJECT:		COMPRESSED AIR SYSTEM
NAME OF PACKAGE:		PE-TS-426-555-A001
TECHNICAL SPECIFICATION:		
S. No.	DESCRIPTION	Quantity for each type of equipment / instrument
A	MECHANICAL	
1	HP Stage	
	Complete HP Stage assembly consisting of high pressure element, Bearing for male and female rotors (drive end), Bearing for male and female rotors (non-drive end), Timing gears, Graphite ring shaft for compressor chamber seals or white metal labyrinth, suction valve, discharge valve, packing set, Axial thrust bearing, Labyrinth oil seal or radial seals or double acting seals for drive shafts.	2 Sets
2	LP Stage	
	Complete LP Stage assembly consisting of high pressure element, Bearing for male and female rotors (drive end), Bearing for male and female rotors (non-drive end), Timing gears, Graphite ring shaft for compressor chamber seals or white metal labyrinth, suction valve, discharge valve, packing set, Axial thrust bearing, Labyrinth oil seal or radial seals or double acting seals for drive shafts.	2 Sets
3)	Motor Bearing	2 sets of each type.
4)	HP stage Gear and Pinion	2 sets of each type.
5)	LP stage Gear and Pinion	2 sets of each type.
6)	Air Intake Filter Element with Gaskets	4 sets of each type.
7)	Oil Filter Element with Gaskets & Seals	4 sets of each type.
8)	Safety Valve Springs and Gaskets for HP stage	2 set of each type
9)	Safety Valve Springs and Gaskets for LP stage	2 set of each type
10)	Valves (Within compressors house and Air drying Plant)	
a)	Check Valve Flap or Disc/Kit	1 set of each type
b)	Control Valve Disc with Internal Assembly	1 set
c)	Control Valve Gaskets	2 sets
d)	Control Valve gland packing	2 sets
e)	Gate Valve, Globe Valve, ball Valve and Check Valve	1 No. of each type and size
f)	Actuators	1 No of each type and size
11)	Gaskets & Seals for Inter Cooler	2 Sets
12)	Gaskets & Seals for After Cooler	2 sets
13)	Oil Pump/Motor	
a)	Oil Pump Assembly	1 set
b)	Impeller/Rotor with shaft	1 set
c)	Bearings for pumps and drives	2 sets
d)	Set of Seals	2 sets
14)	Oil Pump Kit	2 nos
15)	Complete Drain trap valve assembly	4 sets of each type/size.
16)	Gaskets and seals for Oil cooler	2 sets
17)	Moisture trap element/ assembly	4 sets of each type/size
18)	HP Discharge silencer kit	2 sets
19)	Air drying plant	
a)	Thermal expansion valve	2
b)	Moisture separator	2
c)	Refrigerant dryer filter	
	- Refrigerant dryer filter element	2
	- Refrigerant dryer filter element seals & gasket	2
d)	Automatic drain valve (solenoid valve) with packing kit	2
e)	Cooling water regulator	2
f)	Air filter (for dryer)	
	- Pre filter element (ceramic candle)	2
	- After filter element (ceramic candle)	2
g)	Water separator	1
h)	Regulating valve (i.e. hot gas bypass valve)	2
i)	Refrigerant liquid separator	2
j)	Sight glass	2
k)	Dew point meter	1 set
l)	Sensor for dew point meter	1 set
20)	Dew Point meter	1 set
21)	Sensor for Dew Point meter	1 set

LIST OF MANDATORY SPARES		Section IA, Annexure V
		Rev No: 01
		Date of issue: 17.06.2019
NAME OF PROJECT:		1 x 660 MW PANKI TPS
NAME OF PACKAGE:		COMPRESSED AIR SYSTEM
TECHNICAL SPECIFICATION:		PE-TS-426-555-A001
S. No.	DESCRIPTION	Quantity for each type of equipment / instrument
B	CONTROL & INSTRUMENTATION	
1.0	Measuring & Field Instruments	
1.1	Indicators, Recorders, Electrical Metering and Skid Mounted Instruments	
a	Indicators, recorders and meters offered from each model for the project. These instruments shall be supplied with three sets of blank scales.	10 % of Installed of each type/Model or a minimum of one number for each model and type, whichever is more.
b	For skid mounted instruments	10% of total number of instruments for each Type and model or a minimum of one number for each model and type, whichever is more
c	Panel and Wall mounted Indicators	10% of total number of instruments or a minimum of one number for each type, model, range etc. whichever is more
1.2	Temperature Elements and Thermowells	
a	Thermocouple/RTD elements	15% of flue gas temp, coal air mixture temp, boiler/TG metal temp thermocouples and 5% for other applications of total duplex thermocouple element assemblies and duplex RTD assemblies (with head assembly, terminal block and nipple) of each type and length whichever is more. The element assembly shall be suitable for direct replacement in the corresponding thermowell.
b	Thermowells	10% for each type of temperature sensors or a minimum of one for each type & size, whichever is more
1.3	Temperature Transmitters and Electronic Transmitters of all type, range and model no. (For Pressure, DP, Temp, Flow, Level), Process Transmitters, Radar type level transmitter, 3D type level Transmitter with local display, Magnetic/Electromagnetic flow meter with local display, mass flow meter with local display., Process meters, Junction Box, Position Transmitter, Transducer or any other instrument etc.	10% of total number of instruments/transducers offered for each model and type, rating or a minimum of one number for each model, rating and type , whichever is more.
1.4	Process actuated switch Devices- As applicable for each package as per following: 19. Temperature Switches 20. Differential pressure Switches 21. Pressure switches 22. Flow switches 23. Level Switches 24. Safety Protection Switches	5% of total nos. or 1 no. of each make, model, range and type whichever is more
1.5	Local Gauges like temperature gauges, pressure gauges, differential Pressure gauges, flow gauges, flow meters with local display etc.	10% of total number of instruments/transducers offered for each model and type, rating or a minimum of one number for each model, rating and type, whichever is more.
1.6	All type of Rota meters & Sight Flow Indicator.	1 no. of each range and type
1.7	PD type flow transmitters with local display.	1 no. of each type and model
1.8	Guided wave RADAR for Hot well application	1 no.
1.9	Guided wave RADAR for LP heaters	1 no. for each of the LP heaters
1.10	Impact head type flow element	20% or 2 nos. of each make and type, whichever is more
1.11	Ultrasonic type flow measurement	20% or 2 nos. of each make and type, whichever is more
1.12	Ultrasonic type level transmitter	50% of each type and length, including sensors
1.13	Any other instruments not indicated in the tender P&ID but required for control, monitoring and operation of the equipment/plant/systems	10% or 2 nos. of each type whichever is more
1.14	Level Gauges	a) 10% or 2 nos. whichever is more of each type of illuminators with holder and reflector. b) 20% or 5 nos. whichever is more of each type of bulb. c) 10% or 2 nos. whichever is more of each type of bi-color rollers. d) 10% or 2 nos. whichever is more of each type of glass along with pair of gaskets (cushion & wet gaskets). e) 10% or 2 nos. whichever is more of each type of gaskets for gauge cocks/valve bonnet/ packing. f) 10% or 2 nos. whichever is more of each type scale.

LIST OF MANDATORY SPARES		Section IA, Annexure V
		Rev No: 01
		Date of issue: 17.06.2019
		1 x 660 MW PANKI TPS
NAME OF PROJECT:		COMPRESSED AIR SYSTEM
NAME OF PACKAGE:		PE-TS-426-555-A001
TECHNICAL SPECIFICATION:		
S. No.	DESCRIPTION	Quantity for each type of equipment / instrument
1.15	Complete Electronic card/PCB assembly and Power supply card assembly.	10% of Electronic card/PCB assembly for each type, model & rating or a minimum of one number for each model, rating and type, whichever is more for each type of Transmitter, switch & Flow Meters.
2	Microprocessor based control system	
2.1	Complete set including integral microprocessor based control system along with system & application software and special cables.	10% or 1 set of each type/model whichever is more
3	Mandatory spares not covered above	
3.1	Bidder to supply 10% or 1 no. (whichever is more) of each type of sensor/instrument, instrumentation/mechanical fittings etc for any other electronic system, feeder control cabinets, hydrastep (EWLI), Vibration Monitoring System, CCTV, C&I Lab Instruments, On line Carbon in Ash analyser system, On line Coal mass flow/speed measurement system, On line secondary air flow measurement system, Mass Flow meter, Solid flow meter, 3 D Acoustic type level transmitters, Nucleonic & non nucleonic density transmitter etc.	
Note: i) Mandatory spares listed above is bare minimum requirement. In case any additional mandatory spares requirement is covered elsewhere in the tender specification apart from specified above, same shall be deemed to have been covered in bidders scope of supply. ii) Wherever set is mentioned, one set of the spares of that item shall be for complete replacement of that particular item for one equipment. iii) Whenever the quantity is mentioned in "sets" the bidder has to give the item details and prices of each item. iv) BHEL reserves the right to buy any or all the mandatory spares parts.		

1X660 MW PANKI TPS

COMPRESSED AIR SYSTEM

SECTION – IA

ANNEXURE - VI

(PAINTING SPECIFICATION)



BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR PROJECT ENGINEERING MANAGEMENT
NOIDA-INDIA

PAINTING

1.0 SCOPE

This section covers the painting requirements for the power plant equipment, structures, piping etc. and any other surface required to be painted. The painting system should ensure optimal protection of the installation with minimum need for maintenance, environmental friendly & easy to apply.

2.0 CODES AND STANDARDS

Painting of equipment shall be carried out as per the specifications indicated below and shall conform to the relevant IS contract for the material and workmanship.

The following Indian Standards may be referred to for carrying out the painting job:

IS: 5	:	Colours for ready mixed paints and enamels
IS: 101	:	All Parts and Sections for paint testing
IS: 1303	:	Glossary of terms relating to paints
IS: 2379	:	Colour code for identification of pipelines
IS: 1477	:	Code of practice for painting of ferrous metals in buildings (Parts I & II)
IS: 2524	:	Code of practice for painting of non-ferrous metals in buildings (Parts I & II)
IS: 6278	:	Code of practice for white washing and colour Washing
IS: 13183	:	Aluminium Paint, heat Resistant specification
IS: 158	:	Ready mixed paint, brushing, bituminous, black, Lead free, acid, alkali, water and heat resisting
IS: 2074	:	Ready mixed paint, air drying, red Oxide Zinc Chrome, priming
IS: 104	:	Ready mixed paint, brushing, Zinc Chrome, priming
IS: 2932	:	Enamel, synthetic, exterior (a) undercoating (b) finishing.
IS: 2629	:	Recommended Practice for Hot Dip Galvanising
BS EN ISO 14713	:	Code of practice for protection of iron & steel structure against corrosion
ISO 8501-1	:	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 8502-3	:	Assessment of dust on steel surface prepared for painting (Pressure sensitive tape method)
ISO 12944 (Part 1 to 7)	:	Corrosion protection of steel structures by Protective paint systems
SSPC	:	US Specifications of Steel Structures Painting Council, SSPC Volumes I and II
SSPC-SP-08	:	Surface preparation by Pickling
NORSOK M-501	:	Surface preparation & Protective coating
ISO 20340	:	Pre-Qualification test
ASTM	:	American Standard Test Method for paints and coatings
AWWA	:	American Water Works Association

In the event of conflict between the Codes and Standards referred to in the specification and the requirement of this specification, the latter shall govern. Statutory and Local regulations shall be strictly followed in selection and application of paint.

3.0 GENERAL

- 3.1 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).
- 3.2 Coating materials according to SSPC, EN ISO, ASTM, BIS or DIN standards, shall be used. The paint shall comply with applicable laws, regulations, ordinances etc., of the local authority, state or the nation pertains to the work. The materials shall be matched with each other so that they are compatible. Coatings deviating this specification shall be subject to approval. Standards of surface preparation and painting shall give a time to first maintenance of 10 years.
- 3.3 The paint to be applied shall be approved by Customer / Engineer.
- 3.4 All paints & paint material used shall be procured from approved manufacturers. Paint shall be supplied in manufacturers original containers with the description of content, specification No., colour, ref no, date of manufacture, shelf life expiry date & pot life.
- 3.5 The paint manufacturers shall provide coating system data sheet for each coating system to be used containing the following information:
1. Surface preparations
 2. Film thickness (min and max)
 3. Min and max recoating intervals at relevant temperatures
 4. Mixing ratio, thinner details and coating repair systems
- 3.6 The sample for testing the paint being used may be taken by the customer at any time.
- 3.7 In general 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.
- 3.8 For equipment that has received shop prime coat, touch-up prime coat and additional coats 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.
- 3.9 Necessary precautions shall be provided to all equipment, structures to protect other surfaces from abrasive blasting, coating over spray and spatter. Damage to other surfaces or equipment shall be repaired by the vendor.
- 3.10 The Contractor shall submit the following for review and approval by the Customer:
-

-
1. Manufacturer's recommended paint scheme for the project
 2. Latest published product & instructions for application data,
 3. Procedures for surface preparation and application.
 4. Pre qualification for equipments and blasting materials, product, procedure and personnel qualifications for the paint and painting systems.
 5. Painting repair procedures

Painting records shall contain:

- Equipment/components/location painted
- Date of painting
- Paint details such as specification No, colour, date of manufacture, shelf life, expiry date
- Application equipments
- Ambient conditions at the time of painting
- Surface temperature
- Drying time between coating, DFT and number of coatings
- Appropriate work plan for painting.

- 3.11 The supply of all necessary equipments, weather protection, and scaffolding for painting to ensure work is carried out in accordance with the specification and agreed programme.
- 3.12 Maintenance of the paint work until completion of the contract, this shall include repair of any damaged areas caused by third party.
- 3.13 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.
- 3.14 It is a mandatory requirement that all operatives working to this procedure take full cognizance and implement necessary safety precautions.

4.0 PREPARATION OF SURFACES

- 4.1 All surfaces to be painted shall be thoroughly cleaned of all grease, oil, loose mill scale, dust, rust, weld spatters, sharp edges and any other foreign matter. Removal of grease and oil contamination shall be in accordance with SSPC-SP1 prior to cleaning process described below.
- 4.2 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. Cleaning with solvents shall be resorted to only in such areas where other methods specified above have not achieved the desired results. Cleaning with solvents shall be adopted only after written approval of the Engineer.
- 4.3 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 shall be reprocessed.

Mechanical Cleaning:

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 purchaser/engineer.

	Condition of surface	ISO 8504-3	SIS 055900	SSPC
Hand tool cleaning	Rusted	C St2	C St2	SP2
	Rusted and pitted	D St2	D St2	SP2
Power tool cleaning	Rusted	C St3	C St3	SP3
	Rusted and pitted	D St3	D St3	SP3

- i) 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.
- ii) 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.

Blast cleaning:

Compressors: Compressed air supply for blast cleaning shall be free of water and oil. Air compressors shall not be allowed to deliver air at 110deg 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.

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.).

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.

Surfaces to be coated shall be free of all grease, oil, loose rust, and loose mill scale. Rust, mill scale, weld spatter, flux, shall be removed by the methods indicated in the Coating Schedule. Oil and grease shall be removed by solvent cleaning method as outlined in SSPC - SP - 1 prior to blasting.

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.

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.

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 4 hours, but in any case must commence before signs of degradation occur).

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.

The grades of surface finish:

	ISO 8501-1	SIS 055900	SSPC	NACE
White metal	Sa3	Sa3	SP5	1
Near White metal	Sa 2½	Sa 2½	SP10	2
Commercial blast	Sa2	Sa2	SP6	3
Brush off blast	Sa1	Sa1	SP7	4

Paint Application

General:

Paints and other coating materials shall be applied in accordance with the paint manufacturer's instructions. The surface preparation and painting system shall be as described in ANNEXURE with the following exceptions:

- Nameplates, code stampings and push buttons
- Concrete brickwork, tile, and glass unless specified by the Purchaser / Engineer
- Non-ferrous materials
- Austenitic stainless steel
- Plastic and / or plastic coated materials
- Insulated surface of equipment and pipes except colour coating wherever required
- Any surface specified by the Purchaser / Engineer not to be painted.

Paint Application Requirements

The paint shall be applied in accordance with the paint manufacturer's product data sheet, which shall include the mix ratio, the method of application, and the use of thinners and over coating times.

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.

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 Customer 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 Vendor.

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.

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

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.

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.

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.

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).

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.

Spray Application

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.

Approval of Purchaser / Engineer shall be obtained during spray painting which may cause interference to other works. If spray painting is to be carried out, the following shall be taken into account:

The correct spray tips, air pressures, etc, as recommended by the equipment supplier, shall be used.

Conventional air spray equipment is used, the correct combination of air volume, air pressure and fluid flow to give good atomisation to be ensured to

get 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.

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.

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.

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.

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

Brush application

Brush application may be used under the following circumstances:

- 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
- Where the paint manufacturer considers the coating material suitable for brush application.

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

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.

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.

Roller application

Roller application shall only be used on relatively large surface areas and only if spraying is not an option. Roller application shall only be used if the first or priming coat of paint has been applied by brush. Roller application shall be in accordance with the paint Manufacturer's instructions.

Coating materials

The selected coating materials shall be suitable for the intended use and shall be selected after an evaluation of all relevant aspects such as

- Corrosion protective properties
- Requirements to health, safety and environment
- Properties related to application conditions, equipment and personnel
- Experience with the coating materials and coating system.

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. All coating materials and solvents shall be stored in the original container bearing the manufacturer's label and instructions. Performance standard as listed below shall be established by paint manufacturer the records shall be submitted for review.

- Adhesion test (pull off test)
- Flexibility test
- Salt spray test (min 1000 Hrs)
- Water absorption test
- UV resistance test (external coating)
- Cathodic disbonding test (internal coating)
- Abrasion test (internal coating)
- Impact resistance test
- Sea water immersion test (structures in tidal, splash zone and conveying sea water)

Each product shall have a batch number showing year and month of manufacture and giving full traceability of production. Shelf life shall be included in the technical data sheet. All coating materials and solvents shall be stored in the original container bearing the manufacturer's label and instructions.

The composition of the paint shall be at the discretion of the manufacturer, provided that the finished product meets the requirements of, State or Local regulatory bodies for the products. All vehicle components for use in the manufacture of paints and enamels shall meet the ASTM/ ISO Specification except as otherwise stated coating systems shall be selected as per corrosivity category listed in the table below. Coating systems are tabulated in ANNEXURE and shall be pre-qualified in accordance with specification. Coating systems/ alternative coating systems may be re-subjected to pre-qualification, at the discretion of OWNER/ ENGINEER. The specified coating systems, the number of coats and the coating film thicknesses given in Annexure are minimum requirements Top coat colors should be in accordance with Annexure.

Gratings and 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 gms/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.

CORROSIVITY OF ENVIRONMENTS

Corrosivity category		Mass loss per unit surface (per year of exposure)	
		Mass loss g/mm ²	Thickness loss μ m
C2	Low	>10 to 100	>1.30 to 25
C3	Medium	200-400 g/m ²	(25-50 μ m)
C4	High	400-650 g/m ²	(50-80 μ m)
C5	Very High Industrial & marine	650-1500g/m ²	(80-200 μ m)

Tests required for evaluation of acceptance of coating materials:

TABLE -1

PERFORMANCE TEST OF PAINT

SL. No.	Test	ASTM TEST METHOD
1.0	Abrasion Resistance: (topcoat only)	ASTM D4060
2.0	Adhesion:	ASTM D4541
3.0	Dry Heat Resistance:	ASTM D2485
4.0	Flexibility: (topcoat only)	ASTM D522, 180° bend
5.0	Pencil Hardness: (topcoat only)	ASTM D3363
6.0	Salt Fog Resistance:	ASTM B117, 1000 hours
7.0	Weather Resistance:	ASTMG23 Type D
8.0	Test	ASTM Test Method
9.0	Density	D 1475
10.0	Dipping properties	D 823
11.0	Drying time	D 1640
12.0	Flexibility	D 1737/D 522
13.0	Hardness	D 3363
14.0	Adhesion (pull off test)	D 4541
15.0	Abrasion resistance	D 968/D 4060
16.0	DFT/Coat	As per SSPC Guidelines
17.0	Storage Stability	D 1849
18.0	Resistance to	
	i) Humidity for 2000 hrs.	D 2247
	ii) Salt Spray for 2000 hrs.	B 117
	iii) Accelerated Weathering	D 822

INSPECTION:

Inspection will be performed by an inspector authorised by Purchaser / Engineer. 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.

The painting work shall be subjected to inspection by purchaser / engineer at all times. The vendor shall offer following stage of inspection:

- Surface preparation
- Primer application
- Subsequent coats
- Paint qualification test

Vendor shall provide the expert technical services of the paint manufactures as and when required by purchaser / 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 purchaser.

The following coating inspection & test shall be carried out:

1. Ambient and steel temperature, relative humidity and dew point min twice in a shift.
2. Surface finish & profile check each component or once per 10 m2 after surface preparation.
3. Salt contamination test - Free from salt contamination.
4. Dry Film Thickness as per ISO 2808 No.6.
5. Holiday Test as per ASTM D 5162/ NACE RP 0188.
6. Adhesion Test as per ISO 2409 for cross-cut test, or a pull-off test as per ISO 4624/ ASTM D 4541.

6.0 SUGGESTED COLOUR CODES FOR PAINTING:

Sl. No.	Item / Service	Colour	IS-5	Colour (Band)	IS-5
1.0	Structures, platforms, ladders and handrails	Dark Admiralty Grey	632		
2.0	Boiler casing, ESP and ducting	Nut Brown	413		
3.0	Fans, pumps, motors,	Light Grey	631		
4.0	Tanks (without insulation and cladding)				
4.1	Outdoor	Aluminium			
4.2	Indoor	Light grey	631		
5.0	Vessels & all other proprietary equipment (without insulation & cladding)	Light grey	631		
6.0	Switchgear	Light grey	631		
7.0	Control & relay panels	Light grey	631 78 of IS1650		
8.0	Turbine	Golden	356		

Sl. No.	Item / Service	Colour	IS-5	Colour (Band)	IS-5
		Yellow			
9.0	Generator & exciter	Light grey	631		
10.0	Transformers	Aluminium			
11.0	Machinery guards	Signal red	537		
12.0	Crane				
12.1	Crane structure	Golden Yellow	356		
12.2	Trolley and hook	Crimson	540		
13.0	Piping (without insulation and cladding)				
13.1	Water System				
13.1.1	Boiler feed	Sea green	217		
13.1.2	Condensate	Sea green	217	Light brown	410
13.1.3	Bearing cooling water	Sea green	217	French blue	166

Notes:

1. This colour code basically refers to IS: 2379 for piping with necessary modifications.
2. Where band colour is specified, same shall be provided at 30 meter intervals on long uninterrupted lines and also adjacent to valves and junctions.

PAINTING SCHEME FOR C2 AND C3 ENVIRONMENT

S. No	Description	Surface Preparation	Primer			Intermediate paint			Finish coat			Total DFT
			Paint	No. of coats	DF T	Paint	No. of coats	DFT	Paint	No. of coats	DFT	Min.
1.	Boiler structure, un-insulated ducts, suspensions, hangers temperature <120°C	Sa 2 ½	In organic Zn silicate	2	80 μ	HB MIO epoxy	1	120 μ	Poly urethane	2		260μ
2.	Indoor structure	Sa 2 ½	HB Zn Phosphate	2	80 μ	HB MIO epoxy	1	120 μ	--	--	--	260μ
3.	Insulated parts exposed to temp >120°C	Sa 2 ½	In organic Zn silicate	2	60 μ							60μ
4.	Work shop	Sa 2 ½	HB Zn Phosphate	2	80 μ	HB MIO epoxy	1	120 μ	--	--	--	260μ
5.	Water Treatment Plant (external)	Sa 2 ½	Zn rich epoxy	2	80 μ	HB MIO epoxy	2	200 μ	Aliphatic poly urethane	2	80 μ	360μ
6.	Coal Handling Plant	Sa 2 ½	In organic Zn silicate	2	80 μ	HB MIO epoxy	1	120 μ	poly urethane	2	60 μ	260μ
7.	Fuel pipings	Sa 2	Ehthy Zn silicate	1	40 μ				HR aluminium paint	2	40 μ	80μ
8.	Un insulated silencer, steel stacks >120°C	Sa 2 ½	Ehthy Zn Silicate	1	40 μ				HR silicone aluminium paint	2	40 μ	80μ
9.	Above ground piping	Sa 2 ½	In organic Zn silicate	2	80 μ	HB MIO epoxy	1	120 μ	Poly urethane	2	60 μ	260μ
10.	Burried piping (External)	Sa 2 ½	Coal tar primer, coal tar enamel, inner wrap of fibre glass, final outer wrap of enamel impregnated fibre									4.0m m
11.	Burried piping (Internal)	Sa 2 ½	Solid rigid poly urethane 500 μ									500μ
12.	Storage tanks (external)	Sa 2 ½	In organic Zn silicate	2	80 μ	HB MIO epoxy	1	120 μ	Poly urethane	2	60 μ	260μ
13.	Storage tanks (internal)	Sa 2 ½	3 coats of amine adducts									400μ

14.	DM water piping (internal)	Sa 2 ½	Hard rubber lining min 4 mm thickness									4. mm
15.	DM water tank (internal)	Sa 2 ½	In organic Zn silicate	2	80 μ	HB MIO epoxy	1	150 μ	HB coal tar epoxy	1	150 μ	380μ
16.	Fuel oil tanks (internal)	Sa 2 ½	In organic Zn silicate	2	80 μ	HB MIO epoxy	1	150 μ	HB coal tar epoxy	1	150 μ	380μ
17.	Insulated parts continuously exposed to condensing water	Sa 2 ½	In organic Zn silicate	2	75 μ							75μ
18.	For insulated piping <125°C	Sa 2 ½	Polyamide cured epoxy coating	2	250 μ							250μ
19.	Electrical parts, control panels, valves, pumps & motors (indoor)*	Sa 2 ½	Zn phosphate epoxy	2	80 μ				Chlorinated rubber	2	80 μ	160μ
20.	Electrical parts, control panels, valves, pumps & motors (outdoor)*	Sa 2 ½	Zn phosphate epoxy	2	80 μ				Chlorinated rubber	2	100 μ	180μ
21.	Switch yard, floor grills walk ways	Sa 2 ½	Hot dip galvanising 80μ									80μ

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

PAINTING SCHEME FOR C4 AMD C5 ENVIRONMENT

S. No	Description	Surface Preparation	Primer			Intermediate paint			Finish coat			Total DFT
			Paint	No. of coats	DFT	Paint	No. of coats	DFT	Paint	No. of coats	DFT	Min.
1.	Boiler structure, un-insulated ducts, suspensions, hangers temperature <120°C	Sa 2 ½	HB Zn Phospate	2	80 µ	HB MIO epoxy	2	200 µ	Epoxy PU HB	2	80 µ	360µ
2.	Indoor structure	Sa 2 ½	HB Zn Phospate	2	80 µ	HB MIO epoxy	1	120 µ	Poly eurethene	2	60 µ	260µ
3.	Insulated parts exposed to temp >120°C	Sa 2 ½	In organic Zn silicate	2	60 µ							60µ
4.	Work shop	Sa 2 ½	HB Zn Phospate	2	80 µ	HB MIO epoxy	1	120 µ	Poly eurethene	2	60 µ	260µ
5.	Water Treatment Plant (external)	Sa 2 ½	Zn rich epoxy	2	80 µ	HB MIO epoxy	2	200 µ	Epoxy PU HB	2	80 µ	360µ
6.	Coal Handling Plant	Sa 2 ½	HB Zn Phospate	2	80 µ	HB MIO epoxy	2	200 µ	Poly eurethene	2	60 µ	340µ
7.	Coal Fuel pipings	Sa 2	Ehthy Zn silicate	1	40 µ				HR aluminium paint	2	40 µ	80µ
8.	Un insulated silencer, steel stacks >120°C	Sa 2 ½	Ehthy Zn Silicate	1	40 µ				HR silicone aluminium paint	2	40 µ	80µ
9.	Above ground piping	Sa 2 ½	In organic Zn silicate	2	80 µ	HB MIO epoxy	1	120 µ	Poly eurethene	2	60 µ	260µ
10.	Burried piping (external)	Sa 2 ½	Coal tar primer, coal tar enamel, inner wrap of fibre glass, final outer wrap of enamel									4.0 mm
11.	Burried piping (internal)	Sa 2 ½	Solid rigid poly eurethene 500 µ									500µ
12.	Storage tanks (external)	Sa 2 ½	In organic Zn silicate	2	80 µ	HB MIO epoxy	2	200 µ	Poly eurethene	2	60 µ	340µ
13.	Storage tanks (internal)	Sa 2 ½	3 coats of amine adducts									400µ
14.	DM water piping (internal)	Sa 2 ½	Hard rubber lining min 4 mm thickness									4.0

												mm
15.	DM water tank (internal)	Sa 2 ½	In organic Zn silicate	2	80 µ	HB MIO epoxy	1	150 µ	HB coal tar epoxy	1	150 µ	380µ
16.	Fuel oil tanks (internal)	Sa 2 ½	In organic Zn silicate	2	80 µ	HB MIO epoxy	1	150 µ	HB coal tar epoxy	1	150 µ	380µ
17.	Insulated parts continuously exposed to condensing water	Sa 2 ½	In organic Zn silicate	2	75 µ							75µ
18.	For insulated piping <125°C	Sa 2 ½	Polyamide cured epoxy coating	2	250 µ							250µ
19.	Electrical parts, control panels, valves, pumps & motors (indoor)*	Sa 2 ½	Zn phosphate epoxy	2	80 µ				Chlorinated rubber	2	80 µ	160µ
20.	Electrical parts, control panels, valves, pumps & motors (outdoor)*	Sa 2 ½	Zn phosphate epoxy	2	80 µ				Chlorinated rubber	2	100 µ	180µ
21.	Switch yard, floor grills walk ways	Sa 2 ½	Hot dip galvanising coating Wt. 610 gms/M ² (coating thickness of 80µ)									80µ

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

1X660 MW PANKI TPS

COMPRESSED AIR SYSTEM

SECTION – IA

ANNEXURE - VII

(COOLING WATER ANALYSIS)



BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR PROJECT ENGINEERING MANAGEMENT
NOIDA-INDIA

1. DM Water Analysis (Compressor cooling water):

a. pH : maintained at 8.5 to 9.5



**1X660 MW PANKI TPS EXTN.
COMPRESSED AIR SYSTEM
TECHNICAL SPECIFICATION
(ELECTRICAL PORTION)**

SPECIFICATION No: PE-TS-426-555-A001

SECTION : IB

REV. 01

DATE: 17.06.2019

SHEET: 1 OF 1

**SECTION: IB
TECHNICAL SPECIFICATION (ELECTRICAL PORTION)**



TITLE :
ELECTRICAL EQUIPMENT SPECIFICATION
FOR
COMPRESSED AIR SYSTEM
1X660MW PANKI TPS

SPECIFICATION NO.

PE-TS-426-555-A001

SECTION : IB

REV NO. : DATE : 11.07.2018

SHEET : 1 OF 3

TECHNICAL SPECIFICATION
FOR
COMPRESSED AIR SYSTEM
(ELECTRICAL PORTION)

	TITLE : ELECTRICAL EQUIPMENT SPECIFICATION FOR COMPRESSED AIR SYSTEM 1X660MW PANKI TPS	SPECIFICATION NO.
		PE-TS-426-555-A001
		SECTION : IB
		REV NO. : DATE : 11.07.2018
		SHEET : 2 OF 3

1.0 EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER:

- a) Services and equipment as per “Electrical Scope between BHEL and Vendor”.
- b) Any item/work either supply of equipment or erection material which have not been specifically mentioned but are necessary to complete the work for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification. The same shall be provided by the bidder without any extra charge.
- c) Supply of mandatory spares as specified in the specifications of mechanical equipments.
- d) Electrical load requirement for **Compressed Air system**.
- e) All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned in the enclosed project information.
- f) Bidder to furnish list of makes for each equipment at contract stage, which shall be subject to customer/BHEL approval without any commercial and delivery implications to BHEL
- g) Various drawings, data sheets as per required format, Quality plans, calculations, test reports, test certificates, operation and maintenance manuals etc shall be furnished as specified at contract stage. All documents shall be subject to customer/BHEL approval without any commercial implication to BHEL.
- h) Motor shall meet minimum requirement of motor specification.
- i) Vendor to clearly indicate equipment locations and local routing lengths in their cable listing furnished to BHEL.
- j) Cable BOQ worked out based on routing of cable listing provided by the vendor for “ both end equipment in vendor’s scope”shall be binding to the vendor with +10 % margin to take care of slight variation in routing length & wastages.

a. EQUIPMENT & SERVICES TO BE PROVIDED BY PURCHASER FOR ELECTRICAL & TERMINAL POINTS:

Refer “Electrical Scope between BHEL and Vendor”.

2.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID

- 2.1 The electrical specification without any deviation from the technical/quality assurance requirements stipulated shall be deemed to be complied by the bidder in case bidder furnishes the overall compliance of package technical specification in the form of compliance certificate/No deviation certificate.
- 2.2 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.
- 2.3 Enclosed quality plan of motor is tentative and subject to approval of NTPC/BHEL during detailed engineering with out any commercial implication to BHEL.

	TITLE : ELECTRICAL EQUIPMENT SPECIFICATION FOR COMPRESSED AIR SYSTEM 1X660MW PANKI TPS	SPECIFICATION NO.
		PE-TS-426-555-A001
		SECTION : IB
		REV NO. : DATE : 11.07.2018
		SHEET : 3 OF 3

3.0 List of enclosures :

- a) Electrical scope between BHEL & vendor
- b) Customer (M/s DCPL) specification for Motors
- c) Customer (M/s DCPL) cabling spec (to be referred by vendor for their scope of work (as per Electrical scope between BHEL & vendor)).
- d) Quality plan for motors
- e) Datasheet (Annexure- I)
- f) Datasheet-C
- g) Electrical Load data format (Annexure –II)
- h) BHEL cable listing format (Annexure –III)

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR**PACKAGES: COMPRESSED AIR SYSTEM****SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT****PROJECT: 1X660MW PANKI TPS**

<u>S.NO</u>	<u>DETAILS</u>	<u>SCOPE SUPPLY</u>	<u>SCOPE E&C</u>	<u>REMARKS</u>
1	11 kV/ 6.6 KV / 3.3 KV / 415 V Switchgear	BHEL	BHEL	11kV (3 ph 3 wire), 3.3kV (3 ph 3 wire) and 415 V AC (3 ph 4 wire)/240 V AC (supply feeder) shall be provided by BHEL/NTPC based on load data provided by vendor at contract stage for all equipment supplied by vendor as part of contract. Any other voltage level (AC/DC) required will be derived by the vendor.
2	Local Push Button Station (for motors)	BHEL	BHEL	Located near the motors.
3	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 3.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.
4	Junction box for control & instrumentation cable	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.
5	Any special type of cable like compensating, co-axial, prefab, MICC, etc.	Vendor	Vendor	Refer C&I portion of specification for scope of fibre Optical cables if used between PLC/ microprocessor & DCS.
6	Cable trays, accessories & cable trays supporting system. 100/50 mm cable trays/Conduits/Galvanised steel cable troughs for local cabling	BHEL Vendor	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	Cable glands, lugs & bimetallic strip for equipments 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 & control cables.
8	Conduit and conduit accessories for cabling between equipments supplied by vendor.	Vendor	Vendor	Conduits shall be medium duty, hot dip galvanised cold rolled mild steel rigid conduit as per IS: 9537.
9	Lighting	NTPC	NTPC	--
10	Equipment grounding (including electronic earthing) & lightning protection	BHEL	BHEL	Refer note no. 4 for electronic earthing
11	Below grade grounding	BHEL	BHEL	--
12	Motors with base plate and foundation hardware	Vendor	Vendor	Makes shall be subject to customer/ BHEL approval at contract stage.

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR**PACKAGES: COMPRESSED AIR SYSTEM****SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT****PROJECT: 1X660MW PANKI TPS**

13	Mandatory spares	Vendor	-	Vendor to quote as per specification.
14	Recommended O & M spares	Vendor	-	As specified elsewhere in specification
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 system).	Vendor	Vendor	--
16	a. Input cable schedules (C & I) b. Cable interconnection detail for the above c. Cable block diagram	Vendor Vendor Vendor	- - -	Cable listing for Control and Instrumentation Cable and electronic earthing cable in enclosed excel format shall be submitted by vendor during detailed engineering stage.
17	Cabling layout drawings	Vendor	-	a. Vendor to furnish drawing (both in print form as well as in AUTOCAD) of compressor room layout clearly indicating all motors, panels, JB's etc. which require cabling alongwith their terminal box/location/ Foundation etc. b. Vendor shall prepare & submit cable tray/trench & equipment layout (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 for BHEL review & approval.
18	Electrical equipment GA drawing	Vendor	-	For necessary interface review.

NOTES:

1. Make of all electrical equipments/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 mismatch due to vendor engineering at later stage, vendor shall supply the junction box for suitable termination.
4. Vendor shall indicate location of Electronic Earth pit in their Civil assignment drawing.

CHAPTER 17 : AC & DC MOTORS**1.00 MOTORS****1.1 SCOPE**

This specification is intended to cover design, manufacture, assembly and testing of AC Squirrel Cage Induction 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.

SITE CONDITIONS

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

1.2 Gases, Fumes & Dust Particles

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

1.2.02 Dust Particles

1 Outdoor locations - Heavily dusty with abrasive dust and coal particles of size five (5) to hundred (100) microns present in atmosphere in large quantity.

2 Indoor Locations.

2.1 Coal conveyors - As for outdoor as per clause 1.02.02.1 above.

2.2 Other locations - Lightly dusty with abrasive dust and coal particles of size five (5) to twenty (20) microns present in atmosphere.

1.2.03 Special Fumes

1 Water treatment plant and acid cleaning room - Acid and alkali fumes present.

2 Fuel oil pumping areas & Hydrogen generation plant - Explosive fumes (flameproof motors required).

1.2.04 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.

1.3 LOCATION OF MOTOR - As required

1.4 **SPECIFICATIONS & STANDARDS**.....Motors shall comply with the latest revisions of all relevant standards of BIS (IS-325, IS-900, IS-996, IS-1231, IS-1885, IS-2148, IS-2223, IS-2253, IS-2254, IS-2848, IS-3202, IS-4029, IS-4691, IS-4722, IS-4728, IS-4889, IS-6362, IS-7816, IS-8223, IS-8789, IS: 12615, IS:3177 and IEC : 60034 3Φ Induction motor) except as modified herein or in driven equipment specification.

Motors conforming to BS or IEC Publications, which ensure equivalent quality shall also be acceptable. In case of any difference between IS Specification/International Standards (IEC; NEMA etc.), this motor specification prevails.

1.5 TYPE

1.5.1 AC Motors:

- a) Squirrel cage induction motor suitable for direct-on-line starting.
- b) Continuous duty LT motors upto 160 KW Output rating (at 50 deg. C ambient temperature), shall be **Efficiency class-IE2**, conforming to IS 12615, or IEC:60034-30.
- c) Crane duty motors shall be slip ring/ squirrel cage Induction motor as per the requirement.

1.5.2 DC Motors Shunt wound.

1.6 VOLTAGE (NOMINAL)

1.6.1 LV Motors

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

1.6.2 MV MOTORS

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

For CHP conveyors motor above 160 kW, 3.3 kV, AC supply is to be used. However all the motors on stacker reclaimer shall be on 415 V AC only.

1.6.3 HV Motors

For motors above 1500kW - eleven(11) KV

1.6.4 All motors are to be designed for system grounding described in "System Particulars" under site information of the Driven Equipment Specification.

1.7 **FREQUENCY (NOMINAL)** - fifty (50) Hertz

1.8 NUMBER OF PHASES - Three (3)

1.9 SPEED - As required by the driven equipment

1.10 TYPE OF STARTING :

Direct on-line (VFD/Soft-starter/star/delta starting in special cases)

1.11 DUTY

1.11.1 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 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.

- 1.11.2 All HT motors shall have vibration pads for mounting vibration detectors.
- 1.11.3 All motors shall be designed to withstand hundred twenty (120) percent of rated speed without any mechanical damage for two (2) minutes.
- 1.11.4 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.
- 1.11.5 All LV motors rated 0.37kW and higher with S1 duty shall be compulsorily be of energy efficiency level IE 2 as per IS 12615:2011.

Motors rated above 37kW shall have efficiency higher than 0.92 and high power factor of atleast 0.88.

1.12 **SUPPLY VARIATIONS**

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

- 1.12.1 All equipments shall be suitable for rated frequency of 50 Hz with a variation of (+) 3% and (-)5%, voltage variation of ($\pm$) 6% for 11 kV & 3.3 kV and ($\pm$)10% for 415V and 10% (absolute sum) combined variation of voltage and frequency unless specifically brought out in the specification.

1.13 **ABNORMAL CONDITIONS CAPABILITY**

Motor shall have following capabilities as specified design ambient temperature:

- 1.13.1 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.

1.13.2 Low Voltage Running :

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

1.13.3 Momentary Low Voltage Withstanding :

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

1.14 **STARTING CAPABILITY**

1.14.1 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%.

- 1.14.2 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 will be made till lapse of further thirty (30) minutes.
- 1.14.3 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 will be made till lapse of further thirty (30) minutes.
- 1.14.4 Motor shall also be suitable for three (3) equally spread starts per hour when the motor is under normal service condition.
- 1.14.5 Break-away Starting Current Breakaway starting current as percent of full load current for various motor ratings shall not exceed the values given below:
- 1.14.5.1 Motors above 1500 KW upto 4000kW 600% without any positive tolerance except for ID Fan Motor.
- 1.14.5.2 Motors above 4000 KW 450%. Not subject to any positive tolerance.
- 1.14.5.3 For D.C. Motors the starting current shall be limited to 2 times full load current.
- 1.14.5.3 **Starting voltage requirement**
- a) All Motors (except Mill Motors)
- 80% of rated voltage for Motors upto 4000 kW
 - 75% of rated voltage for Motors above 4000 kW
- b) For Mill Motors:
- 85% of rated voltage for Motors above 1000 kW
 - 90% of rated voltage for Motors below 1000 kW
- Except AOP & JOP motors running on D.G emergency supply, starting voltage shall be 80%.
- 1.14.5.4 **Starting Time**
- 1.14.5.4.1 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 at least 2.5 secs. more than starting time.
- 1.14.5.4.2 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 at least 5 secs. more than starting time.
- 1.14.5.4.3 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 at least 10% of the starting time.

1.14.5.5 Torque Requirements:-

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

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

1.15 SAFE STALL TIME

1.15.1 To avoid problem in selecting standard protective relays without using speed switches, safe stall time under hot conditions (corresponding to 110% nominal voltage at motor terminals) shall be more than the accelerating time (corresponding to 80% nominal voltage at motor terminals) by the following minimum values :

1.15.1.01 Two (2) seconds, where accelerating time (at 80% nominal voltage) does not exceed 20 seconds.

1.15.1.02 Three (3) seconds, where accelerating time (at 80% nominal voltage) exceeds 20 seconds.

1.15.1.03 At no stage, speed switch shall be provided to achieve the above requirements mentioned under Clause No. 1.14.5.4

1.16 CLASS OF INSULATION

1.16.1 LV Motors Class F.

1.16.2 MV & HV Motors Class F

1.16.03 However temperature rise shall be restricted to limits corresponding to Class 'B' insulation for both HT & LT motors. The temperature under abnormal running conditions shall be limited to 5°C above class 'B' limits.

1.16.04 The value of the polarization index for motors above 200kW should not be less than 2 when determined according to IS: 7816.

1.17 **TEMPERATURE RISE UNDER NORMAL CONDITIONS**..... 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
1.17.01	50°C	60°C	70°C
1.17.02	45°C	65°C	75°C
1.17.03	40°C	70°C	80°C

1.18 BUS TRANSFER WITHSTAND CAPABILITY

Motors will 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 manufacturer/vendor shall indicate the special precautions taken to meet the above requirements and confirm.

- 1.18.01 That about 5000 bus transfers, in lifetime of motor, shall not puncture its insulation.
- 1.18.02 That motor shall be capable of withstanding heavy inrush transient current caused by such bus transfers without damage.
- 1.18.03 That the motor windings shall be adequately braced to satisfactorily withstand mechanical stresses under these conditions.
- 1.18.04 The motor and driven equipment shafts shall be adequately sized to satisfactorily withstand transient torques under these conditions.

1.19 TYPE OF ENCLOSURE

- 1.19.01 Outdoor Motors IP 55 (Additional canopy to be provided by EPC contractor.
- 1.19.02 Indoor Motors IP 55
- 1.19.03 IP-55 degree of protection shall be achieved without application of any compound, putty etc.
- 1.19.04 Motor located in hazardous area shall have flameproof enclosure conforming to IS: 2148 /Equiv. as detailed below:
- a) Fuel Oil area : Group IIB
 - b) Hydrogen generation plant area : Group IIC (or Group-I, Div-II as per NEC or Class-1, Gr-B, Div-II as per NEMA/IEC60034).

1.20 METHOD OF COOLING

- 1.20.1 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).
- 1.20.2 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 Owner.

1.21 TYPE OF MOUNTING As required for the driven equipment.**1.21 MAXIMUM MECHANICAL VIBRATIONS**

- 1.21.01 Noise level for all the motors shall be limited to 85dB(A) except for BFP motor for which the maximum limit shall be 90dB(A). Vibration shall be limited within the limits

prescribed in IS: 12075 / IEC 60034-14. Motors shall withstand vibrations produced by driven equipment. HT motor bearing housings shall have flat surfaces, in both X and Y directions, suitable for mounting 80mmX80mm vibration pads.

1.21.02 Noise level

The noise level of motors shall not exceed 85 db (A) at 1m from operating motor measured in accordance with IS: 10265.

1.21.03 Motor body shall have two earthing points on opposite sides.

1.21.04 11 KV motors shall be offered with Separate Insulated Connector (Elastimould or Equivalent make) as per IEEE 386. The offered Elastimould terminations shall be provided with protective cover and trifurcating sleeves. Elastimould termination kit shall be suitable for fault level of 25 KA for 0.17 seconds.

1.21.05 3.3 KV motors shall be offered with dust tight phase separated double walled (metallic as well as insulated barrier) Terminal box. Suitable termination kit shall be provided for the offered Terminal box. The offered Terminal Box shall be suitable for fault level of 250 MVA for 0.12 sec. Removable gland plates of thickness 3 mm (hot/cold rolled sheet steel) or 4 mm (non magnetic material for single core cables) shall be provided.

1.21.06 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
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 200 KW 203

For HT motors the distance between gland plate and the terminal studs shall not be less than 500 mm.

1.21.07 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.

1.21.08 For motors rated 1500 KW & above, neutral current transformers of PS class shall be provided on each phase in a separate neutral terminal box.

1.21.09 The ratio of locked rotor KVA at rated voltage to rated KW shall not exceed the following (without any further tolerance) except for BFP motor.

(a)	Below 110KW	:	10.0
(b)	From 110 KW & upto 200 KW	:	9.0
(c)	Above 200 KW & upto 1000KW	:	10.0
(d)	From 1001KW & upto 4000KW	:	9.0
(e)	Above 4000KW	:	6 to 6.5

1.22 WINDING & INSULATION

- (a) Type : Non-hygroscopic, oil resistant, flame resistant
- (b) Starting duty : Two hot starts in succession, with motor initially at normal running temperature.
- (c) 11kV & 3.3 kV : Thermal class 155 (F) insulation.
AC motors
The winding insulation process shall be total Vacuum Pressure Impregnated i.e resin poor method. The lightning Impulse & interturn insulation surge withstand level shall be as per IEC-60034 part-15
- (d) 240VAC, 415V : Thermal Class(B) or better
AC & 220V
DC motors

1.23 DIRECTION OF ROTATION

1.23.1 As needed by driven equipment.

1.23.2 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.

1.23.3 If, in the case of HT 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.

1.24 BEARINGS



- 1.24.1 General Greased ball, roller and/or sleeve bearing shall be rated for minimum standard life of 20,000 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.
- Bearing shall be effectively sealed against dust ingress and shall be pressure grease gun lubricated.
- 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.
- 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.
- For MV & HV motors, the bearings shall be insulated wherever necessary to prevent damage to motor bearings from shaft current.
- 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.
- 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.
- 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.
- Bearings shall be of reputed make subject to the approval of the Owner/Consulting Engineer.
- 1.24.2 Large motors 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.
- 1.25 **SHAFT EXTENSION** Key slotted bare shaft extension of required length with key on driving end.
- 1.26 **DRAIN HOLES** Two (2) drain holes with plugs, one (1) on either end of motor at the bottom most point.
- 1.27 **LIFTING DEVICES** Motors shall be provided with eyebolts, lugs or other means to facilitate safe lifting.
- 1.28 **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).

1.29 **CENTERING SPIGOT**..... Flange mounted motor shall have centering spigot to match driven equipment socket.

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

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

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.

1.31.1 Temperature rise under normal/abnormal conditions.

1.31.2 Type of bearing and recommended lubricants.

1.32 **FINISH**..... Motor shall have glossy, light grey finish No. 631 as per IS: 5 for withstanding site conditions as per Clause 1.00 above.

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.

1.33 **TERMINAL BOXES**

1.33.1 General Motors shall be provided with separate terminal boxes for main, space heaters, embedded temperature detectors, bearing temperature indicators and moisture detectors 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 conforming 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 Owner /Consulting Engineer. All terminal boxes shall be suitable for proper termination of the type and tentative size of cables specified in Clause 1.34 below, however, exact size of cables shall be furnished by Owner during engineering stage.

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 HT motors shall be provided with phase segregated terminal box.

Terminal bushings and clamps shall be non-absorbent, non- inflammable, insulated material for connecting with cable.

1.33.2 **Main Terminal Box**

1.33.2.1 LV Motors Main terminal box shall be capable of being turned through 360 degrees in steps of 90 degrees.

1.33.2.2 MV & HV Motors Motor 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. These should be interchangeable to facilitate cable routing.

Neutral terminal box for HT motors rated above 1500 KW shall be suitable for mounting of three (3) Nos. wound/bar primary/ring type cast resin insulated current transformers for differential protection. These transformers shall be supplied and mounted in the motor terminal box. In addition to above, 3 Nos. of identical current transformers shall be supplied loose for mounting in the switchgear. Stator phase terminal box may either be phase segregated or standard terminal box suitable for both top and 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 or push on type terminating Kit. Terminal leading shall be stud type or leading wire type.

1.33.2.3 Cable End Boxes.....Terminal Boxes shall be provided with cable end boxes having cable lugs and cable glands for cables of sizes as specified in Clause 1.34 below.

Cable box shall be suitable for glanding the cables; and shall have adequate space between cable glands terminating studs to allow suitable bends of cable inside the cable box for all 3 phases of relevant cable sizes specified.

1.33.2.4 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.

Min. fault level for MV Motors - 40 KA

Min. fault level for LV & HV Motors - 50 KA

1.33.2.5 **PHASE TO PHASE/ PHASE TO EARTH AIR CLEARANCE:**

NOTE: 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

1.33.2.6 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 as specified in Clause 1.34 below.

1.34 **TYPE AND SIZE OF CABLES**

1.34.1 **Space Heaters**



- 1.34.1.1 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).
- 1.34.1.2 For MV & HV Motors: Six (6) mm² two core aluminium conductor PVC insulated armoured and FRLS PVC sheathed heavy duty 650/1100V grade cable to IS: 1554 (Part-I).
- 1.34.2 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).
- 1.34.3 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.
- 1.34.4 For Moisture Detectors.....As for space heaters as per Clause 33.01.01 above.

1.34.5 For Main Terminals

LT Motors

1. Three (3) core cables Stranded aluminium conductor, XLPE insulated, colour coded, laid up, PVC sheathed, GI wire / strip armoured, FRLS PVC jacketed overall, 650 / 1100V grade, heavy-duty cables as per IS: 1554 (Part-I).
2. Single core cables Stranded aluminium conductor, XLPE insulated, hard drawn aluminium wire/ strip armoured FRLS PVC jacketed overall, 650 / 1100V grade, heavy duty cable as per IS: 1554 (Part-I).

HT Motors

1. Three (3) core cables stranded aluminium conductor, XLPE insulated, screened colour coded, laid up, PVC sheathed, GI wire/strip armoured FRLS PVC jacketed overall, 6.6 KV / 11 KV grade, heavy duty cables as per requirement for unearthed system as per IS: 7098 (Part-II).

The size and no. of cable to be intimated to the successful bidder during detailed engineering and the contractor shall provide terminal box, cable gland and lugs suitable for the same.

Cable size may be increased in some cases because of large number of cables in under-ground ducts or because of voltage drop consideration. The supplier shall supply with terminal box and cable accessories suitable for higher size of cable at no extra cost.

1.35 EARTHING

- 1.35.01 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.



- 1.35.02 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.
- 1.35.03 MV & HV Motors.....Non-corrodible metallic grounding pad shall be 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.
- 1.36 **EMBEDDED TEMPERATURE DETECTORS**.....HT motor shall be provided with six (6) Nos. duplex resistance temperature detectors (RTDs) 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
- 1.37 **BEARINGS TEMPERATURE INDICATORS**..... HT motors shall be provided with dial type two (2) bearing temperature indicators and will 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 will be set to operate at lower value to give alarm and other set at a higher value to trip the motor.
- 1.38 **SPACE HEATERS**.....Valve / Damper actuator motors; and Motors above 30 KW 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. Motors upto 30 kW shall have stator windings suitable for connections to 24V, 50 Hz AC supply for space heating.
- Motors upto 30 kW shall have stator windings suitable for connection to 24V, 50 Hz ac supply for space heating
- The terminals of space heaters shall be brought out to a separate totally enclosed dust proof and weatherproof terminal box.
- 1.39 **HOT AIR TEMPERATURE DETECTOR**
- If the motor is of CACA or CACW enclosure, a thermometer with alarm contracts in hot air circuit shall be provided.
- 1.40 **WATER FLOW INDICATOR**
- 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.
- 1.41 **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.

1.42 **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.

1.43 **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.

1.44 **TYPE TEST**

1.44.01 **HT MOTORS**

- a) The contractor shall carry out the type tests as listed in this specification on the equipment to be supplied under this contract. The bidder shall indicate the charges for each of these type tests separately. The type tests charges shall be paid only for the test(s) actually conducted successfully under this contract.
- b) The type tests shall be carried out in presence of the Purchaser's representative, for which minimum 15 days notice shall be given by the contractor. The contractor shall obtain the Purchaser's approval for the type test procedure before conducting the type test. The type test procedure shall clearly specify the test set-up, instruments to be used, procedure acceptance norms, recording of different parameters, interval of recording, precautions to be taken etc. for the type test(s) to be carried out.
- c) In case the contractor has conducted such specified type test(s) within last five years as on the date of bid opening, he may submit during detailed engineering the type test reports to the Purchaser's for waiver of conductance of such test(s). These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. The Purchaser's reserves the right to waive conducting of any or all the specified type test(s) under this contract. In case type tests are waived, the type test charges shall not be payable to the contractor.
- d) Further the Contractor shall only submit the reports of the type tests as listed in "LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED" and carried out within last five years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. However if the contractor is not able to submit report of the type test(s) conducted within last five years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the Purchaser's either at third party lab or in presence of client representative and submit the reports for approval.

e) **LIST OF TYPE TESTS TO BE CONDUCTED**



The following type tests shall be conducted on each type and rating of HT motor

- i) No load saturation and loss curves upto approximately 115% of rated voltage
- ii) Measurement of noise at no load.
- iii) Momentary excess torque test (subject to test bed constraint).
- iv) Full load test(subject to test bed constraint)
- v) 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) LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED

The following type test reports shall be submitted for each type and rating of HT motor

- i) Degree of protection test for the enclosure followed by IR, HV and no load run test.
- ii) Terminal box-fault level withstand test for each type of terminal box of HT motors only.
- iii) Lightning Impulse withstand test on the sample coil shall be as per clause no. 4.3 IEC-60034, part-15
- iv) Surge-withstand test on interturn insulation shall be as per clause no. 4.2 of IEC 60034, part-15

1.44.02

LT Motors

- a) LT Motors supplied shall be of type tested design. During detailed engineering, the contractor shall submit for Purchaser's approval the reports of all the type tests as listed in this specification and carried out within last five years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.
- b) However if the contractor is not able to submit report of the type test(s) conducted within last five years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the Purchaser's shall conduct all such tests under this contract at no additional cost to the Purchaser either at third party lab or in presence of client representative and submit the reports for approval.

1.44.03

LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED

1 x 660 MW – Panki Thermal Power Station

Bidding Doc. No. 14A14-SPC-G-0001

Page 264 of 429



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

- i) Measurement of resistance of windings of stator and wound rotor.
- ii) No load test at rated voltage to determine input current power and speed.
- iii) Open circuit voltage ratio of wound rotor motors (in case of Slip ring motors)
- iv) Full load test to determine efficiency power factor and slip .
- v) Temperature rise test.
- vi) Momentary excess torque test.
- vii) High voltage test.
- viii) Test for vibration severity of motor.
- ix) Test for noise levels of motor(Shall be limited as per clause no 1.21.01 of this section)
- x) Test for degree of protection and
- xi) Over speed test.
- xii) Type test reports for motors located in fuel oil area having flame proof enclosures as per IS 2148 / IEC 60079-1

1.44.04 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.

1.45 INFORMATION WITH PROPOSAL

1.45.1 AC Motor Data Sheet.

1.45.2 Dimension Drawing/Foundation load details of motor and driven equipment.
1.45.03 Manufacturer's catalogue showing constructional details.

1.46.00 **INFORMATION ON AWARD OF CONTRACT**.....Within six (6) weeks from the date of award of the Contract, following shall be furnished:

1.46.01 Motor Data Sheet.

1.46.02 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.

1.46.03 Following characteristics curves:

1.46.03.01 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.

1.46.03.02 Current-speed curves at eight (80), hundred (100) and hundred ten (110) percent rated voltage

1.46.03.03 Current-time curves at eighty (80), hundred (100) and hundred ten (110) percent rated voltage.

1.46.03.04 Thermal withstand curves for hot and cold at eighty (80), hundred (100) and hundred ten (110) percent rated voltage.



- 1.46.03.05 Efficiency, power factor, current and speed versus power output curves.
- 1.46.03.06 Speed-time curves at eight (80), hundred (100) and hundred ten (110) percent rated voltage.
- 1.46.03.07 Negative phase sequence current withstand characteristics.

1.47 COMMISSIONING CHECK LIST (HT MOTORS)

A PRELIMINARY CHECKS

Check the following:

1. Check the name plate details according to specification. Discrepancies, if any, to be satisfactorily resolved.
2. Check tightness of all bolts, clamps and connecting terminals.
3. Check body earthing
4. Check whether bearing lubrication is adequate
5. Check clearance inside terminal box
6. Checking stator (motor air gap) Check – Grease lubrication (for ball or roller bearing) is adequate if the motor was in storage for very long period replace the grease, by fresh grease after flushing the bearing clean. Excess grease in the bearing (housing ... is overheat of bearings) Check the free rotation of the rotor in decoupled condition. Check the air gap between stator and rotor at four positions 90° apart at driving and non-driving end. Compare the recorded values with factory results. For slip ring motors : with starting resistances.
 - a) Check the variation of resistance
 - b) Check brush lifting and slip ring short.

B COMMISSIONING CHECKS

1. Meggar tests of motor winding and cables
2. Continuity check of motor windings control and power cables
3. Measure resistance of motor winding (in case of large motors)
4. Control and interlocks should be checked
5. Motor protection relay to be calibrated
6. Phase sequence and direction of rotation
7. Other than DOL scheme to be checked example trafo starts
9. Measure starting current starting timer and no load current
10. On load operations starting and running currents (observed vibrations, temperatures of bearings and body)
11. On load operation, starting and running currents (observed vibrations, temperatures of bearings and body)
12. In case of forced water cooling of start or check winding temperatures as ready by built in RTDs.
13. Water level (start up cooling) low to be checked for limit switch operation.

1.48 COMMISSIONING CHECK LIST (LT MOTORS)**A PRELIMINARY CHECKS**

Check the following:

1. Check the name plate details according to specification. Discrepancies, if any, to be satisfactorily resolved.
2. Check tightness of all bolts, clamps and connecting terminals.
3. Check body earthing
4. Check whether bearing lubrication is adequate
5. Check clearance inside terminal box

B COMMISSIONING CHECKS

1. Meggar tests of motor winding and cables
2. Continuity check of motor windings control and power cables
3. Over load and short circuit relay tests and settings
4. Control and interlocks should be checked
5. Phase sequence and direction of rotation
6. Operation of timer in case of star delta starting
7. Measure starting current starting timer and no load current
8. On load operations starting and running currents

1.49 DC MOTOR SPECIFICATION

DC Motor will be of continuous duty type totally enclosed fan cooled (TEFC) having IP-54 degree of protection suitable for 220 V DC supply. DC motor will be shunt wound type having high torque characteristic suitable for Bi-directional rotation at rated speed and output. The general constructional features and details of DC motor will be in line with details/ particulars stipulated in the specification for AC squirrel cage induction motors.

Contractor will furnish the data in respect of DC motors.

DATASHEET

Auxiliary power supply		
1.1	HV supply	
	11kV, 3 Φ , 3W, 50 Hz non effectively earthed	Motors rated above 1500 kW
	Fault level	50 kA for 1 second
1.2	MV supply	
	3.3kV, 3 Φ , 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, 3 Φ , 3W, 50 Hz effectively earthed	Motors below and including 200kW
	Fault level	50kA for 1 second
	110V, 1 Φ , 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.		

CHAPTER 26 : CABLING SYSTEM**1.00.00 SCOPE OF WORK**

The scope of work covers supply, erection, testing and commissioning of complete electrical system including cabling, fire stop mortar seal, fire retardant cable coating system etc. the scope shall broadly cover, but not be limited to:

- (a) Main power house building.
- (b) Boiler area, ESP.
- (c) Transformer yard.
- (d) All auxiliary buildings (including electrical rooms of respective buildings) and structures as per details in the General electrical specification/ plot plan/ & related drawings.
- (e) Coal handling plant.
- (f) Ash handling plant including ash dyke
- (g) Raw water system
- (h) Fuel oil unloading & transfer system.
- (i) Aux. power transformers
- (j) Pipe cum cable rack.
- (k) All electrical equipment as described in different sections.
- (l) As built drawing for all above systems on completion of project.

The scope of work shall also include all civil and structural works necessary for successful installation, commissioning & commercial operation of all electrical equipment to be erected under this specification.

2.00.00 SCOPE OF SUPPLY

2.01.00 The equipments and materials within the scope of supply shall include but not limited to :-

- i. Power & control cabling works (including that of special cables):
- ii. Galvanized steel pre-fabricated cable trays, coupler plates, nuts, bolts & washers, reducers, covers, wall brackets, hanger clamps, straight run, elbows, bends, cable trays supporting structures etc.
- iii. Supply and installation (including laying & termination) of control cables, special cables, instrumentation cables for all equipments and systems.

- iv. Supply and installation (including laying & termination) of all power cables (HV and LV) of all power cables (HV and LV) for all equipments and systems.
- v. Cable routing has to be planned such that it shall not cross the steam lines, oil lines.
- vi. Fire Sealing Arrangement: All cable entries into the panel (HV & MV & LV SWGR panels) should be provided with fire sealing arrangements.
- vii. Cable/cable tray openings in walls and floors or through pipe sleeves from one area to another or from one elevation to another within the unit shall be sealed by a fire proof sealing system (FPSS). The FPSS shall effectively prevent the spread of fire from the flaming to non-flaming side of a fire.
- viii. Galvanized steel rigid/ flexible conduits and accessories, ferrules, lugs, glands, terminal blocks, galvanized sheet steel junction boxes, cable fixing clamps, nuts & bolts etc as required.
- ix. All necessary erection materials, consumables and sundry items including arc welding rods to complete the installation for satisfactory and trouble free operation.
- x. Any item of works or erection materials which have not been specifically mentioned but are necessary to complete the work involved shall be deemed to be included in the scope of this specification and shall be furnished by the contractor without any extra charge to the purchaser.

3.00.00 CODES AND STANDARDS

All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS codes, standards, etc.) referred to herein, the former shall prevail. All work shall be carried out as per the following standards/ codes as applicable.

IS:513	Cold rolled low carbon steel sheets and strips.
IS:1079	Hot Rolled carbon steel sheet & strips
IS:1239	Mild steel tubes, tubular and other wrought steel fittings
IS:1255	Code of practice for installation and maintenance of power cables upto and including 33 KV rating
IS:1367 Part-13	Technical supply conditions for threaded Steel fasteners. (Hot dip galvanized coatings on threaded fasteners).
IS:2147	Degree of protection provided by enclosures for low voltage switchgear and control gear
IS:9537	Conduits for electrical installation.
IS:9595	Metal – arc welding of carbon and carbon manganese steels - recommendations.
IS:13573	Joints and terminations for polymeric cables for working voltages from 3.3kv up to and including 33kv performance requirements and type tests.
IS:802	Code of practice for the use of Structural Steel in Overhead Transmission Line Towers.



IS:2309	Code of practice for the protection of building and allied structures against lighting.
IS:2629	Recommended practice for hot dip galvanising of iron & steel.
IS:2633	Method for testing uniformity of coating on zinc coated articles.
IS:6745	Method for determination of mass of zinc-coating on zinc coated iron & steel articles.
IS:8308	Compression type tubular in-line connectors for aluminium conductors of insulated class.
IS:8309	Compression type tubular terminal ends for aluminium conductors of insulated cables.
BS:476	Fire tests on building materials and structures
DIN 46267 (Part-II)	Non tension proof compression joints for Aluminium conductors.
DIN 46329	Cable lugs for compression connections, ring type ,for Aluminium conductors
VDE 0278	Tests on cable terminations and straight through joints
BS:6121	Specification for mechanical Cable glands for elastomers and plastic insulated cables.
	Indian Electricity Act.
	Indian Electricity Rules.

Equipment complying with other internationally accepted standards such as IEC, BS, DIN, USA, VDE etc. will also be considered if they ensure performance and constructional features equivalent or superior to standards listed above. In such a case, the Contractor shall clearly indicate the standard(s) adopted, furnish a copy in English of the latest revision of the standards along with copies of all official amendments and revisions in force as on date of opening of bid and shall clearly bring out the salient features for comparison.

4.00.00 DESIGN AND CONSTRUCTIONAL FEATURES

4.00.01 Inter Plant Cabling

4.01.00

Interplant cable routing will be on overhead cable trays on pipe cum cable trestle or only cable trestle except where approved by purchaser/consultant.

Major routes in boiler area to individual boiler drives, fly ash conveying compressor building, ESP building, CW pump house, Raw water pump house, DM plant, Filter water pump house, Clarified water pump house, Fly ash silo fluidizing blower house etc will be on overhead Cable trays either supported from available structures or on pipe cum cable trestle or on only cable trestle. Only in specific areas as will be approved by purchaser/consultant where number of cables are too small compared to the route length like Intake pump house & Ash dyke, cables may be directly buried underground with marker.

Overhead trestle will be provided to the extent possible. Cable route shall be provided in such a manner that movement of crane does not get restricted and also the cables are to be routed at a safe distance from hot pipes. Generally the bottom of steel supporting structure shall be at 6.5m above the grade level. Where rail/road crossing is involved the same shall be minimum at 8m above the grade level.

Individual shallow trench shall be routed from switchyard equipment to main switchyard trench which will be routed up to Switchyard control room. Interconnecting cables from Power House to Switchyard control room shall be routed through RCC trenches. From trenches to the switchyard equipments, all power and control cables shall be laid through PVC conduit.

Space for accommodating additional trays, which may come in future shall be provided in present cable route. Some trays may be required for use by the purchaser, which will be finalized during detail engineering stage. The successful bidder shall provide such trays without any extra cost to purchaser.

For Power supply to Raw Water Intake Pump house, Cable from powerhouse will run on overhead Cable trays up to Plant boundary. After that it will be buried cable that will follow the intake pipeline corridor.

For Power supply from Power House to Main CHP Substation Building and from Main CHP Substation Building to Crusher House & Pump House, Cable will run on overhead Cable trestles. Further, Cable shall be routed through the conveyor gallery / TPs / Crusher House by separate supporting structures and trench in the pump house.

4.02.00 Trenches

4.02.01 PCC flooring of built up trenches shall be sloped for effective drainage with sump pits and sump pumps.

4.02.02

4.02.03 All field switches for equipments corresponding to a stream located within a radius of 4-5 m shall be wired out to a field junction box and from field junction box to control panel/Input - Output cabinet by screened instrumentation cables.

4.02.04 For CHP following shall also be applicable:

- a) All cable routes shall be overhead along the route of the conveyor gallery by separate supporting structures and cables shall be laid in vertical trays. The bottom of the steel shall be such that the existing facilities, movement of trucks/human beings etc. does not get affected. The cable trestle shall have a minimum 600 mm clear walk way and shall have maintenance platforms as required. The bottom of the steel supporting structure shall be generally at 6.5 M above the grade level except for rail/road crossings where it shall be at 8.0 M above grade level. However in bunker area the bottom of the cable trestle shall be 10 to 14 M depending on boiler/bunker layout.
- b) Cable trenches shall be provided only in Switchgear/MCC rooms.
- c) **Cables shall not be routed through the conveyor galleries except for the equipment located in the conveyor galleries for a particular conveyor i.e. protection switches, receptacles etc.**
- d) Cables for Pull cord switches and belt sway switches shall be taken in cable trays. The trailing cables of the mobile machines shall also be laid in cable trays.

- e) Two separate cable routes one on each side shall be provided for each boiler unit. cables for one set of auxiliaries such as ID,FD & PA fans & half of the coal mills shall be routed in one route & for through other set of auxiliaries through other route.

Cable trays in Boiler & ESP area shall be supported from the Boiler & ESP structure. The same shall be co-ordinated with SG/ESP contractors

Cable trays in these areas shall be in vertical formation to avoid dust accumulation. No cable trenches shall be provided in Boiler/ESP area.

Contractor shall provide two independent routes for cables between ESP control room & ESP. Contractor shall provide the cable trays along with its supporting structure arrangement on the trestle.

- f) **Turbine Hall Area:**

Two separate cable routes shall be provided for cable routing of working & standby drives or different sets/groups say 50% capacity) of auxiliaries.

- g) **OffSite Area:**

In offsite area pumphouses, overhead cable tray arrangement shall be preferably followed.

- #### h) **Cable Vault:**

Cable gallery (over ground) to be provided below each electrical control/switchgear room .

Cable vault of not less than 3 mts clear height from bottom of beam shall be provided.

Clear access passage of at least 750 mm wide & 2.0 Mts clear height shall be provided at entrances & along cable ways. Wherever the passage is through cable routes clear height shall not be less than 1.5 Mts.

Cable vaults shall be provided with adequate drainage facility for drainage of fire water.

Each cable vault should have two doors.

Exit signs shall be provided near doors for personnel escape in case of emergency.

5.00.00 EQUIPMENT DESCRIPTION

5.01.00 Cable trays, Fittings & Accessories

- 5.01.01 Cable trays shall be ladder/perforated type as specified complete with matching fittings (like brackets, elbows, bends, reducers, tees, crosses, etc.), accessories (like side coupler plates, etc.) and hardware (like bolts, nuts,



washers, G.I. strap, hook etc.) as required. Cable tray shall be ladder type for power & control cables and perforated for instrumentation cables.

5.01.02 These shall be either prefabricated hot dip galvanized sheet steel trays or site fabricated angle iron trays free from flaws such as laminations, rolling marks, pitting etc. These (including hardware) shall be hot dip galvanized as per relevant IS.

5.01.03 Cable trays shall have standard width of 600 mm, however trays with 450mm, 300mm and 150mm may be used in places considering the requirement and space constraint. and standard lengths of 2.5 metre. Minimum thickness of mild steel sheets used for fabrication of cable trays and fittings shall be 2 mm. The thickness of side coupler plates shall be minimum 3 mm.

5.01.04 Cable troughs shall be required for branching out few cables from main cable route. These shall be U-shaped, fabricated of mild steel sheets of minimum thickness 2 mm and shall be hot dip galvanized as per relevant IS. Troughs shall be standard width of 50 mm & 75 mm with depth of 25 mm.

5.01.05 Prefabricated hot dip galvanized sheet steel cable trays shall be used for maximum support span of maximum 1.25M for horizontally and 1.0M for vertically unless design is approved for larger span. Cable trays shall be suitable for a cable weight of 100 kg/meter running length of tray. Minimum thickness of sheet steel/galvanizing shall be 2mm/86 microns respectively. The amount of zinc deposit shall not be less than 610 gm per square meter.

In areas, where acid/alkalie ingration is likely to occur, glass reinforced plstic trays with fire retardant corrosion resistance properties shall be used.

5.01.06 Cable trays fabricated from standard rolled sections shall be 50x50x6/75x75x6 sections for runners for supporting spans limited to 2000 mm/more than 2000 mm respectively. Cross support shall be 32x6 mm / 50x6 flat for widths up to 500mm/more than 500mm respectively.

5.01.07 Separate coloured paint strips shall be applied for identification of different type of trays depending upon types of usage/applications/area as below:

High/ medium voltage cables: red strips, 2 inch width each, numbers
11kv/3.3kv equally spaced at 5 metres interval
1.1kv power cables : yellow strips ----- do -----
1.1kv control cables : blue strips ----- do -----
Instrumentation cables : green strips ----- do -----

5.02.00 Support System for Cable Trays

5.02.01 Cable tray support system shall be pre-fabricated similar or equivalent to "Unistrut make".

5.02.02 Support system for cable trays shall essentially comprise of the two components i.e. main support channel and cantilever arms. The main support channel shall be of two types: (i) C1:- having provision of supporting cable trays on one side and (ii) C2:-having provision of supporting cable trays on both sides. The support system shall be the type described hereunder:

a. Cable supporting steel work for cable racks/cables shall comprise of various channel sections, cantilever arms, various brackets, clamps, floor

plates, all hardware such as lock washers, hexagon nuts, hexagon head bolt, support hooks, stud nuts, hexagon head screw, channel nut, channel nut with springs, fixing studs, etc.

- b. The system shall be designed such that it allows easy assembly at site by using bolting. All cable supporting steel work, hardware's fittings and accessories shall be prefabricated factory galvanised.
- c. The main support and cantilever arms shall be fixed at site using necessary brackets, clamps, fittings, bolts, nuts and other hardware etc. to form various arrangements required to support the cable trays. Welding of the components shall not be allowed. However, welding of the bracket (to which the main support channel is bolted) to the overhead beams, structural steel, insert plates or reinforcement bars will be permitted. Any cutting or welding of the galvanized surface shall be brushed and red lead primer, oil primer & aluminium paint shall be applied.
- d. All steel components, accessories, fittings and hardware shall be hot dip galvanized after completing welding, cutting, drilling and other machining operation.
- e. The main support channel and cantilever arms shall be fabricated out of minimum 2.5 thick rolled steel sheets conforming to IS.
- f. Cantilever arms of 300 mm, 600 mm and 750 mm in length are required. The arm portion shall be suitable for assembling the complete arm assembly on to component constructed of standard channel section. The back plate shall allow sufficient clearance for fixing bolt to be tightened with tray in position.
- g. Cable trays in areas subjected to excessive coal dust or mechanical damage shall have hot dip galvanized sheet steel metal trays cover installed on front tray in vertical run and inverted 'V' type on upper tray in horizontal run with consideration for ventilation.

5.02.03 The size of structural steel members or thickness of sheet steel of main support channel and cantilever arms and other accessories as indicated above are indicative only. Nevertheless, the support system shall be designed by the contractor to fully meet the requirements of type tests as specified. In case the system fails in the tests, the components design modification shall be done by the Contractor without any additional cost. The contractor shall submit the detailed drawings of the system offered by him along with the bid.

5.03.00 Pipes, Fittings & Accessories

5.03.01 Pipes offered shall be complete with fittings and accessories (like tees, elbows, bends, check nuts, bushings, reducers, enlargers, coupling caps, nipples etc.)

5.03.02 The size of the pipe shall be selected on the basis of maximum 40% fill criteria GI Pipes shall be of medium duty as per IS: 1239.

5.03.03 The contractor shall provide and install all conduits, mild steel pipes, flexible conduits, rigid PVC pipes, etc. complete with accessories like tees, bends, adopters, locknuts, pull boxes, conduit plugs, caps, etc as required for the cabling work. Conduits shall be furnished in standard length of 5 metres, threaded at both ends.

5.03.04 Conduits diameter upto and including 25mm size shall be of 16 SWG and conduits above 25 mm diameter shall be of 14 SWG. Minimum diameter of conduits shall be 20 mm.



- 5.03.05 Conduits shall be made of hot-dip galvanized steel with an organic corrosion resistant ID coating. In chemical handling areas, battery room, etc., the exterior surface shall be further coated with chromate and polymer for better resistance to corrosion. Conduits, fittings & accessories shall have ISI mark.
- 5.03.06 For sizes above 63 mm, hot dip galvanized - both on inside and outside - steel pipes with necessary fittings & accessories shall be provided and installed by the contractor. The pipes and fittings shall be of heavy duty class with relevant ISI mark.
- 5.03.07 Flexible conduits complying to relevant IS and made with bright, cold_rolled, annealed and electro_galvanized mild steel strips shall be used between embedded conduits/pipes and the motor terminals. It shall also be used between fixed conduit and any equipment with vibration or equipment requiring regular removal.
- 5.03.08 Duct banks shall be High Density PE pipes encased in PCC (10% spare of each size, subject to minimum one) with suitable water-proof manholes.

5.04.00 Junction Boxes

- 5.04.01 Junction Boxes shall comprise of a case with hinged door constructed from cold rolled sheet steel of minimum thickness 2mm. Top of the boxes shall be arranged to slope towards rear of the box. Gland plate shall be 3 mm thick sheet steel with neoprene/synthetic rubber gaskets. All junction boxes shall be of adequate strength and rigidity, hot dip galvanised as per relevant IS, and suitable for mounting on wall, columns, structures etc. The boxes shall include brackets, bolts, nuts, screws M8 earthing stud etc. required for installation.

5.04.02 Glass Fibre Reinforced Junction Boxes (for outdoor use)

No. of Ways: 12/24/36/48 with 20% spares terminals.

- 5.04.03 Junction boxes shall be Glass Fibre Reinforced with saturated polyester conforming to standards like DIN 16911 type 803/16913 type 834, 5 self extinguishing in accordance with ASTM D635/UL 94 VO.

Junction boxes for use in outdoor or damp locations shall be sturdy construction. Temperature resistance shall be between – 10 to 100°C. Impact resistance shall be greater than 7 Nm, (EN 50014). Protective insulation shall be in line with VDE 0100, dielectric strength shall be greater than 10 KV/mm, halogen free toxicity, the enclosure and door cover shall be painted and electro statically power coated (preferably in RAL 7032). Earth connection (studs size shall be M 6) shall be provided on the cover as well as door.

5.04.04 Doors

With integrated viewing window of 3mm resistant plexi glass or equivalent. The doors shall be industrial heavy duty hinges. The doors shall be easily but firmly lockable with quick release fastener.

5.04.05 Protection Class

Protection Category shall be IP 66 to EN 60529. There shall be guaranteed perfect seal to meet Protection class IP 66 providing arrangement like highly elastic foamed in special type seal like polyurethane/chloroprene. The sealing

rubber shall not have aging effect and shall retain its sealing characteristics for more than 20 years. Contractor shall indicate this in data sheet. The rubber seal should be pasted at its place with pasting technology for like more than 20 years (double sealing arrangement is preferred).

5.04.06 **Mounting clamps and accessories**

Junction boxes shall be suitable for mounting on walls, columns and structure. Brackets, bolts, nuts, screws, glands and lugs required for erection shall be of brass. The accessories like mounting plates etc. of steel shall be powder coated. The support rails for terminal box shall be zinc coated.

5.04.07 General

- JBs shall have small canopy at the top.
- There shall be rainwater collection arrangement from top and side of the outer ages to ensure that any leakage into the junction box shall be avoided and it shall fall outside.
- Cable entry shall be from bottom side only.
- Ensure gland plate sealing perfect. It shall be of the same quality and arrangement as that of door to cover arrangement.

5.04.08 **Steel Junction Boxes (for indoor use)**

5.04.09 No. of Ways

12/24/36/48 with 20% spares terminals.

5.04.10 Junction boxes shall be designed in accordance with NEC, article 370, paragraph 18,19 & 20 or equivalent standards.

5.04.11 Enclosure

Junction boxes for use in outdoor or damp locations shall be sturdy steel construction. The enclosure and door cover shall be surface finished clean, degreased, phosphated, deep coated primed (preferably in RAL 7044) and electro-statically powder coated (preferably in RAL 7032). Earth connection (studs size shall be M6) shall be provided on the cover as well as door. The sheath steel thickness shall be more than 2 mm.

5.04.12 Doors

The doors shall be hinged and lockable. The doors shall have industrial heavy duty hinges. The doors shall be easily but firmly lockable with quick release fastener.

5.04.13 Protection Class

Protection Category shall be IP 66 to EN60529/1091 complies with NEMA 4. There shall be guaranteed perfect seal to meet Protection class IP 66 providing sealing arrangement like highly elastic foamed in special type seal like polyurethane. There shall be an arrangement like multifold protection channel for additional stability and prevention of ingress of dust and water when the enclosure is open.

The sealing rubber shall not have aging effect and shall retain its sealing characteristics for more than 20 years. Contractor shall indicate this in data

sheet. The rubber seal should be pasted at its place with pasting technology for like more than 20 years (double sealing arrangement is preferred).

5.04.14 Mounting clamps and accessories

The mounting clamps and accessories shall be suitable for mounting on walls, columns and structure. Brackets, bolts, nuts, screws, glands and lugs required for erection shall be of brass.

5.04.15 General

- JBs shall have small canopy at the top.
- There shall be rainwater collection arrangement from top and side of the outer ages to ensure that any leakage in to the junction box shall be avoided and it shall fall outside.
- Cable entry shall be from bottom side only.
- Ensure gland plate sealing perfect. It shall be of the same quality and arrangement as that of door to cover arrangement.

5.04.16 Junction boxes shall be provided with two nos. earthing terminals (externally available) suitable for connection of 8 SWG G.I. wire. Knockouts shall be provided at bottom and both sides. These shall be provided by fixing plates in order to make them detachable type with suitable neoprene gaskets. Bottom and side plates for cable/conduit connection shall be provided. All unused holes shall be sealed with suitable grommets.

5.04.17 Junction boxes shall be provided with external designation label. The label inscriptions shall be informed to the Contractor by the Owner. Junction boxes shall be provided with danger sign in case of 415V circuit.

5.04.18 Junction boxes shall be of two types, viz. One suitable for control cabling and the other suitable for power cabling.

Junction boxes for control cabling shall have 24 way/ 48 way terminal blocks suitable for up to 2.5 sq.mm. Cu. Cable. However, for instrumentation junction boxes there shall be 24/48 ways suitable for terminating cable of 0.5 sq.mm. Cu. Cable.

5.04.19 Junction boxes for power circuit cabling shall be suitable for 1 no. 3 core 16 sq.mm. Al. Incoming cable and 1 no. 3 core 2.5 sq.mm Cu. Outgoing cable.

5.05.00 Terminal blocks

Terminal blocks shall be 650 volts grade, rated for 10 Amps and in one piece, rigid, Bakelite moulded, with disconnecting /shorting link. It shall be complete with insulating barriers, Klip-on-type terminals and identification strips, terminal studs, washers, nuts, lock nuts, marking strips etc.

Marking on terminal strip shall correspond to the terminal numbering on wiring diagrams. It shall be Elmex type CSLT-1 with insulating material of Melamine conforming to ESI Standard 12.1 or equivalent. Cage clamp type terminal block suitable for terminating 2 wires of 2.5 sq mm. on both sides arranged to facilitate easy termination shall be provided.

5.06.00 Terminations & Straight through Joints

5.06.01 Termination and jointing kits for 11/3.3 kV grade XLPE insulated cables shall be of proven design and make which have already been extensively used and type tested. Termination kits and jointing kits shall be pre-moulded type, taped type or heat shrinkable type. 11/3.3 kV grade joints and terminations shall be type tested as per IS: 13573. Critical components used in cable accessories shall be of tested and proven quality as per relevant product specification/ESI specification. Kit contents shall be supplied from the same source as were used for type testing. The kit shall be complete with the aluminium solder less crimping type cable lugs & ferrule as per DIN standard.

5.06.02 Straight through joint and termination shall be capable of withstanding the fault level for 11 kV and 3.3 kV systems.

5.06.03 1.1 KV grade straight through joints shall be of proven design.

5.07.00 Cable glands

5.07.01 Cable glands shall conform to BS: 6121 and be of robust construction capable of clamping cable and cable armour (for armoured cables) firmly without injury to insulation. Cable glands shall be made of heavy duty brass machine finished and nickel chrome plated. Thickness of plating shall not be less than 10 micron. All washers and hardware shall also be made of brass with nickel chrome plating. Rubber components shall be of neoprene and of tested quality. Necessary cable dimensions shall be furnished to the successful contractor.

5.07.02 Cable glands shall be single compression for indoor use, double compression type for outdoor use. Glands for classified hazardous areas shall be double compression type flameproof and weather proof duly certified by CMRS and approved by CCE. Cable glands shall match with the sizes of different HT/LT/Control cables.

5.08.00 Cable lugs/ferrules

5.08.01 The cables lugs shall be conforming to IS: 8309.

5.08.02 Machine ferruling shall be adopted.

5.08.03 Cable lugs for power cables shall be Aluminium solder less crimping type suitable for aluminium compacted conductor cables.

5.08.04 The cable lugs for control/instrumentation/ telephone cables shall be provided with insulating sleeve and shall suit the type of terminals provided on the equipments.

Cable lugs shall be suitable for termination of different cross-sections of control/ instrumentation /telephone cables and shall be of following types.

- i) Copper tubular terminal end for solder less crimping to copper conductors.
- ii) Cable lugs for control cable termination shall be insulated type. These lugs shall be flat type/ring type/U type to suit the terminals provided in the panel.
- iii) Pin type lugs shall not be used.
- iv) Aluminium tubular terminal ends for solder less crimping of to Aluminium conductor.

Solder less crimping of terminals shall be done by using corrosion inhibiting compound. The cable lugs shall suit the type of terminals provided on the equipment. Lugs for control/instrumentation cables shall be PVC insulated/sleeved type.

5.09.00 Cable Clamps & Straps

5.09.01 The cable clamps required to clamp multicore cables on vertical run shall be made up of Aluminium strip of 25x3 mm size. For clamping the multicore cables, self-locking, de-interlocking type nylon clamps/straps shall be used. The clamps/straps shall have sufficient strength and shall not get affected by direct exposure to sun rays and outdoor environment.

5.09.02 Trefoil clamps for single core cables shall be pressure die cast aluminum or fibre glass or nylon and shall include necessary fixing accessories like G.I. nuts, bolts, washers, etc. Trefoil clamps shall have adequate mechanical strength to withstand the forces generated by the system short circuit current of 105 KA peak.

5.10.00 Galvanizing

5.10.01 Galvanizing of steel components and accessories shall conform to IS: 2629 & IS: 2633. Additionally galvanizing shall be uniform, clean smooth, continuous and free from acid spots

5.10.02 The amount of zinc deposit over threaded portion of bolts, nuts, screws and washers shall be as per IS: 1367. The removal of extra zinc on threaded portion of components shall be carefully done to ensure that the threads shall have the required zinc coating on them as specified.

5.11.00 Welding

5.11.01 The welding shall be carried out in accordance with IS: 9595. All welding procedures and welders qualification shall also be followed strictly in line with IS: 9595.

6.00.00 CONSUMABLES AND HARDWARE

- i. The contractor shall furnish all erection materials, hardware and consumables required to complete the installation.
- ii. The materials shall include but not limited to the following:
- iii. Consumables: Welding rods & gas, oil and grease, cleaning fluids, paints, electrical tape, soldering materials etc.
- iv. Hardware: Bolts, nuts, washers, screws, brackets, supports, clamps, hangers, saddles, cleats, sills, shims etc.
- v. Supply of cement, sand, stone etc. required for the execution of the contract shall be the responsibility of the Contractor.

7.00.00 METHODS AND WORKMANSHIP

- i. All work shall be installed in a first class, neat workmanlike manner by mechanics/electricians skilled in the trade involved.



- ii. The erection work shall be supervised by competent supervisors holding relevant supervisory license from the government.
- iii. All details on installation shall be electrically and mechanically correct.
- iv. The installation shall be carried out in such a manner as to preserve access to other equipment installed.

8.00.00 INSTALLATION

8.00.01 Cable tray and Support System Installation

- 08.01.01 Cables shall run in cable trays mounted horizontally or vertically on cable tray support system which in turn shall be supported from floor, ceiling, overhead structures, trestles, pipe racks, trenches or other building structures. All cable trays shall be in vertical configuration in boiler, CHP, AHP & ESP areas.
- 8.01.02 Horizontally running cable trays shall be clamped by bolting to cantilever arms and vertically running cable trays shall be bolted to main support channel by suitable bracket/clamps on both top and bottom side rails at an interval of 1500 mm. For vertical cable risers/shafts cable trays shall be supported at an interval of 1000 mm. Fixing of cable trays to cantilever arms or main support channel by welding shall not be accepted. Cable tray installation shall generally be carried out as per relevant Standard. The cantilever arms shall be positioned on the main support channel with a minimum vertical spacing of 300 mm unless otherwise indicated in the relevant approved tray layout drawings.
- 8.01.03 All cable way sections shall have identification, designations as per approved cable way layout as and painted/stenciled at each end of cable way and where there is a branch connection to another cable way. Minimum height of letter shall be not less than 75 mm. For long lengths of trays, the identification shall be painted at every 10 meter. Risers shall additionally be painted/ stenciled with identification numbers at every floor.
- 8.01.04 In certain cases it may be necessary to site fabricate portions of trays, supports and other non standard bends where the normal prefabricated trays, supports and accessories may not be suitable. In such cases the Contractor shall fabricate at site suitable sections of trays, supports and accessories to make the installation complete for the specific purpose after obtaining owner's prior approval, which shall be neat in appearance and shall match with the prefabricated sections in the dimensions. They shall be applied with one coat of red lead primer, one coat of oil primer followed by two finishing coats of aluminium paint.

9.00.00 Conduits/Pipes/Ducts Installation

- 9.01.00 The Contractor shall be fully responsible for properly embedding conduit pipe sleeves wherever necessary for cabling work. All openings in the floor/roof/wall / cable tunnel/cable trenches made for conduit installation shall be sealed and made water proof by the Contractor.
- 9.02.00 GI pull wire of adequate size shall be laid in all conduits before installation. Metallic conduit runs at termination shall have two lock nuts wherever required for junction boxes etc.



- 9.03.00 Conduit runs/sleeves shall be provided with PVC bushings having round edge at each end. All conduits/pipes shall have their ends closed by caps until cables are pulled. After cables are pulled, the ends of conduits/pipes shall be sealed with Glass wool/Cement Mortar/Putty to prevent entrance of moisture and foreign material.
- 9.04.00 Cable routing between lined cable trench and equipment/motors shall be taken through GI pipe sleeves of adequate size. Pipe sleeves shall be laid at an angle of maximum 150 to the trench wall. In case of larger dia cables i.e. 50mm and above, adequately sized pipe with larger bend radius shall be provided for ease of drawing of cable or for replacement. In places where it is not possible, a smaller trench may be provided if approved by Site Engineer.
- 9.05.00 Exposed conduit/pipe shall be adequately supported by racks, clamps, straps or by other approved means. Conduits /pipe support shall be installed square and true to line and grade with an average spacing between the supports as given below, unless specified otherwise

Conduit /pipe size (dia).	Spacing
Up to 40 mm	1 M
50 mm	2.0 M
65-85 mm	2.5 M
100 mm	3.0 M

- 9.06.00 In areas like WTP, chemical handling, battery room etc. exterior surface of the conduits shall be further coated with chromate or polymer for better resistance to corrosion.
- 9.07.00 All G.I. pipes shall be laid as per approved layout drawings and site requirements. Before fabrication of various profiles of pipe by hydraulically operated bending machine (which is to be arranged by the contractor), all the burrs from the pipes shall be removed. The bends formed shall be smooth. GI Pipes with bends shall be buried in oil/concrete in such way that that the bends shall be totally concealed. For GI pipes shall be undertaken well before paving is completed and necessary co-ordination with paving agency shall be the responsibility of Electrical Contractor. The open ends of pipes shall be suitably plugged with G.I. plugs after they are laid in final position. G.I. plugs shall be supplied by the contractor at no extra cost.

10.00.00 Junction Boxes Installation

- 10.01.00 Junction boxes shall be mounted at a height of 1200mm above floor level or as specified in the approved drawings or as decided by Owner and shall be adequately supported/mounted on masonry wall by means of anchor fasteners/ expandable bolts or shall be mounted on an angle, plate or other structural supports fixed to floor, wall, ceiling or equipment foundations.

11.00.00 Cable Laying and Installation

- 11.01.00 Cable network shall include power, control, lighting, communication and fire alarm system cables, which shall be laid in trenches, cables trays/conduits as detailed in the approved drawings and cable schedules. Erection of cable trays



and aligning and leveling as required shall be the responsibility of the contractor.

- 11.02.00 Cable installation shall be carried out as per IS: 1255 and other applicable standards. Cable drums shall be unloaded, handled and stored in an approved manner on hard and well drained surface so that they may not sink. In no case shall be drum be stored flat i.e. with flange horizontal. Rolling of drums shall be avoided as far as possible. For short distances, the drums may be rolled provided they are rolled slowly and in proper direction as marked on the drum. In absence of any indication, the drums may be rolled in the same direction as it was rolled during taking up the cables. For unreeling the cable, the drum shall be mounted on suitable jacks or on cable wheels and shall be rolled slowly so that cable comes out over the drum and not from below. All possible care shall be taken during unreeling and laying to avoid damage due to twist, kink or sharp bends. Cable ends shall be provided with sealed plastic caps to prevent damage and ingress of moisture.
- 11.03.00a. In outdoor areas, buried cables, wherever called for, shall be laid and covered with sand/riddled earth and protected from damage by bricks at sides and precast slab at top.
- b. When buried cables cross road/railway track, additional protection shall be provided in the form of hume / galvanised iron pipes/RCC box culvert.
- 11.04.00 For coal handling plant the cables shall not be routed along conveyor galleries. The cables shall be routed on independent cable trestles.
- 11.05.00 All tray levels shall be checked after erection and marked in as built drawings. Cable routing given on the layout drawings shall be checked in the field to avoid interference with structures, heat sources, drains, piping, air-conditioning duct etc. and minor adjustments shall be done to suit the field conditions wherever deemed necessary. All tray runs shall be installed parallel to the trench/building walls and floors except otherwise noted in the approved drawings. The contractor shall have to secure rack/tray supports by welding to those inserts, suitable embedded steel inserts shall be provided. Outdoor trays shall be installed by welding on the steel/concrete structure with inserts by the contractor. As far as practicable, cable trays shall be supported from one side only in order to facilitate installation and maintenance of cables from the other side.
- 11.06.00 While laying cable, ground rollers shall be used at every 2 metre interval to avoid cable touching ground. The cables shall be pushed over the rollers by a gang of people positioned in between the rollers. Cables shall not be pulled from the end without having intermediate pushing arrangements. Pulling tension shall not exceed the values recommended by cable manufacturer. Selection of cable drums for each run shall be so planned so as to avoid using straight through joints. Care should be taken while laying the cables so as to avoid damage to cables.
- 11.07.00 All temporary ends of cables must be protected against dirt and moisture to prevent damage to the insulation. For this purpose, ends of all cables shall be tapped with an approved PVC or rubber insulating tape. Use of friction type or other fabric type tape is not permitted.



11.08.00 Cables installed above grade shall be run in trays, exposed on walls, ceilings or structures and shall be run parallel or at right angles to beams, walls columns. Cables shall be so routed that they will not be subjected to heat from adjacent hot piping or vessels.

12.00.00 Laying of cables in cable trays

12.01.00 Cables shall be laid on cable trays strictly in line with cable schedule furnished. Where specific cable layouts are not shown on approved drawings, contractor shall route these as directed by the Owner.

12.02.00 Power and control cables shall be laid on separate tiers. The laying of different voltage grade cables shall be on different tiers according to the voltage grade of the cables. In horizontal tray stacks, H.V. cables shall be laid on topmost tier and cables of subsequent lower voltage grades on lower tiers of trays. Single core cable in trefoil formation shall be laid with a distance of four times the diameter of cable between trefoil center lines and clamped at every two metre. All multicore cables shall be laid in touching formation. LT power cables above 95 sq.mm size shall be laid in single layer touching formation in trays while cables upto & including 95 sq.mm shall be laid in maximum of 2 layers. Control and Instrumentation cables can be laid upto a maximum of three layers in each tray.

12.02.00 All communication cables (telephone, P.A. System) RTD Cables shall run on instrument trays/ducts/trenches. Wherever these are not available, cables shall be taken in a separate trench/trays with a minimum clearance of 600mm away from electrical trench/trays as per the direction of Site Engineer and Communication cables shall cross power cables at right angles

12.03.00 Power and control cables shall be secured fixed to trays/support with self locking type nylon cable straps with de-interlocking facilities. For horizontal trays arrangements, multicore power cables and control cables shall be secured at every five meter interval. For vertical tray arrangement, individual multicore power cables and control cables shall be secured at every one meter by nylon cable strap. After completion of cable laying work in the particular vertical tray, all the control cables shall be binded to trays/supports by aluminium strips at every five meter interval and at every bend.

12.04.00 Bending radii for cables shall be as per manufacturer's recommendations and IS: 1255.

12.05.00 Individual cables or small groups which run along structures/walls etc will be clamped by means of 16 SWG GI saddles on 25x6mm saddle bars. The cost of saddle and saddle bars shall be deemed to have been included in the installation of cables. Alternatively small group of cables can be taken through 100mm slotted channel/ISMC 100. They shall be rightly supported on structural steel and masonry, individual or in groups as required, if drilling of steel must be drilled where the minimum weakening of the structure will result.

12.06.00 Cables shall be supported so as to prevent unsightly sagging. In general distance between supports shall be approximately 300mm for cables upto 25mm diameter and maximum 500mm for cables larger than 25mm dia and

- cables laid in vertical run of cable trays shall be clamped at an interval of 900mm.
- 12.07.00 Where cables cross roads/rail tracks, the cables shall be laid in Hume pipe/PVC pipe. At road crossing and other places where cables enter pipe sleeves adequate bed of sand shall be given so that the cables do not slack and get damaged by pipe ends. the hume pipes shall be laid at a depth of minimum 1000mm such that cables are not damaged.
- 12.08.00 Power and Control Cables, as far as possible, shall be laid in complete, uncut lengths from one termination to the other. Straight through joints in power cable shall be allowed only in nearest of rare situation only after approval of owner.
- 12.09.00 Joints for less than 250 Meters run of cable shall not be permitted.
- 12.10.00 In each cable run some extra length shall be kept at suitable point to enable one LV/two HV straight through joints to made, should the cable develop fault at a later stage. Control cable termination inside equipment enclosure shall have sufficient lengths so that shifting of termination in terminal blocks can be done without requiring any splicing.
- 12.11.00 Wherever few cables are branching out from main trunk route troughs shall be used.
- 12.12.00 Cables shall be neatly arranged in the trays in such a manner so that criss-crossing is avoided and final take off to the motor/switchgear is facilitated. Arrangement of cables within the trays shall be the responsibility of the contractor.
- 12.13.00 The contractor shall ascertain the exact requirement of cable for a particular feeder by measuring at site and avoiding interference with structure, foundation, pipelines or any other works. Before the start of cable laying, cable drum schedule shall be prepared by electrical contractor and get that approved by site engineer to minimize/avoid straight through joints. The actual number of straight through joints required shall be worked out by the contractor. During the erection period the contractor shall furnish a monthly report on cable position in an approved proforma so as to keep the owner appraised of the position.
- 12.14.00 The installation work shall be carried out in a neat workman like manner & areas of work shall be cleaned of all scraps, water, etc. after the completion of work in each area every day. Contractor shall replace RCC/Steel trench covers after the Installation work in that particular area is completed or when further work is not likely to be taken up for some time.
- 12.15.00 Electrical cable trays exposed to hazardous process fluid shall be covered with detachable G.I. covers. The covers shall be suitable to resist wind forces.
- For cables laid above ground in cable racks, asbestos sheeting of 3mm thickness shall be provided below the bottom cable tray to protect the cables from fire.
- 12.16.00 Supporting steel shall be painted before laying of cables. The painting shall be done with one coat of red lead paint and two coats of approved bituminous aluminium paint unless otherwise specified.

12.17.00 Separation

Sufficient spacing not less than 300mm shall be provided between different tiers of trays and maintained to permit adequate access for installation and maintenance of cables.

At least 300mm clearance shall be provided between :

- HV power & LV power cables,
- LV power & LV control/instrumentation cables,

12.19.00 Segregation

Segregation means physical isolation to prevent fire jumping.

Cables from two different services viz. supply from Station Board and Unit Board shall be segregated.

Interplant cables of station auxiliaries and unit critical drives shall be segregated in such a way that not more than half of the drives are lost in case of single incident of fire. Power and control cables for AC drives and corresponding emergency AC or DC drives shall be laid in segregated routes. Cable routes for one set of auxiliaries of same unit shall be segregated from the other set.

For Coal Handling Plant all the cables of one stream shall be segregated from the cables of the other stream and shall run on either side of the trestle.

13.00.00 Cable fire sealing

13.01.00 Cable/cable tray openings in walls and floors or through pipe sleeves from one area to another or from one elevation to another within the unit shall be sealed by a fire proof sealing system (FPSS). The FPSS shall effectively prevent the spread of fire from the flaming to non-flaming side of a fire.

13.02.00 Wherever the cables/cable trays pass through walls/floors, fire proof cable penetration seals rated for one-twenty (120) minutes shall be provided. This shall be by suitable block system using individual blocks with suitable framework or by silicon RTV foaming system. In case foaming system is offered, damming board, if used, shall not be considered for fire rating criteria. Any of the system offered shall be of proven type as per BS: 476 (Part-20) or equivalent standard.

13.03.00 In order to prevent fire propagation through cable penetrations, after laying, dressing & clamping of cables, all the openings shall be properly sealed by using Fire Stop Mortar Seal and Fire Retardant Cable coating compound. Also the cable runs both before and after the fire scale shall be suitably sprayed with anti-fire propagation liquid.

14.00.00 Cable laying in trenches

14.01.00 RCC cable trenches with removable covers will be provided by the contractor. Cables shall be laid in 3 or 4 tires in these trenches. Concrete cable trenches shall be filled with sand where specified to avoid accumulation of hazardous gases. RCC covers of trenches in process area shall be effectively sealed to avoid ingress of chemicals etc. Removal of concrete covers for purposes of

cable laying and reinstating them in their proper positions after the cables are laid shall be done by the contractor at no extra cost.

- 14.02.00 For cable trays are laid in trench in more than two tiers a space of minimum 600 mm shall be available for maintenance. In case two or more tiers of cable trays are running parallel along both sides of trench walls there shall be space of minimum 600 mm between them.
- 14.03.00 Cables shall be handled carefully during installation to prevent mechanical injury to the cables. Ends of cable leaving trenches shall be coiled and provided with a protective pipe or cover till such times the final termination to the equipment is completed.
- 14.04.00 Prior to laying of cables inside both indoor and outdoor trenches, the contractor shall properly clean inside of those trenches.
- 14.05.00 When cables are laid in multiple tiers, spacing between individual tiers shall be as approved by Site Engineer. Space between individual tiers shall be filled and compacted with soil and sand.
- 14.06.00 As each row of cables is laid in place and before covering with sand every cable shall be given on insulation test in the presence of Site Engineer. Any cable, which proves defective, shall be replaced before the next groups of cables are laid.
- 14.07.00 All wall openings/pipe sleeves shall be effectively sealed after installation of cables to avoid seepage of water inside building/lined trench.
- 14.08.00 Where cables rise from trenches to motor, control station, lighting panels etc., they shall be taken in G.I. Pipes for mechanical protection up to a minimum of 150mm above grade.
- 14.09.00 Cable ends shall be carefully pulled through the conduit, to prevent damage to these cables. Where required, approved cable lubricant shall be used for this purpose. Where cable enters conduit the cable should be bent in large radius. Radius shall not be less than the recommended bending radius of the cables specified by the manufacturer.

Following guide of the pipe fill shall be used for sizing the pipe size:

- a) 1 cable in pipe - 53% full
- b) 2 cables in pipe - 51% full
- c) 3 or more cables - 43% full
- d) Multiple cables - 40% full

After the cables are installed and all testing is complete, conduit ends above grade shall be plugged with a suitable weatherproof plastic compound/'PUTTI' for sealing purpose. Alternatively G.I. Lids or PVC bushes shall be employed for sealing purposes. The cost for the same shall be deemed to have been included in the installation of G.I. pipe and no separate payment shall be allowed.

- 14.10.00 Where cables pass through foundation walls or other underground structures, the necessary ducts or openings will be provided in advance for the same. However, should it become necessary to cut holes in existing foundations or

structures, the electrical contractor shall determine their location and obtain approval of the Site Engineer before cutting is done.

15.00.00 CABLE IDENTIFICATION

15.01.00 Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct/conduit entry & exit, and at every 20 meters in cable tray/trench runs. Cable tags shall also be provided inside the switchgear, motor control centers, control and relay panels etc. where a number of cables enter together through a gland plate. Cable tag shall be of rectangular shape for power cables and control cables. Cable tag shall be of 2 mm thick aluminum with number punched on it and securely attached to the cable by not less than two turns of 20 SWG GI wire conforming to IS:280. Alternatively, the Contractor may also provide cable tags made of nylon, cable marking ties of 'TY-CAB' or equivalent type with cable number heat stamped on the cable tags.

15.02.00 For laying of underground cable (applicable for Raw Water Intake Switchgear & Ash dyke) shall be provided with identity tags of Stain less steel securely fastened every 30 M of its underground length with at least one tag at each end before the cable enters the ground. In unpaved areas cable trenches shall be identified by means of markers. These posts shall be placed at location of changes in the direction of cables and at intervals of not more than 30 M for straight run and at cable joint locations with additional inscription 'Cable Joint'. For buried cables the marker shall project 150mm above ground.

15.03.00 Drum number of each cable from which it is taken shall be recorded against the cable number in the cable schedule.

16.00.00 CABLE TERMINATIONS & CONNECTIONS

16.01.00 The termination and connection of cables shall be done strictly in accordance with cable termination kit manufacturer" instructions, drawings and/or as directed by Site Engineer. Cable jointer shall be qualified to carryout satisfactory cable jointing/termination. Contractor shall furnish for review documentary evidence/experience reports of the jointers to be deployed at site.

16.02.00 Work shall include all clamps, fittings etc. and clamping, fitting, fixing, plumbing, soldering, drilling, cutting, taping, preparation of cable end, crimping of lug, insulated sleeving over control cable lugs, heat shrinking (where applicable), connecting to cable terminal, shorting and grounding as required to complete the job to the satisfaction of the Site Engineer.

16.03.00 Responsibility of proper termination shall lie on the contractor. Guarantee for termination shall also have to be given by the contractor.

16.04.00 The equipment will be generally provided with undrilled gland plates for cables/conduit entry. The Contractor shall be responsible for punching of gland plates, painting and touching up. Holes shall not be made by gas cutting. The holes shall be true in shape. All cable entry points shall be sealed and made vermin and dust proof. Unused openings shall be effectively sealed by 2mm thick aluminium sheets.

- 16.05.00 Contractor shall drill holes for fixing glands wherever necessary at no extra cost. Gland plate shall be of non-magnetic material/aluminium sheet in case of single core cables. If the cable end box or terminal chamber provided on the equipment is found unsuitable and requires major modifications the same shall be carried out by the contractor at the discretion of the Engineer- in-Charge.
- 16.06.00 Control cable cores entering control panel/switchgear/MCC/miscellaneous panels shall be neatly bunched, clamped and tied with self locking type nylon cable ties with de interlocking facility to keep them in position.
- 16.07.00 The panels where a larger number of cables are to be terminated and cable identification may be difficult, each core ferrule shall include the complete cable number. The ferrules shall be indelible interlocking type and shall fit tightly on cores. Spare cores shall have similarly ferrules with a suffix letter 'S' alongwith cable numbers and coiled up after end sealing.
- 16.08.00 All cable terminations shall be appropriately tightened to ensure secure and reliable connections.
- 16.09.00 It is the responsibility of the Contractor to terminate the cables at motor terminals in correct phase sequence to ensure the proper direction of rotation.
- 16.10.00 All cables upto 1.1KV grade shall be terminated at the equipments by means of compression type cable glands. They shall have a screwed nipple with conduit electrical threads and check nut.
- 16.11.00 All cable entries shall be through bottom only and top entry terminations are made only after getting approval of Site Engineer.
- 16.12.00 Power cables, wherever colour coding is not available, shall be identified with red, yellow and blue PVC tapes. Where copper to aluminium connections is made, necessary bimetallic washers shall be used. For trip circuit identification additional red ferrules shall be used only in the particular cores of control cables at the termination points in the Switchgear/Control panels and Control Switches.
- 16.13.00 In case of control cables all cores shall be identified at both ends by their terminal numbers by means of PVC ferrules. Wire numbers shall be as per schematic/ wiring/ inter-connection diagram. Contractors shall have the samples of PVC markers approved before starting the work. All unused spare cores of control cables shall be neatly bunched and ferruled with cable tag at both ends. Control cables shall be neatly bunched and served with PVC perforated tape to keep it in position at the terminal block.
- 16.14.00 Where threaded cable gland is screwed into threaded opening of different size, suitable brass threaded reducing bushing shall be used provided.
- 16.15.00 The cable shall be taken through glands inside the panels or any other electrical equipment such as motors. The individual cores shall then be dressed and taken along the cable ways (if provided) or shall be fixed to the panels with polyethylene straps. Only control cables of single strand and lighting cables may be directly terminated on to the terminals.

In case of termination of cables at the bottom of a panel over a cable trench having no access from the bottom, close fit hole should be drilled in the bottom plate for all the cables in one line, and then bottom plate should be split in two parts along the centre line of holes. After installation of bottom plate and cables it should be sealed with cold setting compound. Cables shall be clamped over the open armouring to connect it to earth bus.

- 16.16.00 Cable leads shall be terminated at the equipment terminals by means of crimped type solder less connectors.

Crimping shall be done by hand crimping/hydraulically-operated tool and conducting jelly shall be applied on the conductor.

Insulation of the leads should be removed immediately before the crimping. Conductor surface shall be cleaned and shall not be left open.

- 16.17.00 Termination and connection shall be carried out in such a manner as to avoid strain on the terminals.

- 16.18.00 All cable entry points shall be properly sealed and made dust and vermin proof. Unusual opening, if any, shall be effectively closed. Sealing work shall be carried out with approved sealing compound having fire withstand capability for at least one-twenty (120) minutes.

17.00.00 Cable accessories for H.V. Systems

- 17.01.00 The H.V. cables terminations/joints shall be done by skilled and experienced jointers duly approved by the Site Engineer.

- 17.02.00 The termination and straight through joint kits for use on high voltage system shall be suitable for the type of cables offered by the contractor or the type of cables issued by owner for installation. The materials required for termination and straight through joints shall be supplied in kit form. The kit shall include all insulating and sealing materials apart from conductor fittings and consumable items. An installation instruction shall be included in each kit.

- 17.03.00 The termination kits shall be suitable for termination of the cables to an indoor switchgear or to a weatherproof cable box of an outdoor mounted transformer/motor. The termination kits shall preferably be as of the following types.

- a. 'PUSH ON' type for LV cables.
- b. Heat-shrinkable sleeve type for LV & HV cables.

However, termination kits for HV cables shall be of Heat Shrinkable type of makes with specific approval of owner.

For outdoor installations, weather shields/sealing ends and any other accessories required shall also form part of the kit.

- 17.04.00 The straight through jointing kits shall be suitable for underground buried installation with uncontrolled backfill and possibility of flooding by water. The jointing kit shall be one of the following types.

- a. 'TAPEX' of M-seal make or equivalent for LV cables
- b. Heat-shrinkable sleeve type for LV & HV cables.



However, termination kits for HV cables shall be of Heat Shrinkable type of makes with specific approval of owner.

For outdoor installations, weather shields/sealing ends and any other accessories required shall also form part of the kit.

18.00.00 EXCAVATION AND BACK FILLING

18.01.00 The contractor shall perform all excavations and backfilling as required for buried cable and ground connections.

18.02.00 Excavation shall be performed up to the required depth. Such sheeting and shoring shall be done as may be necessary for protection of the work.

18.03.00 The contractor shall make use of his own arrangement for pumping out any water that may be accumulated in the excavation.

18.04.00 All excavation shall be backfilled to the original level with good consolidation.

19.00.00 CLEANING UP OF WORK SITE

19.01.00 The Contractor shall, from time to time, remove all rubbish resulting from execution of his work. No materials shall be stored or placed on passage or drive ways.

19.02.00 Upon completion of work, the contractor shall remove all rubbish, tools, scaffoldings, temporary structures and surplus materials etc. to leave the premises clean and fit for use.

20.00.00 QUALITY ASSURANCE PROGRAMME

20.01.00 Contractor shall furnish detailed Quality Assurance Programme and Quality Plans for all materials and accessories to be supplied and installed under the scope of the specification as per General Technical Conditions of technical specification. The Quality Plans shall include all tests/ checks as per relevant National/International Standards and the requirements of this specification including tests listed in this section.

21.00.00 TESTS

21.01.01 Type tests on Cable Trays support system

A) Test 1A:

On main support channel type-C2 for cantilever arms fixed on one side only. A 3.5 metre length of main support channel shall be fixed vertically at each end to a rigid structure as per appropriate fixing arrangement. Eight (8) nos. 750 mm cantilever arms shall be fixed to the main channel and each arm shall be loaded over the outboard 600 mm with a uniform working load of 100 kg. Subsequently a point load of 100 kg shall be applied on arm 2. A uniform proof load on all the arms equal to twice the working load shall be then be applied. Deflections shall be measured at the following load intervals and other necessary points:

i) Working load

- ii) Working load + point load
- iii) Off load
- iv) Proof load + point load
- v) Off load

The deflection measured at working loads shall not exceed 16 mm. The permanent deflection after removing the combination of working load and point load shall not exceed 10 mm at the arm tips and 6 mm on the channel. No collapse of the structure shall occur with a combination of proof load and point load applied.

B) Test 1B:

Test 1A shall be repeated with Eight Cantilever arms uniformly loaded and with the same point load on arm 2

Test 2: On Main support channel type -C2 for cantilever arms fixed on both sides

a) Test 2A: A 3.5 m length of main support channel C2 for cantilever arms fixing on both sides shall be fixed at each end to rigid structure as per appropriate fixing arrangement. Six (6), 750 mm cantilever arms shall be attached to each sides and each arm uniformly loaded to a working load of 100 kg over the out board 600 mm. A point load of 100 kg shall than be applied to arm 2, followed by a uniform proof load of twice the working load on all the arms; deflection shall be measured at the following load intervals and other necessary points.

- i) Working load
- ii) Working load + Point load

iii) Off load

- iv) Proof load + Point load
- v) Off load

The deflection measured at working loads shall not exceed 16mm. The permanent deflection after removing the combination of working load and point load shall not exceed 10 mm at the arm tips and 6 mm on the channel. No collapse of the structure shall occur with a combination of proof load and point load applied

b) Test 2B: The test 2 A shall be repeated with the assembly but with an asymmetrical load on the C2 column and point load applied to arm 8. The 100 kg and 200 kg uniformly distributed loads shall be applied to the upper three arms on one side and the lower three arms on the opposite side.

Test 3:

A length of main support channel section shall be fixed to steel structure/floor and have loads applied as detailed below and other important points not mentioned herein.

a) Test 3A : A length of steel structure shall be rigidly supported. It should be fitted on a metre length of channel section using beam clamps welded/bolted. A point load of 1200 kg shall be applied to the centre point via two brackets. No distortion or pulling of the components shall take place.

- b) **Test 3B:** With the components assembled as in Test 3A, two perpendicular point loads of 600 kg shall be simultaneously applied at positions 150 mm either side of the centre line, no distortion or pulling of the components shall take place.
- c) **Test 3C:** With the components assembled as in Test 3A, a perpendicular point load shall be applied at a point 150 mm on one side of the centre line.
The load shall be gradually increased to the maximum value that can be applied without causing distortion or pulling of the components. This value shall be recorded.

Test 4 Channel nut slip characteristics (what ever applicable)

Tests 4A1, 4A2, 4A3:

A length of channel C1 section 200 mm long shall have fitted bracket with the two bolts fixing.

With loads applied at the appropriate position nut slip shall be determined with bolt torque of 30 NM, 50 NM and 65 NM No fewer than three measurements shall be made or each torque setting.

A minimum loading of 720 kg shall be obtained before nut slip with bolt torque of 65 NM.

Tests 4B1, 4B2, 4B3:

The length of channel C1 section 200 mm long shall have fitted bracket with the one bolt fixing. With loads applied at the appropriate position, nut slip shall be determined with bolt torques of 30 NM, 50 NM and 65 NM. No fewer than three measurements shall be made for each torque setting.

A minimum loading of 350 kg shall be obtained before nut slip with a bolt torque of 65 NM

Test 5 Weld Integrity Test

After deflection test as per test 1A, 1B, 2, 3 & 4 weld integrity shall be checked by magnetic particle inspection to detect sub-surface cracks developed, if any.

Cable termination kit and straight through joints should have been tested as per IS: 13573 for 3.3kV and 11kV class.

Fire proof Cable Penetration system should have been tested for the following tests:

- Accelerated Ageing test
- Water absorption test
- Fire rating test
- Hose Stream test
- Vibration test followed by fire rating test

21.02.00 Routine/ Acceptance Tests

Following routine/acceptance tests shall be carried out on all the equipments, devices & materials supplied:

22.00.00 Galvanizing Tests



The quality of galvanizing shall be inspected visually and shall be smooth, continuous, and free from flux stains.

- i) Uniformity of coating – The coating of any article shall withstand four 1 minute dips in standard copper sulphate solution without the formation of an adherent red spot of metallic copper upon the basic metal.
- ii) The quality of cadmium/zinc plating on items with screw threads shall be inspected visually and shall be free from visible defects such as unplanted areas, blisters and modules.
- iii) In addition, the plating thickness shall be determined microscopically/chemically or electronically.

23.00.00 Welding

The quality of welding shall be visually inspected, particular attention being paid to the following points.

- 1) The welded joints shall be continuous along its length on both sides and of uniform width and thickness. It should be free from blow holes.
- 2). The weld metal shall be properly fused with the parent metal without undercutting.
- 3) The outside surface of the weld shall be clean. All slag shall have been removed. All welding shall be regularly checked for cracking using magnetic particle inspection or their equivalent technique.
 - 1. Physical and dimensional checks for all items.
 - 2. All conduits/pipes, etc. shall be routine/acceptance tested as per relevant standards.
 - 3. All acceptance and routine tests on cable glands as for BS: 6121. Additionally Proof torque test shall be carried out as acceptance on each body group of cable glands.
 - 4. Deflection test cable trays.
 - 5. All acceptance and routine tests on Junction boxes.
 - 6. Following tests shall also be carried out on each type of equipments, devices and materials/items supplied:
 - i) Physical and Dimensional checks
 - ii) Check/measurement of thickness for Nickel chrome plating for cable glands and tinning for cable lugs.
 - iii) Check chemical composition of brass parts for cable glands.
 - iv) Hardness check on gaskets.
 - v) Test for uniformity of galvanization.

24.00.00 Cable trays / supports and accessories

- 1) Check for proper galvanizing/painting and identification number of the cable trays/supports and accessories.
- 2) Check for continuity of cable trays over the entire route.
- 3) Check that all sharp corners, burrs, and waste materials have been removed from the trays supports.
- 4) Check for earth continuity and earth connection of cable trays.

QUALITY PLAN FOR MOTORS BELOW 55 KW (LV)

		QUALITY PLAN		CUSTOMER :		PROJECT			SPECIFICATION :			
				BIDDER/ :		TITLE			NUMBER :			
		SHEET 1 OF 2		VENDOR		QUALITY PLAN NUMBER PED-506-00-Q-006, REV-01			SPECIFICATION TITLE			
		SYSTEM		ITEM AC ELECT. MOTORS BELOW 55KW (LV)			SECTION			VOLUME III		
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
1.0	ASSEMBLY	1.WORKMANSHIP	MA	VISUAL	100%	MANUF'S SPEC	MANUF'S SPEC	-DO-	2	-	-	
		2.DIMENSIONS	MA	-DO-	-DO-	MFG. DRG./ MFG. SPEC.	MFG. DRG./ MFG. SPEC.	-DO-	2	-	-	
		3.CORRECTNESS COMPLETENESS TERMINATIONS/ MARKING/COLOUR CODE	MA	VISUAL	100%	MFG.SPEC./ RELEVANT IS	MFG.SPEC. RELEVANT IS	-DO-	2	-	-	
2.0	PAINTING	1.SHADE	MA	VISUAL	SAMPLE	MANUFR'S SPEC/BHEL SPEC./RELEVANT STANDARD	BHEL SPEC. SAME AS COL.7	LOG BOOK	2	-	-	NOTE -1 & NOTE-3
3.0	TESTS	1.ROUTINE TEST INCLUDING SPECIAL TEST AS PER BHEL SPEC.	MA	-DO-	100%	IS-325/ BHEL SPEC./ DATA SHEET	SAME AS COL.7	TEST REPORT	2	1		NOTE -1 & NOTE-3
		2.OVERALL DIMENSIONS & ORIENTATION	MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPN. REPORT	2	1	-	NOTE -1 & NOTE-3
BHEL			PARTICULARS			BIDDER/VENDOR						
			NAME									
			SIGNATURE									

	QUALITY PLAN		CUSTOMER :			PROJECT			SPECIFICATION :			
			BIDDER/ :			TITLE			NUMBER :			
	SHEET 2 OF 2		VENDOR			QUALITY PLAN			SPECIFICATION :			
		SYSTEM			NUMBER PED-506-00-Q-006, REV-01			TITLE :				
					ITEM AC ELECT. MOTORS BELOW 55KW (LV)			SECTION		VOLUME III		
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
1	2	3	4	5	6	7	8	9	P	W	V	11
		3.NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPN. REPORT	2	1	-	
NOTES: 1 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON 2 WHERE EVER CUSTOMER IS INVOLVED IN INSPECTION, (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER. 3 FOR EXHAUST/VENTILATION FAN MOTORS OF RATING UPTO 1.5KW , ONLY ROUTINE TEST CERTIFICATES SHALL BE FURNISHED FOR SCRUTINY. <u>Legends for Inspection agency</u> 1. BHEL/CUSTOMER 2. VENDOR (MOTOR MANUFACTURER) 3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER) P. PERFORM W. WITNESS V. VERIFY												
BHEL			PARTICULARS			BIDDER/VENDOR						
			NAME									
			SIGNATURE									
			DATE						BIDDER'S/VENDORS COMPANY SEAL			

QUALITY PLAN FOR MOTORS 55 KW & ABOVE

		QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION :		
				BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE		
		SHEET 1 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION		VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
1.0	RAW MATERIAL & BOUGHT OUT CONTROL											
1.1	SHEET STEEL, PLATES, SECTION, EYEBOLTS	1.SURFACE CONDITION	MA	VISUAL	100%	-	FREE FROM BLINKS, CRACKS, WAVINESS ETC	LOG BOOK	3	-	-	PROPERTY CLASS MARKING SHALL BE CHECKED BY THE VENDOR
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANFR'S DRG./SPEC	MANFR'S DRG./SPEC	-DO-	3	-	-	
		3.PROOF LOAD TEST (EYE BOLT)	MA	MECH. TEST	-DO-	-DO-	-DO-	INSPEC. REPORT	3	-	2	
1.2	HARDWARES	1.SURFACE CONDITION	MA	VISUAL	100%		FREE FROM CRACKS, UN-EVENNESS ETC.	-DO-	3	-	-	
		2.PROPERTY CLASS	MA	VISUAL	SAMPLES	MANFR'S DRG./SPEC BOOK	RELEVENT IS/SPEC.	SUPPLIERS TC & LOG	3	-	2	
1.3	CASTING	1.SURFACE CONDITION	MA	VISUAL	100%		FREE FROM CRACKS, BLOW HOLES ETC.	LOG BOOK	3	-	2	
		2.CHEM. & PHY. PROP.	MA	CHEM & MECH TEST	1/HEAT NO.	MANFR'S DRG./SPEC	RELEVENT IS/	SUPPLIER'S TC	3	-	2	HEAT NO. SHALL BE VERIFIED
		3.DIMENSIONS	MA	MEASUREMENT	100%	MANUFR'S DRG.	MANUFR'S DRG.	LOG BOOK	3	-	2	
1.4	PAINT & VARNISH	1.MAKE, SHADE, SHELF LIFE & TYPE	MA	VISUAL	100% CONTINUOUS	MANFR'S DRG./SPEC	MANFR'S DRG./SPEC	LOG BOOK	3	-	2	
BHEL			PARTICULARS			BIDDER/VENDOR						
			NAME									
			SIGNATURE									
			DATE						BIDDER'S/VENDORS COMPANY SEAL			

		QUALITY PLAN		CUSTOMER :		PROJECT			SPECIFICATION :			
				BIDDER/		TITLE			NUMBER :			
				VENDOR		QUALITY PLAN			SPECIFICATION :			
SHEET 2 OF 9		SYSTEM		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III		
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
1.5	SHAFT (FORGED OR ROLLED)	1. SURFACE COND.	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	-	VENDOR'S APPROVAL IDENTIFICATION SHALL BE MAINTAINED
		2. CHEM. & PHYSICAL PROPERTIES	MA	CHEM. & PHYSICAL TESTS	1/HEAT NO. OR HEAT TREATMENT BATCH NO	MFG. DRG. SPEC.	RELEVANT IS	SUPPLIER'S TC	3	-	2	
		3. DIMENSIONS	MA	MEASUREMENT	100%	-DO-	MANUFR'S DRG.	LOG BOOK	3	-	2	
		4.INTERNAL FLAWS	CR	UT	-DO-	ASTM-A388	MANUFR'S SPEC. BHEL SPEC.	-DO-	3	2	1	
1.6	SPACE HEATERS, CONNEC- TORS, TERMINAL BLOCKS, CABLES, CABLE LUGS, CARBON BRUSH TEMP. DETECTORS, RTD, BTD'S	1. MAKE & RATING	MA	VISUAL	-DO-	MANUFR'S DRG. SPEC.	MANUFR'S DRG. SPEC.	-DO-	3	-	2	FOR DIA OF 55 MM & ABOVE
		2. PHYSICAL COND.	MA	-DO-	-DO-	-	NO PHYS. DAMAGE, NO ELECTRICAL DISCONTINUITY	-DO-	3	-	2	
		3.DIMENSIONS (WHEREVER APPLICABLE)	MA	MEASUREMENT	SAMPLE	MANUFR'S DRG./ SPEC.	MANUFR'S DRG. / SPEC.	-DO-	3	-	2	
		4.PERFORMANCE/ CALIBRATION	MA	TEST	100%	-DO-	-DO-	INSP. REPORT	3	-	2	
BHEL			PARTICULARS		BIDDER/VENDOR							
			NAME									
			SIGNATURE									
			DATE					BIDDER'S/VENDORS COMPANY SEAL				

		QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :		
				BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE		
		SHEET 3 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION		VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
1	2	3	4	5	6	7	8	9	P	W	V	11
1.7	OTHER INSULATING MATERIALS LIKE SLEEVES, BINDINGS CORDS, PAPERS, PRESS BOARDS ETC.	1. SURFACE COND. ETC.	MA	VISUAL	100%	-	NO VISUAL DEFECTS	INSPT. REPORT	3	-	2	FOR MV MOTOR INSULATION/VARNISH THICKNESS SHALL BE MORE THAN THE BURS HEIGHT * MOTOR MANUFACTURER TO CONDUCT VISUAL CHECK FOR SURFACE FINISH ON RANDOM BASIS (10% SAMPLE) AT HIS WORKS AND MAINTAIN RECORD FOR VERIFICATION BY BHEL/CUSTOMER.
		2. OTHER CHARACTERISTICS	MA	TEST	SAMPLE	MANUF'S SPEC.	MANUF'S SPEC.	LOG BOOK AND OR SUPPLIER'S TC	3	-	2	
1.8	SHEET STAMPING (PUNCHED)	1. SURFACE COND.	MA	VISUAL	100%	-	NO VISUAL DEFECTS (FREE FROM BURS)	LOG BOOK	3	-	-	
		2.DIMENSIONS INCLUDING BURS HEIGHT	MA	MEASUREMENT	SAMPLE	MANUFR'S DRG. .	MANUFR'S DRG.	-DO-	3	-	2	
		3. ACCEPTANCE TESTS	MA	ELECT. & MECH TESTS	-DO-	MANUF'S SPEC./ RELEVANT IS	RELEVANT IS	SUPPLIER'S TC	3	-	2	
1.9	CONDUCTORS	1. SURFACE FINISH	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	LOG BOOK	3*	-	2*	
		2.ELECT. PROP, & MECH. PROP	MA	ELECT. & MECH.TEST	SAMPLES	RELEVANT IS/ BS OR OTHER STANDARDS	RELEVANT IS/ BS OR OTHER STANDARDS	SUPPLIERS TC & VENDOR'S INSPN. REPORTS	3	-	2	
BHEL			PARTICULARS			BIDDER/VENDOR						
			NAME									
			SIGNATURE									
			DATE						BIDDER'S/VENDORS COMPANY SEAL			

		QUALITY PLAN		CUSTOMER :		PROJECT TITLE			SPECIFICATION : NUMBER :			
				BIDDER/ VENDOR :		QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
		SHEET 4 OF 9		SYSTEM		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION		VOLUME III	
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.10	BEARINGS	3.DIMENSIONS	MA	MEASUREMENT	-DO-	-DO-	-DO-	Log Book	3	-	2	
		1.MAKE & TYPE	MA	VISUAL	100%	MANFR'S DRG./ APPROVED DATASHEET	MANFR'S DRG./ APPROVED DATASHEET	-DO-	3	-	2	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	BHEL DATA SHEET	BHEL DATA SHEET BEARING MANUF'S CATALOGUES	-DO-	3	-	2	
		3.SURFACE FINISH	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	2	
1.11	SLIP RING (WHEREVER APPLICABLE)	1.SURFACE COND.	MA	VISUAL	100%	-	-DO-	-DO-	3	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANUF'S DRG	MANUF'S DRG	-DO-	3	-	-	
		3.TEMP.WITH-STAND CAPACITY	MA	ELECT.TEST	-DO-	MANUF'S SPEC./ BHEL SPEC.	MANUF'S SPEC./ BHEL SPEC.	-DO-	3	-	2	
		4.HV/IR	MA	-DO-	100%	-DO-	-DO-	-DO-	3	-	2	
1.12	OIL SEALS & GASKETS	1.MATERIAL OF GASKET	MA	VISUAL	100%	MANUF'S DRG/SPECS	MANUF'S DRG./ SPECS.	-DO-	3	-	-	
		2.SURFACE COND.	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	-	
		3.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANUF'S DRG	MANUF'S DRG	-DO-	3	-	-	
BHEL			PARTICULARS		BIDDER/VENDOR							
			NAME									
			SIGNATURE									
			DATE						BIDDER'S/VENDORS COMPANY SEAL			

		QUALITY PLAN		CUSTOMER :		PROJECT			SPECIFICATION :			
				BIDDER/ :		TITLE			NUMBER :			
		SHEET 5 OF 9		VENDOR		QUALITY PLAN			SPECIFICATION :			
		SYSTEM		NUMBER PED-506-00-Q-007, REV-03			TITLE					
				ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III		
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
2.0	IN PROCESS											
2.1	STATOR FRAME WELDING (IN CASE OF FABRICATED STATOR)	1.WORKMANSHIP & CLEANNESS	MA	VISUAL	100%	-DO-	GOOD FINISH	LOG BOOK	3/2	2	-	
		2.DIMENSIONS	MA	MEASUREMENT	-DO-	MANUF'S DRG	MANUF'S DRG	-DO-	2	-	-	
2.2	MACHINING	1.FINISH	MA	VISUAL	100%	-DO-	GOOD FINISH	LOG BOOK	2	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	-DO-	MANUF'S DRG	MANUF'S DRG	-DO-	2	-	-	
		3.SHAFT SURFACE FLOWS	MA	PT	-DO-	RELEVANT SPEC./ ASTM-E165	MANUF'S SPEC./ BHEL SPEC./	-DO-	2	-	1	
2.3	PAINTING	1.SURFACE PREPARATION	MA	VISUAL	100%	MANFR'S SPEC/BHEL SPEC./ RELEVANT STAND	BHEL SPEC. SAME AS COL.7	LOG BOOK	2	-	-	
		2.PAINT THICKNESS (BOTH PRIMER & FINISH COAT)	MA	MEASUREMENT BY ELCOMETER	SAMPLE	-DO-	-DO-	-DO-	2	-	-	
		3.SHADE	MA	VISUAL	-DO-	-DO-	-DO-	Log Book	2	-	-	
		4.ADHESION	MA	CROSS CUTTING & TAPE TEST	-DO-	-DO-	-DO-	Log Book	2	-	-	
BHEL			PARTICULARS			BIDDER/VENDOR						
			NAME									
			SIGNATURE									
			DATE						BIDDER'S/VENDORS COMPANY SEAL			

		QUALITY PLAN		CUSTOMER :		PROJECT TITLE			SPECIFICATION : NUMBER :				
				BIDDER/ : VENDOR		QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE				
		SHEET 6 OF 9		SYSTEM		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION		VOLUME III		
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS	
1	2	3	4	5	6	7	8	9	10	P	W	V	11
2.4	SHEET STACKING	1.COMPLETENESS	MA	MEASUREMENT	SAMPLE	MANUFR'S SPEC.	MANUFR'S SPEC.	Log Book	2	-	-		(FOR MOTORS OF 2MW AND ABOVE) * ON 10% RANDOM SAMPLE
		2.COMPRESSION & TIGHTENING	MA	MEASUREMENT	100%	-DO-	-DO-	Log Book	2	-	-		
		3.CORE LOSS & HOTSPOT	MA	ELECT.TEST	-DO-	-DO-	-DO-	Log Book	2	1*	1		
2.5	WINDING	1.COMPLETENESS	CR	VISUAL	100%	MANUFR'S SPEC./BHEL SPEC.	MANUFR'S SPEC./BHEL SPEC.	Log Book	2	-	-		
		2.CLEANLINESS	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-		
		3.IR-HV-IR	CR	ELECT. TEST	-DO-	-DO-	-DO-	Log Book	2	-	1		
		4.RESISTANCE	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1		
		5.INTERTURN INSULATION	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-		
		6.SURGE WITH STAND AND TAN. DELTA TEST	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1		
2.6	IMPREGNATION	1.VISCOSCITY	MA	PHY. TEST	AT STARTING	-DO-	-DO-	Log Book	2	-	-		FOR MV MOTOR
		2.TEMP. PRESSURE VACCUM	MA	PROCESS CHECK	CONTINUOUS	-DO-	-DO-	Log Book	2	-	-		
		3.NO. OF DIPS	MA	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1		
BHEL			PARTICULARS		BIDDER/VENDOR								
			NAME										
			SIGNATURE										
			DATE						BIDDER'S/VENDORS COMPANY SEAL				

		QUALITY PLAN		CUSTOMER :			PROJECT TITLE		SPECIFICATION : NUMBER :			
				BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03		SPECIFICATION : TITLE			
		SHEET 7 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)		SECTION		VOLUME III	
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
1	2	3	4	5	6	7	8	9	10		11	
2.7	COMPLETE STATOR ASSEMBLY	4.DURATION	MA	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	VERIFICATION FOR MV MOTOR ONLY
2.8	BRAZING/COMPRESSION JOINT	1.COMPACTNESS & CLEANLINESS	MA	VISUAL	100%	-DO-	-DO-	Log Book	2	-	-	
2.9	COMPLETE ROTOR ASSEMBLY	1.COMPLETENESS	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-	
		2.SOUNDNESS	CR	MALLET TEST & UT	-DO-	-DO-	-DO-	Log Book	2		1	
		3.HV	MA	ELECT. TEST	-DO-	-DO-	-DO-	Log Book	2		1	
2.10	ASSEMBLY	1.RESIDUAL UNBALANCE	CR	DYN. BALANCE	-DO-	MFG SPEC./ ISO 1940	MFG. DWG.	Log Book	2		1	
		2.SOUNDNESS OF DIE CASTING	CR	ELECT. (GROWLER TEST)	-DO-	MFG. SPEC.	MFG. SPEC.	Log Book	2		1	
		1.ALIGNMENT	MA	MEAS.	-DO-	-DO-	-DO-	Log Book	2	-	-	
		2.WORKMANSHIP	MA	VISUAL	-DO-	-DO-	-DO-	Log Book	2	-	-	
		3.AXIAL PLAY	MA	MEAS.	-DO-	-DO-	-DO-	Log Book	2	-	1	
		4.DIMENSIONS	MA	-DO-	-DO-	MFG.DRG./ MFG SPEC.	MFG. DRG/ RELEVANT IS	Log Book	2	-	-	
		5.CORRECTNESS, COMPLETENESS TERMINATIONS/ MARKING/ COLOUR CODE	MA	VISUAL	100%	MFG SPEC. RELEVANT IS	MFG SPEC. RELEVANT IS	Log Book	2	-	-	
	6. RTD, BTD & SPACE HEATER MOUNTING.	MA	VISUAL	100%	MFG SPEC. RELEVANT IS	MFG SPEC. RELEVANT IS	Log Book	2		1		
BHEL			PARTICULARS		BIDDER/VENDOR							
			NAME									
			SIGNATURE									
			DATE									
BIDDER'S/VENDORS COMPANY SEAL												

		QUALITY PLAN		CUSTOMER :		PROJECT			SPECIFICATION :			
				BIDDER/ :		TITLE			NUMBER :			
		SHEET 8 OF 9		VENDOR		QUALITY PLAN			SPECIFICATION :			
		SYSTEM		NUMBER PED-506-00-Q-007, REV-03			TITLE					
				ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III		
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
3.0	TESTS	1. TYPE TESTS INCLUDING SPECIAL TESTS AS PER BHEL SPEC.	MA	ELECT. TEST	1/TYPE/SIZE	IS-325/ BHEL SPEC./ DATA SHEET	IS-325/ BHEL SPEC./ DATA SHEET	TEST REPORT	2	1*	1	* NOTE - 1
		2. ROUTINE TESTS INCLUDING SPECIAL TEST AS PER BHEL SPEC.	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1\$	1	\$ NOTE - 2
		3. VIBRATION & NOISE LEVEL	MA	-DO-	100%	IS-12075 & IS-12065	IS-12075 & IS-12065	-DO-	2	1\$	1	\$ NOTE - 2
		4. OVERALL DIMENSIONS AND ORIENTATION	MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPC. REPORT	2	1	-	
		5. DEGREE OF PROTECTION	MA	ELECT. & MECH. TEST	1/TYPE/ SIZE	RELEVANT IS	BHEL SPEC. AND DATA SHEET	TC	2	-	1	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		6. MEASUREMENT OF RESISTANCE OF RTD & BTD	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1\$	1	\$ NOTE - 2
		7. MEASUREMENT OF RESISTANCE, IR OF SPACE HEATER	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1\$	1	\$ NOTE - 2
		8. NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPC. REPORT	2	1\$	1	\$ NOTE - 2
		9. EXPLOSION FLAME PROOF NESS (IF SPECIFIED)	MA	EXPLOSION FLAME PROOF TEST	1/TYPE	IS-3682 IS-8239 IS-8240	IS-3682 IS-8239 IS-8240	TC	2	-	1	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		10. PAINT SHADE, THICKNESS & FINISH	MA	VISUAL & MEASUREMENT BY ELKOMETER	SAMPLE	BHEL SPEC. & DATA SHEET	BHEL SPEC. & DATA SHEET	TC	2	1\$	1	SAMPLING PLAN TO BE DECIDED BY INSPECTION AGENCY \$ NOTE - 2
BHEL			PARTICULARS			BIDDER/VENDOR						
			NAME									
			SIGNATURE									
			DATE						BIDDER'S/VENDORS COMPANY SEAL			



		QUALITY PLAN		CUSTOMER :		PROJECT TITLE		SPECIFICATION : NUMBER :				
				BIDDER/ : VENDOR		QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03		SPECIFICATION : TITLE				
		SHEET 9 OF 9		SYSTEM		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)		SECTION		VOLUME III		
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P W V			REMARKS
1	2	3	4	5	6	7	8	9	10			11
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 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, THESE TEST MAY NOT BE REPEATED. 4 WHEREVER CUSTOMER IS INVOLVED IN INSPECTION, AGENCY (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER. <u>Legends for Inspection agency</u> 1. BHEL/CUSTOMER 2. VENDOR (MOTOR MANUFACTURER) 3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER) P. PERFORM W. WITNESS V. VERIFY												
BHEL			PARTICULARS		BIDDER/VENDOR				BIDDER'S/VENDORS COMPANY SEAL			
			NAME									
			SIGNATURE									
			DATE									

	TITLE	ANENEXURE – I LV MOTORS <u>DATA SHEET-A</u>		SPECIFICATION NO.	
				VOLUME	
				SECTION	
				REV NO. 00	DATE 11.07.2018
				SHEET 1	OF 1

1.0	Design ambient temperature	:	50 °C
2.0	Maximum acceptable kW rating of LV motor	:	≤200KW
3.0	Installation (Indoors/ Outdoors)	:	As required
4.0	Degree Of Protection (Indoor/Outdoor)	:	IP55
5.0	Type of Cooling	:	Refer clause 1.20 of Customer Motor Specification.
6.0	Details of supply system		
	a) Rated voltage (with variation)	:	415V ± 10%
	b) Rated frequency (with variation)	:	50 Hz (Variation: +3% TO –5%)
	c) Combined voltage & freq. variation	:	10%
	d) System fault level at rated voltage	:	50 kA for 1 sec
	e) Short time rating for terminal boxes		
	○ 90kW & Above (Breaker controlled)	:	50 kA for 1 sec
	○ Below 90kW (MCCB Contactor controlled)	:	50 KA for 01 sec.
	f) LV System grounding	:	Solidly
7.0	Class of insulation	:	Refer clause 1.16 of Customer Motor Specification
8.0	Minimum voltage for starting (As percentage of rated voltage)	:	Refer clause 1.14.5.3 & 4 of Customer Motor Specification
9.0	Power cables data	:	Shall be given during Detailed engg.
10.0	Earth Conductor Size & Material	:	Shall be given during Detailed engg.
11.0	Space heater supply	:	240 V, 1Φ , 50 Hz
12.0	Rating up to which Single phase motor	:	Acceptable upto 0.20 kW
13.0	Tests	:	Refer clause 1.44.02 of Customer Motor Specification
14.0	Energy efficient/ Flame proof motor	:	As per Customer spec. requirement

- Also detail Customer spec. for Motors to be referred as enclosed with the specification.

	TITLE MOTOR DATA SHEET - C	SPECIFICATION NO.	
		VOLUME	II B
		SECTION D	
		REV NO. 00 DATE 29/08/2005	
		SHEET	1 OF 2

S. No.	Description		Data to be filled by successful bidder
A.	General		
1	Manufacturer & country of origin		
2	Motor type		
3	Type of starting		
4	Name of the equipment driven by motor & Quantity		
5	Maximum Power requirement of driven equipment		
6	Rated speed of Driven Equipment		
7	Design ambient temperature		
B.	Design and Performance Data		
1	Frame size & type designation		
2	Type of duty		
3	Rated Voltage		
4	Permissible variation for		
5	a	Voltage	
6	b	Frequency	
7	c	Combined voltage & frequency	
8	Rated output at design ambient temp (by resistance method)		
9	Synchronous speed & Rated slip		
10	Minimum permissible starting voltage		
11	Starting time in sec with mechanism coupled		
12	a) At rated voltage		
13	b) At min starting voltage		
14	Locked rotor current as percentage of FLC (including IS tolerance)		
15	Torque		
	a) Starting		
	b) Maximum		
16	Permissible temp rise at rated output over ambient temp & method		
17	Noise level at 1.0 m (dB		
18	Amplitude of vibration		
19	Efficiency & P.F. at rated voltage & frequency		
	a) At 100% load		
	c) At 75% load		

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			

	TITLE MOTOR DATA SHEET - C	SPECIFICATION NO.	
		VOLUME	II B
		SECTION D	
		REV NO. 00 DATE 29/08/2005	
		SHEET	2 OF 2

S. No.	Description	Data to be filled by successful bidder
	c) At starting	
C.	Constructional Features	
1	Method of connection of motor driven equipment	
2	Applicable Standard	
3	DOP of Enclosure	
4	Method of cooling	
5	Class of insulation	
6	Main terminal box	
	a) Type	
	b) Power Cable details (Conductor, size, armour/unarmour)	
	c) Cable Gland & lugs details (Size, type & material)	
	d) Permissible Fault level (kArms & duration in sec)	
7	Space heater details (Voltage & watts)	
8	Flame proof motor details (if applicable)	
	a) Enclosure	
	b) suitability for hazardous area	
	i Zone	O / I / II
	ii Group	IIA / IIB / IIC
9	No. of Stator winding	
10	Winding connection	
11	Kind of rotor winding	
12	Kind of bearings	
13	Direction of rotation when viewed from NDE	
14	Paint Shade & type	
15	Net weight of motor	
16	Outline mounting drawing No (To be enclosed as annexure)	
D.	Characteristic curves/ drawings (To be enclosed for motors of rating $\geq 55\text{KW}$)	
	a) Torque speed characteristic	
	b) Thermal withstand characteristic	
	c) Current vs time	
	d) Speed vs time	

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			

[illegible]

ANNEXURE III

[illegible]



**1X660 MW PANKI TPS EXTN.
COMPRESSED AIR SYSTEM
TECHNICAL SPECIFICATION
(ELECTRICAL PORTION)**

SPECIFICATION No: PE-TS-426-555-A001

SECTION : IC

REV. 01

DATE: 17.06.2019

SHEET: 1 OF 1

**SECTION: IC
TECHNICAL SPECIFICATION (C&I PORTION)**



Technical specification for
Compressed Air System

1X660 MW TPS PANKI EXTN.

REV. NO. 00 DATE : 13.07.2018

SECTION: IC

**C&I SPECIFICATION FOR
COMPRESSED AIR SYSTEM**



Technical specification for
Compressed Air System

1X660 MW TPS PANKI EXTN.

REV. NO. 00 DATE : 13.07.2018

Table of Contents

Section C

- 1.1 Specific Technical Requirement

Section D

- 1.1 Hardware Interface Philosophy
- 1.2 Instruments Specifications
- 1.3 Instrumentation Check Lists
- 1.4 Instrument Stub Details
- 1.5 LCP & JB/Racks Specification
- 1.6 Actuator Specification & Datasheet
- 1.7 Applicable Cable Types
- 1.8 KKS Philosophy



Technical specification for
CONTROL & INSTRUMENTATION
1X660MW PANKI TPS EXTN.

SECTION D

REV. NO. 00

DATE : 13.07.2018

PART - C

SPECIFIC TECHNICAL REQUIREMENT



Specific Technical Requirement For
Compressed Air System

1 x 660 MW PANKI TPS

1. Complete C&I System for Compressed Air System is in bidder scope of supply. The requirements given are to be read in conjunction with detailed Technical specification. Further in case of any discrepancy in the requirement within the same section noted by the bidder in the specification, the same will be brought to the notice of BHEL in the form of pre bid clarification. In absence of any pre bid clarification, the more stringent requirement as per interpretation of customer shall prevail without any commercial and time implication.
2. Integrated microprocessor based control system along with suitable operator interface shall be provided for each Instrument Air Compressor & Service Air Compressor. All PT, DPT, TE, and other instruments outside the compressor skid shall be hooked-up to this system.
3. In addition to above, Compressed Air System shall be controlled and monitored from plant DCS (DCS shall be in BHEL's scope). To achieve these operational & functional requirements, hardwired signals shall be provided/accepted for DCS use. Number of hardwired signal shall be decided during detailed engineering. For realizing total loading/unloading cycles, standby start logic, remote start-up logic, Group control of air compressors, bidder shall furnish the required logic, control write-up and HMI graphics for overall operation of the compressor from DCS, during detailed engineering. Provision for hardwired START, STOP, LOAD & UNLOAD commands from DCS to all the compressors & their status feedbacks shall also be provided.
4. Dual two way redundant Ethernet connectivity to DCS shall be provided through redundant optical fiber link for information.
5. Bidder to furnish the configuration diagram of control system of compressor showing communication with DCS along with the bid. (Optical fiber cable shall be in BHEL's scope.)
6. The quantity of instruments for the system shall be as per tender P & ID wherever provided of the respective system as a minimum, for bidding purpose. However, Bidder shall also include in his proposal all the instruments and devices that are needed for the completeness of the plant auxiliary system/ equipment supplied by the bidder, even if the same is not specifically appearing in the P & ID. During detail engineering if any additional instruments & items are required for safe & reliable operation of plant, bidder shall supply the same without any price implication.
7. All the instruments shall be supplied along with necessary fittings, accessories, valve manifold, root valves, Junction box, Canopy & Structural steel as required. Instrument Installation along with hardware shall be in bidder scope. Double root valves shall be provided where pressure is above 40 Kg/cm².
8. The solenoid operated valves/ damper/gates shall have limit switches for open/ close feedback. Solenoid valve shall be rated for 24 V DC only.



9. Bidder to include all the instruments (PG, PS, LS, TS, Dew Point meter, etc.) required for the package along with fittings, accessories and valve manifold.
10. **Redundancy of sensors shall be provided, irrespective of instrumentation shown in the PID, by bidder as per sheet attached in the specification. (ANNEXURE A)**
11. The junction boxes/LIEs for termination of instruments /solenoid valve limit switches etc. are in bidder's scope. All instruments shall be terminated on JB/LCP in field and both instrument and JB/LCP are in bidder scope.
12. BHEL shall provide 230 V AC UPS supply feeder at a single point. Further distribution to various instruments shall be in Bidder's scope. Bidder to include necessary power distribution board in his scope. Any power supply other than the above, if required by any instrument/device, has to be derived by the Bidder and all necessary hardware/software for the same shall be in bidder's scope. Bidder to furnish UPS / Electrical load data along with the bid.
13. All transmitters & electronics items including JB's will be explosion proof / intrinsically safe as per hazardous area classification.
14. The make/model of various instruments/items/systems shall be subject to approval of owner/purchaser during detailed engineering stage. No commercial implication in this regard shall be acceptable. In case of any conflict or repetition of clauses in the specification, the more stringent requirements among them are to be complied with.
15. All Instruments must have separate tapping lines. Sharing of the same tapping pipe for redundant instruments or various different instruments is not acceptable.
16. As a general rule, measuring points and measuring equipment for critical protection shall be separate from and not combined with measuring equipment for the automatic control equipment.
17. Electronic instruments shall not be located close to hot lines, vessels or other hot equipment. Ambient temperatures exceeding 80 °C shall not result in calibration difficulties or rapid deterioration of electronic components.
18. All H.T. motors shall have provision for VMS sensors on DE & NDE bearings of motors and fans/pumps/compressors. Each bearing shall have two vibration sensor, one in X direction and other in Y direction along with key phasor for online vibration monitoring and analysis.
19. In case of HT motors, winding temperature for each stator winding and bearing temperature of motors & driven equipment shall be monitored on LCP for abnormal rise.



- 20.** Mandatory spares as per specification shall be supplied by bidder.
- 21.** The design, manufacture, inspection, testing, site calibration and installation of all C&I equipment and systems covered under this specification shall conform to the latest editions of applicable codes and standards eg. ANSI, ASME, IEEE, ISO, IEC, IGCI, AWS, NFPA, AISC, IGS, SAMA, UBC, UL, NESC, NEMA, ISA, DIN, VDE, IS etc.
- 22.** For instrument & control cable scope of supply refer 'Electrical scope sheet between BHEL & vendor'.
- 23.** Electrical Actuators shall be with integral starter.
- 24.** 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.
- 25.** Provision for separate Terminal block/wiring diagram for power and control blocks of control panel to be ensured.
- 26.** All pneumatic operated regulating control valves (if any) shall be envisaged with smart positioner.
- 27.** Power supply derived for Transmitters, contact interrogation, interposing relay and solenoid shall generally be ungrounded 24V D.C only. In all cases redundancy in power modules shall be considered.
- 28.** All transmitters shall be smart type and shall have 4-20mA DC signal with superimposed digital communication (HART). All transmitters shall be fitted with a local analog/digital indicator displaying appropriate physical units which may be read clearly from an easily accessible position. Each Temperature element shall be supplied with temperature transmitters, compensating cable, JB/LIE/LIR & other erection hardware.
- 29.** Bidder to note that all the transmitters/instruments supplied by Bidder shall be rack mounted. The racks shall be preassembled and provided by Bidder. Also no instruments / analyzers & JB's/Racks should be protruding on the walkway.
- 30.** Each valve/instrument shall be fitted with a stainless steel or aluminum nameplate indicating the valve/instrument service and reference number in accordance with the approved equipment coding system.
- 31.** The equipment shall be of modern, compact design incorporating the latest developments in proven technology.



- 32.** Bidder shall provide Cable Schedule in BHEL excel format which shall be provided during detailed engineering. Also, Cable Interconnections for Complete System shall be in Bidders' scope. DCS side details for hardwired signals shall be furnished by BHEL during detailed engineering. Bidder to delegate/depute their person/experts as per owner/consultant requirements.
- 33.** Bidder shall provide the signal exchange, to Plant DCS in BHEL prescribed format to be furnished during detailed engineering.
- 34.** Generally, equipment shall be supplied from one composite range of measurements and control equipment as marketed by a reputable manufacturer of international standing and shall have a minimum of three years' operational use on similar projects.
- 35.** Editable & pdf copy of following Drawings/Documents and data shall be furnished after award of the contract:

Control & operational write-up for the system
Recommended control scheme/ logic diagram
Process manuscript for implementation in DCS
List of Drives (Solenoid valves etc.)
I/O list (DCS)
GA & wiring diagram of local panel.
Power requirement.
Local control panel and field instruments quality plan.
Local control panel
Instruments data sheet.
JB/LIE/LIR grouping document.
Cable schedule and cable interconnection drawing.
Instrument schedule
Instrument hook-up diagram.
Mandatory spare BOQ
UPS load list
Any other document decided during detailed engineering.

Notes:

1. All equipment items shall be of latest design with proven on track record from reputed experienced manufacturers of specified type and range of equipment. The make/model of various instruments/items/systems and instrument sub-vendor shall be subject to approval of BHEL/Customer during detailed engineering stage.
2. 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.



Specific Technical Requirement For
Compressed Air System

1 x 660 MW PANKI TPS

3. Documents of C&I System shall be submitted to end user/owner for approval during detail engineering. Changes, if any, shall be accommodated by the bidder without any price/time implication.
4. Uniformity of make and type of instruments and control components shall be followed throughout for rationalization of spares' inventory, except for certain proprietary items where this requirement cannot be met.
5. In case of any discrepancy in Section-C and Section-D of the specification, Section-C shall prevail.

ANNEXURE - 1**(g) Redundancy requirements****i Triple Redundancy**

Triple Sensing device shall be provided for following applications:-

- a. **For** Binary and analog inputs required for protection of boiler, turbine and major auxiliaries of main plant whose non-availability may result in 50% loss of unit availability and loss of generation.
- b. Binary and analog inputs, which are, required for protection of more than one equipment as well as protection signals for important auxiliaries and HT Drives of main plant (fed by a supply feeder of ratings 3.3 kV onwards)/MDBP/TDBFP etc.,
- c. Separate triple sensors for Instruments required for auto starting of HT driven pumps or HT driven pump tripping due to very low level of water & discharge pressure very low.
- d. For binary and analog inputs which are also required for protection in addition to CLCS. The same shall include but not limited to the critical measurement used for following CLCS :-
Furnace draft, main steam and reheat steam temperatures, feed-water flow, throttle pressure, turbine first stage pressure, separator level, LPH and HPH level, deaerator level, hotwell level, CEP minimum recirculation, BFP minimum recirculation etc.
- e. For lube oil protection of all the HT drives, 2 out of 3 logics and necessary pressure transmitters for lube oil pressure shall be provided by bidder accordingly. However for bearing / winding temperature of HT motor, refer Electrical subsections, Vol. IV.
- f. Left and right side shall be treated as individual path / individual parameter, and each side/path shall have own triple redundancy accordingly.

ii Dual Redundancy

Dual Sensing device shall be provided for following applications:

- a. For binary and analog inputs required for all other closed loop control system (CLCS), protection and interlock conditions purpose of other equipments.
- b. For Instruments required for auto starting of LT driven pumps or LT driven pump tripping due to very low level of water/discharge pressure very low.
- c. Dual redundant position transmitters shall be provided for Steam Admission Valves i.e. (Emergency Stop & Control Valves, Reheat Stop Valves & Control valves), Extraction steam QCNRV, CRH NRV.
- d. For instruments required for Heat rate measurements & PADO calculations.

- iii. For binary and analog inputs used for alarm and monitoring only, single sensor criteria shall be applicable.



Technical specification for
CONTROL & INSTRUMENTATION
1X660MW PANKI TPS EXTN.

SECTION D

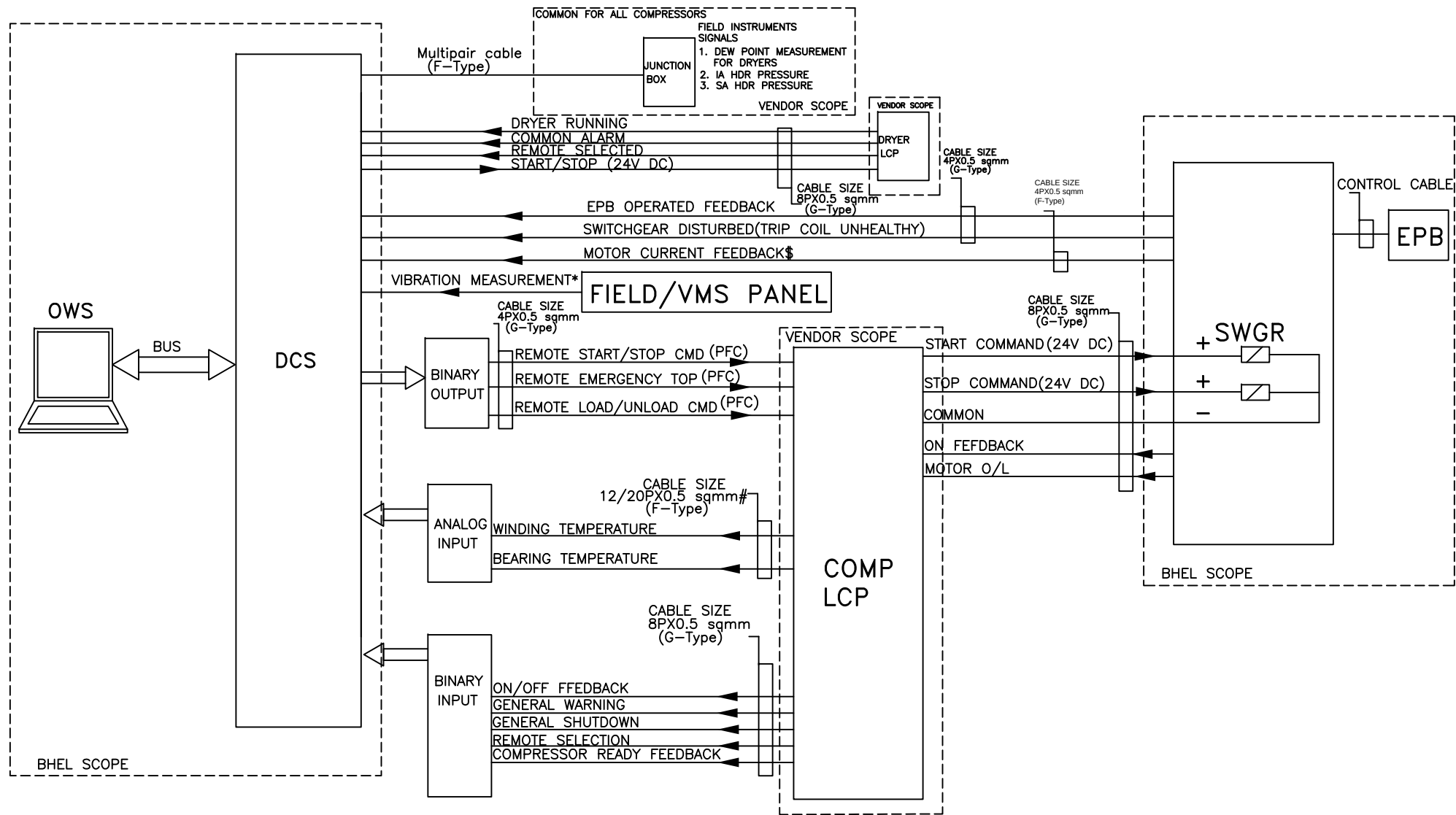
REV. NO. 00

DATE : 13.07.2018

PART - D

HARDWARE INTERFACE PHILOSOPHY

STANDARD HARDWIRED INTERFACE BETWEEN COMPRESSOR CONTROL SYSTEM, DCS AND SWGR



NOTE:

1. *APPLICABLE FOR HT MOTORS (PROJECT SPECIFIC)
2. #12P APPLICABLE IF 'TT' IS ENVISAGED. 20P APPLICABLE IF 'RTD' IS ENVISAGED.
3. \$FOR NTPC PROJECTS MIN 4P(F-TYPE) TO BE USED.
4. CABLE SCOPE SHALL BE AS PER ELECTRICAL SCOPE MATRIX OF PARTICULAR PROJECT



PROJECT:STANDARD HARDWIRE INTERFACE

TITLE

DDCMIS/LCP/SWGR INTERFACE FOR
INDIVIDUAL COMPRESSOR/DRYER

DRG.NO.

DATE

REV.NO.

00

SHT

03

OF

04

	Technical specification for CONTROL & INSTRUMENTATION 1X660MW PANKI TPS EXTN.		
	SECTION D		
	REV. NO.	00	DATE : 13.07.2018

INSTRUMENTS SPECIFICATION

CHAPTER-2: FIELD AND MEASURING INSTRUMENTS**2.00.00 MEASURING INSTRUMENTS (PRIMARY AND SECONDARY)**

- 2.00.01 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. Refer Sub-section/chapter 1, Vol. V, Basic Design Criteria. Further, all instruments shall be of proven reliability, accuracy, and repeatability requiring a minimum of maintenance and shall comply with the acceptable international standards and shall be subject to Owner's approval.
- 2.00.02 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.
- 2.00.03 All transmitters, sensors, and switches, 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 Bidder shall furnish all Instrumentation / Control equipment & accessories under this specification as per technical specification, ranges, makes & model as approved by the Owner during detailed engineering.
- 2.00.04 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./sq.cm.
- 2.00.05 For corrosive applications, all instruments applications, they shall be provided with wetted parts made of Monel/ Hastelloy C or any other material (if proven ness experience of the proposed material for such applications is established by bidder).
- All instruments shall be provided with durable epoxy coating for housings and all exposed surfaces of the instruments.
- 2.00.06 All field instruments shall be weatherproof, drip tight, dust tight and splash proof suitable for use under outdoor ambient conditions prevalent in the subject plant. All field-mounted instruments shall be mounted in suitable locations where maximum accessibility for maintenance is achieved. The enclosures of all electronic instruments shall conform to IP-65 unless otherwise specified (Explosion proof for NEC article 500, class 1/2, Division 1 area & Flame proof area) and an anti corrosive paint shall be applied to the field mounted enclosures / instruments.



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



In general, double cable entry shall be provided, wherever available, unused cable entry shall be provided with blind metal plug. All the field instruments shall also be provided with SS tag nameplate. Counter and mating flange (SS316 material), fastener, gaskets, Nuts, bolts etc. shall also be included wherever required with the field instruments.

- 2.00.07 In general, front draw out type instruments with plug-in facility at the rear for connecting cables for power supply and signal shall be provided unless otherwise specified like for Explosion proof area, Flame proof area and high vibration prone area. Separate plugs & socket connection shall be provided for connecting power supply cables and signal cables.

The plug & sockets shall be polarized to prevent wrong connections and have facility for secure coupling in plug-in position to prevent loose connections.

Signal and Electrical connection shall be screwed connection with double compression type Nickel-plated brass/SS316 cable glands (Material as decided by owner) for Explosion proof area, Flame proof area and high vibration prone area.

- 2.00.08 The quantity of secondary instruments etc. to be provided by Bidder shall be adequate to meet the requirements of Technical Specifications. Any other additional quantity of secondary instruments envisaged by Bidder as per system and process requirements shall also be supplied without any cost implication.

2.01.00 SPECIFICATION FOR ELECTRONIC TRANSMITTERS

2.01.01 SPECIFICATION FOR ELECTRONIC TRANSMITTER FOR PRESSURE, DIFF. PRESSURE AND DP BASED FLOW, LEVEL MEASUREMENTS

Sl. No.	Features	Essential/Minimum Requirements
1	Type of Transmitter	Microprocessor based 2 wire type, Hart protocol compatible
2	Accuracy	± 0.1% of calibrated span (minimum) (upto turn down ratio of 10:1).
3	Output signal range	4-20 mA DC (Analog) along with superimposed digital signal (based on HART protocol)
4	Turn down ratio	10:1 for vacuum/very low pressure applications. 5:1 for very high pressure application. 30:1 for other applications.
5	Stability	± 0.1% of calibrated span for six months for Ranges up to and including 70Kg/cm ² . ± 0.25% of calibrated span for six months for Ranges more than 70Kg/cm ² .
6	Zero and span drift	+/- 0.015% per deg.C at max span.



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



		+/- 0.011% per deg.C at min. span.
7	Load impedance	500 ohm (min.)
8	Housing	Weather proof as per IP-65 with durable corrosion resistant coating.
9	Over Pressure	150% of max. Operating pressure.
10	Connection (Electrical)	Plug and socket type
11	Process connection	1/2 inch NPT (F)
12	Span and Zero	Continuous, tamper proof, Remote as well as adjustability manual from instrument with zero suppression and elevation facility
13	Material	Die cast Aluminum with epoxy coating/SS316 for body. SS316 for Diaphragm.
14	Accessories	-Diaphragm seal, pulsation dampeners, syphon etc. as required by service and operating condition. - LCD/TFT digital integral Indicators with scale of Engg. Units. -2 valve SS316 manifold for absolute & Gauge pressure transmitters, 3-valve SS316 manifold for vacuum pressure transmitters & where DP transmitters are being used for pressure measurement and 5 valve SS316 manifold for DP/Level/Flow applicable. Transmitters should not be mounted directly on the manifold; Manifold shall be non integral type only. - Snubbers/Pulsation dampners shall be used where the process media is unstable for measurement such as the discharge of a pump. -For hazardous area, explosions proof enclosure as described in NEC article 500.
15	Diagnostics	Self Indicating feature
16	Power supply	24V DC $\pm$ 10%.
17	Adjustment/calibration From hand held calibrator/centralized OWS based system n/maintenance (as applicable).	From hand held calibrator/centralized OWS based system

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.

2.02.00 Specification for Pressure Gauge, D.P Gauge, Temperature Gauge and Level Gauge

s. no.	Features	Essential minimum requirements		
		Pr. Gauge/DP Gauge/Draught gauges	Temperature gauge	Level Gauge
1	Sensing Element and Material	Bourdon for high pressure, Diaphragm/ Bellow for Low pr. Of SS 316	Mercury in Steel/Bimetallic type for below 450°C and inert gas actuated for above 450°C of SS bulb and capillary	Tempered * toughened Borosilicate gauge glass steel armoured reflex or transparent type.
2	Body Material	Die Cast Aluminum with stoved enamel black finish /SS316	Die Cast Aluminum with stoved enamel black finish /SS316	Forged carbon steel/SS 304
3	Dial Size	150 mm with toughened shatter proof glass	150 mm with toughened shatter proof glass	Tubular covering entire range
4	End Connection	½ inch NPT (M)	¾" NPT (M)	Process connection as per ASME PTC and drain/vent 15 NB
5	Accuracy	+/- 1% span	+/- 1% span	+/- 2%
6	Scale	Linear, 270° arc graduated in metric units	Linear, 270° arc graduated in °C	Linear vertical
7	Range Selection	Cover 125% of max. of scale	Cover 125% of max. of scale	Cover 125% of max. of scale



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



8	Over range test	Test pr. For the assembly shall be 1.5 to the max. Design pr. At 38°C		
9	Housing	Weather and dust proof as per IP-65	Weather and dust proof as per IP-65	CS/304 SS leak proof.
10	Zero/span Adjustment	Provided	Provided	-
11	Identification	Engraved with service legend or laminated phenolic name plate		
12	Accessories	Blow out Disc, siphon, snubber, pulsation dampener, chemical seal (if required by process) gauge isolation valve	SS316 Thermowell	Gasket for all KEL-F shield for transparent type vent and drain valves of steel/SS as per CS/ alloy process requirement.
13	Material of Bourdon/ movement	SS 316	SS 316	

Notes – *Bicolour type level gauges will be provided for applications involving steam and water except for condensate and feed water services.

Length of gauge glass shall not be more than 1400 mm. If the vessel is higher, multiple gauge glasses with 50 mm overlapping shall be provided.

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 inert liquid suitable for the application.

2.03.00 GUIDED WAVE RADAR TYPE LEVEL TRANSMITTER

Guided wave radar type level transmitters shall be provided for level measurements of the vessel under vacuum or low pressure applications as specified in Part-A.	
Type	Guided wave Radar
Principle	TDR (Time domain reflectometry)
Probe Type & Material	Coaxial, SS316/316L. If required, probe shall be suitable for overfill prevention.
Connection type and material	Flanged and SS316/316L.
Signal o/p	4-20mA with HART signal suitable for overfill prevention.
Display	Integral
Power supply	24 VDC



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



Accuracy	5mm
Electromagnetic compatibility	Shall meet EN 61326-1 (1997) and AmdtA1, class A equipment/EN 50081-2 & EN 50082-1-2 & EN 50082-2
Housing material	Die cast Aluminum/SS316.
Vent & Drain Plug material	SS 316
Local Display	LCD digital type, configured in engg. Units.
Accessories	Integral cable between sensor and transmitter unit with connectors on both side, gasket and cable gland, digital panel meter, name plate and metal tag. All material of accessories will be SS 316.
Mounting	External cage mounting
The transmitters shall be provided with IP-65 protection class with durable corrosion resistant coating. The transmitters shall be able to provide digital signals super imposed on 4-20 mA signal as per HART protocol.	

2.04.00 Ultrasonic Type level Transmitter

Sl.No.	Features	Essential / Minimum requirement
1.	Type of Transmitter	Non contact Microprocessor based 2 wire type, HART protocol compatible Ultrasonic transmitter. Also refer note-3.
2.	Output signal	4-20mA DC (Analog) along with superimposed digital signal (based on HART protocol)
3.	Sensor Accuracy	+/- 0.5% of calibrated span.
4.	Sensor Repeatability	3mm or better
5.	Power supply	24 V DC +/-10%
6.	Temperature compensation	To be provided within transducer
7.	Configuration	
8.	Housing	Weather proof as per IP-65 with durable corrosion resistant coating.
9.	Adjustment/Calibration/maintenance	From hand held calibrators/ centralized OWS HART based system (as applicable)
10.	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.



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



11.	Sensor Material	Corrosion resistant material to suit individual application requirement.
12.	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
13.	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, vapors etc.
14.	Display	LCD display with integral keypad to be provided.
15.	Diagnostics	Loss of echo alarm etc.
16.	Load Impedance	500 ohms minimum.
17.	Electrical Connection	Plug and socket.
18.	Accessories	- All weather canopy for protection from direct sunlight and direct rain. - All mounting hardware and accessories required for erection and commissioning mounting fittings materials shall be SS 316. For hazardous area, explosion proof enclosure as described in NEC article 500.
Note:- 1) Bidder can also provide Radar type transmitter in place of ultrasonic transmitters subject to approval by Owner during detailed Engineering. 2) The frequency used for Ultrasonic /sonic measurements shall be suitable for envisaged applications and this shall be supported by the standard product catalogue of the instrument manufacture. 3) Four wire type transmitters can also be provided subject to Owner's approval during detailed engineering stage. However, in such cases isolated 4-20mA DC (analog) output shall be provided. Power supply required for such transmitters shall be 24V DC for main plant and CW system applications. Power supply can be 240V AC (UPS) / 24V DC for other application.		



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



	4) Additional separate local display unit with large Alphanumeric back light LCD/LED & to be provided for the applications which will be decided by owner during detailed engineering. Separate Sensor unit & electronics unit with LCD display to be provided for the applications, which will be decided during detailed engineering by owner.

2.05.00 HART Hand Held calibrator

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

HART hand held calibrator shall be provided with following minimum accessories per set:-

- i. Soft carrying case with adjustable shoulder straps & lead compartments.
- ii. HART lead set.
- iii. Rechargeable batteries.
- iv. Battery charger.
- v. Power adaptor.
- vi. Universal plug kit for power adaptor.
- vii. Load resistor.
- viii. Interfacing cables of each type as per requirements.
- ix. Protective boot.
- x. Standard banana jack.
- xi. Operation manual & software CD.

The quantity of HART hand held calibrator to be provided by Bidder is listed in Appendix- I to Vol.V, Table IV, Part A of Technical Specifications.

2.06.00 Temperature Elements and accessories

2.06.01 Thermocouples

S.No.	Features	Essential/Minimum Requirements
1.	Type of Thermocouple	16 AWG wire of Chromel-Alumel (Type K) or 24 AWG wire Pt-Rhodium Pt (Type S/R) depending on operating temperature Range (ungrounded type).
2.	No. of element	Duplex
3.	Housing/Head	IP-65/Die cast Aluminum. Head of TE to be provided with sufficient space and arrangement to head



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



		mounted temperature transmitter (as applicable). Plug in connectors are to be provided for external signal cable connection.
4.	Sheathing of Thermocouple	Swaged type magnesium oxide insulation
5.	Calibration and accuracy	As per IEC-751/ANSI-C-96.1(special class) for T/C
6.	Characteristic	Linear with respect to temp, within $\pm 1/2$ percent of top range value
7.	Accessories	Thermo well (as specified below) and shall be spring loaded for positive contacts with the well.
8.	Standard	ANSI C 96.1 for Thermocouple and ASME PTC-19.3 (latest edition) for Thermo-well.
9.	Sheath Material/ Insulation	316SS/Compacted Magnesium Oxide.
	Sheath O D	8 mm.
10.	Response Time	6-10 Sec bare & 30 Sec. With protective sheath/thermowell
11.	Instrument Connection	1/2 " NPT (F).
12.	Electrical connection	Gold plated Plug in type. Double entry, one unused entry with blind plug.
13.	Enclosure Class	IP-65 or better.
14.	Process Connection	i) M33 x 2 ii) Flanged for Air & Gas systems with mating flanges, fastner, gasket etc.
15.	Extension	Threaded union (SS316) 1/2" NPT (F) with two nipples of SS 316 having 1/2"NPT(M) threads at both ends
16.	Extension neck length	Minimum 100 mm above Insulation of pipe and Minimum 160 mm when there is no insulation on pipe.

Notes

1. Extension cable exposed to atmosphere in the conventional method melts away due to high temperature at the top of mill or due to coal burning. Hence The terminals of temperature sensors shall not be at the top of mills



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



itself. The temperature sensors wires are to be laid up to JB though SS tube of required diameter and the head shall be placed nearer to the JB.

2. Thermocouples provided for steam services like super heater / de super heater area, where the process pipe is inside the insulation of boiler penthouse, Thermowells are inaccessible and terminal head and connecting cable cannot withstand high temperature, for such services thermocouples shall be provided with flexible extension SS316 Sheath of 10-15 meters.
3. The specification for thermocouples of bearings metal and winding temp measurements can be as per their manufacturer standards. The manufacturer shall submit the adequate supporting documents for establishing their standard practice. However type of thermocouples shall be K-type.

2.06.02 Resistance Temperature Detector (RTD)

S.No.	Features	Essential/ Minimum Requirements
1.	Type of RTD	Four /Three wire, Pt-100 (100 Ohms resistance at zero degree Centigrade).
2.	No. of element	Duplex
3.	Housing/Head	IP-65/Diecast Aluminum. Head of TE to be provided with sufficient space and arrangement to mount head mounted temperature transmitter (as applicable). Plug in connectors are to be provided for external signal cable connection.
4.	Sheathing of RTD	Metal sheathed, ceramic packed
5.	Calibration and accuracy	As per DIN-43760/IEC 60751 Class-A for RTD
6.	Characteristic	Linear with respect to temp, within $\pm 1/2$ percent of top range value.
7.	Accessories	Thermo well (as specified below) and shall be spring loaded for positive contacts with the well
8.	Standard	DIN-43760/IEC 60751 for RTD and ASME PTC-19.3 (latest edition) for Thermo-well.
9.	Sheath Material/ Insulation	316SS/Compacted Magnesium Oxide.



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



	Sheath O D	8 mm.
	Gauge	18 SWG
10.	Response Time	6-10 Sec bare & 30 Sec. With protective sheath/thermowell
11.	Instrument Connection	1/2 " NPT (F).
12.	Electrical connection	Gold plated Plug in type. Double entry, one unused entry with blind plug.
13.	Enclosure Class	IP-65 or better.
14.	Process Connection	i) M33 x 2 ii) Flanged for Air & Gas systems with mating flanges, fastner, gasket etc.
15.	Extension	Threaded union (SS316) 1/2" NPT (F) with two nipples of SS 316 having 1/2"NPT(M) threads at both ends
16.	Extension neck length	Minimum 100 mm above Insulation of pipe and Minimum 160 mm when there is no insulation on pipe.

NOTES:

- 1) The specifications for RTDs of winding/ bearings of motor/ pump can be as per their manufacturer standards. The manufacturer shall submit the adequate supporting documents for establishing their standard practice. However the type of RTD shall be PT100.

2.06.03 Metal Temperature Thermocouples

S.No.	Features	Essential / Minimum Requirements
1.	Measuring Medium	Metal Temperature
2.	Material of Thermocouple	Chromel Alumel Type K
3.	Type of Thermocouple	Duplex with separate hot junctions, ungrounded Insulation Mineral Insulation Magnesium Oxide.
4.	Thermocouple wire gauge	16 AWG
5.	Protective sheath	SS 321
6.	Protective sheath dia	8 mm O.D
7.	Characteristics of Thermocouple	Special limits of error as in ANSI thermocouple MC 96.01, 1975
8.	Mounting accessories	1/2" BSP SS sliding end connector, weld pad, clamps of heat resistant steel SS310



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



		or as per OEM design
9.	Cold end sealing	SS pot weal with colour coded PTFE headed sleeve Insulated flexible tails. Sealing compound- Epoxy resin
10.	Minimum bending radius	30 mm
11.	Length of T/C	30 Mtr. (minimum)

Notes:

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

2.06.04 Thermo well (for all process temp. elements) - (As per ASME PTC 19.3, latest edition)

- a. Shall be one piece solid bored type of 316 SS/F11/F22/F91 of step-less tapered design for water and steam Services depending upon process parameters.
- b. For Mill classifier outlet long life solid sintered tungsten carbide material of high abrasion resistance shall be provided.
- c. For Air & Flue gas 316 SS protecting tube with welded cap. (However bidder shall provide better material for Flue gas service if required based on the specified boiler design parameters).
- d. For furnace zone, impervious ceramic protecting tube of suitable material along with Incoloy supporting tubes and adjustable flanges.
- e. Bidder shall provide calculation for thermowell as per ASME – PTC-19.3 (latest edition).

"All Thermowells in high velocity steam service shall be checked for Strouhal's frequency limit to arrive at a safer size and design of Thermowells".

2.06.04 Void

2.06.05 TEST THERMOWELLS (TW)



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



Applicable Standard	:	ASME PTC 19.3 TW - 2010
Type/Construction	:	Machined from Bar Stock
Material	:	316 SS/F11/F22/F91
Connection		
- Pipe	:	M33 x 2
- Test Instrument	:	To suit test instruments
Accessories	:	Plug with SS chain
IBR Certification	:	For high pressure service, Steam Temp., Fuel oil temp. measurement as per IBR rules and regulations Bidder shall provide calculation for thermowell as per ASME – PTC- 19.3 TW - 2010.

Test wells shall be provided on main steam, reheat steam, extraction steam, feed water, condensate, spray water lines and other piping as required to meet ASME test requirements.

2.07.00 TEMPERATURE TRANSMITTER

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

a. **Single Input Head mounted Temperature Transmitter**

These shall be suitable for mounting in the head of temperature element itself. The protection class of head of thermo well along with its plug-in connector shall be min. IP65.

b. **Single Input DIN-rail mounted Temperature Transmitter**

These shall be suitable for mounting on DIN-rails in JB's. The specifications of the JB's shall be same as indicated in Subsection INST CABLE with additional DIN-rails and IP 65 Protection class. This temperature transmitter shall be the ones which are especially designed for DIN-rail mounting with IP 20 protection class. These shall have terminals for input/output provided on front side when mounted on DIN-rail.

Head mounted temperature transmitter with clamps to make it suitable for DIN-rail mounting shall not be acceptable under this category.

c. **Dual-input Temperature Transmitter with Indicator:**



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



These shall be suitable for mounting on pipes/ support. Indicator shall be provided with these transmitters. These transmitters shall have bump less change over facility to second sensor in case first sensor fails. This change-over is to be alarmed. Protection class shall be IP65 minimum.

The exact applications for which this type of transmitter is to be provided shall be finalized by owner during detailed engineering.

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

Output : 2-wire (power supply from input card of Control System) with 4-20mA output with superimposed HART protocol signal.

Input : Same transmitter shall be capable to handle Pt-100 RTD, Thermocouples –K&R types (input type to be selectable at site through HART terminal)

Isolation : Min. 500 V AC

EMC compatibility : as per EN 61326

Operating ambient temperature : 0 to 85 deg C (without indicator)
0 to 70 deg C (with indicator)

Power supply : Compatible with input module of Control System

Accessories : Mounting arrangements including Clamps etc.

Composite Accuracy : (a) For head mounted and DIN-rail mounted type Refer note-2
RTD = <0.4% of 0-250 deg C span
T/C-K type = <0.4% of 0-600 deg C span
T/C-R type = <0.4% of 0-1000 deg C span

(b) For dual-input type:
RTD = <0.25% of 0-250 deg C span

T/C-K type = <0.2% of 0-600 deg C span

e. Field bus compatible temperature transmitters

Temperature transmitters of this category shall be field mounting type & shall be capable of withstanding operating ambient temperature upto 85 deg C. These modules shall be connected to DDCMIS through field bus such as Profibus, Foundation Field bus etc directly from the transmitter. Maximum Number of inputs per such temperature transmitter shall be eight. These shall be mounted in cabinets in non-AC areas.



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



As an alternate, these signals from temperature transmitters can be connected to DDCMIS through standard remote I/O modules of the DCS, in which case, the temperature transmitter signals will be acquired through 4-20mA input modules in the remote I/O cabinet for connecting to DDCMIS through remote I/O bus.

Notes (Common for a to e above):-

1. In case of failure (open or burn-out) of RTD/thermocouple, temp. Transmitter shall provide low temperature output.
2. Composite Accuracy is to be calculated as summation of all applicable accuracies of temp transmitter, for converting sensor input to output in 4-20 mA (e.g., basic accuracy, digital accuracy, D/A accuracy, etc.) and temperature effect on these accuracies at ambient temperature of 50 deg C, based on the figure/ formula given in the standard product catalogue for span as specified above for various types of Temperature Elements specified. All such accuracy/ temp effect figures in catalogue shall be first converted to deg C, and then percentage of this converted accuracy in specified span shall be calculated to compare with the specified composite accuracy figures.

2.08.00 IMPACT HEAD TYPE FLOW ELEMENT

The impact head type element shall be tubular insert type with four impact ports facing upstream direction, located precisely for determination of average flow velocity and shall be of SS 316 L.

Accuracy shall be 1.0% of actual value or better. Repeatability shall be $\pm 0.1\%$ of actual value or better.

The elements shall be supplied complete with mounting hardware; end support plugs and SS316 valve manifold (1/2" NPT connection) for instrument connections. All pertinent data including Owner's instrument tag no. for the flow element shall be punched on a stainless steel plate and affixed to the element.

Flushing arrangement shall be provided.

Dual path transit time clamp-on Ultrasonic Flow meter may also be used for measurement of CW flow.

2.09.00 FLUE GAS ANALYSER

The following flue Gas analyzers are envisaged:-

- i) Flue Gas analyzers for control and monitoring – quantities as indicated in Vol. V, Appendix I, Sr. no. G1, Part A.
- ii) Flue Gas Dust Emission analyzer for each ESP (at each Path) – quantities as indicated in Vol. V, Appendix I, Sr. no. G1, Part A.



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



- 2.09.03.05 All necessary approach, platform etc. for the dust monitors shall be provided for maintenance of each dust monitor by bidder.
- 2.09.03.06 The bidder shall, after installation at site, establish the correlations between the optical density output and particulate grain loading for display and recording of particulate grain loading.
- 2.09.04 Connectivity with DDCMIS:-
1. 4-20mA signals from all the above analysers/flow meters/temperature transmitter to DDCMIS.
 2. All the accessories and cables required for connecting Analysers outputs to DDCMIS shall be provided by Bidder on as required basis.



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



2.11.00 Instrument Air System

The instrument Air Supply System for various pneumatic Control & Instrumentation devices like pneumatic actuators, power cylinders, I/P converters, pneumatically operated valves etc. shall be complete in all respect with necessary Air Filter Regulators, valves, piping/tubing etc. Each pneumatic instrument shall have an individual air shut off valve. The pressure-regulating valve shall be equipped with an internal filter, a 50 mm pressure gauge and a built in filter-housing blow down valve.

Filter shall be of minimum 5-micron size & sintered bronze material.

On collection of water in the drains of instrument air lines, mechanical automatic drains and periodically solenoid operated drains (with electronic timer - 15m, 30m, 60m and 2 Hours & Timing adjustable) are to be provided.

For mechanical type & Electrical type, the locations to be provided in the instrument air lines of boiler area, Chimney area, turbine area etc., shall be decided during detailed Engineering.

2.11.01 Air Filter Regulator (AFR)

Constant bleed type AFR with an accuracy of ± 1.0 % inlet pressure range of 5-8 kg/ cm² and suitable spring ranges (AFR) for use with positioners in control valves, control damper, E/P convertors and shut off valves with phosphor bronze sintered filter element; Filtering particles above five microns. Weather and water proof enclosure. Built in blow down valve shall be provided. AFR shall have automatic drain feature. Material of accessories will be SS316. Body material of Air Filter regulator shall be Die Cast Aluminum or SS316. Degree of protection shall be IP 65.

Air filter regulators shall be provided in the :

- (a) Air supply line to valve positioners / power cylinders.
- (b) Air supply line to electric to pneumatic converters.



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



- (c) Air supply line to pneumatic interlocked block valves.
- (d) For each instrument rack, field instruments enclosure for purging.

2.11.02 E-P CONVERTER

E-P converters and associated accessories shall be furnished in accordance with the specifications given below:

Air supply: 1.5 kg/cm sq., 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: 0.5% of span or better, Ambient Temperature 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 65. On loss of control signal, the last set point pressure shall be maintained so that the associated control valve remains in stay put condition without any additional solenoid valve. The allowable drift rate will be +2% of set point/ hour maximum. Material of accessories will be SS. E/P converters shall have fail freeze (stay put) feature also. Zero/span adjustment facility shall be provided.

2.12.00 SPECIFICATION FOR FLOW ELEMENTS & FLOW METERS

2.12.01 Orifice Plate

Sr No.	Features	Essential / Minimum Requirements
1	Features	Essential/Minimum Requirements
2	Type	Concentric as per ASME PTC-19.5 (Part-II), ISA RP-3.2, 1960 or BS-1042, ISO 5167
3	Material	316 SS
4	Thickness	3 mm for main pipe diameter up to 300 mm and 6 mm for main pipe dia above 300 mm.
5	Material of branch pipe	Same as main pipe
6	Root valve type	Globe
7	Root valve material	316 SS
8	Root valve size	1 / 2 inch or 1 inch (as applicable)
9	Impulse pipe of same material up to root valve	Required
10	Tapping	Flanged weld neck or D & D/2 with 3 pairs of tapping (as applicable). Root valves to be provided in all the tappings.
11	Beta Ratio	0.34 to 0.7
12	Beta Ratio	Yes



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



	calculation to be submitted	
13	Assembly drg. and flow Vs DP Curves	Yes
14	Accessories	Root valves, flanges, Vent/drain hole (As required)
Bidder shall submit certified flow calculation and differential pressure vs. flow curves for each element for Owner's approval. Sizing calculation, precise flow calculation for all the flow elements, fabrication and assembly drawings and installation drawings shall be submitted for Owner's approval. One Flow element of each type shall be calibrated in the test laboratory for validation of commutated flow calculations		

2.12.02 Flow Nozzle

Sr No.	Features	Essential/ Minimum Requirements
1.	Type	Long radius, welded type as per ASME PTC- 19.5 (Part-III) or BS-1042
2	Material	316 SS
3	Thickness	Suitable for intended application.
4	Material of branch pipe	Same as main pipe
5	Root valve type	Globe
6	Root valve material	316 SS
7	Root valve size	1 inch
8	Impulse pipe of same material up to root valve	Required
9	Tappings	Flanged weld neck or D & D/2 with 3 pairs of tapping (as applicable).
10	Beta Ratio	Around 0.7
11	Beta Ratio calculation to be submitted	Yes
12	Assembly drg. and flow Vs DP Curves	Yes
13	Accessories	Root valves, vent and drain hole.
Bidder shall submit certified flow calculation and differential pressure vs. flow curves for each element for Owner's approval. Sizing calculation, precise flow calculation for all the flow elements, fabrication and assembly drawings and installation drawings shall be submitted for Owner's approval. One Flow element of each type shall be calibrated in the test laboratory for validation of commutated flow calculations		

2.12.03 ROTAMETERS

Sr No.	Features	Essential/ Minimum Requirements



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



Accessories : Clamping strip, bracket, prefab cable etc. Calibration or configurator kit.

2.12.08 Vortex Flow meter

Sensor

Type : Vortex

Output Signal : Pulse

Material of Construction : AISI 316

Sensor Seal : PTFE / higher based on temperature

Flow range : As required.

Linearity : 0.25% or better.

Repeatability : 0.02% or better.

Ambient temperature : 50 deg C

Mounting : On-Line mounting with flanges of stainless steel.

Enclosure : IP-65 (Explosion proof for NEC Class-1/2, Division 1 area)/ flame proof (IEC- 79.1, Part I). As applicable).

Accessories : Nuts, bolts, gaskets etc.

Transmitter

Electronics : Solid State

Power Supply : 230V AC, 50Hz. UPS

Input : Input from Sensor

Display : 4 1/2 digit LCD

Output : Isolated 4-20mA DC HART

Measuring Accuracy : 0.5% of full scale range

Totalized Value : Required

Housing : IP-65 (Explosion proof for NEC Class-1, Division 1 area)/ flame proof (IEC-



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



79.1, Part I). As applicable).

Nameplate	:	Tag number, service engraved in stainless steel tag plate
Accessories	:	a) Clamping strip, bracket, prefab cable etc. b) Special tool kit for calibration/configuration.
Application	:	Instrument and Service air.

2.12.09 SIGHT FLOW GLASS INDICATORS

Type/Construction : Flapper type.

Materials

Body	:	Carbon steel/SS316 as per process requirement
Glass	:	Toughened Borosilicate
Gaskets	:	Neoprene
Bolts & nuts	:	SS
Flappers / Rotating Wheel	:	316 SS
Flappers / Rotating Wheel holder	:	304 SS
Process Connection	:	SW
Accessories	:	Scale, Bolts, Nuts, Cover plates and Gaskets as required
Tests	:	Tested at two hundred (200) percent of the maximum process Pressure

2.12.10 SOLID FLOWMETER

Type	:	Online Impact type Microprocessor Based
Measuring Principle	:	The system measurement is basically pertains to the measurement of horizontal deflection using LVDT, created by the impact of solid flow upon online sensing plate. The horizontal deflection being proportional to the impact forces, LVDT convert this horizontal movement into electrical signal. The inbuilt



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



integrator convert this signal into time based flow rate indication & provide totalized flow also.

Sensing plate	:	316 SS
Sensing head	:	Sensing mechanism shall be mounted outside the process flow line.
Enclosure	:	316 SS
Enclosure protection	:	IP 67)/ Explosion proof for NEC Class-1/2, Division 1 area)/ flame proof (IEC-79.1, Part I). As applicable).
Class		
Accuracy	:	+/-1% of measured value.
Repeatability	:	+/- 0.1%
Drift	:	Both zero & span + 2% / month
Output	:	4-20mA DC isolated, load 600 ohm (min)
Digital communication (HART) facility	:	yes
Power supply	:	230 V AC, 50Hz. UPS
Ambient condition	:	Temperature -600 C, RH-95% Environment – Highly Dusty
Accessories	:	Shall be complete with all the accessories including digital display for flow rate, integral vents, baffles for air separation, etc. whichever required for satisfactory operation.

Note:-

1. The above on line flow meter shall not create any obstruction on flow.
2. User's list shall be submitted to support on proven satisfactory performance for similar process application.

2.13.00 PROCESS ACTUATED SWITCHES

Sr No.	Features	Essential / Minimum Requirements		
		Pressure / Draft Switches / DP Switches	Temperature switches	Level switches
1	Sensing Element	Piston actuated for high pressure and diaphragm or bellows for low pr./ vacuum	Vapor pressure sensing, liquid filled bellow type with SS bulb and capillary (10 m minimum)	Capacitance types for oil and dirty medium, water, condensate application. Float type for applications as



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



				decided by owner during detailed engineering. Capacitance/Conductivity/Ultrasonic type for acid and alkali application. RF/ Ultrasonic type for ash hopper, ash slurry application. Detailed spec are also included below.
2	Material of sensing element & movement.	316 SS	Bulb 316 SS/ capillary 304 SS	316 SS
3	End connection	½ inch NPT (F)	½ inch NPT (F)	Manufacturer standard
4	Over range proof pressure	150% of max. design pr	-	150% of max. design pressure
5	Repeatability	± 0.5% of full range		
6	No. of contacts	2 Nos. +2NC. SPDT snap action dry contact. Auto reset with internal Adjustable snap action micro switch.		
7	Rating of contacts	60 V DC, 6 VA (or more if required by DDCMIS/PLC)		
8	Elect. Connection	Plug in socket		
9	Set point	Provided over full range. Differential shall be adjustable.		
10	Dead band adjustment	Adjustment upto 10% at set points.		
11	Enclosure	Die cast Aluminum with stoved enamel black finish/SS316, Weather and dust proof as per IP-65. Epoxy painting shall be provided for corrosive atmosphere.		
12	Accessories	Siphon, snubber, chemical, pulsation dampers as required by process.	Thermo well of 316 SS and packing glands	All mounting accessories
13	Mounting	Suitable for enclosure/rack mounting or direct mounting	Suitable for rack mounting or direct mounting	-
14	Power Supply (wherever	24 V DC, to be arranged by Bidder except for Ash Level Switches, where the same shall be as per Bidder's Standard practice.		



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



	Required)	

Notes:-

- 1) 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.
- 2) Pressure / Diff Pressure switches for very low pressure / DP measurements can have sensor material other than SS316 e.g. silicon etc., if the offered material is suitable for that application and the offered product is standard product of the manufacturer for very low pressure applications.
- 3) Repeatability can be upto +/-1% of full range in case of switches with diaphragm seals or very low pressure/DP range.

2.13.01 Conductivity Type Level Switch

Type	:	Conductivity discrimination.
Mounting	:	Flanged – on standpipe.
Probe MOC	:	Stainless steel with high purity ceramic.
Probe rating	:	> Maximum design pressure of vessel.
Input	:	Four independent channel with selectable switching threshold for water conductivity.
Relay Output	:	Four isolated output relays for Hi, Lo, Hi-Hi, Lo-Lo.
Contact type & rating	:	2SPDT or 1 DPDT @ 5A 30V DC.
Faults Detection	:	Power Fail/Electrode Connection Open circuit/short circuit to ground, Ground failure. In built Fail Safe Logic.
Indicator	:	One Red LED for steam/ one Green LED for water/ Two no. LED one each for Process & system fault.
Power supply	:	Dual 230V AC, 50 Hz, 1Ph from UPS.



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



Enclosure	:	Corrosion resistant & wall mounting type. IP-65 or better (Explosion proof For NEC Class-1/2, Division 1 area)/ flame proof (IEC-79.1, Part I). As applicable).
Accessories	:	i. PTFE cable from probe to electronics unit. Electronic unit shall be separate. Head mounted electronic unit is not preferred. ii. Mounting accessories iii. standpipe iv. Washer & gasket
Test pressure	:	Two times rated pressure

2.13.02 Capacitance Type Level Switch

Type	:	Capacitance type
Probe	:	a) Rod or suspended electrode b) Rope type probes may be used only where required probe length is greater than 3 meters.
Probe Mounting	:	Stainless steel 1-1/2 ANSI RF Flange / 3/4" NPT (M)
Material of construction	:	316 SS
Insulation	:	PTFE Part/Full as per service.
Enclosure	:	Powder/Epoxy coated Die cast Aluminum. with neoprene gasket conforming to IP-65. (Explosion proof for NEC Class-1/2, Division 1 area)/ flame proof (IEC-79.1, Part I). As applicable).
Ambient temperature	:	0-60 °C.
Mounting	:	On Top
Supply voltage	:	230V AC, 50Hz from UPS / 24V DC
Relay output	:	2SPDT
Contact rating	:	5A min. at 240V AC on resistive load
Response time	:	100 m sec or better
Cable connection	:	Plug in type



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



Accessories : Counter flange, Cable gland, prefab cable and stainless steel name plate engraved with alpha-numeric.

2.13.03 RF TYPE LEVEL SWITCH

A. Electronic Controller

1.	Input Supply	:	230 V AC from UPS
2.	Construction	:	Cast Aluminum Housing
3.	Relay Output	:	2 Nos. Relay Changeover Potential Free Contacts (2 SPDT)
4.	Contact Rating	:	5A at 240 V AC & 0.25 at 220 V DC
5.	Class of Protection	:	IP-66
6.	Ambient Temperature:	:	55 Deg. C (Max)
7.	Local Indication	:	Local LED Indications
	Green	:	Normal Level
	Red	:	Alarm Level
	Yellow	:	Probe Healthy
8.	Cable Connection	:	3/4" ET (2 Nos.) for Supply and Output 5/8" ET (1 No.) for Probe Connection
9.	Repeatability	:	100%

B. Sensing Probe

1.	Type of Probe	:	Rigid
2.	Material	:	Stainless steel SS 316
3.	Probe Head Housing	:	Cast Aluminum
4.	Insulation (B/W Active & Shield And Shield & Ground)	:	PTFE
5.	Probe Head Protection	:	IP-66
6.	Mounting	:	Side Mounted
7.	Cable Connection	:	5/8" ET (1No.)
8.	Process Connection	:	40 NB BSP THREADED
C.	Signal Cable	:	Coaxial cable for Connection Between Sensing probe and electronic Controller (@ 10 Mtrs. Per Level Probe)

D. Application : Silos

2.14.00 SOLENOID VALVES

Solenoid valves shall fulfill the following requirements:



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



- a. Type 2/3/4 way with body material of SS 316/Forged Brass and epoxy painting (depending on the application subject to Owner's approval during detailed Engg.). Material of Wetted parts shall be SS316.
- b. Power supply 24 V DC + 10%.
- c. Plug and socket electrical connection.
- d. Insulation: Class 'H'.
- e. All solenoid shall be with, LED indication, surge suppression diode circuits.

2.15.00 Power Cylinders (Pneumatic)

Mounting Type	:	a) Fixed position mounting (End mounting).
	:	b) Trunnion mounting
Control Signal	:	0.2 to 1 Kg/Sq. cm. from I/P converter for modulating purposes. 24V/48VDC operated solenoid valve operating on pneumatic line. The Pilot solenoid will have separate coils for open closing purpose.
Supply Air	:	0-7 Kg / Cm ² .
Selection	:	Based upon thrust / torque, stroke length, angular movement, full-scale travel time, repeatability, space factor etc. Provision for air-to-open and air-to-close operation.
Casing	:	IP-65.
Accessories (as required)	:	a) Air lock relay b) Hand wheel. c) Air filter regulator with gauge. d) Volume Booster. e) Limit Switches. f) Positioner with Input, Output and supply pressure gauges. g) Pilot Solenoid Valve (Double Coil type) h) Position Transmitter (4-20 mA DC linear output, LVDT or non contact type).
Fail-safe operation	:	Stay put, open or close position on pneumatic / electrical power supply failure as per process safety criteria.
Repeatability	:	Better than 0.5% of full travel.



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



Location : Field (Direct Mounting)

2.17.00 AC PLANT AND COMPRESSOR RELATED SPECIAL INSTRUMENTS

2.17.01 (HUMIDITY SENSOR)

Sensor : Capacitance type
Accuracy : +/-3% R.H
Range : 0-100% R.H
Output : 4-20 ma
Time constant: 2 mins.

Output from the sensor is to be connected to respective control system. Bidder can also provide combined instrument for measurement of humidity and temperature subject to Owner's approval during detailed engineering. In all such cases, 4-20 ma outputs, each for temperature and humidity measurements are to be provided.

2.17.02 TEMPERATURE/ HUMIDITY INDICATOR

Sensor : RTD for (Pt 100) for temperature
: Capacitance Type for Humidity (specs for humidity and temperature shall be as mentioned above)
Display : Combined enclosure with two three digit seven segments LED display with decimal point after two digits. LED height shall be 4 inches, clearly legible from a distance of at least 10 meters.
Range : 0-60 Deg C for temperature.
: 0-95.0 % for Relative Humidity.
Accuracy : Better than +/-0.5 % for Temperature
: Better than +/-2.5 % for Relative Humidity
Mounting : Table Top/ wall mounting.
Power supply : 240 V AC, 50 Hz.
Output : 4-20 mA signal each for temperature.
Qty. : 15 nos. each of temperature & Humidity indicators (combined indicators for Humidity and temperature is also applicable).

One Set of output signal is to be connected to respective control system. Apart from displaying the temperature/humidity values on indicator.

2.17.03 DEW POINT METER

Type : 2 Wire Loop Powered Dew point
Transmitter



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



Overall Range	:	-60°C to +20°C Dew point
Accuracy	:	± 2°C Dew point
Material	:	SS316 (wetted parts)
Features	:	a) AUTOMATIC CALIBRATION (b) Can be Configured for Linear 4-20mA signal in °C & °F Dewpoint, ppm(v), ppb(v), g/m3 (c) Temperature Compensation (d) Failure Diagnostics (e) Long Term Stability (f) Fast Response (g) IP 66 / NEMA4X Protection (h) Supplied with Calibration Certificate Traceable to National & International Humidity Standards (i) Sensor protection with sintered filter (j) Local LCD Display for Dew Point

2.18.00 Limit switches

For offsite plant application Limit switches shall be gold plated with high conductivity and non corrosive type. Contact rating shall be sufficient to meet the requirement of DDCMIS subject to a minimum of 60 V, 6 VA rating. Protection class shall be IP 65. Contact shall be either 1 no, DPDT or 2 nos. SPDT minimum.

For main plant application, limit switches are to be provided as per bidder standard and proven practice.

All limit switch shall be conform to IEC-60947-5-1.



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



	Technical specification for CONTROL & INSTRUMENTATION 1X660MW PANKI TPS EXTN.		
		SECTION D	
		REV. NO. 00	DATE : 13.07.2018

INSTRUMENT CHECK LISTS



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 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 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 corelation is not available, MFR'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.

[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.



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 :

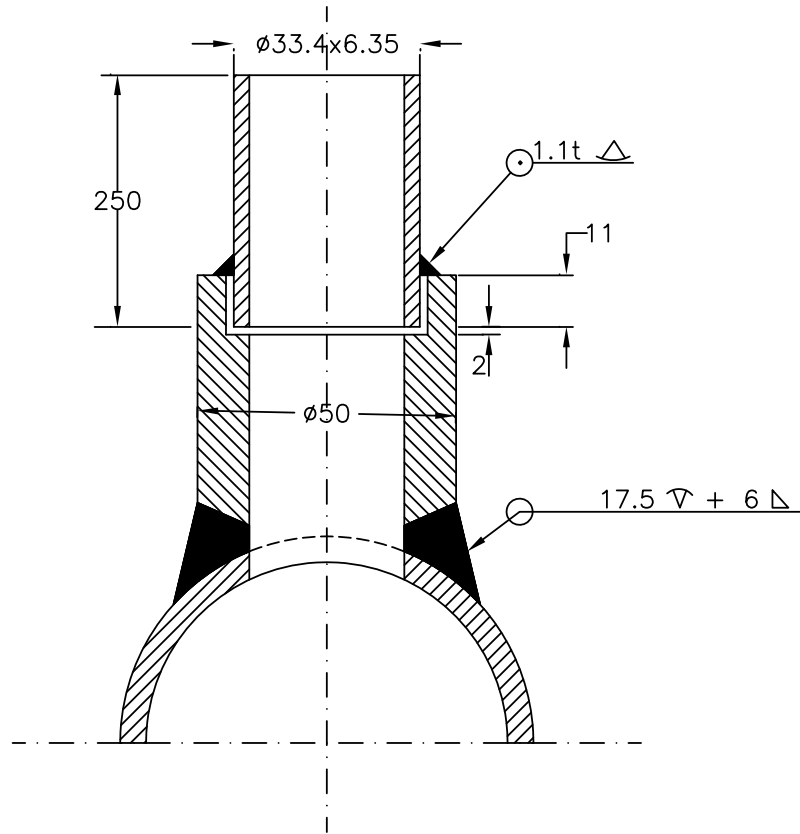
** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

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 %.
- Contractor to provide compliance certificate for tests/checks verified by contractor and submit the same alongwith test certificates to be verified by BHEL.

	Technical specification for CONTROL & INSTRUMENTATION 1X660MW PANKI TPS EXTN.		
	SECTION D		
	REV. NO.	00	DATE : 13.07.2018

INSTRUMENT STUB DETAILS



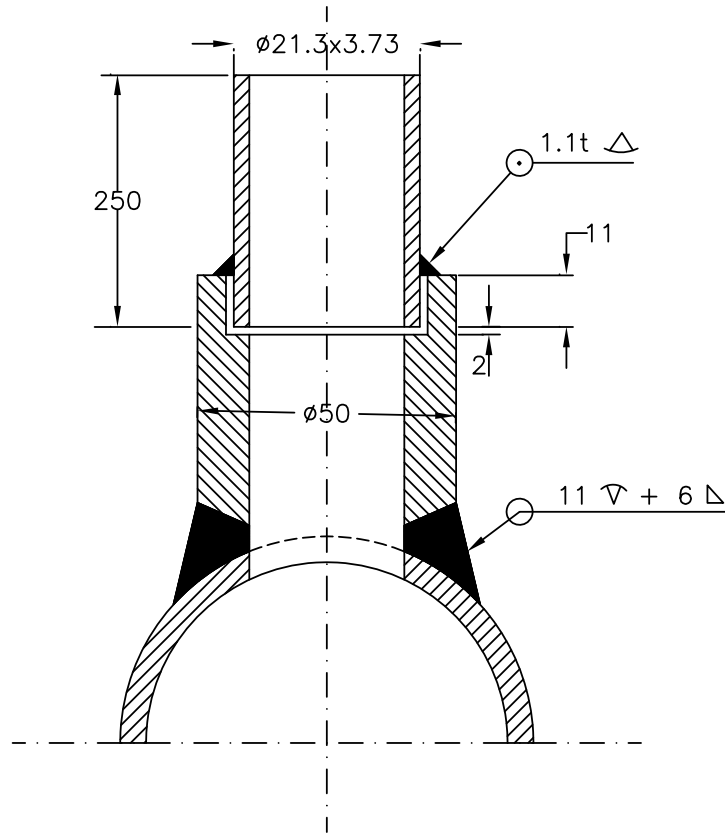
NOTE :

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. STUB LENGTH SHALL BE 64mm UPTO 200Nb PIPE, 45mm ABOVE 200Nb PIPE SIZE.
4. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE INDICATED
5. 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**
 (SYSTEM PRESS > 40Kg/Cm2, CLASS 6000#)

DRG. NO.
PE-SS-999-145-I101A
 REV. 00
 SH. 03 OF 10 SHS.



NOTE :

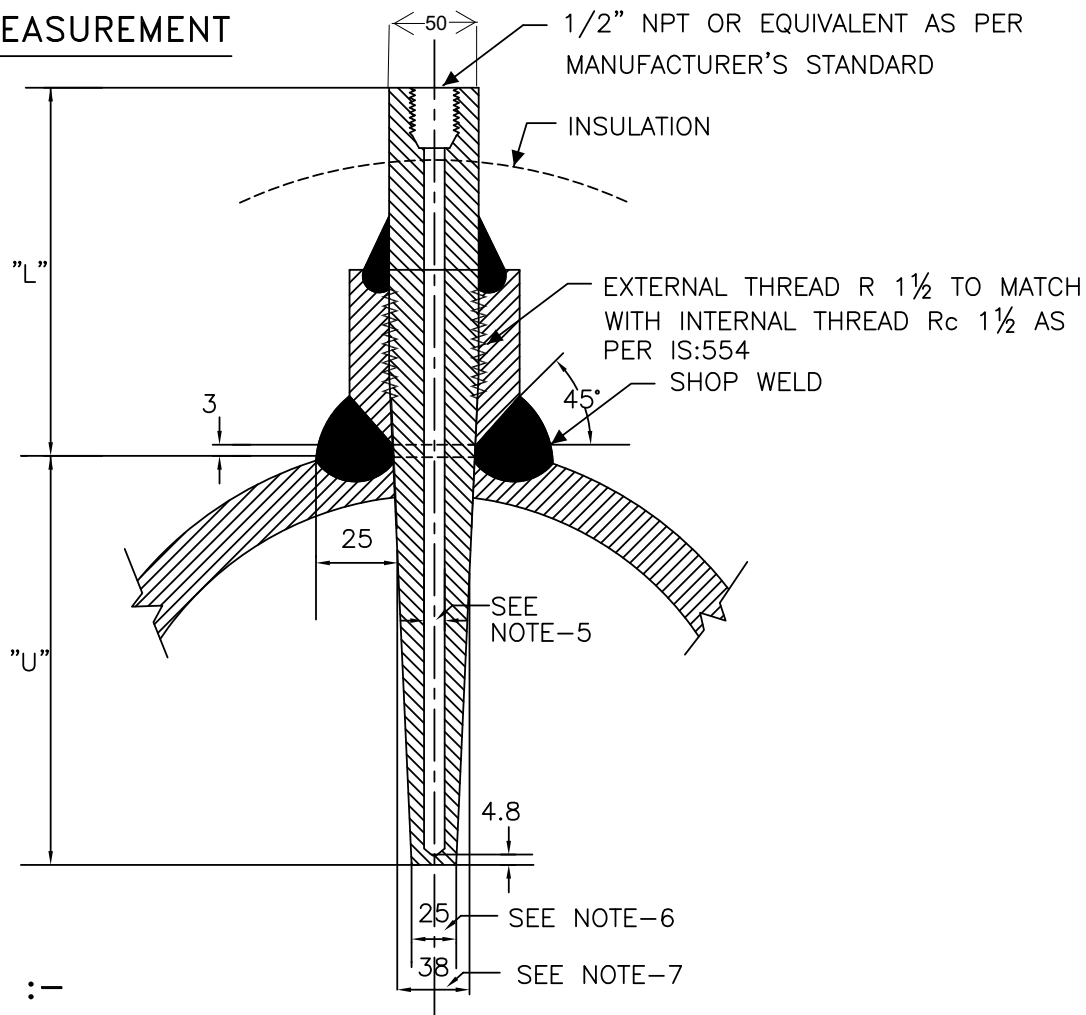
1. MATERIAL OF THE BOSS AND NIPPLE SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED AND CONFORM TO ANSI B16.11.
2. THE LENGTH OF NIPPLE SHALL BE 250 MM.
3. STUB LENGTH SHALL BE 64mm UPTO 200Nb PIPE, 45mm ABOVE 200Nb PIPE SIZE.
4. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE INDICATED
5. EDGE HOLE MUST BE CLEAN AND SQUARE OR ROUNDED SLIGHTLY ($1/64''$ RADIUS) FREE FROM BURRS, WIRE EDGES OR OTHER IRREGULARITIES
6. FOR PU COATED PIPE REFER SHT NO-9.



TITLE :
INSTRUMENT STUB DETAILS
FOR PRESSURE MEASUREMENT
 (SYSTEM PRESS UPTO 40Kg/Cm², CLASS 3000#)

DRG. NO.
PE-SS-999-145-I101A
 REV. 00
 SH. 04 OF 10 SHS.

TEMP. MEASUREMENT



NOTES :-

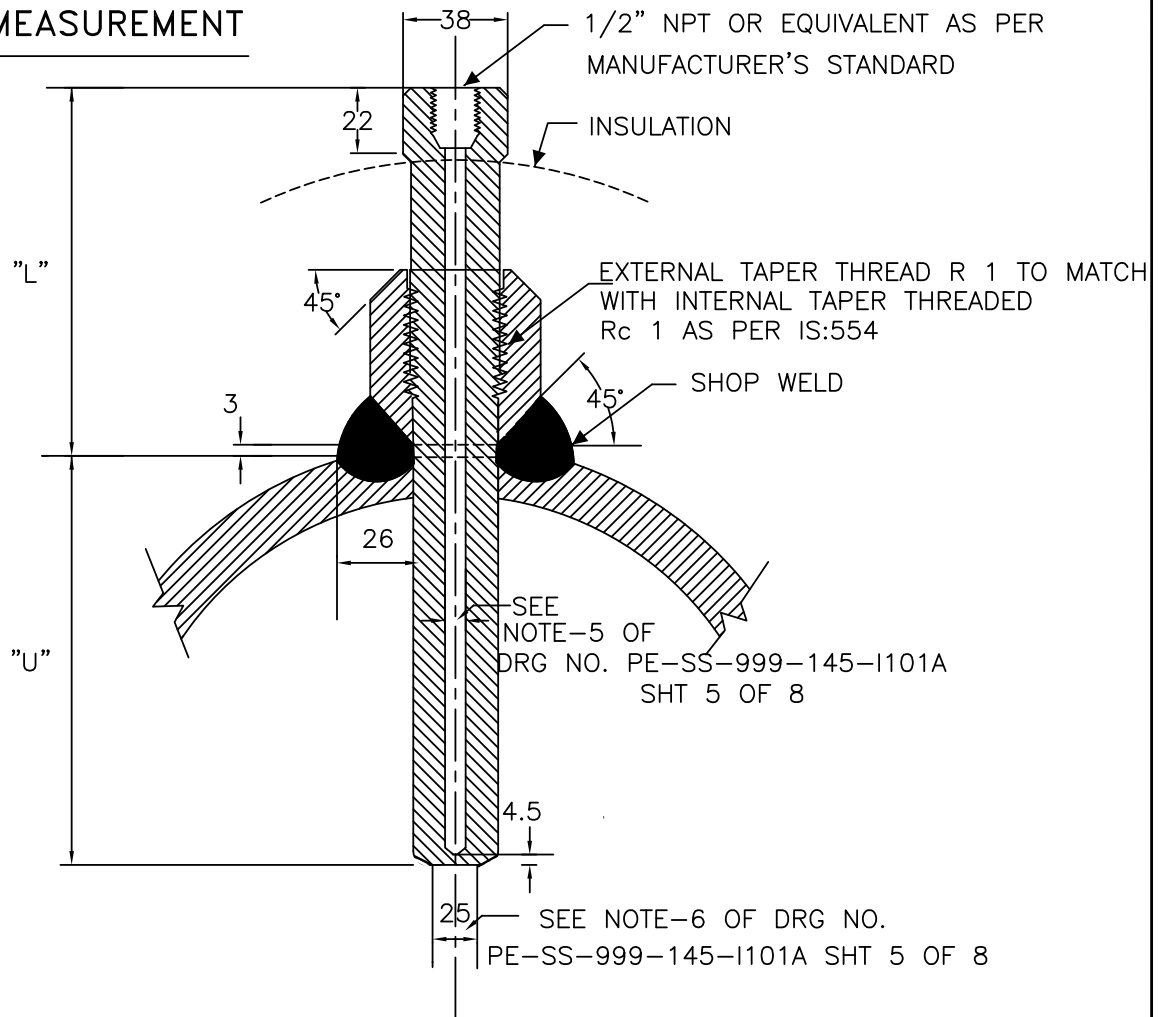
1. THIS TYPE OF TEMPERATURE BOSS SHALL BE USED FOR THE PROCESS PRESS EQUAL/ ABOVE 40 KG/CM2(g).
2. THE MATERIAL OF THE BOSS SHALL BE SIMILAR TO PIPING MATERIAL.
3. MATERIAL OF THE THERMOWELL SHALL BE OF 316SS.
4. THERMOWELL SHALL BE DRILLED BAR STOCK TYPE.
5. INTERNAL BORE OF THE THERMOWELL SHOULD BE 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. THERMOWELL SHALL BE SUITABLE TO MATCH THE STUB DIMENSIONS AS PER Rc 1 1/2.
8. THE 'U' & 'L' DIMENSIONS SHALL BE SELECTED BASED ON PARTICULAR APPLICATION.
9. 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.
10. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE INDICATED



TITLE : INSTRUMENT STUB DETAILS (TEMP)
(APPLICABLE FOR PIPE SIZE ABOVE 4")
[PROCESS PRESS EQUAL/> 40 Kg/Cm2 (g)]

DRG. NO. PE-SS-999-145-I101A
REV. 00
SH. 05 OF 10 SHS.

TEMP. MEASUREMENT



NOTES :-

1. THIS TYPE OF TEMPERATURE BOSS IS APPLICABLE FOR THE PROCESS 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 9 IN SHT. 5 OF 8 OF THIS DRG.
4. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE INDICATED
5. FOR PU COATED PIPING REFER SHEET NO-10 FOR TEMP STUB DETAILS.

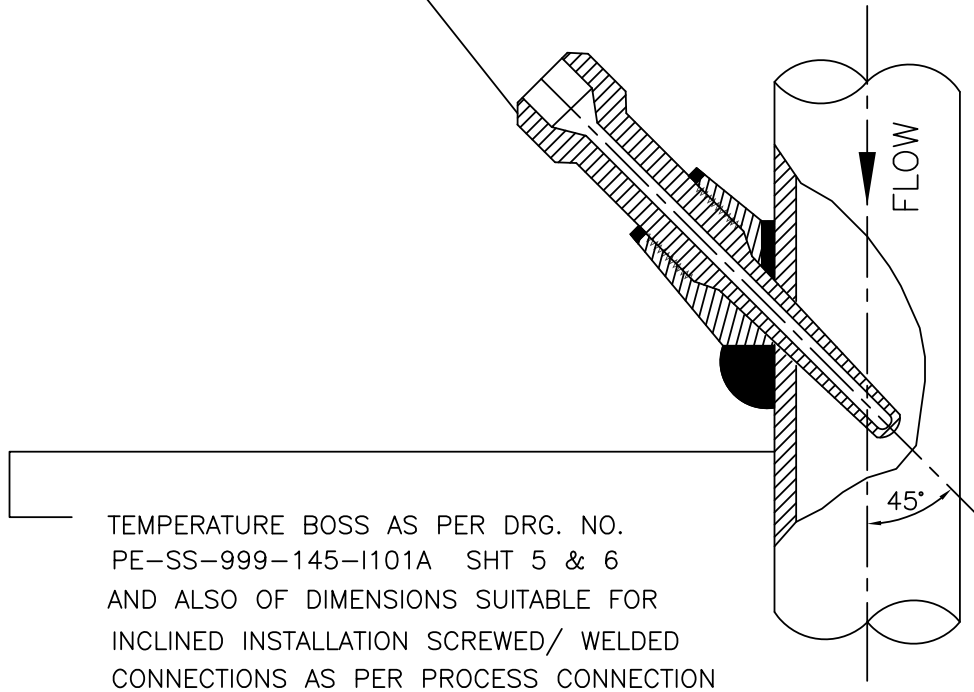


TITLE :
INST. STUB DETAILS (TEMP)
 (APPLICABLE FOR PIPE SIZE ABOVE 4")

DRG. NO.
PE-SS-999-145-I101A
 REV. 00

[PROCESS PRESS < 40 Kg/Cm² (g), TEMP < 400 °C] SH. 06 OF 10 SHS.

THERMOWELL SUITABLE FOR THE BOSS
AS PER DRG. NO.
PE-SS-999-145-I101A 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 :

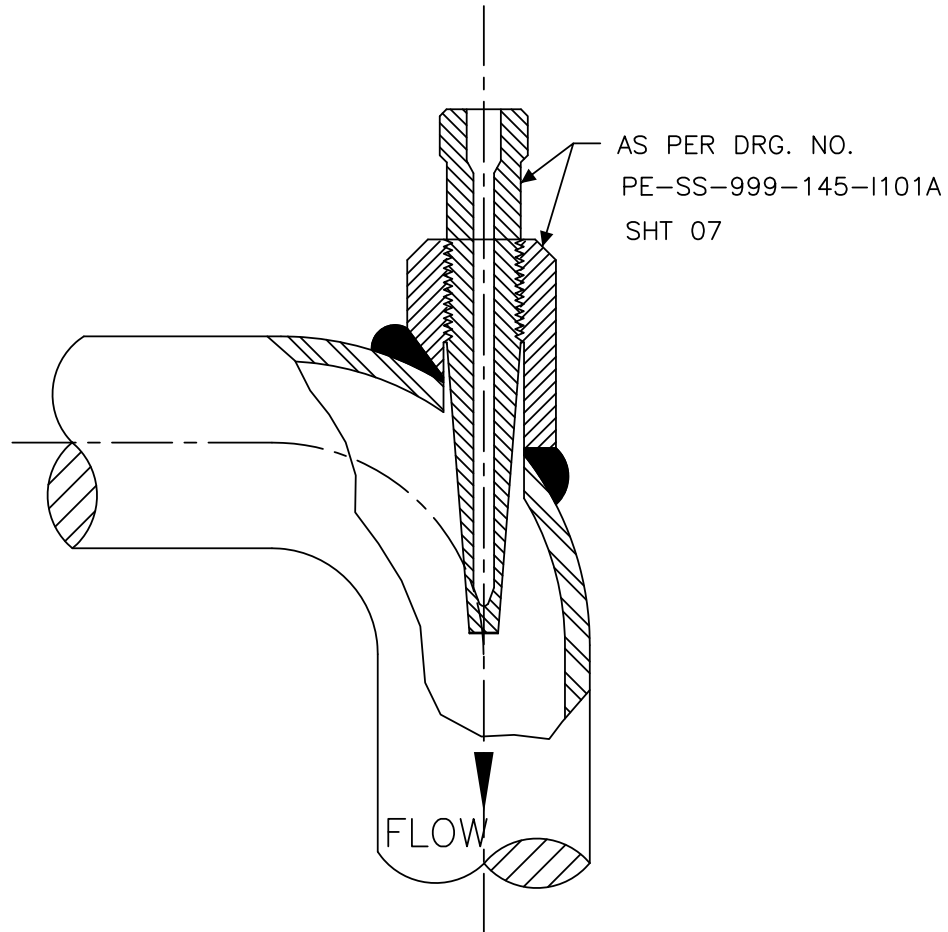
THERMOWELL INSTALLATION

DRG. NO.

PE-SS-999-145-I101A

REV. 00

SH. 07 OF 10 SHS.



NOTES :-

1. FLOW INSTALLATION OF THERMOWELL SHALL BE APPLICABLE FOR 4" AND SMALLER LINE SIZE BUT LIMITED TO MINIMUM 3" LINE SIZE.
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 :

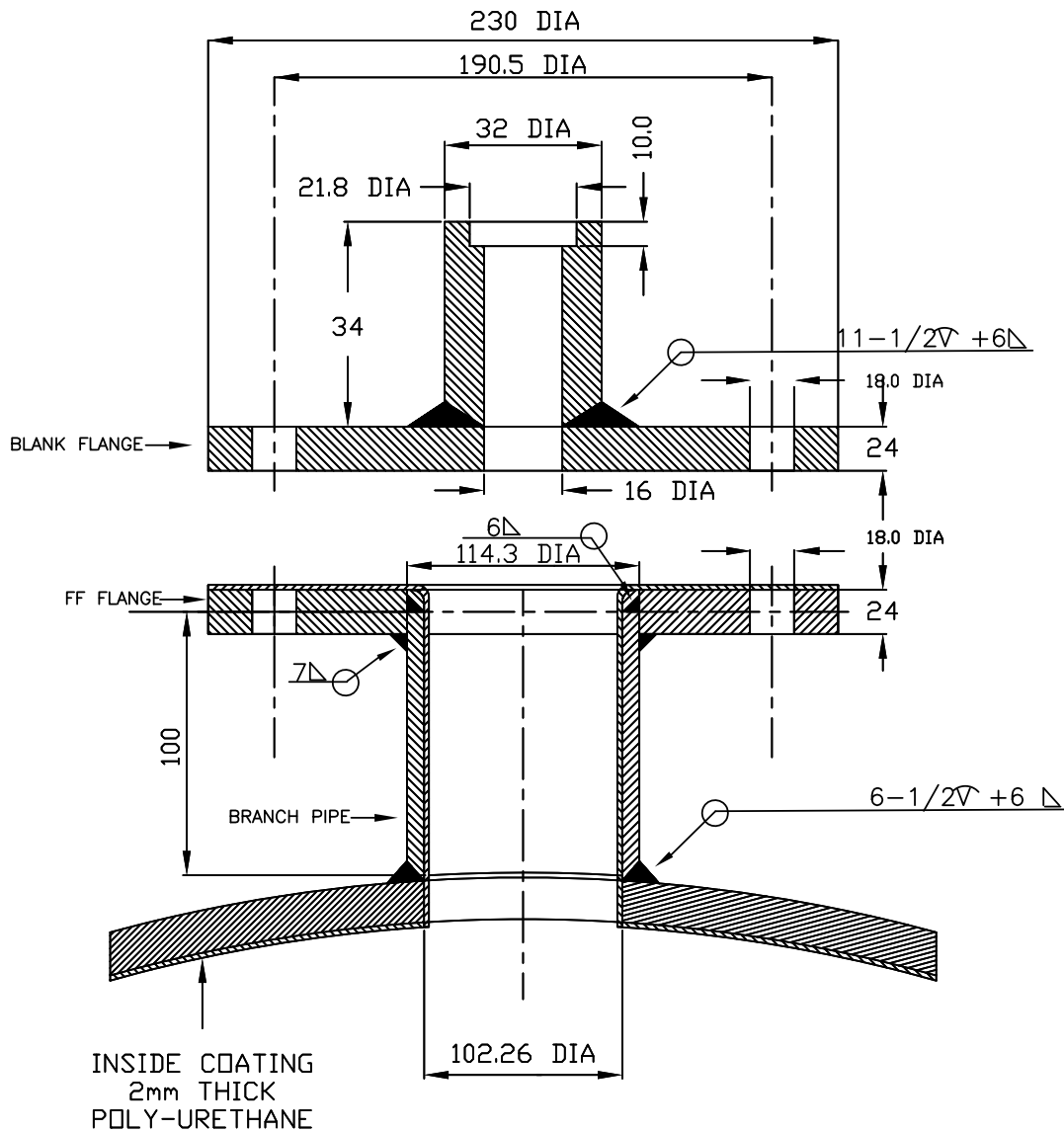
THERMOWELL INSTALLATION

DRG. NO.

PE-SS-999-145-I101A

REV. 00

SH. 08 OF 10 SHS.



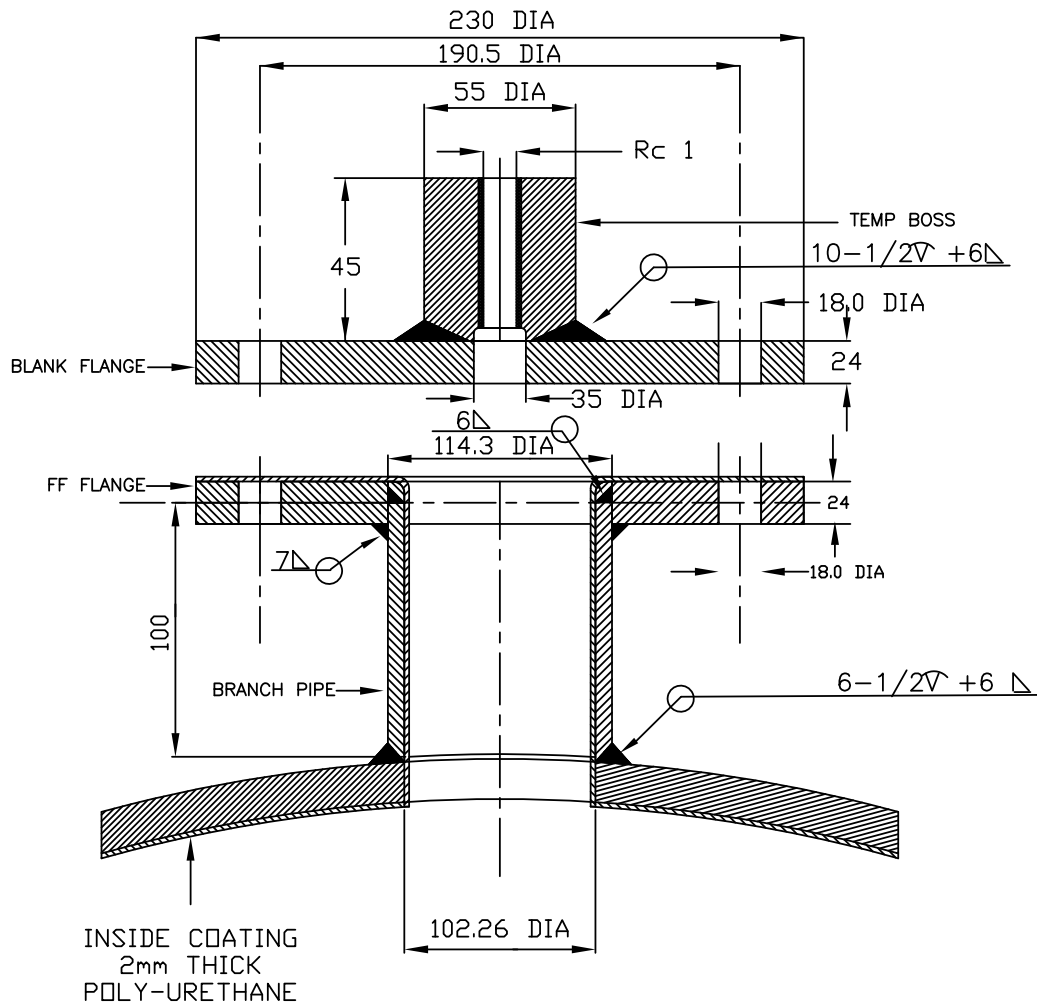
NOTES :-

1. THIS TYPE OF PRESSURE TAPPING IS APPLICABLE FOR PU COATED PIPING.
2. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE INDICATED.
3. MATERIAL OF BLANK FLANGE, BOSS WILL BE OF SS304.
4. BRANCH PIPE MATERIAL SHALL BE SAME AS MAIN PIPE MATERIAL.
5. FF FLANGE SHALL BE NB100, CLASS 150 AND OF THE SAME MATERIAL AS THAT OF MAIN PIPE.



TITLE :
INST. STUB DETAILS (PRESS)
 APPLICABLE FOR PU COATED PIPES
 (CW/ACW SYSTEM)

DRG. NO.
PE-SS-999-145-I101A
 REV. 00
 SH. 09 OF 10 SHS.



NOTES :-

1. THIS TYPE OF TEMPERATURE TAPPING IS APPLICABLE FOR PU COATED PIPING.
2. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE INDICATED.
3. MATERIAL OF THERMOWELL SHALL BE SS316L.
4. MATERIAL OF BLANK FLANGE, TEMP BOSS SHALL BE OF SS304.
5. BRANCH PIPE MATERIAL SHALL BE SAME AS MAIN PIPE MATERIAL.
6. FF FLANGE SHALL BE NB100, CLASS 150 AND OF THE SAME MATERIAL AS THAT OF MAIN PIPE.



TITLE :
INST. STUB DETAILS (TEMP)
 APPLICABLE FOR PU COATED PIPES
 (CW/ACW SYSTEM)

DRG. NO.
PE-SS-999-145-I101A
 REV. 00
 SH. 10 OF 10 SHS.

	Technical specification for CONTROL & INSTRUMENTATION 1X660MW PANKI TPS EXTN.		
	SECTION D		
	REV. NO.	00	DATE : 13.07.2018

LOCAL CONTROL PANEL SPECIFICATION & QUALITY PLAN

6.10.00 CONSTRUCTIONAL FEATURES OF LOCAL CONTROL PANELS, CONSOLES, CONTROL Desk, CUBICLES & ENCLOSURES

- i. All control panels, cubicles, consoles, SOV panels and enclosures provided anywhere for subject plant per this specification shall be of free standing type and shall be constructed of specified gauge of steel plates (CRCA). The minimum sheet thickness of panels shall be as follows unless otherwise specified herein.

Side and top – not less than 1.6 mm

Door – not less than 2.0 mm

Mounting plate – 2.5 mm

Base metal plate - 2.5 mm

Gland plate – 3 mm

- ii. The panels, consoles/desks shall be reinforced as required to ensure true surfaces and adequate support for instruments mounted thereon. All instrument cutouts, mounting studs, and support brackets shall be accurately located. All welds on the exposed panel surfaces shall be ground smooth. Finished panel surfaces shall be free from waves, bellies, or other imperfections. Unless specified, otherwise, panel doors shall be 4 points hinged and shall have turned back edges and additional bracing where required to ensure rigidity. Door hinges shall be of the concealed type. Door latches shall be of the three/four -point type to ensure tight closing. Door locks shall be furnished which will allow actuation of all locks by a single master key. All panels shall have removable lifting eyebolts for safe lifting from top during storage and installation handling.

Cabinet doors shall be hinged and shall have turned back edges and additional bracing where required ensuring rigidity. Hinges shall be of concealed type. Door latches shall be of three/four -point type to assure tight closing. Detachable lifting eyes or angles shall be furnished at the top of each separately shipped section and all necessary provisions shall be made to facilitate handling without damage. Front and rear doors shall be provided with locking arrangements with a master key for all cabinets. If width of a cabinet is equal or more than 800 mm, double doors shall be provided.



- iii. All panels shall be mounted on vibration dampers, which are secured to C-channels mounted on the floor. The channels shall be field welded to steel plates set into the concrete flooring. The steel plates shall be located such as to approximate the outline of panel bases. The exact mounting details shall be as approved by the owner during detailed engineering stage. All panels shall be provided with adequate ventilation and packaging density of components shall be restricted so as to limit the temperature rise above ambient to 10°C under the worst conditions. All panels shall have auto on/off switch for internal lighting. All the power supply circuit for control panels shall be provided with auto changeover circuitry.
- iv. In each panel /cabinet, a 24 VDC Voltmeter digital type shall be provided to check the Field Interrogation voltage.
- v. Exhaust Fans with louvers & filters shall be provided on upper side to remove hot air in all consoles and panels.
- vi. Fire & Smoke detectors shall be provided inside the Control room mounted system/control cabinets.
- vii. Feeder failure/ healthy indication shall be provided in each cabinet & remote indication shall be hooked up to DDCMIS/ PLC/annunciation & suitably grouped.
- viii. All the panels shall be equipped with Anti vibration pad of min. 15 mm size thickness. Cable gland plate thickness shall be 3 mm. C Channel height shall be min. 100 mm.
- ix. Doors shall be provided with neoprene/polyurethane gasket only. The front and rear doors shall be of full height .
- x. Protection class shall be as specified at Vol. V, Part B, chapter 1.
- xi. All the cable entries shall be at the bottom of electronic cubicles/control panels.
- xii. Control panels shall be provided with proper arrangement and hardware to terminate the inert gas required for fire protection.
- xiii. 25x6 mm copper ground bus to be provided for each panel/control desk.
- xiv. Terminal blocks shall be Rail mounted 650 V AC grade Terminal blocks (Screw less cage clamp type) with markers and 20% spare wired terminals of each type.
- xv. For Panels/cubicles internal wiring details, Bidder to refer Vol. V, Part B, Chapter 9.

6.11.00 TERMINATION / Marshalling CABINETS & Interposing Relay Panel

Marshalling/Termination cabinets for the control system shall be supplied for terminating all cables originating from the field, MCC/SWGR or any other source



of signal and for distributing the signals to different functional panels, MCC/SWGR and control cubicles.

Incoming cables from the field, MCC/SWGR or any other source of signal shall be terminated in suitable terminal blocks in logical sequence.

Prefabricated cables with plug in connectors at both ends shall be used for extending the signals to the functional panels. Matching plug sockets shall be provided in the termination cabinets for terminating the plugs.

Interposing relay panels for the system shall be supplied for mounting interposing relays & terminating all cables originating from the DO cards in case of solenoid valves, HW Annunciation windows and other required services etc. IPR panels shall be placed in CER and LCR.

Interposing relay shall be mounted in respective SWGR/MCC/integral starter required for commands signals of HT/LT unidirectional drives and bidirectional drives, breakers, isolators, bus couplers etc from DDCMIS/DCS/PLC or any control system.

Terminal blocks shall be located inside the cabinets on support wings fabricated of metal plates.

The plug socket shall be mounted on hinged plates to provide an access to the rear pins of the plugs.

General features of termination cabinets and accessories shall conform to the general design and construction specification of panels. Terminal blocks shall be Rail mounted 650 V AC grade Terminal blocks (Screw less cage clamp type) with markers and 20% spare wired terminals.

Wiring shall be 650V grade. PVC insulated FRLS stranded copper wire.

6.12.00 SURFACE PREPARATION AND PAINTING

All panel exterior steel surfaces shall be ground smooth, and painted as specified below:

Suitable filler shall be applied to all pits, blemishes and voids in the surfaces. The filler shall be sand blasted so that surfaces are level and flat, corners are smooth and even. Exposed raw metal edges shall be ground burr free. The entire panel surface shall be sand blasted to remove rust and scale and all other residue due to the fabrication operation. Oil grease and salts etc. shall be removed from the panels by one or more solvent cleaning methods. Alternatively 7 tank process shall be followed.

Two spray coats of inhibitive epoxy primer – surface shall be applied to all exterior and interior surfaces, each coat of primer surface shall be of dry film thickness of 1.5 mil. A minimum of two spray coats of final finish colour (Catalysed epoxy finish) shall be applied to all surfaces of dry film thickness 2.0 mil. 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.

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.

The finish colours for exterior and interior surfaces shall conform to the following shades:

a) Exterior - RAL 7032/RAL 7035.

b) Interior - Glossy white two coats/RAL 7035 with fire resistant paint

One uniform colour shade as finalized by owner during detailed engineering shall be applicable for complete plant.

Paint films, which show sags, checks, blisters teardrops, fat edges or other painting imperfections, shall not be acceptable and if any such defects appear, they shall be repaired by and at the expenses of the Bidder.

6.13.00 PANEL ILLUMINATION

Panels shall be provided with LED based illuminating lamps with door switch and six (6) point 5/15A, 240V AC universal type power sockets with switch for maintenance purposes. These switches shall be with quick make and break mechanism. 100 % spare LED lamps shall be provided with each panel, these are in additional to mandatory spares.

6.14.00 Panel Cooling Fans (for ventilation of the DDCMIS/ PLC / DCS & other cabinets)

Filter Fan for electrical cabinets and enclosures to be used with 120 V or 230 V AC versions having very low acoustic noise and lower power consumption. The fans must have UL approval and should have air flow volume as per the cabinet requirement. Wherever required, the EMC filter fans may be used. Fans should have a life of 50,000 Hours at 40 Deg C. Fan Housing, cover should be of V0 material as per UL94. Filter mat should be compliant to EU3 according to DIN 24185 standard and have a filtering degree of 80 to 90 %. The Ambient temperature range °C should be -10 to +70 Deg C and Protection class should be IP 54. Filter Material shall be Synthetic fibre with progressive construction, temperature resistant to +100°C, self extinguishing, Class F1 as per DIN 53438 standard.

6.15.00 Panel Thermostat (for temperature control of the DDCMIS/PLC/DCS panel – to be connected to switch On/Off Fan/Heater)

The panel thermostat shall be DIN Rail Mounted with an inbuilt snap action thermostatic bimetal sensor and shall be connected in series with the load without any additional supply voltage. The panel thermostat shall be available in setting temperature range of -20 deg C to 40 deg C or 0 to 60 deg C with separate modules for NO or NC contact. The electrical life at rated load AC1 shall be 1 Lakh switching cycles and shall work at an ambient temperature of -45 to +80 deg C. With AgNi contact material for switching, the contact current carrying



capacity shall be 10 Amp at a rated voltage of 250 V AC with a dielectric strength between open contacts of 500 V AC and shall have UL approval.

6.16.00 FUSES & MCB

All fuses shall be fast acting semiconductor types for AC supply and compatible to the UPS fuses. For all DC Powered devices, similarly the fuses shall be fast acting compatible to DCDB fuse provisions. All the AC power supplies shall be provided with the protection of Fast acting semi conductor fuses & 2 P thermo magnetic type MCB. For all the DC power supply circuits, electronic type DC MCB shall be used only. Make of DC MCB shall be Siemens, Phoenix contacts, Murr, Weidmuller, or Lutze.

50 % spare fuses shall be provided with each panel, these are in additional to mandatory spares.

6.17.00 NAME PLATES AND LABELS

Name plates of adequate size shall be provided for each panel on front and rear of the panel. Instruments/other accessories mounted inside the panels shall have identification marking clearly visible from inside.

Devices to be mounted on the panels shall also be labeled on the panels shall also be labeled on the outside of the panel. Name plates shall be of polyamide sheets with black letters on white background. Name plates shall be attached to the boards by means of stainless steel panhead screws. Fuses provided for protection of various boxes shall be accessible for replacement. Fuse boxes shall be provided with circuit label and fuse rated current and voltage.

Markings /Labels

All markers/labels shall be made of halogen & silicon free polyamide material with inflammability class V2 as per UL 94, ensuring scratch proof printing with the use of environment friendly solvent free ink & latest BLUEMARK UV technology so as to comply the WIPE RESISTANCE according to DIN EN 61010-1/VDE 0411-1.

6.18.00 QUANTITIES

Refer Appendix-I to Part-A, Vol.-V of Technical Specifications. Quantities indicated are the minimum requirements, however each & every item shall be provided as per system requirements.

6.19.00 Design Criteria for Control Rooms:

The interiors of the each control Room shall be aesthetically designed with modern designs and technologies. The bidder shall have 2-D and 3-D software for designing the control room layouts. The bidder shall have thorough knowledge on Indian power plant control room requirements. Control rooms shall also be designed as per standard "ISO 11064 (1-7) - Ergonomic design of control centres".

- 6.19.01 The TG building operating floor area and other elevations shall be partitioned to different rooms suitably by bidder with approval from owner to house the following equipment/panels/cabinets:
- (a) Unit Control Desk (UCD), Printers, Electrical Control Panel (ECP), LVS, Fire Alarm Panel, Plant CCTV monitoring System, etc. in the main central control room.
 - (b) The system cabinets, marshalling cabinets and electrical auxiliary cabinets, TSI & VMS panels, Electrical panels, DAVR panels, GCP, DDCMIS/DCS Network panels, & other aux. system cabinets etc. in the electronic cubicle room.
 - (c) Maintenance Engineer & Shift Incharge's OPERATING STATIONS with keyboards, printers and other peripherals in Maintenance Engineer room (Computer Room) and Shift Incharge's Room respectively. A separate air conditioned room shall also be provided for PADO.
 - (d) Uninterrupted Power Supply (i.e., inverters and distribution boards) (UPS) in UPS room and 24 V DC charger with DCDB in 24 V DC charger room. A separate room shall also be provided for Batteries.
 - (e) Similarly OPC servers, MIS server & station LAN Network panel shall be located in separate Air conditioned room.
 - (f) SWAS Room.
- 6.19.02 Every control room layout shall be designed in line with guidelines given below.
- (a) Lighting shall be designed for maximum comfort and minimisation of OPERATING STATION/LVS glare and shall be adjustable.
 - (b) Co-ordinated colours and material for floors, walls and ceiling shall be provided.
 - (c) Room designs shall absorb noise in the control room and engineers/shift supervisor room.
 - (d) Positively pressurised and filtered air conditioning shall be provided for all control rooms.
 - (e) Designs and material will be in accordance with NFPA Fire protection for Power/Electric Generating plant.
 - (f) All control Rooms shall be designed to minimise dust ingress. Air locks shall be provided at main entry.
 - (g) Double Doors and the corridors shall be of sufficient size and layout to allow access of 2750 mm height for equipment.
 - (h) Fire and Smoke detection equipment shall be located in all ceilings.
 - (i) Temp. & humidity monitoring system in each control room, cubicle room, meeting room, training room, & conference room etc.



(j) Air Curtains at each entrance to Main Control room & BOP control room.

6.19.03 Item (a) to (e) referred above at cl. No. 6.19.01 shall be mounted in an air-conditioned control room having false roof and false flooring. In addition SWAS dry room shall also be air conditioned only. The control room will be partitioned with toughened glass/insulated glass between the following rooms:

(a) Main Control Room and Maintenance Engineer's Room/Computer Room.

(b) Maintenance Engineer/Computer's Room and Electronic Cubicle Room

(c) Main control room and Shift Incharge room.

(d) Main control room and Electronic cubicle room.

(e) Main control room and Operating Floor.

6.19.04 In additions to above following rooms shall be provided at operating floor-

1) C&I Staff air-conditioned room.

2) Shift Supervisor air-conditioned room.

3) Documentation air-conditioned Centre for storage for all Plant O & M manuals, control system software backup, & all others operating / maintenance files, logs, records etc.

4) Conference air-conditioned sound proof Room.

5) Pantry room.

6) Toilets/refreshing room.

6.19.05 Following C&I rooms shall be provided in service building -

1) Meeting Room/ Conference air-conditioned sound proof Room.

2) DMS air-conditioned Room.

3) C & I Maintenance/laboratory air-conditioned Room.

4) DDCMIS/DCS Simulator air-conditioned sound proof room.

5) CAAQMS air – conditioned room.

6) Training air-conditioned sound proof Room.

6.19.06 Following rooms shall be provided at Local control room building for respective BOP/offsite packages-

1) Control room and Electronic cubicle room (air-conditioned).

2) UPS room (air-conditioned).

3) UPS Battery room.



- 4) Toilets/refreshing room.
- 5) Locker & staff air-conditioned room.
- 6) Pantry Room.
- 7) Office Rooms.

6.19.07 Quantities of above mentioned rooms are minimum to be met by bidder, however actual quantities & size of rooms shall be finalised by owner during detailed engineering.

STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL													STD QUALITY PLAN NO.: PE-QP-999-145-1056					
 PEM :: C&I													VOLUME		IIB			
													SECTION		D			
													REV. NO.		01		DATE: 22-02-2008	
													SHEET		1		OF 7	
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks						
									P	W	V							
1.0	INCOMING Sheet Steel (CRCA & HR)	1. Chemical Composition	MA	Chemical analysis	Sample	Relevant standard	Relevant standard	Test Certificate	3	---	2							
		2. Bend Test	CR	Mech. test	Sample	Relevant standard	Relevant standard	Log Book	2	---	---							
		3. Surface finish	MA	Visual	100%	Factory Standard / Sample	Factory Standard / Sample	Log Book	2	---	---							
		4. Waviness	MA	Visual	100%	Factory Standard	No Waviness	Log Book	2	---	---							
		5. Thickness	MA	Measurement	100%	BHEL Spec.	BHEL Spec.	Log Book	2	---	---							
		6. Mill marking	MA	Visual	100%	Factory Standard	Factory Standard	Log Book	2	---	1							
2.0	Flats / Angles / Channels	1. Dimensions	MA	Measurement	Sample	Relevant standard	Relevant standard	Log Book	2	---	---							
		2. Surface Defects	MA	Visual	100%	Factory Standard / Sample	Factory Standard / Sample	Log Book	2	---	---							
		3. Straightness	MA	Measurement	100%	Factory Std.	Factory Std.	Log Book	2	---	---							
		4. Mill marking	MA	Visual	100%	Relevant standard	Relevant standard	Log Book	2	---	1							
3.0	Cables / Wires	1. Visual / Surface defects	MA	Visual	100%	BHEL Spec. and Relevant standard	BHEL Spec. and Relevant standard	Log Book	2	---	---							
		2. IR and HV	MA	Electrical	100%	BHEL Spec. and Relevant standard	BHEL Spec. and Relevant standard	Log Book	2	---	---							
LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics													\$			P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.		
													1 - BHEL 2 - Vendor 3 - Sub-vendor					

STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL												STD QUALITY PLAN NO.: PE-QP-999-145-1056		
												VOLUME IIB		
												SECTION D		
												REV. NO. 01		
												DATE: 22-02-2008		
SHEET 2 OF 7														
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks		
									P	W	V			
		3. Conductor a) Resistance b) Size c) Sheet colour	MA MA MA	Electrical Measurement Visual	100% 100% 100%	BHEL Spec. and Relevant standard	BHEL Spec. and Relevant standard	Log Book	2	---	---	---		
		4. Type / Routine Test Certificates	MA	Verification	100%	BHEL Spec. and Relevant standard	BHEL Spec. and Relevant standard	Log Book	3	---	---	2		
4.0	Electrical Components like Annunciator Transformers Lamps Switches PBs Contactors Relays Timers Space Heaters Thermostat Indicating meters etc.	1. Verification at make and Type 2. Verification of Test Certificates 3. Operation / Functional check 4. I.R. 5. H.V. 6. Calibration 7. Pick up / Drop off Voltage	CR CR CR MA MA MA MA	Visual Scrutiny of Type / Routine T.Cs. Electrical Electrical Electrical Electrical Electrical	Sample 100% Sample+ 100% 100% 100% 100% 100%	BHEL Spec. and BOM Relevant standard Relevant standard & Catalogue Relevant standard & Catalogue Relevant standard & Catalogue Relevant standard & Catalogue Relevant standard & Catalogue	BHEL Spec. and BOM Relevant standard Relevant standard & Catalogue Relevant standard & Catalogue Relevant standard & Catalogue Relevant standard & Catalogue Relevant standard & Catalogue	Log Book Log Book Log Book Log Book Log Book Log Book Log Book Log Book Log Book Log Book Log Book	2 2 2 2 2 2 2 2 2 2 2	--- --- --- --- --- --- --- --- --- --- ---	--- --- --- --- --- 1 --- ---	+ for relay & contactors only @ for all components except relays & contactors.		
LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics														
P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.														
1 - BHEL 2 - Vendor 3 - Sub-vendor														

LEGEND: * CR - Critical characteristics
 MA - Major characteristics
 MI - Minor characteristics

\$ P - Agency Performing the Test.
 W - Agency Witnessing the Test.
 V - Agency Verifying the Test.

1 - BHEL
 2 - Vendor
 3 - Sub-vendor

STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL													STD QUALITY PLAN NO.: PE-QP-999-145-1056															
PEM :: C&I													VOLUME		IIB													
													SECTION		D													
													REV. NO.		01		DATE: 22-02-2008											
													SHEET		3		OF 7											
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks																
									P	W	V																	
5.0	Misc. Components like Gaskets, Terminal Blocks etc.	1. Verification of Type / Make 2. Surface defects 3. IR / HV on Terminal Blocks	MA MA MA	Visual Visual Electrical	Sample Sample Sample	BHEL Spec. & Mfrs. Catalogue BHEL Spec. & Mfrs. Catalogue BHEL Spec. & Mfrs. Catalogue	BHEL Spec. & Mfrs. Catalogue BHEL Spec. & Mfrs. Catalogue BHEL Spec. & Mfrs. Catalogue	Log Book Log Book Log Book	2 2 2	-- -- --	-- -- --																	
6.0	IN PROCESS Blanking / Bending / Forming	1. Dimensions 2. Surface defects after bending	MI MA	Measurement Visual	100% 100%	Approved Mfr. drgs. Factory Standard	Approved Mfr. drgs. Factory Standard	Log Book Log Book	2 2	-- --	-- --																	
7.0	Nibbling / Punching	1. Cutout Sizes 2. Deburring	MI MA	Measurement Visual	100% 100%	Approved Mfr. drgs. Approved Mfr. drgs.	Approved Mfr. drgs. Approved Mfr. drgs.	Log Book Log Book	2 2	-- --	-- --																	
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. / Mfr. Standards Approved drg. / Mfr. Standards Approved drg. / Mfr. Standards Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards Approved drg. / Mfr. Standards Approved drg. / Mfr. Standards Approved drg. / Mfr. Standards	Log Book Log Book Log Book Log Book	2 2 2 2	-- -- -- --	2 2 2 2																	
LEGEND: * CR MA MI													- Critical characteristics - Major characteristics - Minor characteristics				\$ P W V				- Agency Performing the Test. - Agency Witnessing the Test. - Agency Verifying the Test.				1 - BHEL 2 - Vendor 3 - Sub-vendor			

LEGEND: * CR - Critical characteristics
 MA - Major characteristics
 MI - Minor characteristics

\$ P - Agency Performing the Test.
 W - Agency Witnessing the Test.
 V - Agency Verifying the Test.

1 - BHEL
 2 - Vendor
 3 - Sub-vendor

STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL										STD QUALITY PLAN NO.: PE-QP-999-145-1056					
										VOLUME		IIB			
										SECTION		D			
										REV. NO.		01		DATE: 22-02-2008	
										SHEET		4		OF 7	
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks			
									P	W	V				
9.0	Pre-treatment and Painting	1. Pretreatment Process	MA	Visual	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1				
		2. Process parameters like bath temp. concentration etc.	MA	Measurement	Periodic	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1				
		3. Dipping / Removal Time	MA	Measurement	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1				
		4. Surface quality after every dip	MA	Visual	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1				
		5. Primer after phosphating	MA	Visual, Thickness	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1				
		6. Putty Application & Rubbing after primer	MA	Visual	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1				
		7. Paint first coat	MA	Visual, Thickness	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1				
		8. Putty Application and Rubbing after first coat of paint	MA	Visual	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1				
		9. Paint second coat	MA	Visual, Thickness, Scratch test Colour adhesion	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1				

LEGEND: * CR - Critical characteristics
MA - Major characteristics
MI - Minor characteristics

\$ P - Agency Performing the Test.
W - Agency Witnessing the Test.
V - Agency Verifying the Test.

1 - BHEL
2 - Vendor
3 - Sub-vendor

LEGEND: * CR - Critical characteristics
 MA - Major characteristics
 MI - Minor characteristics

\$ P - Agency Performing the Test.
 W - Agency Witnessing the Test.
 V - Agency Verifying the Test.

1 - BHEL
 2 - Vendor
 3 - Sub-vendor

 PEM :: C&I		STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL										STD QUALITY PLAN NO.: PE-QP-999-145-1056					
												VOLUME		IIB			
												SECTION		D			
												REV. NO.		01		DATE: 22-02-2008	
												SHEET		5		OF	
Sl. No.	Component / operation	Characteristics Checked	* Cate gory	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks					
									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 drgs. & Specs. Approved drgs. & Specs. Approved drgs. & Specs. Approved drgs. & Specs. Approved drgs. & Specs.	Approved drgs. & Specs. Approved drgs. & Specs. Approved drgs. & Specs. Approved drgs. & Specs. Approved drgs. & Specs.	Log Book Log Book Log Book Log Book Log Book	2 2 2 2 2	-- -- -- -- --	-- -- -- 1 1	-- -- -- -- --					
11.	Component Mounting	1. Correct components 2. Fixing	MA MA	Visual Visual	100% 100%	Approved drgs., Specs. & BOM Approved drgs., Specs. & BOM	Approved drgs., Specs. & BOM Approved drgs., Specs. & BOM	Log Book Log Book	2 2	-- --	-- --	-- --					
12.	FINAL Final Inspection	1. Workmanship 2. Component layout (neatness, accessibility & safety) Mounting / Proper fixing of all components 3. Components identification Marking / Name plates	MA MA MA	Visual Visual Visual	100% 100% 100%	Factory Standard BHEL approved drg. / Spec. BHEL approved drg. / Spec.	Factory Standard BHEL approved drg. / Spec. BHEL approved drg. / Spec.	Inspection Report Inspection Report Inspection Report	2 2 2	1 1 1	1 1 1	1 1 1	At Random by BHEL, based on 100 % internal test reports by Mfr.				
LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics																	
\$ P - Agency Performing the Test. 1 - BHEL W - Agency Witnessing the Test. 2 - Vendor V - Agency Verifying the Test. 3 - Sub-vendor																	

 PEM :: C&I		STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL							STD QUALITY PLAN NO.: PE-QP-999-145-1056				
									VOLUME		IIB		
									SECTION		D		
									REV. NO.		01		
									DATE: 22-02-2008		SHEET		6
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks	
									P	W	V		
		5. Dimensions	MA	Measurement	100%	BHEL approved drg. / Spec., BOM	BHEL approved drg. / Spec., BOM	Inspection Report	2	1	1	At Random by BHEL, based on 100 % internal test reports by Mfr.	
		6. Door functioning	MA	Functional	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1		
		7. Paint Shade	CR	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1		
		8. Paint Thickness	CR	Measurement	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1		
		9. Workmanship of Gaskets	MA	Visual	100%	Factory Standard	Factory Standard	Inspection Report	2	1	1		
		10. Wiring Layout	MA	Visual	100%	BHEL approved drg.	BHEL approved drg.	Inspection Report	2	1	1		
		11. Wire Termination	MA	Pulling manually	Sample	-----	Firm termination	Inspection Report	2	1	1		
		12. Continuity	MA	Electrical	100%	-----	Continuity OK	Inspection Report	2	1	1		

LEGEND: * CR - Critical characteristics
 MA - Major characteristics
 MI - Minor characteristics

\$ P - Agency Performing the Test.
 W - Agency Witnessing the Test.
 V - Agency Verifying the Test.

1 - BHEL
 2 - Vendor
 3 - Sub-vendor

भारतीय BHEL PEM :: C&I		STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL										STD QUALITY PLAN NO.: PE-QP-999-145-1056			
												VOLUME IIB			Remarks
												SECTION D			
												REV. NO. 01			
												DATE: 22-02-2008			
SHEET 7 OF 7															
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$						
									P	W	V				
13.	TYPE TEST	Degree of Protection	CR	Mech. Protection	Sample	BHEL approved spec., drg relevant IEC-60947, IEC-60079	BHEL approved spec., drg relevant IEC-60947, IEC-60079	Type Test Certificate	3	---	1				
14	ROUTINE TEST	IR before & after HV Test	CR	Electrical	100%	BHEL approved spec., drg., BOM & relevant standard	BHEL approved spec., drg., BOM & relevant standard	Test Report	2	1	1				
15	FUNCTIONAL TEST	1. Control Logic Operation	CR	Electrical	100%	BHEL approved spec. / drg.	BHEL approved spec. / drg.	Inspection Report	2	1	1				
		2. Instrument Calibration	CR	Electrical	10%	BHEL approved spec. / drg.	BHEL approved spec. / drg.	Inspection Report	2	1	1				
		3. Temperature rise	CR	Electrical	100%	BHEL approved spec/drg. & relevant standard	BHEL approved spec/drg & relevant standard	Inspection Report	2	1	1				

LEGEND: * CR - Critical characteristics
MA - Major characteristics
MI - Minor characteristics

\$ P - Agency Performing the Test.
W - Agency Witnessing the Test.
V - Agency Verifying the Test.

1 - BHEL
2 - Vendor
3 - Sub-vendor

	Technical specification for CONTROL & INSTRUMENTATION 1X660MW PANKI TPS EXTN.		
		SECTION D	
		REV. NO. 00	DATE : 13.07.2018

ACTUATOR SPECIFICATION & DATASHEET

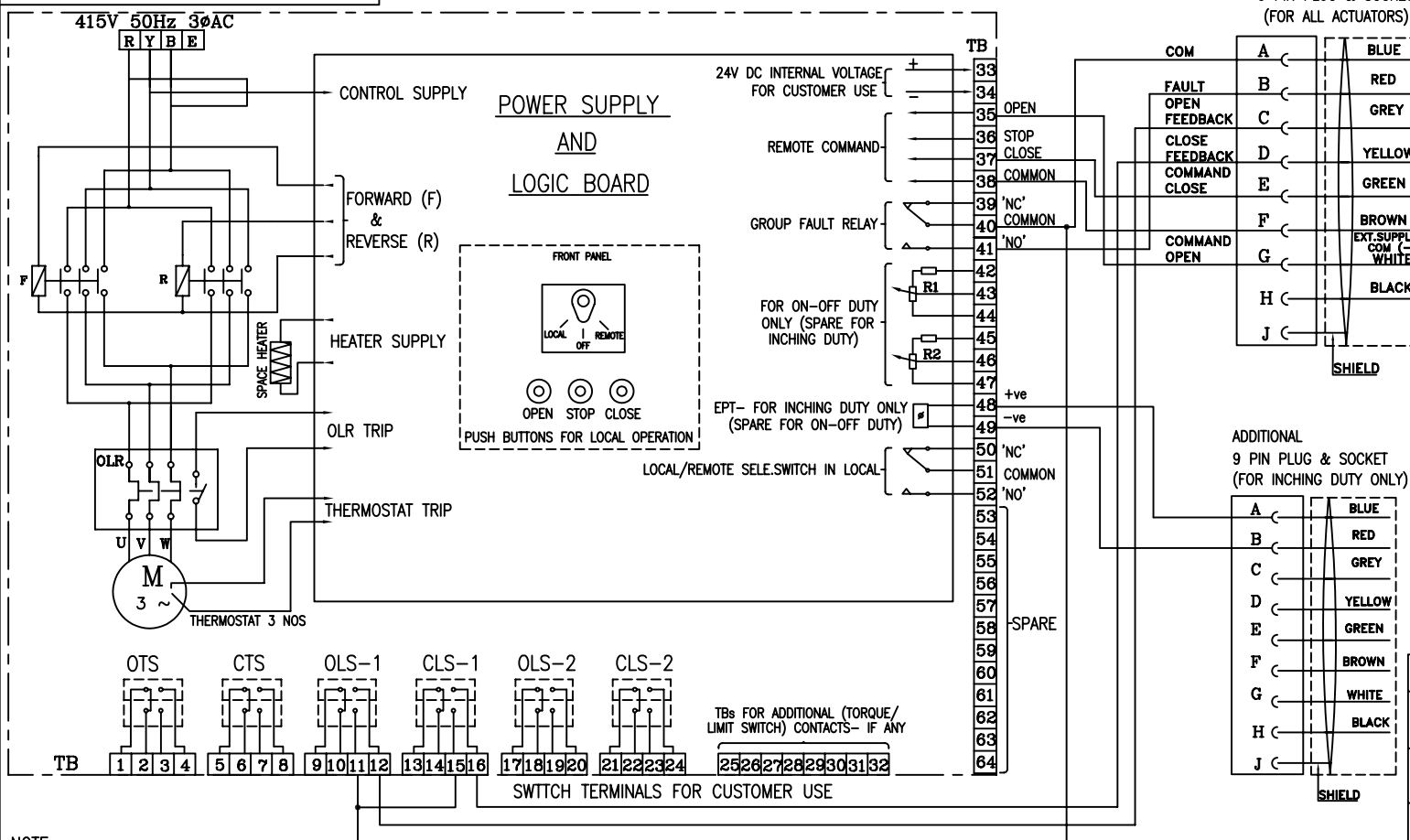
	SPECIFICATION FOR MOTORISED VALVE ACTUATOR		SPECIFICATION NO.:			
			VOLUME			
			SECTION			
			REV. NO.	00	DATE:	27.02.18
			SHEET	1	OF	3
Data Sheet A & B						
DATA SHEET-A (TO BE FILLED BY PURCHASER)			DATA SHEET-B (TO BE FILLED-UP BY BIDDER)			
GENERAL *	* PROJECT	1 X 660 MW PANKI TPS				
	OFFER 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 0-55 DEG C AND RELATIVE HUMIDITY OF 0-95%				
	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, DUST TIGHT, WEATHER PROOF, SUITABLE FOR OUTDOOR USE WITHOUT CANOPY, IP:65			
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 REGULATING SERVICE - 150 STARTS/HR MINIMUM				
HANDWHEEL	* 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)	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 ☒ DRG. NO. 3-V-MISC-24227 R00 (INDICATIVE)				
	COLOUR SHADE	☒ BLUE (RAL 5012), To be decided during detail engg.				
	PAINT TYPE (## Refer Notes)	☐ ENAMEL ☒ EPOXY ☐				
	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				
	@ CONTROL VOLTAGE REQUIREMENT	TO BE DERIVED FROM THE POWER SUPPLY TO THE STARTER ☐ 230 V ☐ 110 V				
	@ ENCLOSURE CLASS OF MOTOR	☐ IP 65 ☐ FLAME PROOF				

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR		SPECIFICATION NO.:		
			VOLUME		
			SECTION		
			REV. NO.	00	DATE: 06.01.2015
			SHEET	2	OF 3
Data Sheet A & B					
DATA SHEET-A (TO BE FILLED BY PURCHASER)				DATA SHEET-B (TO BE FILLED-UP BY BIDDER)	
INTEGRAL STARTER	@ 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			
	INTEGRAL STARTER	☒ REQUIRED ☐ NOT REQUIRED			
	TYPE OF SWITCHING DEVICE	☒ CONTACTORS ☐ THYRISTORS			
	TYPE	☒ CONVENTIONAL ☐ SMART (NON-INTRUSIVE)			
	IF SMART	NOT APPLICABLE			
	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 (O/L RELAY OPERATED, CONT. /POWER SUPPLY FAILED, S/S IN LOCAL, TORQUE SWITCH OPTD. MID WAY)				
INTERPOSING RELAY/OPTO COUPLER (Applicable for integral Starter)	TYPE OF ISOLATING DEVICE	☒ INTERPOSING RELAY ☐ OPTO COUPLER ☐ EITHER			
	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			
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			

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR		SPECIFICATION NO.:		
			VOLUME		
			SECTION		
			REV. NO.	00	DATE: 06.01.2015
			SHEET	3	OF 3
Data Sheet A & B					
DATA SHEET-A (TO BE FILLED BY PURCHASER)			DATA SHEET-B (TO BE FILLED-UP BY BIDDER)		
POSITION TRANSMITTER	POSITION TRANSMITTER	☒ 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 (9 PIN) (FOR COMM, LS/TS FEED BACK, PoT)	☐ REQUIRED ☒ NOT REQUIRED ☐ 2 NOS. ☐			
CABLE GLANDS	@ POWER CABLE GLAND	SIZE:-----			
	@ SPACE HEATER CABLE GLAND	SIZE:-----			
	OTHER CONTROL CABLE GLANDS-1	☐ 1No. for BFV of CW PUMP (Cable size 2Px1.5mm2)			
	OTHER CONTROL CABLE GLANDS-2	QUANTITY & SIZE: 1no., 2.5 sq. mm			
WEIGHT	TOTAL WEIGHT (ACTUATOR + ACCESSORIES)	BIDDER TO SPECIFY		_____ Kg.	
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 AND IS-4722 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, WITH NICKEL COATING 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 OPERATE SATISFACTORILY UNDER THE +/- 10% SUPPLY VOLTAGE VARIATION AT RATED FREQUENCY, -5% TO +3% VARIATION IN FREQUENCY AT RATED SUPPLY VOLTAGE, SIMULTANEOUS VARIATION IN VOLTAGE & FREQUENCY THE SUM OF ABSOLUTE PERCENTAGE NOT EXCEEDING 10%. 7. THE MOTOR SHALL BE SUITABLE FOR DIRECT ON LINE STARTING. \$\$ TORQUE SWITCH & LIMIT SWITCH SHALL ACT INDEPENDENT OF EACH OTHER. TANDEM OPERATION IS NOT ACCEPTABLE. ## EPOXY PAINT IS RECOMMENDED FOR COASTAL AREAS.					
			VENDOR COMPANY SEAL NAME SIGNATURE DATE		
NOTES* = TO BE FILLED BY MPL (LEAD AGENCY). @ = TO BE FILLED BY ES					

3-V-MISC-24283

DRAWING NO.



CONTACT DEVELOPMENT DIAGRAM

OTS	1-2	OPEN AT OVER TORQUE DURING OPENING TRAVEL				
	3-4	CLOSE AT OVER TORQUE DURING OPENING TRAVEL				
CTS	5-6	OPEN AT OVER TORQUE DURING CLOSING TRAVEL				
	7-8	CLOSE AT OVER TORQUE DURING CLOSING TRAVEL				
OLS-1	9-10					
	11-12					
CLS-1	13-14					
	15-16					
OLS-2	17-18					
	19-20					
CLS-2	21-22					
	23-24					
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

NOTE:-

- ALL TORQUE AND LIMIT SWITCHES (OTS, CTS, OLS1&2, CLS1&2) ARE WITH 2NO+2NC CONTACTS '1NO+1NC' IS TERMINATED IN TBS 1-24, REMAINING CONTACTS ARE FOR INTERNAL USE.
- ANY SPARE CONTACTS WHICH ARE NOT USED INTERNALLY ARE TO BE TERMINATED IN TBS 25-32
- CTS - TORQUE SWITCHES FOR CW ROTATION (CLOSE)
- OTS - TORQUE SWITCHES FOR CCW ROTATION (OPEN)
- OLS-1, OLS-2 - LIMITSWITCHES FOR POSITION OPEN
- CLS-1, CLS-2 - LIMITSWITCHES FOR POSITION CLOSE
- EPT - ELECTRONIC POSITION TRANSMITTER (CONTACTLESS TYPE, FOR INCHING DUTY)
- R1-R2-POTENTIOMETER 2 x 100 OHMS (FOR ON-OFF DUTY)
- FOR COMMANDS & EPT EITHER INTERNALLY GENERATED 24 VDC OR EXTERNAL SUPPLY OF 24VDC CAN BE USED
- M - MOTOR 3φ 415V 50 Hz AC SUPPLY
- TORQUE SWITCH BYPASS WITH LIMITSWITCH BOTH ON OPEN & CLOSE DIRECTION TO BE DONE INTERNALLY.

REV	DATE	ALTERED
		CHD & APPD

CAUTION: The information on this document is the property of BHARAT HEAVY ELECTRICALS LTD. It must not be used directly or indirectly in any way detrimental to the interest of the company.

TYPE OF PRODUCT
OR NAME OF
CUSTOMER/PROJECT

ELECTRICAL VALVE ACTUATORS (AC) WITH INTEGRAL STARTERS
FOR NTPC PROJECTS
(DRAWN FOR INTERMEDIATE POSITION OF VALVES)



BHARAT HEAVY ELECTRICALS LTD.,
UNIT: HIGH PRESSURE BOILER PLANT.
TIRUCHIRAPALLI-620014.

DEPT
VL

CODE

TITLE

FOR ACTUATOR WITH INTEGRAL STARTER WITH PLUG & SOCKET

FOR NTPC PROJECTS

SCALE

WEIGHT (KG).

REFERENCE INFORMATION

NO. OF ITEMS

CARD CODE

DRAWING NO.

REV

U 01

3-V-MISC-24283

0

	Technical specification for CONTROL & INSTRUMENTATION 1X660MW PANKI TPS EXTN.		
	SECTION D		
	REV. NO.	00	DATE : 13.07.2018

APPLICABLE CABLE TYPES

Cable Sizes for 1X660MW TPS PANKI EXTN.	
Sl no.	Cable Type
G-TYPE	
1	2P X 0.5 sqmm
2	4P X 0.5 sq mm
3	8P X 0.5 sqmm
4	12P X 0.5 sqmm
F-TYPE	
1	4P X 0.5 sqmm
2	8P X 0.5 sqmm
3	12P X 0.5 sqmm
4	20P X 0.5 sqmm
CONTROL CABLE	
1	3C X 2.5 sqmm

	Technical specification for CONTROL & INSTRUMENTATION 1X660MW PANKI TPS EXTN.		
		SECTION D	
		REV. NO. 00	DATE : 13.07.2018

KKS PHILOSOPHY

**KKS NUMBERING PHILOSOPHY**

For identifying (tagging) an instrument / equipment in Power plant KKS numbering scheme is used. The purpose is to assign a unique number to every equipment in the power plant. For C&I equipment unique number are to be provided up to the signal level so that a unique number Input / Output exist in DCS for every signal.

Normally KKS number is a 10 digit alpha-numeric code and is typically split into the following:

X	X	X	A	A	Y	Y	B	B	B

First three digits indicate the Sub-System. The Code for the major system are given as per **Annexure-1**.

Fourth and Fifth digits are the **Numerical Keys at System Code Level** and used to distinguish between main systems having same Alpha Codes.

Sixth and Seventh digits are the **Equipment / Apparatus / Measuring Circuit Code**. The code of various Equipment / Apparatus / Measuring Circuit is shown in **Annexure-2**

Eight, Nine and tenth digits are the **Numerical Keys at Equipment / Apparatus / Measuring Circuit Code** and used to distinguish between various instruments in the same sub-group. Numerical keys at System / Equipment / Apparatus / Measuring Circuit is shown in **Annexure-3**.

**ANNEXURE-1****List of System / Sub-System Codes used in Power Plant:**

- 1) Compressed air system : QEA, QEB, QEC, QED

ANNEXURE-2**Standard Equipment Codes:**

AA	Valves including drives, also hand operated
AB	Seclusions, Lock, Gates, Doors
AC	Heat Exchanger
AE	Turning, Driving, Lifting equipment
AF	Continuous conveyors, Feeders
AG	Generator Units
AH	Heating and Cooling Units
AK	Pressing and Packaging equipment
AM	Mixer, Stirrer
AN	Blower, Air Pumps / Fans, Compressor Units
AP	Pump Units
AT	Purification, Drying, Filter
AV	Combustion Equipment e.g. grates

Standard Apparatus Codes:

BB	Vessels and Tank
BF	Foundation
BG	Boiler Heating Surfaces
BN	Injector, Ejector
BP	Flow and throughput limitation equipment (Orifice)
BQ	Holders, Carrying Equipment, Support
BR	Piping, Ducts, Chutes, Compensator
BS	Sound Absorber
BU	Insulations, Sheatings

Standard Measuring Circuits Codes:

CD	Density
CE	Electrical Quantities
CF	Flow, throughput
CG	Distance, Length, Position
CK	Time
CL	Level

बी एच ई एल BHEL		DOCUMENT TITLE	
		KKS NUMBERING PHILOSOPHY	
		1X660 MW PANKI TPS EXTN.	
CM	Humidity		
CQ	Analysis (SWAS)		
CS	Speed, Velocity, Frequency		
CT	Temperature		
CY	Vibration, Expansion		
ANNEXURE-3			
Numerical Keys			
A) Numerical Keys at System Code Level			
i) Use 10, 20, 30... To distinguish between main systems having same Alpha Codes. Examples:			
a) Main Steam (Left) and Main Steam (Right)			
b) BFP – A/B/C			
c) ID Fan – A/B, FD Fan A/B, AH – A/B			
ii) For branch off from main system path having code say 10, keep the same alpha code and use 11, 12, 13 etc. Similarly for other branch off from main system path having code say 20, keep the same alpha code and use 21, 22, 23 etc and shall carry on further in the same way.			
iii) If the branch off from main system / sub system path is used for some other system, where different alpha codes can be applied, then in that case the said branch line will be designated by the alpha codes of the system to which it is providing the input.			
B) Numerical keys at Equipment Code level:			
There are three numerical keys available for each type of equipment code. Following has been agreed upon considering present practice, better flexibility and ease in sorting.			
i) Valves and Dampers --- Equipment Code – AA			
Motorised (on/off duty)	-	N1 0	N2 N3 01 to 50
Motorised (inching duty)	-	0	51 to 99
Pneumatic (Control)	-	1	01 to 50
Motorised (thyrestor Control)	-	1	51 to 99
Sol. Operated	-	2	01 to 99
(Open / Close duty (Valves, NRVs, Gate)			
Hydraulic	-	3	01 to 99

KKS NUMBERING PHILOSOPHY

1X660 MW PANKI TPS EXTN.

NRV (Without actuation)	-	4	01 to 99
Manual	-	5	01 to 99
Manual	-	6	01 to 99
Relief & Safety Valves	-	7	01 to 99
Reserve	-	8	01 to 99
Reserve	-	9	01 to 99

ii) Field Instruments

Field Transmitters & Analog Signals	-	0	01 to 99
Field Switches & Binary Signals	-	1	00 to 99
PG Test Point	-	4	00 to 99
Gauges	-	5	00 to 99
Automatic Turbine Tester (ATT)-HWR	-	2	00 to 99
(Reserved for protection Signals used by Hardwar)			

Example of Numerical Key Usage:

In line with the philosophy adopted for Valves / Dampers /instruments etc. pumps and fans in the main systems (having different system code) can be numbered as AP/N100 and as AP/N101, 102, ... Where system code is same.

1X660 MW PANKI TPS

COMPRESSED AIR SYSTEM

SECTION-II

(STANDARD TECHNICAL SPECIFICATIONS)



BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR PROJECT ENGINEERING MANAGEMENT
NOIDA-INDIA

1X660 MW PANKI TPS

TECHNICAL SPECIFICATION
FOR
COMPRESSED AIR SYSTEM

SECTION-IIA
(FORMAT FOR O& M MANUAL)



BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR PROJECT ENGINEERING MANAGEMENT
NOIDA-INDIA

Check List for Operation & Maintenance Manual

Project name:

Project number:

Package Name:

Sl.no. & Sections	Description	Yes	No	Not Applicable	Remarks
1.	Cover page				
1.1	Project Name				
1.2	Customer Name				
1.3	Name of Package				
1.4	Supplier details with phone, FAX email address				
1.5	Name and sign of prepared by , checked by & approved by				
2.0	Index				
2.1	showing the sections & related page nos All the pages should be numbered section wise				
3.0	Description of Plant				
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				
3.7	Single line/wiring diagrams				
3.8	Control philosophy /control write-ups				
4.0	Commissioning Activities (if not covered in separate document i.e. erection manual, commissioning manual)				
4.1	Pre-Commissioning Checks				
4.2	Transportation and handling 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 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 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.				
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.				

1X660 MW PANKI TPS

TECHNICAL SPECIFICATION
FOR
COMPRESSED AIR SYSTEM

SECTION - IIB

(SITE STORAGE AND PRESERVATION MANUAL)



BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR PROJECT ENGINEERING MANAGEMENT
NOIDA-INDIA

SITE STORAGE AND PRESERVATION GUIDELINES

FOR

MECHANICAL 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.

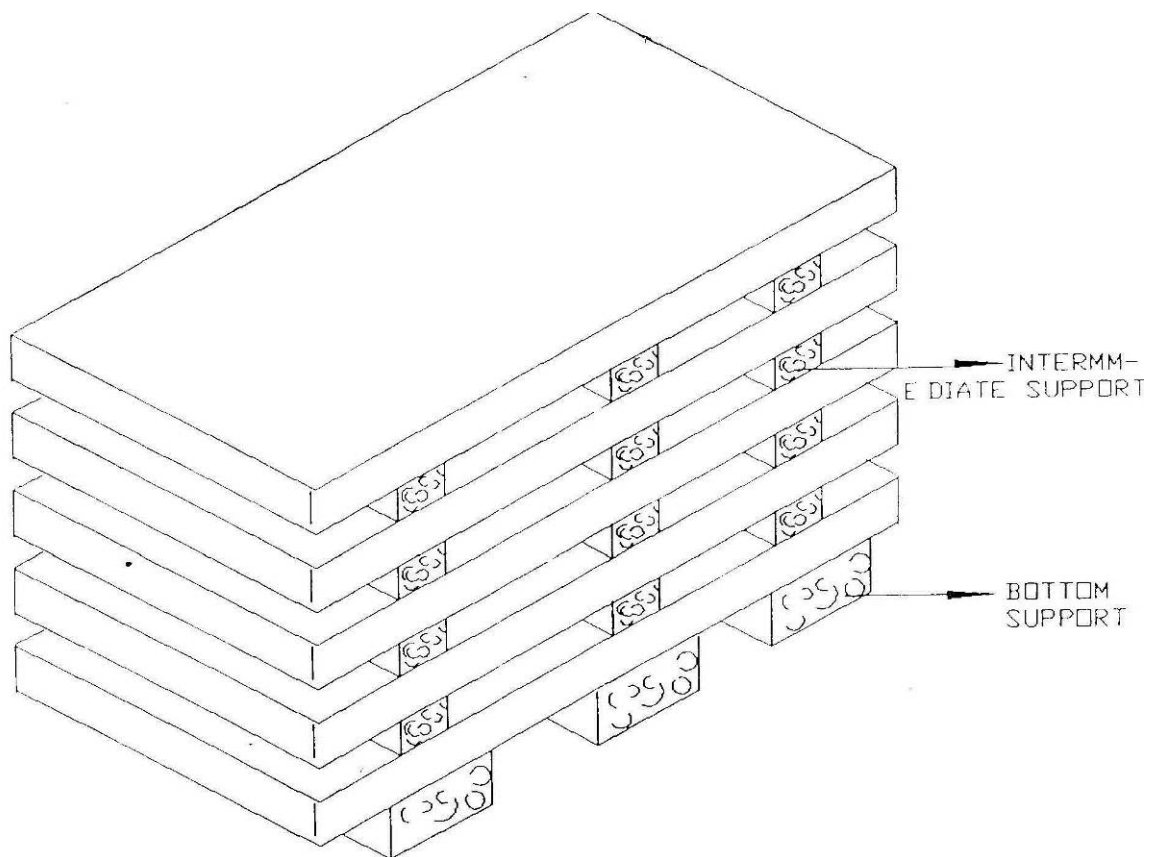


Figure – 1 – PLATE STACKING ARRANGEMENT

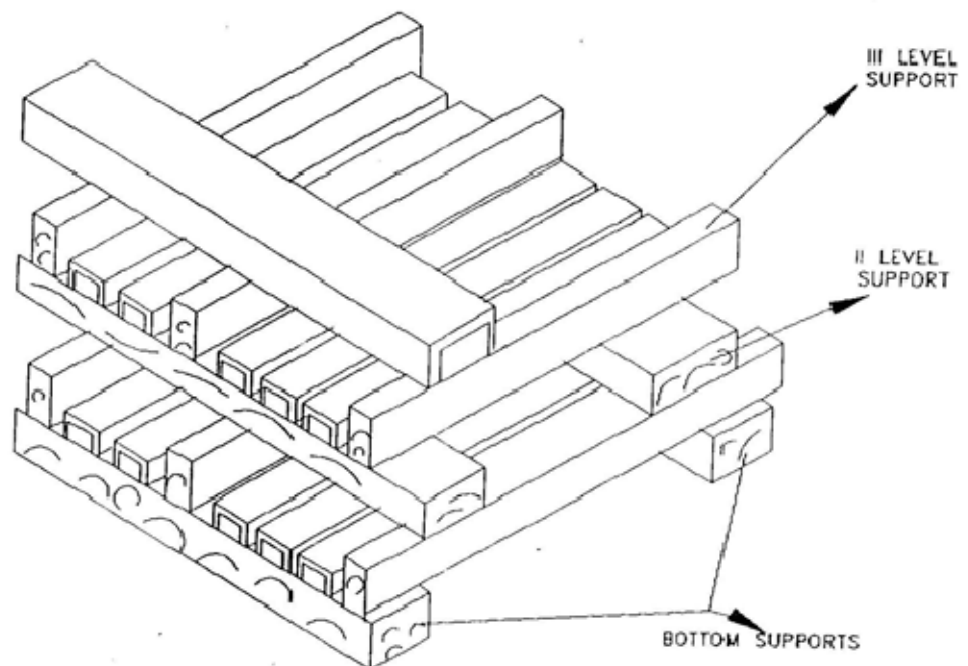


Figure – 2 – STRUCTURAL STEEL STACKING ARRANGEMENT

1X660 MW PANKI TPS

TECHNICAL SPECIFICATION

FOR

COMPRESSED AIR SYSTEM

SECTION - III

DOCUMENTS TO BE SUBMITTED BY BIDDER



BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR PROJECT ENGINEERING MANAGEMENT
NOIDA-INDIA



**TECHNICAL SPECIFICATION FOR
COMPRESSED AIR SYSTEM
1X660 MW PANKI TPS**

SPECIFICATION NO. PE-TS-426-555-A001

SECTION IIIA

REV – 01

DATE : 17.06.2019

1X660 MW PANKI TPS

**TECHNICAL SPECIFICATION
FOR
COMPRESSED AIR SYSTEM**

SECTION-IIIA



**BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR PROJECT ENGINEERING MANAGEMENT
NOIDA-INDIA**



**TECHNICAL SPECIFICATION FOR
COMPRESSED AIR SYSTEM
1X660 MW PANKI TPS**

SPECIFICATION NO. PE-TS-426-555-A001

SECTION IIIA

REV – 01

DATE : 17.06.2019

LIST OF DOCUMENTS TO BE SUBMITTED WITH THE BID

Bidder shall submit following drawings / documents along with their bid:

- a. Copy of pre-bid clarification, if any, duly signed and stamped.
- b. Copy of electrical scope between BHEL & vendor duly signed and stamped.
- c. Electrical equipment specification for Compressed air system duly signed and stamped.
- d. Electrical load list duly filled
- e. Deviation schedule with reference to specific clauses of the specification along with reason for such deviation.
- f. Copy of unpriced price bid indicating "QUOTED / NOT QUOTED" / "NOT APPLICABLE" as the case may be.
- g. Copy of drwg/doc schedule duly signed and stamped.
- h. Compliance cum confirmation certificate
- i. Filled in Guarantee power consumption.

NOTES:

OFFER WILL BE CONSIDERED AS INCOMPLETE IN ABSENCE OF ANY OF THE ABOVE DOCUMENTS.

DOCUMENTS OTHER THAN ABOVE, IF ANY, SUBMITTED WITH THE OFFER WILL NOT FORM PART OF CONTRACT AND ACCORDINGLY WILL NOT BE CONSIDERED FOR BID EVALUATION.



TITLE:

**TECHNICAL SPECIFICATION
1X660 MW PANKI TPS
COMPLIANCE CUM CONFIRMATION
CERTIFICATE**

SPEC. NO.: PE-TS-426-555-A001

SECTION: IIIB

REV. NO. 01 DATE: 17.06.2019

SHEET 1 OF 2

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', if applicable, 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 shall be within the contracted price with no extra implications to BHEL after award of the contract.
- d) All drawings/ data-sheets/ calculations etc. submitted along with the offer shall be considered for reference only, same shall be subject to BHEL/ CUSTOMER approval in the event of order.
- 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 as applicable, 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. This clause will apply in case during site 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.



TITLE:

**TECHNICAL SPECIFICATION
1X660 MW PANKI TPS
COMPLIANCE CUM CONFIRMATION
CERTIFICATE**

SPEC. NO.: PE-TS-426-555-A001

SECTION: IIIB

REV. NO. **01** DATE: 17.06.2019

SHEET **2** OF **2**

- 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.

SIGNATURE: _____

NAME : _____

DESIGNATION: _____

COMPANY: _____

DATE: _____

COMPANY SEAL



TITLE

**TECHNICAL SPECIFICATION FOR CAS
1X660 MW PANKI TPS**

SPECIFICATION NO. PE-TS-426 -555-A001

SECTION IIIC

REV 01

PRE-BID CLARIFICATION SCHEDULE

S.No.	Section/Clause/ Page No.	Statement of the referred clause	Clarification required

The bidder hereby certifies that above mentioned are the only clarifications required on the technical specification for the subject package.

SIGNATURE: _____

NAME : _____

DESIGNATION: _____

COMPANY: _____

DATE: _____

COMPANY SEAL

DEVIATION SHEET (COST OF WITHDRAWAL)**PROJECT:- 1X660 MW PANKI TPS****PACKAGE:- COMPRESSED AIR SYSTEM****TENDER ENQUIRY REFERENCE:-****NAME OF VENDOR:-**

SL NO	VOULME/ SECTION	PAGE NO.	CLAUSE NO.	TECHNICAL SPECIFICATION/ TENDER DOCUMENT	COMPLETE DESCRIPTION OF DEVIATION	COST OF WITHDRAWAL OF DEVIATION	REFERENCE OF PRICE SCHEDULE ON WHICH COST OF WITHDRAWAL OF DEVIATION IS APPLICABLE	NATURE OF COST OF WITHDRAWAL OF DEVIATION (POSITIVE/ NEGATIVE)	REASON FOR QUOTING DEVIATION

TECHNICAL DEVIATIONS

COMMERCIAL DEVIATIONS

PARTICULARS OF BIDDERS/ AUTHORISED REPRESENTATIVE

NAME	DESIGNATIONS	SIGN & DATE	

NOTES:

- For self manufactured items of bidder, cost of withdrawal of deviation will be applicable on the basic price (i.e. excluding taxes, duties & freight) only.
- For directly dispatchable items, cost of withdrawal of deviation will be applicable on the basic price including taxes, duties & freight.
- All the bidders have to list out all their Technical & Commercial Deviations (if any) in detail in the above format.
- Any deviation not mentioned above and shown separately or found hidden in offer, will not be taken cognizance of.
- 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.
- Bidder shall furnish price copy of above format along with price bid.
- The final decision of acceptance/ rejection of the deviations quoted by the bidder shall be at discretion of the Purchaser.
- Bidders to note that any deviation (technical/commercial) not listed in above and asked after Part-I opening shall not be considered.
- For deviations w.r.t. Payment terms, Liquidated damages, Firm prices and submission of E1/ E2 forms before claiming 10% payment, if a bidder chooses not to give any cost of withdrawal of deviation loading as per Annexure-VIII of GCC, Rev-06 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.
- Any deviation mentioned in priced copy of this format, but not mentioned in the un-priced copy, shall not be accepted.
- 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.
- 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.
- In case nature of cost of withdrawal (positive/negative) is not specified it shall be assumed as positive.
- In case of discrepancy in the nature of impact (positive/ negative), positive will be considered for evaluation and negative for ordering.

1X660 MW PANKI TPS

TECHNICAL SPECIFICATION

FOR

COMPRESSED AIR SYSTEM

SECTION - III E

ELECTRIC LOAD DATA OF CAS



BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR PROJECT ENGINEERING MANAGEMENT
NOIDA-INDIA

LOAD TITLE	RATING (KW / A)		UNIT (U)/STN (S)	Nos.		VOLTAGE CODE*	FEEDER CODE**	EMER. LOAD (Y)	CONT.(C)/ INTT.(I)	STARTING TIME >5 SEC (Y)	LOCATION	BOARD NO.	CABLE		BLOCK CABLE DRG. No.	CONTROL CODE	REMARKS	LOAD No.
	NAME PLATE	MAX. CONT. DEMAND (MCR)		RUNNING	STANDBY								SIZE CODE	NOS				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19

Note:

- Bidder to note that for the system being supplied by them, only the above loads will be provided. In case any other load is required, the same would be derived / multiplied by bidder on their own from these feeders only.
- Any change in the electrical load list shall be entertained only subject to its feasibility, and BHEL reserves the right to debit the vendor cost of any changes necessitated in the switch gear /MCC on account of changed loads.

NOTES:

1. COLUMN 1 TO 12 & 18 SHALL BE FILLED BY THE REQUISITIONER (ORIGINATING AGENCY); REMAINING COLUMNS ARE TO BE FILLED UP BY PEM (ELECTRICAL)/ CUSTOMER

2. ABBREVIATIONS : * VOLTAGE CODE (7):- (ac) A=11 KV, B=6.6 KV, C=3.3 KV, D=415 V, E=240 V (1 PH), F=110 V (cc): G=220 V, H=110 V, J=48 V, K=+24V, L=-24 V

: ** FEEDER CODE (8):- U=UNIDIRECTIONAL STARTER, B=BI-DIRECTIONAL STARTER, S=SUPPLY FEEDER, D=SUPPLY FEEDER (CONTACTOR CONTROLLED)

LOAD DATA (ELECTRICAL)	JOB NO.			ORIGINATING AGENCY		PEM (ELECTRICAL)	
	PROJECT TITLE			NAME			DATA FILLED UP ON
	SYSTEM	COMPRESSED AIR SYSTEM		SIGN.			DATA ENTERED ON
	DEPTT. / SECTION	MAX		SHEET 1 OF 1	REV. 01	DE'S SIGN. & DATE	

1X660 MW PANKI TPS

TECHNICAL SPECIFICATION

FOR

COMPRESSED AIR SYSTEM

SECTION - IIIF

GUARANTEED POWER CONSUMPTION



BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR PROJECT ENGINEERING MANAGEMENT
NOIDA-INDIA

Guaranteed Power Consumption For Air Compressor System				SECTION: IIIF		
				Date of issue		
				17.06.2019		
NAME OF PROJECT:		1x660 MW PANKI TPS				
NAME OF PACKAGE:		COMPRESSED AIR SYSTEM				
TECHNICAL SPECIFICATION:		PE-TS-426-555-A001, Rev 01				
S.No. (1)	Description of Equipments (2)	Nos. of Equipments (3)		Total Guaranteed Power Consumption for Each Equipment at Motor Input Terminals & control Panel (4)	Duty Factor (5)	Total (KW) (6) = (3A)*(4)*(5)
		Working A	Standby B			
1	Air Compressors for Service air application (Oil free Screw type) of capacity 40 NM3/min at 8.5 Kg/cm2 pressure	2	1		0.33	
2	Air Compressors for Instrument air application (Oil free Screw type) of capacity 40 NM3/min at 8.5 Kg/cm2 pressure	2	1		0.60	
3.1	Air Drying plant (Heaters) (If applicable)	2	1		0.50	
3.2	Air Drying plant (Blowers) (If applicable)	2	1		1.00	
					TOTAL	
Note :						
1	Estimated Power Consumption Figure for the compressed air system (For Working Drives Only) considered is 610 KW .					
2	Bidders Guaranteed power consumption at motor input terminals (Not Shaft Power) considering motor efficiency of 95% including power for control panel as furnished in guranteed schedule shall be demonstrated by the successful bidder during performance testing at works/site.					
3	The price quoted by the bidder shall be loaded @ Rs 584000/- for every additional kW increase in consumption from the base figure indicated at Note no. 1.0 above.					
4	In case the successful bidder fails to establish / prove the guaranteed values of power consumption (base figure of auxiliary power consumption or the figure quoted by bidder, whichever is higher) on actual performance testing at the manufacturing works / site, penalty @ Rs 584000/- per kW increase in power consumption figure shall be levied.					
Particulars of bidder / authorised representative						
Name	Designation	Signature	Date	Date	Company Seal	