TAMILNADU GENERATION & DISTRIBUTION CORPORATION LIMITED

1X800MW NORTH CHENNAI TPP STAGE –III-BTG

TECHNICAL SPECIFICATION
FOR
OXYGEN DOSING SYSTEM

SPECIFICATION NO.: PE-TS-423-154A-A002

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA

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PROJECT INFORMATION

CHAPTER 2
PROJECT INFORMATION

1.1 GENERAL

TANGEDCO has planned to establish 1X800MW Coal Based Super Critical North Chennai Thermal Power Project Stage III in the premises of existing NCTPS at Ennore & Puzhudhivakkam Village, Ponneri Taluk, Thiruvallur District, Tamil Nadu, India. This project will be executed in two package mode i.e, BTG with related Civil Works and BOP with related Civil Works.

1.2 LOCATION

The proposed site for main power plant is located near Ennore port (approx 5 km) and also 35 km from Chennai City.

The nearest Railway station is at Athipattu Pudunagar (approx 5 km)

All weather road from Pattamandri on the Thiruvotriyur-Ponneri highway is the nearest road access.

The nearest airport is at Chennai at a distance of 60 km.

1.3 PROJECT INFORMATION

1.1	Project Title	:	1 x 800 MW North Chennai Coal Based Super Critical Thermal Power Project Stage III.
1.2	Plant capacity	:	800 MW
1.3	Type of project	:	Brown field
1.4	Owner	:	Tamil Nadu Generation and Distribution Corporation Limited (TANGEDCO)
1.5	Plant site location	:	In the premises of North Chennai Thermal Power Station (NCTPS)
1.6	Location co-ordinates	:	80° 19’ E to 80° 20’ E Longitude 13° 13’ N to 13° 18’ N Latitude
1.7	Nearest Village	:	Ennore & Puzhudhivakkam Village
1.8	Nearest Town & City	:	Chennai (35 Km)
1.9	State Capital	:	Chennai (35 Km)

1.10	Nearest Railway Station	:	Athipattu Pudunagar (~ 5 Km) on Chennai – Vijayawada Line
1.11	Nearest Airport	:	Chennai (~ 60 Km)
1.12	Nearest Seaport	:	Ennore (~ 3 Km)
1.13	Nearest Road access	:	All weather road from Pattamandri on the Thiruvottiyur – Ponneri highway
2.0	**Meteorological Condition**		
2.1	Climate	:	Tropical, very dry and hot summer, dry and cold winter and good rain-fall in monsoon accompanied with strong wind
2.2	Site Elevation	:	(+) 10.0 Meter above Mean Sea Level
2.3	Ambient Temperature		
a.	Annual Maximum Mean Temperature	:	45 ºC
b.	Annual Minimum Mean Temperature	:	15 ºC
c.	Design ambient temperature	:	30 ºC
2.4	Relative Humidity		
a.	Maximum	:	90 %
b.	Minimum	:	36 %
c.	Design	:	75 %
2.5	Annual Rainfall		
	Maximum	:	2540 mm
	Average	:	1600 mm
	Minimum	:	1175 mm
2.6	Basic Design Wind Pressure	:	As per IS: 875 (Latest Edition)

2.7	Wind Speed	:	11.8 kmph (Avg), 50 m/s (max)
2.7	Seismic zone	:	Zone: III as defined in IS:1893-2002
2.8	Design ambient temperature for Electrical equipment	:	50 °C

1.4 ACCESS TO SITE

Site is well connected to all weather road from Pattamandri on the Thiruvotriyur – Ponneri highway. Site is located adjacent to the Chennai – Howrah broad gauge line and thus well connected by rail also.

1.5 PLANT RATING, CAPACITY, AVAILABILITY, PLF

Plant continuous rating will be 800MW at Generator terminals based on the following site conditions.

- Ambient Air temperature
- Condenser cooling water inlet temperature of 33 Deg. C and 9 Deg. C temperature rise across the condenser.
- Generator Power factor of 0.85
- Fuel Specification as given elsewhere
- Design temperature of electrical equipment is 50 Deg. C

The VWO capacity of the steam turbine shall not be less than 105% TMCR flow at rated parameters. Boiler maximum Continuous Rating (MCR) is at least 1.02 times the steam flow at turbine VWO condition plus continuous auxiliary steam requirement of unit at TMCR, rounded to next integer divisible by 5.

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. The plant load factor (PLF) being considered is 85%.

1.6 SOURCES OF FUEL

TANGEDCO has long term linkage of Coal from the coal sources of Talcher or Mahanadi in Orissa. Domestic coal requirement for the power plant will be sourced from kalinga block of the Talcher, Mahanadhi and IB valley coal field.

The Imported coal has been sourced from foreign countries through sea to Ennore port. The coal will be conveyed from port through conveying system.

The steam generator shall be designed for the following conditions:

Best Coal – 100% Imported Coal
Design Coal – 70% Imported & 30% Domestic Coal
Worst Coal – 50% Imported & 50% Domestic Coal

1.7 Coal Analysis

1.7.1 Coal Quality parameter

a) **Domestic Coal**

A. Proximate Analysis			
1.	Total Moisture	%	16.0
2.	Ash	%	45.0
3.	Volatile matter	%	19.0
4.	Fixed Carbon	%	20.0
5.	Gross calorific value (as received basis)	kcal/kg	2800
B. Ultimate Analysis			
1.	Carbon	%	27.7
2.	Hydrogen	%	2.6
3.	Sulphur	%	0.5
4.	Nitrogen	%	0.52
5.	Oxygen	%	7.26
6.	Moisture	%	16.0
7.	Ash	%	45.0
8	HGI		45 -55, Avg 52
9	Carbonates		0.38
10	Phophorous		0.04
11	YGP Index	mg/kg	50-70
12	Shale and Sand stone Content	%	Max 20
13	Feed Coal Size	mm	Upto 50
C	**Ash Fusion Temperature**		
	Initial Deformatiom, IT	Deg. C	1100
	Spherical, ST	Deg. C	1200
	Hemispherical, HT	Deg. C	1300
	Fluid, FT	Deg. C	-
	ASH ANALYSIS		
	SiO2	%	59.54
	Al2O3	%	29.00
	Fe2O3	%	6.42
	CaO	%	1.50
	Na2O	%	0.08
	K2O	%	-
	TiO2	%	1.60
	SO3	%	0.25
	P2O5	%	0.51
	MgO	%	0.50
	Others	%	0.60
	Total		100.00
	Resistivity of Fly Ash	Ohm-cm	1.73 X10^12

b) **Imported Coal**

A. Proximate Analysis			
1.	Total Moisture	%	16.50
2.	Ash	%	6.62
3.	Volatile matter	%	36.45
4.	Fixed Carbon	%	40.43
5.	Gross calorific value (as received basis)	kcal/kg	5642
B. Ultimate Analysis			
1.	Carbon	%	60.12
2.	Hydrogen	%	4.38
3.	Sulphur	%	0.53
4.	Nitrogen	%	1.48
5.	Oxygen	%	10.37
6.	Moisture	%	16.5
7.	Ash	%	6.62
8	HGI		51
9	Carbonates		-
10	Phophorous		-
11	Total		100
C	**Ash fusion temperature**		
	Initial Deformatiom, IT	Deg. C	1230
	Spherical, ST	Deg. C	1270
	Hemispherical, HT	Deg. C	1320
	Fluid, FT	Deg. C	-
	ASH ANALYSIS		
	SiO2	%	36.00
	Al2O3	%	13.90
	Fe2O3	%	14.80
	CaO	%	12.70
	Na2O	%	0.70
	K2O	%	1.70
	TiO2	%	0.80
	SO3	%	10.6
	P2O5	%	0.20
	MgO	%	8.60
	Others	%	-
	Total		100.00

c) The plant should be suitable to accept imported coal sourced from any country. The limiting parameters of imported coal are furnished below :

A. Proximate Analysis			
1.	Total Moisture (ARB)	%	Upto 23 Max
2.	Ash (ADB)	%	6.62
3.	Gross calorific value (as dried basis)	kcal/kg	5800 - 6500
4.	Fixed Carbon(ADB)	%	30 - 50
5.	Volatile Matter (ADB)	%	25 - 45
6	HGI		45 - 60
7	IDT (Under Reducing Atmosphere)	Deg.C	1100 - 1250
3.	Sulphur (ADB)	%	Upto 1 Max
4.	Size	mm	< 50

1.7.2 Specification of LDO

Specific Gravity @ 15° C kg/cu.m	: 0.8348
Gross calorific value, kcal/kg	: 10400
Pour point "°C" max.	: 12
Flash point "°C" min.	: 66
Sulphur % "T" max.	: 0.5
K. Viscosity in Centistokes @ 50° C Max	: 7.5
Ash by wt. %	: 0.01
Water & Sediment content Vol. Max. %	: 0.25
Sediment Max. Content by Wt%	: 0.1
Relevant Indian Standard	: IS 1460

1.7.3 Specification of HFO

Flash point "°C" min.	: 66
Sulphur % "T" max.	: 4.5
Viscosity in Centistokes @ 50° C	: 370
Ash by wt. %	: 0.1
Water content Vol. Max. %	: 1.0
Sediment Max. Content by Wt%	: 0.25
Gross Calorific Value, kcal/kg	: 10800

1.8 Fuel Transportation

The coal shall be received at Ennore port. The coal will be transported by conveyor from coal berth 3 in Ennore Port and then through the conveyor to the coal bunker directly or to coal stockyard.

1.9 SOURCE OF WATER

Source of water for the proposed project is sea water. The intake shall be from the existing cooling water fore bay of NCTPS Stage-II. Treated water shall be provided to the plant cycle makeup and other requirements of BTG package at the respective terminal points. Refer Chapter 4 of this section.

1.10 SOURCE OF EQUIPMENT

The proposed plant will be supplied, erected and commissioned on dual EPC basis, i.e, BTG with related civil works and BOP with related civil works.

1.11 POWER EVACUATION PLAN

1x800MW Steam Generating Units shall be with a SF6 Generator Circuit Breaker [GCB] along with necessary additional items between Generator Transformer [GT] and Generator. Therefore GT shall be used for unit start-up / unit shutdown as well as for power evacuation by synchronization of unit by closing GCB.

Power will be evacuated from the proposed thermal power station at 765 KV voltage level through 765 KV transmission lines. The power evacuation lines would be double circuit 765 KV lines which will act as Line in & Line out circuit.

SECTION – I

SPECIFIC TECHNICAL REQUIREMENTS

SUB-SECTION IA - Specific Technical Requirements (Mech.)

SUB-SECTION IB - Specific Technical Requirements (Elec.)

SUB-SECTION IC - Specific Technical Requirements (C & I)

SUB -SECTION – IA

SPECIFIC TECHNICAL REQUIREMENTS (MECHANICAL)

1.0 SCOPE

This specification is intended to cover design, engineering, manufacture, fabrication, assembly, supply, inspection / testing at vendor's & sub-vendor's works, painting, mandatory spares, startup and commissioning spares, special tools and tackles (as applicable), forwarding, proper packing, shipment and delivery at site, preparation and submission of drawing /documents & equipment / system guarantee etc. as specified hereinafter for **1X800 MW COAL BASED NORTH CHENNAI TPP STAGE –III-BTG**.

Two numbers skid for each unit shall be provided for oxygen dosing system (one number for dosing at CPU outlet and one number for dosing at deaerator outlet).

Location of all Oxygen dosing systems inside TG hall 0.0 M. Please refer TG equipment layout drawing at ground floor (at EL 0.0M) BHEL DRG. No. PE-DG-423-100-M003.Location of oxygen dosing skids shall be b/w B row & C row and b/w column no. 6a & 7a.

Broad scope of work of this package includes all equipment and accessories. Please also refer C&I section for C&I scope.

The Oxygen dosing system as specified in Technical Specification shall consist of the followings and shall be in bidder's scope of supply:

- Entire Oxygen dosing system mounted on skid (4nos.) as per P&IDs and Data Sheet-A.
- Instrumentation (minimum) as per the enclosed P&ID.
- Start-up & commissioning spares as required, mandatory spares as specified.
- Racks (1 No.) to hold 30 cylinders, cylinders (30 Nos.), injector assemblies (4 nos.), tees (10 nos.), elbows (10 nos.), loose tubing (200 meter), compression fittings (40 nos.) for loose tubing.
- Required tubing length & fittings for interconnection of oxygen dosing skid for dosing at CPU outlet with stand by skid for oxygen dosing at CPU outlet shall be supplied loose.
- Required tubing length & fittings for interconnection of oxygen dosing skid for dosing at Deaerator outlet with stand by skid for oxygen dosing at Deaerator outlet shall be supplied loose.
- Foundation nuts & bolts to fix each skid on the floor, as required.

Remarks: Redundancy of 100% of oxygen dosing system has to be considered, hence total 4 nos. Oxygen dosing skid shall be supplied for 1X800 MW COAL BASED NORTH CHENNAI TPP STAGE - III. For standby skids please refer the P&ID of oxygen dosing system (Stand by Skid for dosing at CPU Outlet) & P&ID of oxygen dosing system (Stand by Skid for dosing at Deaerator Outlet).

1.1 SCOPE OF SERVICES

The bidder's scope also includes following services for scope under this specification:-

- ✓ Design and engineering.
- ✓ Fabrication of the skid mounted oxygen dosing system.
- ✓ Painting as per the enclosed painting schedule. However, any variation in the painting schedule as finally approved by customer shall be taken care by the bidder without any commercial and delivery implication. Color-coding scheme shall be intimated to vendor during detailed engineering.
- ✓ Inspection and testing of the skid as per the approved quality assurance plan.
- ✓ Supply of the skid mounted oxygen dosing system up to the power plant site along with all accessories as defined in the technical specification.

1.2 CIVIL SCOPE

Nil.

2.0 OXYGEN DOSING SYSTEM: (4 SKIDS PER UNIT; TOTAL= 4 SKIDS)

(Refer Drawing. No. PE-DG-423-154-12000A-A001)

One skid of Oxygen Dosing System consists of the following:-

- ✓ One number of bank of two oxygen cylinders, dosing at downstream of Deaerator/ CPU outlet.
- ✓ Two number of Pressure Regulator as per Sub-Section IA & IIA and Data Sheet – A.
- ✓ Associated Piping, valves, fitting as indicated in the P&ID of oxygen dosing system and Data Sheet-A enclosed and as required to make the system complete.
- ✓ Control & instrumentation as per P&ID of Oxygen Dosing System, Data sheet-A, Section I-C and II-C.

3.0 TERMINAL POINTS

i. All field instruments (pressure and flow transmitters), solenoid valves and MFC shall be terminated at JB by the oxygen dosing vendor for further connection to DCS by BHEL/ Customer.

ii. All vent connections shall be connected via vent header and terminated at one point of the skid for further connection to atmosphere, if required, by BHEL.

iii. Dosing termination point shall be after MFC and terminated at one point by the oxygen dosing supplier for further interconnection till dosing locations by BHEL/ Customer.

iv. 24 V-DC connection to SV-3, SV-4 and SV-5 shall be directly connected by BHEL/ Customer.

4.0 QP AND SUB VENDOR APPROVAL

4.1 The quality assurance plan is enclosed elsewhere in technical specification. However requirement of detailed QP, inspection checklist, certificate of conformance etc. for each equipment and sub-vendor shall be finalized during detailed engineering stage; decision of BHEL/ customer shall be binding on vendor in this regard. Any changes/ additional tests insisted upon by Owner during approval of QAP's shall be accepted by bidder without any commercial and delivery implication to BHEL/ Customer. Bidder shall submit the quality plans in BHEL format during detailed engineering stage. Bidder to note further that during detailed engineering all the QAP's/ check lists etc. shall be submitted to Customer/ BHEL for approval. All inspection & testing etc. shall be carried out accordingly.

4.2 The sub vendor list (Annexure- II) enclosed is indicative only and is subject to approval/ acceptance by customer. Bidder to propose his sub vendor list with back up documents (experience list, end user performance certificate as applicable) etc. The same shall subject to BHEL and Customer approval during detailed engineering stage without any commercial & delivery implication to BHEL/ Customer.

5.0 DOCUMENTS TO BE SUBMITTED BY BIDDER ALONG WITH THE BID

BIDDER SHOULD SUBMIT THE SIGNED AND STAMPED COPY OF THE FOLLOWING DOCUMENTS:

- Deviation, if any in the enclosed Schedule of deviation with cost of withdrawal only with mention of specification clause for which deviation is being asked. (Stamped & Signed).
- Compliance certificate (stamped & signed).
- Price Schedule duly filled in (stamped & signed).
- List of Recommended spares, if any (stamped & signed).

Note: Any other documents submitted by bidder except as asked in the bid's specification shall not be evaluated & considered as null & void.

6.0 DRAWING/ DOCUMENTS REQUIREMENT

For the drawings/ documents submission schedule, please refer ANNEXURE-III.

For the drawings/ documents submission procedure, please refer ANNEXURE-VI. The bidder has to submit the revised drawing/ document along with the compliance sheet indicating enumerate reply to all BHEL and customer comments or observations. Without compliance sheet the submission of the

drawings/documents will not be considered and the delay on this account will be solely on bidder's side only. Bidder to comply with the observations of the BHEL and CUSTOMER without price & delivery implication.

7.0 SPARES

7.1 All the spares for the equipment under the contract provided by the vendor will strictly conform to the specifications and documents and will be identical to the corresponding main equipment/ components supplied under the contract.

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

8.0 MANDATORY SPARES

8.1 The list of mandatory spares considered essential by the BHEL & Customer is indicated in Annexure- V.

8.2 All mandatory spares shall be delivered at site at least two months before scheduled date of initial operation of the first unit. However, spares shall not be dispatched before dispatch of corresponding main equipments.

8.3 Wherever quantity is specified both as a percentage and a value, the Bidder has to supply the higher quantity until and unless specified otherwise.

8.4 The Bidder shall note that if there in any change/ variation in equipment / system during detail engineering which causes any change/ variation in the essential spares quantity, the same shall be supplied without any commercial implications. The price indicated for the mandatory spares shall be considered for the purpose of evaluation.

9.0 START-UP AND COMMISSIONING SPARES

Start-up and Commissioning spares are those which would be required during plant or equipment testing, start-up and commissioning. All spares used until the plant is finally handed over by the Contractor to the Owner come under this category. Commissioning spares if deemed necessary by the bidder for commissioning of oxygen dosing skids shall be supplied by the bidder as a part of base offer. List of commissioning spares quoted for and individual price break up of the same shall be submitted separately.

10.0 RECOMMENDED SPARES

10.1 Bidders shall furnish a recommended spare parts schedule which the Bidder considers necessary and which has not been specified in the list of mandatory spares for the normal and trouble free plant operation for 3 years operation along with their offer for all equipment under the scope. The list of spares shall include such spares which are to be stored to achieve the plant availability level indicated by the bidder. The unit price of each recommended spares shall be indicated separately and shall not be quoted along with the lumpsum price. The price indicated for the recommended spares shall not be considered for the purpose of evaluation.

10.2 All spares supplied under this contract shall be strictly interchangeable with the parts for which they are intended to be replacements. The spares shall be treated and packed for long storage under climatic conditions prevailing at the site, e.g. small items shall be packed in sealed transparent plastic bags with desiccator packs as necessary.

11.0 MAINTENANCE TOOLS AND TACKLES

- One set of all special tools shall be furnished and shipped with each piece of equipment for dismantling, maintenance, adjustment, and calibration of the equipment. The tools shall be shipped in separate heavily constructed wooden boxes provided with hinged covers and padlock hasps.
- The Contractor shall supply under this contract all maintenance tools for each piece of equipment/ system and it shall be boxed separately and the boxes shall be appropriately marked for shipment and identification of contents.
- A weather-proof itemized list of the contents shall also be attached to the outside of each

container.

- The maintenance tools shall include all special handling rigs, bars, slings, cable and all specialized equipment for control system maintenance such as extender boards, scopes, and all software and hardware. Further, Bidder shall also include a full set of regular maintenance tools and tackles required. Bidder shall also include all maintenance tools and tackles in their scope. Total price of all the maintenance tools and tackles shall be included in the quoted lump sum price.

12.0 PACKING

To prevent damage to any equipment/ item of the skid during transit, wooden/ angle iron/ steel frame supports to be provided wherever required. Special attention shall be provided while packing and loading for overhead equipment.

Bidder shall submit the packing details during detailed engineering for approval. Any changes required in packing details shall be complied by the bidder without any price and delivery implication.

13.0 PAINTING

Bidder to note that painting shall be as per approved painting schedule to be finalized during detailed engineering. However the same shall be prepared in line with the schedule enclosed in Section IA/ Annexure-IV.

14.0 OTHER DESIGN REQUIREMENTS

Bidder to note that other design requirement of the Oxygen dosing skids shall be as below: -

- All the terminal points shall be easily accessible and towards one side of skid.
- All valves shall be easily accessible for the operator.
- All equipment shall have SS name plate clearly indicating the equipment name.
- Tube fittings of the system shall be done using elbows and tees. Tube bending is not acceptable.
- All JBs shall be mounted in their respective dosing skids only.
- MFC with **flow indicator** facility shall be provided to check the actual flow rate dosed in the field.MFC shall also be mounted in an enclosure. DOP of enclosure shall be IP-65 minimum. Other technical requirements of this enclosure shall be in line with JB details indicated elsewhere in the specification.
- All cylinders supplied should conform to “Gas Cylinder Rules, 2004” and CCE license for the same shall be arranged by the bidder.
- All items supplied for the oxygen dosing systems shall be suitable for oxygen service. Bidder shall provide the certificates indicating items are oxygen cleaned or suitable for oxygen service.

15.0 MISCELLENEOUS REQUIREMENTS

- Finish paints for touch-up painting of equipment after erection at site in sealed container.
- Document approval by Customer/ BHEL 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 and BHEL 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 after approval of the corresponding drawing, any delay in approval of revised drawing shall be to vendor’s account and shall not be used as a reason for extension in contract completion. However, in case changes are necessitated due to any constraints at Customer/BHEL end, delay in review/ approval of drawing beyond one month will be to Customer/BHEL account.

- Relevant requirements as per GTR, GCC, ECC & SCC. Any statutory requirement / clearance required for the packages from government / local body shall be in bidder's scope.
- In case of any conflict and repetition of clauses in the specification, the more stringent requirements among them are to be complied with.
- Vendor to attend regular engineering meeting with BHEL and Customer fortnightly in BHEL or Customer office as decided during detail engineering. Vendor will depute his entire concerned Engineering representatives along with the project manager for discussion and approval. Meeting can be held at site also.
- Latest version of all codes and standards to be followed.
- For detailed dispatch instructions, Bidder to refer special condition of contract (SCC) of the project.

ANNEXURE I

QUALITY PLAN FOR OXYGEN DOSING SYSTEM

		MANUFACTURER'S NAME & ADDRESS :		MANUFACTURING QUALITY PLAN				PROJECT PACKAGE CONTRACT NO. MAIN SUPPLIER BHEL QP. NO NTPC QP. NO	: OXYGEN DOSING SYSTEM : BHEL/PEM/NOIDA				
				ITEM: OXYGEN DOSING SYSTEM SUB - SYSTEM : DEAERATOR & CEP DISCHARGE DOSING		PSI QP. NO : REV. : DATE : PAGE :							
S.NO.	COMPONENTS/ OPERATION	CHARACTERISTICS CHECKED	CATEGORY	TYPE/ METHOD CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORDS		AGENCY**			REMARKS
										M	C	N	
1	2	3	4	5	6	7	8	9	D*	10			11
1.0	**WELDER'S QUALIFICATION**												
1.1	WELDING PROCEDURE SPECIFICATION (WPS)	CORRECTNESS	MA	SCRUTINY	100%	ASME IX	ASME IX	QW 482		P	V	V	
1.2	WELDER PERFORMANCE & PROCEDURE QUALIFICATION RECORD	WELD SOUNDNESS & WELDING PERFORMANCE	MA	PHYSICAL TEST	100%	ASME IX	ASME IX	QW 483 & QW 484		P	V	V	
2	EMPTY OXYGEN CYLINDER	MTC, HYDRO TEST & RELEVANT TESTS AS PER IS 7285	MA	IS 7285	100%	APPROVED DATASHEET	AS PER APPROVED DATASHEET	MFRS CERTIFICATE		P	V	V	
3	VALVES (BODY & BONNET)	MATERIAL	MA	--	100%	APPROVED DATASHEET	AS PER MODEL DECODIFICATION MENTIONED IN MFRS CATALOGUE	MANUFACTURERS COC		P	V	V	
4	INSTRUMENTS												
4.A	PRESSURE GAUGE	MOC FOR WETTED PARTS, CALIBRATION & BOURDON OVER PRESSURE PROTECTION & TYPE	MA	MEASUREMENT	1/TYPE	APPROVED DATASHEET	AS PER APPROVED DATASHEET	MFRS CERTIFICATE		P	V	V	
4.B	PRESSURE TRANSMITTER	CALIBRATION, OVER LOAD PROTECTION & TYPE TEST CERTIFICATE	MA	MEASUREMENT	100%	APPROVED DATASHEET	AS PER APPROVED DATASHEET	MANUFACTURERS COC		P	V	V	
5	SOLENOID VALVES	MATERIAL	MA	VISUAL	100%	APPROVED DATASHEET	AS PER MODEL DECODIFICATION MENTIONED IN MFRS CATALOGUE	MANUFACTURERS COC		P	V	V	
6	CYLINDER PRESSURE REGULATOR	MATERIAL	MA	VISUAL	100%	APPROVED DATASHEET	AS PER MANUFACTURERS CATALOGUE	MANUFACTURERS COC		P	V	V	
7	TERMINATION BOX	COUNTUNITY,IR-HV-IR & DEGREE OF PROTECTION	MA	ELECTRICAL	100%	APPROVED DATASHEET	AS PER APPROVED DATASHEET	MFRS COC & INSPECTION REPORT		P	V	V	
8	TUBING	CHEMICAL & PHYSICAL	MA	CHEMICAL & PHYSICAL TEST	100%	APPROVED DRAWING DATASHEET	APPROVED DRAWING DATASHEET	LAB REPORT		P	V	V	
9	MASS FLOW CONTROLLER	CALIBRATION REPORT	MA	ELECTRICAL	100%	APPROVED DRAWING & DATASHEET	APPROVED DRAWING & DATASHEET	CALIBRATION REPORT		P	V	V	
10	FITTING	MATERIAL	MA	VISUAL	100%	APPROVED DRAWING	AS PER MODEL DECODIFICATION MENTIONED IN MFRS CATALOGUE	MANUFACTURERS COC		P	V	V	
11	FINAL ASSAMBLY	DIMENSION, ORIENTATION & COMPLETENESS.	MA	MEASUREMENT	100%	APPROVED DRAWING	APPROVED DRAWING	INSPECTION		P	W	W	
	FAT	LEAKAGE		N2 FILL FOR 2HR	100%	APPROVED DRAWING / FACTORY ACCEPTANCE TEST	NO LEAKAGE	INSPECTION REPORT		P	W	W	
12	POWDER COATING STAMPING	DFT MEASUREMENT	MI	VISUAL	100%	NTPC APPROVED PAINTING SCHEME				P	W	V	
13	PMI Test for SS	GRADE CONFIRMATION	MA	CHEM.TEST	100%	BHEL APPD.DATA SHEET/DWG	BHEL APPD.DATA SHEET/ DWG	INSPECTION REPORT		P	W	W	

NOTES: ALL INSTRUMENTS SHALL BE OXYGEN CLEANED AND SUITABLE FOR OXYGEN SERVICE. MANUFACTURERS COC CERTIFYING THE SAME REGARDING OXYGEN CLEANED SHALL BE SUBMITTED FOR REVIEW DURING FINAL INSPECTION.

		LEGEND : * RECORDS IDENTIFIED WITH "TICKS" SHALL BE ESSENTIALLY INCLUDED BY CONTACTION IN QA DOCUMENTATION. ** **M** : MANUFACTURER/SUB-CONTRACTOR **C** : BHEL, N:NTPC INDICATE **"P"** PERFORM, **"W"** WITNESS, AND **"V"** VERIFICATION AS APPROPRIATE, "CHP" SHALL BE IDENTIFIED IN COLUMN **"N".**		**DOC NO.** / **REV :** / **CAT :**
MANUFACTURER/ SUB SUPPLIER	**MAIN SUPPLIER**		**FOR CUSTOMER USE**	
SIGNATURE				**REVIEWED BY** / **APPROVED BY** / **APPROVAL SEAL**

TEST PROCEDURE FOR OXYGEN DOSING SYSTEM

- A Factory Acceptance Testing will be conducted at vendor's Factory. This will be for verification of the functional performance of critical equipment/instruments and hardware design when run at design pressure, temperature and flow.
- FAT will be carried out using **only the inert gas** such as **Nitrogen.** Following will be the FAT protocol.
- Checking the completeness of the system. This will include visual inspection of equipment and instruments as per the P & ID s & GA along with skid after assembling on skid.
- Soap joint leak test of tubing/fittings/valves using nitrogen at 1.25 times of maximum operating pressure.
- **(ANSI B31.8),** for 2 hours. The allowable pressure drop would be up to 0.5 bar over 2 hours.
- Functional testing of calibrated components (equipment/ instruments) using nitrogen. The test controller will be connected to Mass flow controller. The set point will be given from test controller & this will be monitored.
- Testing of Assembly of skid, instruments, termination box will be done by BHEL as per approved Quality Assurance Plan.
- Inert test run using nitrogen to demonstrate flow.
- Final Assembly & Factory Acceptance Test will be witnessed by BHEL & CUSTOMER.

ANNEXURE – II

SUB VENDOR LIST (INDICATIVE)

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
1.	FILLING OF OXYGEN CYLINDER	FILLING OF EMPTY CYLINDERS MAY BE DONE FROM ANY CCE LICENSED OXYGEN GAS FILLER	AS APPLICABLE	
2.	EMPTY OXYGEN CYLINDERS	BPCL	ALLAHABAD	
		EVEREST KANTO	BOMBAY	
		MARUTI KOATSU CYLINDER LTD	HALOL, GUJARAT	
3.	CHECK VALVE/BALL VALVE/	HAMLET	USA	
		SWAGELOK	USA	
		PARKER	USA	
4.	VALVE MANIFOLD	HAMLET	USA	
		EXCEL HYDRO	MUMBAI	
		SCHNEIDER	GERMANY	
		HY LOK	KOREA	
		DK TECH	KOREA	
		ANDERSON GREENWOOD	USA	
		ASLACH	MUMBAI	
		HP VALVE AND FITTING	CHENNAI	
		HYD AIR	LONAVLA	
		FLUID CONTROL	MUMBAI	
		MICRO PRECISION	FARIDABAD	
		PARKER	USA	
		SWAGELOK	USA	
		BALDOTA	MUMBAI	
5.	PRESSURE REDUCING VALVE	TESCOM	USA	
		SWAGELOK	USA	
6.	TUBING	SWAGELOK	USA	
		HAMLET	USA	
		PARKER	USA	
		SANDVIK	USA	
		VIKAS INDUSTRIAL PRODUCTS	NOIDA	
7.	NEEDLE VALVE & PRESSURE SAFETY VALVE	SWAGELOK	USA	
		HAMLET	USA	
		PARKER	USA	
8.	SOLENOID VALVE	ROTEX	BARODA	
		AVCON	MUMBAI	
		ASCO	CHENNAI	
		SMC	NOIDA	
		NUCON	HYDERABAD	
9.	3 WAY VALVE	HI TECH	AHMEDABAD	
		ADVANCE VALVES PVT.LTD	NOIDA	
		BDK	HUBLI	
		FOURESS ENGG.INDIA LTD.	MUMBAI	
		FLUIDLINEVALVES COMPANY PRIVATE LTD.,	MUMBAI	
		INSTRUMENTATION LTD.	PALAKAD	
		KIRLOSKAR BROTHERS LTD.	PUNE	
		VENUS PUMP & ENGG. WORKS	KOLKATA	
		SURYA VALVES AND INSTRUMENTS MANUFACTURING COMPANY	CHENNAI	
		STAFFORD CONTROLS LIMITED	PUNE	
		MICON VALVES (INDIA) PVT.LTD	MUMBAI	
10.	PAINT	ASIAN PAINTS (I) LTD.		

		BERGER PAINTS INDIA LTD		
		GOODLASS NEROLAC		
		JENSON & NICHOLSON (I) LTD		
		CDC CARBOLINE (I) LTD.		
		SHALIMAR PAINTS LTD.		
		ADDISON PAINTS LTD		
		GRAND POLYCOAT		
		BOMBAY PAINTS		
		HEMPLE PAINTS (SINGAPORE)		
		JOTUN PAINTS		
11.	STRUCTURE STEEL	SAIL		
		TISCO		
		JINDAL		
		BHUSWAL		
12	MASS FLOW CONTROLLER	BROOK'S (EMERSON)		

LIST OF C&I VENDORS

Sl No	Package Name	Supplier Name	Supplier Communication Address	Supplier Works Address
1	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	BOSE PANDA INSTRUMENTS PVT.LTD.	Mr. Partha Bose 44, Saheed Hemanta Kumar Bose, Sarani, Kolkata Phone- +91 33 2548 7220 Pincode : 700074 Email : parthabosebpi@gmail.com; bosepanda@vsnl.net	Works-1->Mr. Partha Bose 44, Saheed Hemanta Kumar Bose,Sarani, -Kolkata-WEST BENGAL India Phone- +91 33 2548 7220 FAX : +91 33 2548 0429, Pincode : 700074 Email : parthabosebpi@gmail.com bosepanda@vsnl.net
2	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	A.N. INSTRUMENTS PVT. LTD.	MARKETING DIVISION, 5th FLOOR, 59-B, CHOWRINGHEE ROAD, KOLKATA Phone- 24757784,22472509 Pincode : 700020 Email : anidel@bol.net.in	Works-1->Mr. Gautam Mukherjee Kusumba,Sonarpur Station Road,P.O. -Narendrapur, -Kolkata-WEST BENGAL INDIA Phone- 9836878855 FAX : 033-24342748 Pincode : 700103 Email : gkm_ani@hotmail.com
3	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	PRECISION MASS PRODUCTS PVT. LTD.	Mr. Nishit Patel/Mr. Anuj Verma Plot No.2306, Phase II, GIDC Chhatral Kalol Phone- 9999464663 Pincode : 382729 Email : sales@precisionmass.com	Works-1->Mr. Hitesh Parmar/Mr. Hitesh Parmar Plot No.2306, Phase II, GIDC Chhatral, -Kalol-GUJARAT INDIA Phone- 9327359227 FAX : 02764-233440 Pincode : 382729 Email : hitesh.parmar@ashcroftindia.com
4	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Baumer Technologies India Pvt. Ltd.	Mr. Shyam Warilani/Mr. V Suresh Babu 36, DAMJI SHAMJI INDUSTRIAL COMPLEX, OFF.-MAHAKALI CAVES ROAD, ANDHERI(E) MUMBAI Phone- +91 99589 25151 Pincode : 400093 Email : sales.in@baumer.com	Works-1->Mr. Shyam Warilani/Mr. V Suresh Babu Plot No 34 À GIDC À Phase 1, -VAPI-GUJARAT INDIA Phone- +91 11 4161 7111 FAX : 022 2687 3613 Pincode : 396 195 Email : pbajaj@baumer.com
5	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	H.GURU INSTRUMENTS (SOUTH INDIA) P. LTD	32,INDUSTRIAL SUBURB YESWANTHAPUR BANGALORE Phone- 080-23370300, Pincode : 560022 Email : info@hgurusouth.com	Works-1->Shikha Hazra/ Shyamal Hazra 32, Industrial Suburb,Yeshwanthpur -BANGALORE-KARNATAKA INDIA Phone- 080-23370300 FAX : 080-23379890 Pincode : 560022 Email : shikhahazra@hgurusouth.com
6	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	FORBES MARSHALL (HYD) LTD.	MR SAILESH PATALAY/MR. M K SRINIVASAN PLOT NO.A-19/2, & T-4/2, IDA, NACHARAM, HYDERABAD Phone- 9849913704 Pincode : 500 076 Email : mksrinivasan@forbesmarshall.com	Works-1->MR G.SRINIVASAN/MR ANUJ MALPANI PLOT NO:A-19/2 & T-4/2,I.DA. NACHARAM , -HYDERABAD-TELANGANA INDIA Phone- 09866550762 FAX : 040 27152193 Pincode : 560076 Email : gshrinivasan@forbesmarshall.com

7	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	H.GURU INDUSTRIES	Mr. G. D. Hazra/Mr. P. K. Mitra 10 B, HO-CHI-MINH SARANI, KOLKATA Phone- 033 2282 2463 / 1637 Pincode : 700071 Email : mguru@vsnl.net	Works-1->NA NA -- Phone- FAX : Pincode : Email :
8	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	GAUGE BOURDON INDIA PVT. LTD.	194/195, Gopi Tank Road, Off Pandurang Naik Marg, Mahim Mumbai, Phone- 011-41607463, Pincode : 400016, Email : gicdelhi@general-gauges.com,	Works-1->Gauge Bourdon India Pvt. Ltd., Plot No-4, 5, 6,Jawahar Co-operative Industrial Estate, -Kalamboli Taluka Panvel-MAHARASHTRA India Phone- 022-27421095, FAX : 022-27421901, Pincode : 410209, Email : info@general-gauges.com
9	TRANSMITTERS	Moore Industries International Inc.	Leonard.W. Moore/ Matt Moren 16650 Schoenborn St. North Hills Phone- +1 818 830 5548 Pincode : 91343 Email : mmoren@miinet.com	Works-1->Matt Moren/Gina Cruz 16650 Schoenborn St., North Hills -CALIFORNIA- USA Phone- +1 818 894 7111, ext FAX : +1 818 830 5588 Pincode : 91343 Email : gcruz@miinet.com
10	TRANSMITTERS	TOSHNIWAL INDUSTRIES PVT. LTD.,	Industrial Estate, Makhupura, Ajmer, Phone- 9352009000, Pincode : 305002, Email : info@tipl.com,	Works-1-> Khasra No.: 218-230& 235, Industrial Estate,Makhupura, -Ajmer-RAJASTHAN India Phone-9887865856, FAX : 0145-2695174, Pincode : 305002, Email : rajeev.gupta@tipl.com
11	TRANSMITTERS	Endress + Hauser (India) Pvt. Ltd.,	Mr. Prakash Vaghela 215-216, DLF Tower 'A', Jasola District Centre, New Delhi, Phone-9717593001, Pincode : 110025, Email : prakash.vaghela@in.endress.com,	Works-1-> M-171 to 173, MIDC, Waluj, -Aurangabad-MAHARASHTRA India Phone-9881000474, FAX : 0240-2555179, Pincode : 431136, Email : Narendra.Kulkarni@wetzer.endress.com
12	TRANSMITTERS	PANAM ENGINEERS	Mr. Santosh Shukla 203, Jaisingh Business,Parsiwada, Sahar road,Andheri(East), Mumbai, Phone- 9892179529, Pincode : 400099, Email : santosh@panamengineers.com,	Works-1->Mr. Santosh Shukla Others R-628,TTC Industrial Area, MIDC Rabale, -Navi Mumbai-MAHARASHTRA India Phone-9821350761, FAX : 022-27695559, Pincode : 400701, Email : sales@panamengineers.com
13	TRANSMITTERS	V. AUTOMAT & INTRUMENTS (P) LTD.	Mr. R. K. BASSI/Mr. PRAVEEN KUMAR F-61, OKHLA INDL.AREA, PH-1 NEW DELHI Phone- 9810005826 Pincode : 110 020 Email : sales@vautomat.com	Works-1->Mr. BHAGWAN SINGH/ Mr. NANDAN SINGH F-61, OKHLA INDL.AREA,PHASE-I -NEW DELHI-DELHI INDIA Phone-011-47627200 Extn. 3 FAX : 011-26819440 Pincode : 110 020 Email : production@vautomat.com

14	TRANSMITTERS	ABB LIMITED	MR. RAJIV GOVIL 14, MATHURA ROAD, FARIDABAD Phone- 09971085678 Pincode : 121003 Email : vipin.swami@in.abb.com	
15	TRANSMITTERS	YOKOGAWA INDIA LIMITED,	PLOT NO.96, ELECTRONICS CITY COMPLEX, HOSUR ROAD, BANGALORE, Phone- 080-41586000, Pincode : Email : uday.shankar@in.yokogawa.com,	Works-1-> PLOT NO.96, ELECTRONICS CITY COMPLEX, HOSUR ROAD, -BANGALORE-KARNATAKA INDIA Phone- 080-41586000, FAX : 080-28521442, Pincode : Email : uday.shankar@in.yokogawa.com
16	TRANSMITTERS	Honeywell Automation India Limited	Mr. Ritwij Kulkarni 917, INTERNATIONAL TRADE TOWER, NEHRU PLACE, NEW DELHI Phone- 9890200584 Pincode : 110019 Email : rajesh.chaudhary@honeywell.com	Works-1->Mr.Kedar Tillu 53, 54, 56 & 57,Hadapsar Industrial Estate -PUNE-MAHARASHTRA INDIA Phone- 9665034625 FAX : 020 66039905 Pincode : 411013 Email : kedar.tillu@honeywell.com
17	TRANSMITTERS	SIEMENS LIMITED	Dr. Armin Bruck/Sandeep Mathur 130, Pandurang Budhkar Marg Worli Mumbai Phone- 0124 383 7377 Pincode : 400018 Email : ankit.varshney@siemens.com	Works-1->Ankit Varshney Kalwa Works, Thane-Belapur Road, Thane, -MUMBAI-MAHARASHTRA INDIA Phone- FAX : Pincode : 400708 Email :
18	TRANSMITTERS	EMERSON PROCESS MANAGEMENT (INDIA) PVT.LTD.	Mr. Amit Paithankar/Vikram Raj Singh 206-210,BALARAMA BUILDING 2ND FLR. BANDRA EAST MUMBAI Phone- 9619121500 Pincode : 400051 Email : vikramraj.singh@emerson.com	Works-1->Kalpesh Chandan/Hrishikesh Aghor Plot No. A 145/4 TTC IND AREA,MIDC, PAWANE, -NAVI MUMBAI-MAHARASHTRA INDIA Phone- 9619688001 FAX : 022-66736000 Pincode : 400 705 Email : Kalpesh.chandan@emerson.com
19	TRANSMITTERS	SMART INSTRUMENTS LTD, BRAZIL	Agents: Digital Electronic Ltd. 74/11 'C' Cross Road MIDC Andheri (East) MUMBAI Phone- 28208477 Pincode : 400093 Email : corp@delbby.rpgms.ems.vsnl.net.in	
20	JUNCTION BOX	FLEXPRO ELECTRICALS PVT. LTD.	Mr. Dineshbhai Zaveri C-1/ 27&37, GIDC, Kabilpore, Navsari Phone- 02637-265140,265003 Pincode : 396424 Email : flexpro@flexproltd.com	Works-1->Mr. Dineshbhai Zaveri CEO C-1/ 27&37, GIDC, Kabilpore, -Navsari-GUJARAT INDIA Phone- 02637-265140,265003 FAX : 02637-265308 Pincode : 396424 Email : flexpro@flexproltd.com

21	JUNCTION BOX	Shrenik & Company,	Mr. Mitesh Shah/Mr. Pulin Shah 39 A/3 ,Panchratna Industrial Estate, Sarkhej-Bavla Road Ahmedabad Phone- 9825024921 Pincode : 382213 Email : sales@pustron.com, pulin@sumip.com	Works-1->Mr.Pulin Shah/ Mr. Kaloesh Parmar 39 A/3 ,Panchratna Industrial Est,Sarkhej-Bavla Road, Changodhar - Ahmedabad-GUJARAT INDIA Phone- 98250 80339 1 FAX : 079-26932424 Pincode : 382213 Email : sales@sumip.com
22	JUNCTION BOX	K.S.INSTRUMENTS PVT.LTD.	S Raghavan No. 72, 3rd Main, 1st Stage Industrial Suburb, Yeshwanthpur Bangalore Phone- 9880385770 Pincode : 560022 Email : sales1@ksinstruments.net	
23	JUNCTION BOX	SUCHITRA INDUSTRIES	NO-2,OPP-27 AECS LAYOUT 2ND STG REJAMAHALVILAS EXTN 2ND STG BANGALORE Phone- Pincode : Email : suchitra.industriesblr@gmail.com	Works-1->B. Srinivas Suchitra Industries, Opp No 53, Muneshwara Black Devinagar, Lottagal hal -BANGALORE-KARNATAKA INDIA Phone- 080-23511247 FAX : Pincode : 560094 Email : suchitra_industries@yahoo.com
24	JUNCTION BOX	AJMERA INDUSTRIAL & ENGINEERING WORKS	JIGNESH MAHENDRA AJMERA DENA BANK BLDG.,SHREE NAGESH INDL. ESTATE,STATION ROAD, MUMBAI Phone- 022 67973578 Pincode : 400 088 Email : ajmera@ajmera.net, jmajmera@yahoo.com	Works-1->JIGNESH MAHENDRA AJMERA DENA BANK BLDG., SHREE NAGESHINDL. ESTATE,STATION ROAD, - MUMBAI-MAHARASHTRA INDIA Phone- 022 67973578 FAX : Pincode : 400 088 Email : ajmera@ajmera.net

NOTE:

1. THE SUB VENDOR LIST ABOVE IS INDICATIVE ONLY AND IS SUBJECT TO BHEL AND CUSTOMER APPROVAL DURING DETAILED ENGINEERING STAGE WITHOUT ANY COMMERCIAL & DELIVERY IMPLICATION TO BHEL.

   BIDDER TO PROPOSE SUB VENDOR WITHIN 4 WEEKS OF PLACEMENT OF LOI. THEREAFTER NO REQUEST FOR ADDITIONAL SUB-VENDOR SHALL BE ENTERTAINED.

2. DEALERS ARE NOT ACCEPTABLE FOR ANY ITEM OF THE PACKAGE. BIDDER SHALL PROCURE ALL ITEMS INCLUDING PLATES, STRUCTURAL, FLANGES; COUNTER FLANGES ETC. FROM APPROVED SUB VENDOR ONLY.

3. THE INSPECTION CATEGORY WILL BE INTIMATED AFTER AWARD OF CONTRACT BY BHEL/CUSTOMER. HOWEVER THE SAME WILL BE ADHERED BY THE BIDDER WITHOUT ANY COMMERCIAL AND DELIVERY IMPLICATION TO BHEL/ CUSTOMER.

ANNEXURE III

DRAWING DOCUMENTS DISTRIBUTION SCHEDULE

ANNEXURE -III

S. NO.	DESCRIPTION OF MANUALS	NO OF PRINTS (sets)	NO. OF CD-ROMs (sets)
1	PLANT DEFINITION MANUAL-	-	3 CD-ROMs
2	Drawings "FOR APPROVAL"	10	Soft Copy
3	Drawings "FOR INFORMATION"	10	Soft Copy
4	Drawings "FINAL APPROVED DRAWING"	8	Soft Copy
5	Drawings "AS BUILT "	8	3 CD-ROMs
6	DATASHEETS,DESIGNCALCULATIONS,PURCHASE SPECIFICATIONS, etc. and Other type of documents		
	i) For Approval	10	Soft Copy
	ii) FINAL	8	3 CD-ROMs
	iii) Analysis reports of equipment/ piping/ structures components/ systems employing software packages as detailed in the specifications		
	a) Input	10	Soft Copy
	b) Output	10	Soft Copy
	c) Drawings/ Sketches	10	Soft Copy
7	Erection manual "FINAL"	8	3CD ROMS
8	Operation & Maintenance manual	10	3CD ROMS
9	Plant Hand Book "DRAFT"	6	SOFT COPY
10	Plant Hand Book "FINAL"	15	3CD ROMS
11	Commissioning and Performance Procedure manual	10	3CD ROMS
12	Performance and Functional Guarantees test report	6	3CD ROMS
13	Progress Reports	6	3CD ROMS
14	Project completion report	10	3CD ROMS
15	QA programme including Organization for implementation and QA system manual (with revision-servicing)	1	3CD ROMS
16	Vendor details in respect of proposed vendors including Bidder's evaluation report.		
17	Manufacturing QPs, Field QPs, Field welding schedules and their reference documents like test procedures, WPS, POR etc.		
	i) For review/comment	3	
	ii) For final approval	4	1 set CD ROMS
18	Welding Manual, Heat Treatment Manuals	4	
	Storage & preservation manuals Final Final	4	2 CD ROMS
19	Monthly Vendor Approval and QP approval status	2	1 CD ROM
20	QA Documentation Package for items / equipment manufactured and dispatched to site	2	2 CD ROMS
21	QA Documentation Package for field activities on equipment/systems at site	2	2 CD ROMS

Notes:

- Quantity of prints may change during detailed engineering stage based on BHEL/ Customer requirement. However the same will be adhered by the bidder without any delivery/commercial implication to BHEL.

- All the drawing documents along with the O&M manual (of all the revisions) are necessarily to be submitted in soft copies in addition to hard copies.

- Bidder to submit soft copies of all the drawing and document along with quality plans for BHEL review and approval.

- The date of submission of drawing documents shall be considered as the date of submission of hard and soft copes whichever is later.

- All the drawings shall be prepared on computer auto cad and other documents (like datasheet etc.) on MS office software. Bidder not complying these requirements shall not be considered. For the execution of the contract regular meeting (generally once in 15 days or as per project requirement) is required.

- Bidder has to come for meeting with the concerned dealing persons as per BHEL or customer requirement in a short notice.

- Bidder to submit instrument schedule, cable schedule and valve schedule (as applicable) in MS- Excel format during detailed engineering.

- Bidder to also furnish the auto cad copy/ MS-word (as applicable) of the following documents after award of contract. However any other auto cad copy/ MS-Excel/ MS-word of any other document as per the insistence of BHEL/ customer will also be submitted by the bidder without any delivery/ commercial implication to BHEL/ Customer.
  - P&IDs.
  - GA & Foundation Drawing.
  - Local Control Panel/ Junction Box Wiring Diagram.

ANNEXURE-IV

PAINTING SPECIFICATION

ANNEXURE -IV

PAINTING

1.0 SCOPE

This section defines the technical requirements for surface preparation, selection and application of paints on equipment, vessels, machinery, piping, ducts etc. However, manufacturers shall follow their standard procedures for painting their equipment. The bidder shall submit a detailed painting procedure for approval of owner/ owner's representative after the award of contract.
The following surface and material shall require painting:

a. All un-insulated carbon steel and alloy steel equipment like columns, vessels, storage tanks, pumps, heat exchangers etc.
b. All un-insulated carbon steel and low alloy piping, fitting and valves (including painting of identification marks).
c. All pipe structural steel supports, walkways, platforms, handrails, ladders etc.

The following surfaces and materials shall not require painting:

a. Non-ferrous materials
b. Austentic stainless steel
c. Plastic and / or plastic coated materials
d. Insulated surface of equipment and pipes except colour coating wherever required.
e. Painted equipment like blowers, pumps, valves etc. with finishing coats in good condition and with matching colour code.

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 specification 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 enamel
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:2395	Code of practice for painting of concrete, masonry and plaster surfaces (Parts I & II)
IS:2338	Code of practice for finishing of wood and wood based materials (Parts I & II)
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:4682	Code of practice for lining of vessels & equipment
SIS 559000	Swedish standard for blasting
ISO 8504-2	Preparation of steel substrates before application of paints and related products. Surface preparation methods Part 2 Abrasive blast cleaning
ISO 8501-1	Preparation of steel substrates before application of paints and related products. Visual assessment of surface cleanliness. Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings.
SIS 05 5800	Surface preparation by acid pickling
SSPC SP08	Surface preparation by acid pickling
IS 2629	Recommended practice for hot dip galvanizing of iron and steel
ASTM A780	Standard practice for repair of damaged galvanized coatings
SSPC	Steel structures painting council
NACE	National association of Corrosion Engineers
DIN	Deutsehes Institute for Normung
BS	British Standard
ASTM	American Society for Testing material
AWWA	American Water works association

3.0 SURFACE PREPARATION

The surface shall be prepared in a manner suitable for coatings. Chemical derusters or rust converters shall not be applied. Acid cleaning is subject to approval of Purchaser/ Purchaser's representative.

3.1 BLASTING

The surface of the part/ component shall be blasted before the coating material is applied. Compressed air supply for blast cleaning shall be free of water and oil. Air compressors shall not be allowed to deliver air above 1100°C. Blasting activity shall be performed at temperatures 30°C above due point and substrata temperature between 50°C & 500°C and relative humidity not exceeding 85% shall be maintained during painting. Necessary safety precautions for equipment and operator shall be adhered to and shall comply with applicable laws, regulations, ordinances etc., of the local authority, state or the nation pertains to the work. Abrasive used for blast cleaning carbon steel and alloy steel shall be as per ISO 8504-2 and SSPC painting manual. Suggested abrasives are chilled iron grit, shot steel, malleable iron grit and shots of non-metallic abrasive (aluminium oxide, copper slag, garnet etc.).

The grade of blasting shall be performed in line with the approved painting scheme. The nature, quality and grain size of abrasives and the parameter of their use are to be chosen to obtain the required surface profile depth and cleanliness. Surfaces prepared for coating shall be coated the same day and before any visible rusting occurs (the time elapsed between blast cleaning and

commencement pf painting shall under no circumstances exceed 4 hours, but in any case must commence before signs of degradation occur).

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

Unless otherwise specified in the documents, the surface shall satisfy the following requirements after blasting

a. Blasting according to SIS 055900, Grade Sa 2½
b. Primer paint shall be Zinc Silicate of approved brand. Dry film thickness of each primer coat shall be 15-25 µm.

3.2 Manual Rust Removal

Manual rust removal shall be allowed for welded zones and for touching up installed components.

3.3 Cleaning

Removal of impurity

Impurity	Removal
Dust, Loose deposits	Vacuum cleaning, brushing
Adhesive deposits	Power brushing
Oils, greasy impurities	Wet Blasting, Use of Detergent Additives by agreement
Salt deposits	Rinsing
Markings (eg felt up pen)	Organic solvents to manufacturer's specifications eg Trichloro trifluoro ethane and solvents containing acetone (renew solvent and rag frequently)

3.4 Acid Pickling

Prior to galvanizing the surface preparation shall be done by acid pickling as per SSPC-SP-08.

4.0 PROCESSING

4.1. General Application Conditions

The primer shall be applied to properly prepared surfaces only. The specifications of the coating material manufacturers shall be observed. The minimum temperature 0C shall be + 5and the relative humidity shall not exceed 80%. The temperature of 0 the work piece shall be at least 3C above dew point.

4.2. Application Procedure

The primer shall be applied by means of brush or by spary. The top coats shall be applied by means of brush, roller or spray.

At points where coating application is interrupted, the individual layers shall be adequately stepped to ensure proper layer sequence when coating operations are resumed.

4.3. Touching Up

Before each layer is applied, previous coating shall be touched up where necessary by way of rust removal and cleaning according coating manufacturer's specification. The final top shall be reapplies completely.

4.4. Uncoated Surfaces

Moving parts of machines (e.g stems, shafts, sliding and locating bearings), nameplates, instruments and sealing surface shall not be coated. Welds shall be left free of coating up to a distance of 30 mm on each side of the weld edge until erection and weld examinations, if any, have been completed.

4.5. Bond Strength

The pill off stress determined using the pull off test method for adhesion shall not be less than 1.5 N/mm2, according to ISO 4624.

5.0 SURFACE CONDITIONS OF COATING SURFACES

The coating surface shall have a uniform film thickness, shade and gloss and shall be free from inclusions, sags and wrinkles.

6.0 COATING SYSTEMS

6.1 General Requirements for Coating Systems

Coating materials according to SSPC, BS 5493 or DIN 55 928 shall be used. Intermediate coats are to be pigmented with micaceous iron oxide. 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.

The colour and gloss of top coats shall be in accordance with sub clause suggested colour codes for painting (Sub Clause 6.8)

6.2 Standard Coating System (External Coatings)

(a) Steel Surfaces

i. All steel structures shall receive two primer coats and two sandwich coat of MIO Epoxy paint and one finish coat of painting. First coat of primer shall be given in shop after fabrication before dispatch to erection site after surface preparation as described below. The second coat of primer shall be applied after erection and final alignment of the erected structures. Two intermediate coats and one finished coat shall also be applied after erection.

ii. Steel surface which is to be painted shall be cleaned of dust and grease and the heavier layers of rust shall be removed by chipping prior to actual surface preparation. The

surface shall be abrasive blasted as explained in clause 3.1 to Sa 2½ finish as per SIS05-5900. Primer paint shall be Zinc Silicate of approved brand. Dry film thickness of each primer shall be 60 microns.

iii. Two intermediate MIO Epoxy paint, and one top polyurethane coating of approved brand shall be applied. Dry film thickness of each intermediate coat shall be 90 microns and top polyurethane coating shall be 30 microns. The under coat and finish coat shall be of different tint to distinguish the same from finish paint. The total dry film thickness shall be 330 microns. All paints shall be of approved brand and shade as per owner's requirement.

iv. Joints to be site welded shall have weldable primer applied within 100 mm of welding zone. Similarly where friction grip fasteners are to be used removable anti corrosive coating shall be provided. On completion of the joint the surfaces shall receive the paint as specified.

v. Surfaces inaccessible after assembly shall receive two coats of primer prior to assembly. Surfaces inaccessible after erection including top surfaces of floor beams, supporting gratings or chequered plate shall receive one additional coat of finish paint over the above number of coats specified before erection. Portion of steel member embedded/ to be encased in concrete shall not be painted.

(b) Gratings and Step Threads

i. Surface Preparation
Gratings and step threads shall be cleared by acid pickling as per SSPC-SP-08

ii. Hot Dip galvanizing
The hot dip galvanizing shall be done as per IS 2629. The average mass of coating shall be 610 gm/m2

iii. Post Treatment
Immediately after galvanizing 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 A780.

6.3 Painting of Indoor components such as valves, pumps, motors, electrical parts, tanks etc. At Works

Surface Preparation

Blasting according to SIS 055900 grade Sa 2½. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 25 µm may be used.

Prime Coat

Two (2) layers of Zinc phosphate epoxy, total dry fim thickness 75µm.

At Site
Thorough cleaning to remove oil, grease, dirt and any other contaminants. Derusting of all mechanical damages according to SIS 055900 Grade ST3. Touch up with dry film thickness 50 µm.

Finish Coat
Application of two (2) finishing coats of chlorinated rubber paint in approved shades at 30-40 microns DFT each coat in approved shades.

Remarks
Equipment coated with a standard application system can be accepted if the quality of this application system is corresponding with the quality of the above mentioned system.

6.4 Painting of Outdoor equipment (external surfaces) such as piping, valves, pumps, motors, electrical parts, tanks etc.
Weather exposure, weather resistance, temperature up to 120°C as per clause 6.1 & 6.3.

Surface Preparation
Blasting according to SIS 055900 grade Sa 2½. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 15-25 µm may be used.

Prime Coat
Two (2) layers of Zinc phosphate epoxy, total dry fim thickness 75µm.

Intermediate Coat
One (1) layer 2 pack high build epoxy polyamide MIO, DFT 100µm.

Finish Coat
Application of two (2) finishing coats of chlorinated rubber paint in approved shades at 50 microns DFT each coat in approved shades.

6.5 Special Coating

(a) Parts exposed to temperatures above 120°C, up to 200°C, not insulated

i. **At Works**

Surface Preparation
Blasting according to SIS 055900 grade Sa 2½ and ISO 8501-1:1958. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 15-25 µm may be used.

Prime Coat
Inorganic ethyl Zinc silicate, total dry fim thickness 75µm.

ii. **At Site**

Pre-treatment
Dersuting of all mechanical damages, according to ISO 8501-1:1989, grade St 3 touch up with 1 pack inorganic ethyl zinc silicate, dry film thickness 50µm.

Intermediate Coat
I pack silicon acrylic dry film thickness 35 µm.

Final Coat
1 pack silicon acrylic, dry film thickness as 35µm. Total system dry film thickness 145µm. Final coat according to colour code

(b) Parts exposed to temperatures above 200°C, up to 400°C, not insulated

i. **At Works**
Surface Preparation
Blasting according to ISO 8501-1:1958 grade Sa-2½. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 15-25 µm may be used.

Prime Coat
Inorganic ethyl Zinc silicate, total dry film thickness 75µm.

ii. **At Site**
Pre-treatment
Derusting of all mechanical damages, according to standard Sa 2½ to ISO 8501-1:1988. Touch up with coating system according to manufacturer's recommendations.

(c) Insulated parts continuously exposed to condensing water or parts exposed to temperatures For parts that are provided with insulation on site.

i. **Insulated parts exposed to condensing water**
At Works
Surface Preparation
Blasting according to Sa 2½ to ISO 8501-1:1988. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 15-25 µm shall be used.

Prime Coat
Inorganic ethyl Zinc silicate, total dry film thickness 75µm

ii. **Insulated parts exposed to temperatures**
Parts exposed to temperatures up to < 400°C
Surface Preparation
Blasting according to Sa 2½ to ISO 8501-1:1988. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 15-25 µm shall be used. Parts exposed to temperature above 400°C at works (Steam pipes, pressure tubes and parts for the HRSG, such as heating surfaces, heaters and superheaters, reheaters etc)

Temporary Primer
Varnish

(d) Intermittent exposure due to condensing water/ chemicals (Indoors)

(i) **At Works**

Surface Preparation

Blasting according to Sa 2½ and ISO 8501-1:1988. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 15-25 µm may be used.

Prime Coat

Two layers of Zinc phosphate primer, total dry fim thickness 75µm.

(ii) **At Site**

Pre-treatment

Dersuting of all mechanical damages, according to standard Sa3 to ISO 8501-1:1988, touch up with 2 pack high build epoxy with volume solid content of more than 85%, 75µm.

Intermediate Coat

2 pack high build epoxy, dry film thickness 80 µm.

Finish Coat

2 pack silicon acrylic, dry film thickness of 50µm. Total system dry film thickness 205µm. When exposed o weathering, weather resistance finish coat shall be applied.

(e) Water Exposure

i. **At Site/ Works**

Pre-treatment

Removal of all welding pearls. Blasting according to Sa 3 to ISO 8501-1:1988

Coat

4 coats 2 pack coal tar epoxy, dry film thickness 125 µm each. Total system dry film thickness 500µm Touch up after erection as required.

6.6 Painting of Pipes

6.6.1. 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.

Note: All steel pipes carrying sea water shall be internally coated with corrocoat/ polyurea coating having thickness 1500 DFT.

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

6.6.2. 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 150 microns.
Note: All steel pipes carrying sea water shall be internally coated with corrocoat/ polyurea coating having thickness 1500 DFT.

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.

6.7 Internal Coatings

6.7.1. Tanks (Internal surfaces) as specified in relevant sections of specification

Industrial deionised, demineralised and potable water up to 60°C pH range 4.5-9.5 Blasting according to Sa 2½ and ISO 8501-1:1988.

Prime Coat

Two layers of Zinc phosphate epoxy primer, total dry fim thickness >75µm.

Pre-treatment

Dersuting of all mechanical damages, according to standard Sa3 to ISO 8501- 1:1988, touch up with 2 pack high build epoxy with volume solid content of more than 85%, 75µm.

Intermediate Coat
2 pack high build epoxy, dry film thickness 80 µm.

Finish Coat
2 pack silicon acrylic, dry film thickness of 150µm per coat. In case of service or potable water tanks, the coating material selected shall not taint the water. The paint system shall confirm to regulations issued by Food & drug administration/ National Public Health service/ AWWA/ OSHA and comply with applicable laws, regulations, ordinances etc. of the local authority, state or the nation pertains to work. QA/ QC Procedure including pinhole inspection, shall be submitted for approval by Owner/ Owner's representative.

6.7.2. Rubber Lining of Pipes, Valves and Tanks for DM Water

Pre-treatment
Blasting according to Sa 2½ and ISO 8501-1:1988

Rubber Lining
Hard rubber 5 mm for DM water applications as IS – 4682

6.8 Painting for Electrical items

6.8.1. All the steel work shall be thoroughly cleaned of rust, scale, oil, grease, dirt and swarf by pickling, emulsion cleaning etc. The sheet steel shall be phosphate/ oven dried and then painted with two coats of zinc rich primer paint. After application of the primer, two coats of finishing epoxy paint shall be applied. The colour of the finishing coats inside shall be glossy white and exterior of the treated sheet steel shall be shade 631 of IS-5/ RAL 7032 for all switchboard/ MCC/ Distribution boards, control panels etc.

6.8.2. All electrical equipment shall be given tropical and fungicidal treatment and outdoor equipment shall be provided with rain hood to prevent entry of rain water into the equipment.

6.8.3. Painting of I & C equipment: Epoxy coating required for all I & C equipment.

6.9 SUGGESTED COLOUR CODES FOR PAINTING

SL. NO.	ITEM/SERVICE	COLOUR	IS-5	COLOUR (BAND)	IS-5
1	Structures, platforms, galleries, ladders and handrails	Dark Admiralty Grey	632	-	-
2	Boiler casing, ducting	Nut Brown	413	-	-
3	Crane				
3.1	Crane structure	Golden Yellow	356	Black	-
3.2	Trolley & hook	Crimson	540	-	-

SL. NO.	ITEM/SERVICE	COLOUR	IS-5	COLOUR (BAND)	IS-5
4	Fans, pumps, motors, compressors	Light Grey	631	-	-
5	Tanks (without insulation and cladding)				
5.1	Outdoor	Aluminium	-	-	-
5.2	Indoor	Light grey	631	-	-
6	Vessels & all other proprietary equipment (without insulation & cladding)	Light grey	631	-	-
7	Switchgear	Light grey (Powder coated)		-	-
8	Control & relay panels	Light grey (Powder coated)	631/7078 of IS 1650	-	-
9	Turbines	Light grey	631	-	-
10	Generators & Exciter	Light grey	631	-	-
11	Transformers	Aluminium	-	-	-
12	Machinery guards	Signal red	537	-	-
13	Piping (without insulation and cladding)				
13.1	Water System				
a	Boiler feed	Sea Green	217	-	-
b	Condensate	Sea Green	217	Light Brown	410
c	DM Water	Sea Green	217	Light Orange	557
d	Soft Water	Sea Green	217	French Blue	166
e	Bearing Cooling Water	Sea Green	217	French Blue	166
f	Potable & filtered Water	Sea Green	217	French Blue	166
g	Service and clarified water	Sea Green	217	French Blue	166
h	Cooling water	Sea Green	217	French Blue	166
i	Sea Water	Sea Green	217	White	-
14	Ash Transmitting Vessels and pipe lines	Aluminium	-	-	
15	Air System				
15.1	Station air	Sky blue	101	-	-
15.2	Control air	Sky blue	101	White	-

SL. NO.	ITEM/SERVICE	COLOUR	IS-5	COLOUR (BAND)	IS-5
16	Oil system				
16.1	Fuel oil	Light brown	410	French	166
16.2	Light oil (HSD)	Light brown	410	Brilliant green	221
16.3	Lubricating oil	Light brown	410	Light grey	631
16.4	Transformer oil	Light brown	410	Light orange	557
17	Gas System				
17.1	Carbon dioxide	Canary yellow	309	Light grey	631
17.2	Hydrogen	Canary yellow	309	Signal red	537
18	Fire services	Fire red	536	-	-
19	Effluent pipes	Black	-	-	-
20	Vacuum pipes	Sky blue	101	Black	-

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.

Bidder shall furnish his painting specification to suit corrosive atmosphere of coastal area along with the bid. The specification shall in general be in line with the above requirements.

ANNEXURE-V

MANDATORY SPARES LIST

1X800 MW COAL BASED SUPERCRITICAL NORTH CHENNAI TPP STAGE - III

MANDATORY SPARES

Part 5.3: Control & Instrumentation

Sl No	Name/ Description of Spares	Unit	Qty
i)	**Measuring Instruments - Indicators, Recorders, Electrical Metering and Skid Mounted Instruments**		
1	10% of the number of indicators, recorders and meters offered from each model for the project or a minimum of one number per model, whichever is more. These instruments shall be supplied with three sets of blank scales.	Oxygen Dosing	
2	For skid mounted instruments (if any) - 10% of total number of instruments for each model and type for the project or a minimum of one number for each model and type, whichever is more.		
(ii)	10% of total number of **Temperature Transmitters and Electronic Transmitters (For Pressure, DP, Temp,Flow,Level), Temperature, Pressure, Flow & Level Switch, safety switches,Gauges, meters,Transducer or any other instrument etc.** offered for each model and type for the project or a minimum of one number, whichever is more.	Oxygen Dosing	
vii)	**Alarm Annunciation System**		
1	20% spares of each type installed shall be provided for logic modules, group card modules, power supply modules, Hooters and any other electronic module.		
2	5% spares of each size shall be provided for un-engraved window boxes complete with LED etc.	Oxygen Dosing	
3	20% of installed LEDs for annunciation facia windows and LEDs box assemblies offered for the project shall be provided as mandatory spares.		
4	One (1) spare annunciator hooter of each type.		
viii)	**Erection hardware**		
1	Ten (10) percent of each type & Size installed instrument valve, manifold for each type, rating, model number and size of devices supplied for the project.		
2	Ten (10) percent of total number of condensate pots or four numbers whichever is higher of each type & Size installed.	Oxygen Dosing	
3	Ten (10) percent of each type & Size installed Fittings		
xvi)	**Mandatory spares not covered above**		

	Bidder to supply 10% or 1 no. (whichever is more) of each type of sensor/instrument, analyzers /special instruments/Electronic card, instrumentation/mechanical fittings etc. for any other electronic system, feeder control cabinets, hydra step (EWLI), Vibration Monitoring System, CCTV, C&I Lab Instruments, On line Carbon in Ash analyzer 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.	Oxygen Dosing	
8	**Solenoid valves**	Oxygen Dosing	
(ii)	Solenoid valves.		20% or 2 nos. of each type whichever is more.
xviii)	**Interchangeability & Packing**	Oxygen Dosing	
	All spares supplied under this contract shall be strictly interchangeable with the parts for which they are intended for replacements. The spares shall be treated and packed for long storage under the climatic conditions prevailing at the site. e.g. small items shall be packed in sealed transparent plastic bags with desiccators packs as necessary.		
xix)	**Identification**		
	Each spare shall be clearly marked and labelled on the outside of the packing with its description. When more than one spare part is packed in a single case, a general description of the contents shall be shown on the outside of such case and a detailed list enclosed. All cases, containers, and other packages must be suitably marked and numbered for the purpose of identification.		
xx)	**Contract-Quantities**	Oxygen Dosing	
	The quantities & mandatory spares shall be as specified herein. Any other mandatory spares not listed above however required for any instrumentation item shall also be supplied by bidder. The final quantities may require addition/deletion during the contract stage. The Bidder shall furnish unit price for each mandatory spare under appropriate schedules which shall be used for adjusting the contract price in the event of addition/deletion from contract quantities specified herein.		
xxi)	**Documentation**		
	Bidder shall furnish detailed catalogue, part number and subassembly/assembly drawings with manufacturer's cross reference for each spare part. The data and information furnished shall be of nature and content as per owner's approval to enable owner procurement of these spare parts directly from the respective manufacturer.		

NOTES:

1) All the Mandatory spares for the equipment under the contract provided by the vendor will strictly conform to the specifications and documents and will be identical to the corresponding main Equipment/components supplied under the contract.

2) Wherever quantity is specified both as a percentage and a value, the Bidder has to supply the higher quantity until and unless specified otherwise.

3) In case, mandatory spares are not applicable as per equipment / item selected, bidder has to provide equivalent mandatory spare as per for selected equipment / item in line with list of mandatory spares.

4) In case mandatory spares indicated in the list are not applicable to the particular design offered by the bidder, the bidder should offer spares applicable to offered design with quantities in line with list of mandatory spares.

ANNEXURE VI

DRAWING/ DOCUMENTS SUBMISSION SCHEDULE

ANNEXURE VI

MASTER DRAWING LIST WITH SCHEDULE OF SUBMISSION

After award of LOI/ LOA, following minimum drawing/ documents shall be submitted by the bidder for BHEL/ Customer approval. However any additional drawing/ document, if found necessary for completion of the engineering, the same shall be submitted by bidder without any commercial & delivery implication to BHEL.

S. NO.	DOCUMENT NO.	DOCUMENT TITLE	No. of weeks from LOI dated for submission
1	PE-V0-423-154-A101	P&ID for Oxygen Dosing System	2
2	PE-V0-423-154-A102	GA drawing and foundation detail for Oxygen Dosing System	2
3	PE-V0-423-154-A103	Technical Data sheet for Oxygen Dosing System	4
4	PE-V0-423-154-A104	Junction Box Termination Dwgs. for Oxygen Dosing System	4
5	PE-V0-423-154-A109	QAP for Oxygen Dosing System	2
6	PE-V0-423-154-A106	O&M Manual for Oxygen Dosing System	16

For drawings/ documents submission procedure, please refer above details. Bidder has to submit the revised drawing/ document along with the compliance sheet indicating enumerate reply to all BHEL and customer comments/ observations. Without compliance sheet the submission of the drawings/ documents will not be considered and the delay on this account will be solely on bidder's side only. The number of drawing/ documents to be submitted by the bidder shall be as per enclosed Annexure-III.

Bidder to note that drawings submitted shall be complete in all respects with revised drawing submitted incorporating all comments. Any incomplete drawing submitted shall be treated as non-submission with delays attributable to bidder's account. Engineering meeting shall be held fort nightly, for which the bidder shall depute his concerned engineers along with project manager to PEM office or at customer office without fail.

Bidder to note that drawings submitted shall be complete in all respects with revised drawing submitted incorporating all comments. Any incomplete drawing submitted shall be treated as non-submission with delays attributable to bidder's account.

Drawing/document submission shall be done through web based Document Management System (DMS). Bidder would be provided access to the DMS for drawing/document approval. Detailed methodology would be finalized during detail engineering. Bidder to ensure following at their end:

- 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)

ANNEXURE –VII

FORMAT FOR OPERATION & MAINTENANCE MANUAL

FORMAT FOR OPERATION AND MAINTENANCE MANUAL

Bidder to submit operation and Maintenance manual with minimum information as listed in below check list during contract stage.

Check List for Operation & Maintenance Manual

Project name :
Project number :
Package Name :
PO reference :
Document number :
Revision number :

Sl.no. & Sections	Description	Tick (√)if included in Manual			Remarks
		Yes	No	Not Applicable	
1.	Cover page				
1.1	Project Name				
1.2	Customer/consultant Name				
1.3	Name of Package				
1.4	Supplier details with phone, FAX ,email address, Emergency Contact number				
1.5	Name and sign of prepared by, checked by & approved by				
1.6	Revision history with approval Details				
2.0	Index				
2.1	Showing the sections & related page nos. All the pages should be numbered section wise				
3.0	Description of Plant/ System				
3.1	Description/ write up of operating principle of system equipment/ associated sub-systems & accessories/controls system, operating conditions, performance parameters under normal , start up and special cases				
3.2	Equipment list and basic parameter with Tag numbers				
3.3	Data sheets approved by Customer/ for information and catalogues provided by original manufacturer				
3.4	Associated other packages and Interface/ terminal points				
3.5	P&ID & Process Diagrams				
3.6	GA Layout drawings, As-built drawings, Actual photograph of items/ system (Drawings of A2 & bigger sizes are to be attached in the last)				
3.7	Single line/ wiring diagrams				
3.8	Control philosophy/ control write-ups				
4.0	Commissioning Activities (if not covered in separate document i.e. erection manual, commissioning manual)				
4.1	Pre-Commissioning Checks				
4.2	Handling of items at site				

4.3	Storage at site				
4.4	Unpacking & Installation procedure				
5.0	Operation Guidelines for plant personal/ user/ operator				
5. 1	Interlock & Protection logic along with the limiting values of protection settings for the equipment along with brief philosophy behind the logic, drawings etc. to be provided.				
5. 2	Start up, normal operation and shut down procedure for equipments along with the associated systems in step by step mode. Valve sequence chart, step list, interlocks etc. with Equipment isolating procedures to be mentioned.				
5. 3	Do's & Don't of the equipments.				
5. 4	Safety precautions to be taken during normal operation. Safety symbols, Emergency instructions on total power failure condition/lubrication failure/any other condition				
5. 5	Parameters to be monitored with normal values and limiting values				
5. 6	Trouble shooting with causes and remedial measures				
5. 7	Routine operational checks, recommended logs & records				
5. 8	Changeover schedule if more than one auxiliary for the same purpose is given				
5. 9	Painting requirement and schedule				
5. 10	Inspection, repair, Testing and calibration procedures				
6.0	Maintenance guidelines for plant personal				
6.1	List of Special Tools and Tackles required for Overhaul/Trouble shooting including special testing equipment required for calibration etc.				
6.2	Stepwise dismantling and re-assembly procedure clearly specifying the tools to be used, checks to be made, records to be maintained, clearances etc. to be mentioned. Tolerances for fitment of various components to be given.				
6.3	Preventive Maintenance & Overhauling schedules linked with running hours/ calendar period along with checks to be given				
6.4	Long term maintenance schedules especially for structural, foundations etc.				
6.5	Consumable list along with the estimated quantity required during commissioning, normal running and during maintenance like Preventive Maintenances and Overhaul. Storage/handling requirement of consumables/self-life.				
6.6	List of lubricants with their Indian equivalent, Lubrication Schedule, Quantity required for each equipment for complete replacement is to be given				

6.7	List of vendors & Sub-vendors with their latest addresses, service centres, Telephone Nos., Fax Nos., Mobile Nos., e-mail IDs etc.				
6.8	List of mandatory and recommended spare parts list				
6.9	Tentative Lead time required for ordering of spares from the equipment supplier				
6.10	Guarantee and warranty clauses				
7.0	**Statutory and other specific requirements considerations.**				
8.0	**List of reference documents**				
9.0	**Binding as per requirement**				

ANNEXURE –VIII

GENERAL TECHNICAL REQUIRMENTS

General Technical Requirement

VOLUME II SECTION 1
CHAPTER 6
CONTENTS

CHAPTER 6
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 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. Each of the 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 equipment 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.

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
c. Indian electricity rules
d. Indian Explosives Act
e. Indian Factories Act and State Factories Act
f. Indian Boiler Regulations (IBR)
g. Regulations of the Central Pollution Control Board, India
h. Regulations of the Ministry of Environment & Forest (MoEF), Government of India
i. Pollution Control Regulations of Department of Environment, Government of India
j. State Pollution Control Board.
k. Rules for Electrical installation by Tariff Advisory Committee (TAC).
l. 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. Japanese Industrial Standards (JIS)
b. American National Standards Institute (ANSI)
c. American Society of Testing and Materials (ASTM)
d. American Society of Mechanical Engineers (ASME)
e. American Petroleum Institute (API)
f. Standards of the Hydraulic Institute, U.S.A.
g. International Organisation for Standardization (ISO)
h. Tubular Exchanger Manufacturer's Association (TEMA)
i. American Welding Society (AWS)
j. National Electrical Manufacturers Association (NEMA)
k. National Fire Protection Association (NFPA)
l. International Electro-Technical Commission (IEC)
m. Expansion Joint Manufacturers Association (EJMA)
n. Heat Exchange Institute (HEI)

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 equipment 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 is given elsewhere in the technical specification. 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

All the design procedures, systems and components proposed shall have already been adequately developed and shall have demonstrated good reliability under similar conditions elsewhere.

The Bidder shall be responsible for the selection and design of appropriate equipment 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

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.

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.

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. 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 Bidders may note that this is a contract inclusive of the scope as indicated elsewhere in the specification. Each of the 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 Bidder shall furnish engineering data/drawingsin accordance with the schedule of information as specified in Technical Specification and data sheets.

8.2 The number of copies/prints/CD-ROMs/manuals to be furnished for various types of documents is given in Annexure-I of this chapter.

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:

a. 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:

i. System description of all the mechanical, electrical, control & instrumentation & civil systems.

ii. Technology scan for each system / sub-system & equipment.

iii. Selection of appropriate technology / schemes for various systems/ Selection subsystems including techno-economic studies between various options.

iv. Optimization studies including thermal cycle optimization.

v. Sizing criteria of all the systems, sub-systems including various piping systems/ equipment/ structures/ equipment foundations along with all calculations justifying and identifying the sizing and the design margins.

vi. Schemes and Process & Instrumentation diagrams for the various systems/ sub-system with functional write-ups.

vii. Operation Philosophy and the control philosophy of the Main Plant and other plants.

viii. General Layout plan of the power station incorporating all facilities General in Bidder's as well as those in the Owner's scope. This drawing shall also be furnished in the form of floppy discs to the Owner for engineering of areas not included in Bidder's scope.

ix. 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.

x. Documentation in respect of Quality Assurance System as listed out elsewhere in this specification.

xi. 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.

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

b. Detail Engineering Documentation

i. Layouts, general arrangements, elevations and cross-sections drawings for all the equipment and facilities of the plant.

ii. Flow diagrams, Process & Instrumentation Diagrams along with write-up and system description.

iii. 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.

iv. Piping isometric, composite layout and fabrication drawings.

v. Piping engineering diagrams, pipe and fittings schedules, valve schedules, hanger and support schedules, insulation schedules.

vi. 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.

vii. 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.

viii. Boiler pressure part schedule and sizing calculations. Boiler performance data and boiler design dossier.

ix. Transient, hydraulic and thermal stress analysis of piping and Transient, system wherever applicable & input and output data along with stress analysis isometrics showing nodes

x. Thermal cycle information (heat balance diagrams, boiler performance calculations, condenser and heat exchanger thermal calculations etc.).

xi. Characteristic Curves / Performance Correction Curves. Hydraulic & Mechanical design calculations for condensers & heaters.

xii. Comprehensive list of all terminal points which interface with Owner's facilities giving details of location, terminal pressure, and temperature, fluid handled & end connection details, forces, moments etc.

xiii. Power Supply single line diagram, block logics, control schematics, electrical schematics, etc.

xiv. Protection system diagrams and relay settings.

xv. Interconnection diagrams.

xvi. Cable routing plan.

xvii. Instrument schedule, measuring point list, I/O list, Interconnection & wiring diagram, functional write-ups, and 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.

xviii. Alarm and annunciation list and alarms & trip set points.

xix. Sequence and protection interlock schemes.

xx. Type test reports and power system stability study report.

xxi. Control system configuration diagrams and card circuit diagrams and maintenance details.

xxii. Detailed software manuals & source software listing.

xxiii. Detailed flow chart for digital control system.

xxiv. Mimic diagram layout.

xxv. Civil Task drawings (for the Engineering by Owner), Design and Drawings for the Civil & Structural works in the scope of the Bidder.

xxvi. Model study reports wherever applicable.

xxvii. Functional & guarantee test procedures and test reports.

xxviii. Documentation in respect of Quality Assurance System as listed out elsewhere in this specification.

xxix. Documentation in respect of commissioning as listed out elsewhere in this specification.

xxx. 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.

8.3.1 **Instruction Manuals**

The Bidder shall submit to the Owner, draft Instruction Manuals for all the equipment 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-I of this chapter. 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.

8.3.2 **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.

a) Erection strategy.
b) Sequence of erection.
c) Erection instructions.
d) Critical checks and permissible deviation/tolerances.
e) List of tool, tackles, heavy equipment like cranes, dozers, etc.
f) Bill of Materials
g) Procedure for erection.
h) General safety procedures to be followed during erection/installation.
i) Procedure for initial checking after erection.
j) Procedure for testing and acceptance norms.
k) Procedure / Check list for pre-commissioning activities.
l) Procedure / Check list for commissioning of the system.

m) Safety precautions to be followed in electrical supply distribution during erection

8.3.3 **Operation & Maintenance Manuals**

i. The operating and maintenance instructions together with drawings (other than shop drawings) of the equipment, as completed, shall be in sufficient detail to enable the Owner to operate, maintain, dismantle, reassemble and adjust all parts of the equipment. They shall give a step by step procedure for all operations likely to be carried out during the life of the plant / equipment including, operation, maintenance, dismantling and repair including periodical activities such as chemical cleaning of the generator. Each manual shall also include a complete set of drawings together with performance/rating curves of the equipment and test certificates wherever applicable. The contract shall not be considered to be completed for purposes for taking over until these manuals have been supplied to the Owner.

ii. If after the commissioning and initial operation of the plant, the manuals require any modification / additions / changes, the same shall be incorporated and the updated final instruction manuals shall be submitted to the Owner for records.

iii. A separate section of the manual shall be for each size/ type of equipment and shall contain a detailed description of construction and operation, together with all relevant pamphlets and drawings.

iv. The manuals shall include the following :

a) List of spare parts along with their drawing and catalogues and procedure for ordering spares.
b) 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.
c) Where applicable, fault location charts shall be included to facilitate finding the cause of mal-operation or break down.

v. Detailed specifications for all the consumables including lubricant oils, greases, chemicals etc. system/equipment/assembly/sub- assembly - wise required for the complete plant.

vi. On completion of erection, a complete list of bearings / equipment giving their location, and identification marks etc. shall also be furnished to the Owner indicating lubrication method for each type/category of bearing.

8.3.4 **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, equipment 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 & Don't's
9. 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.

8.3.5 **Project Completion Report**

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

8.3.6 **Drawings**

a. All the plant layouts shall be made in computerized 3D modeling system. The Purchaser reserves the right to review the 3D model at different stages during the progress of engineering. The layout drawings submitted for Purchaser's review shall be fully dimensioned and extracted from 3D model after interference check.

b. All documents submitted by the Bidder for Owner's review shall be in electronic form (soft copies) along with the desired number of hard copies as per Annexure-I. The soft copies to be supplied shall be either in CDs, or through direct transfer via E-mail, etc. depending upon the nature/volume/size of the document. The drawings submitted for approval could be in the Image form.

c. Final copies of the approved drawings shall be submitted on CD-ROM along with the requisite number of hard copies as per Annexure-I.

d. 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 equipment's / systems in the 3D model shall be furnished to Purchaser, along with the design review software which shall include interference check and walk-through animation, loaded on suitable hardware (server and work station). 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 Purchaser's Engineering Office Complex as per mutually agreed schedule.

e. All documents/text information shall be in latest version of MS Office.

f. All drawings submitted by the Bidder 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 equipment and materials, clearance and spaces required between various portions of equipment and any other information specifically requested in the drawing schedules.

g. Each drawing submitted by the Bidder (including those of sub- vendors) shall bear a title block at the right hand bottom corner with clear mention of the name of the Owner, Consultant, name of the Project, system designation, the specifications title, the specification number, drawing/document number and revisions. If standard catalogue pages are submitted the applicable items shall be indicated therein. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.

h. The drawings submitted by the Contractor (or their sub-vendors) shall bear Purchaser's drawing number in addition to contractor's (their sub-vendor's) own drawing number. Purchaser's drawing numbering system shall be made available to the successful bidder so as to enable him to assign Purchaser's drawing numbers to the drawings to be submitted by him during the course of execution of the Contract

i. The Bidder 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 Owner. Such list should clearly indicate the purpose of submission of these drawings i.e. "FOR APPROVAL" or "FOR INFORMATION ONLY".

j. Similarly, all the drawings/ documents submitted by the Bidder during detailed engineering stage shall be stamped "FOR APPROVAL" or "FOR INFORMATION" prior to submission.

k. The furnishing of detailed engineering data and drawings by the Bidder shall be in accordance with the time schedule for the project. The review of these documents/ data/ drawings by the Owner will cover only general conformance of the data/ drawings/ documents to the specifications and contract, interfaces with the equipment provided by others and external connections & dimensions which might affect plant layout. The review by the Owner should not be construed to be a thorough review of all dimensions, quantities and details of the equipment, materials, any devices or items indicated or the accuracy of the information submitted. The review and/ or approval by the Owner / Project Manager shall not relieve the Bidder of any of his responsibilities and liabilities under this contract.

l. After the approval of the drawings, further work by the Bidder shall be in strict accordance with these approved drawings and no deviation shall be permitted without the written approval of the Owner.

m. All manufacturing, fabrication and execution of work in connection with the equipment / system, prior to the approval of the drawings, shall be at the Bidder's risk. The Bidder is expected not to make any changes in the design of the equipment /system, once they are approved by the Owner. However, if some changes are necessitated in the design of the equipment/system at a later date, the Bidder may do so, but such changes shall promptly be brought to the notice of the Owner indicating the reasons for the change and get the revised

drawing approved again in strict conformance to the provisions of the Technical Specification.

n. 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.

o. 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.

p. 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.

q. 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.

r. 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.

s. All engineering data submitted by the Bidder after final process including review and approval by the 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 Owner 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 along with 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 Engineering Information Schedule shall be updated month wise.

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.

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 Technical Co-Ordination Meetings(TCM)

8.6.1 The Bidder shall be called upon to organize and attend monthly Design/ Co- ordination Meetings with the Owner/Owner's representatives, Project 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.

8.6.2 The Bidder 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.

8.6.3 The Bidder 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.

8.6.4 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.

8.6.5 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.

8.7 Design Improvements

The Owner or the Bidder 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.

8.8 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.

8.9 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.

8.10 Lubricants, Servo Fluids and Chemicals

8.10.1. 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.

8.10.2. 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.

8.11 Lubrication

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.

8.12 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.

8.13 Rating Plates, Name Plates & Labels

8.13.1 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.

8.13.2 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.

8.13.3 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.

8.13.4 Items of plant such as valves, which are subject to handling, shall be provided with an 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.

8.13.5 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.

8.13.6 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.

8.13.7 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.

8.13.8 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.

8.13.9 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

8.14 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 along with 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.

8.15 Welding

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

8.16 Colour Code for all Equipment/ Piping/ Pipe Services

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.

8.17 Protection and Preservative Shop Coating

8.17.1 **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.

8.17.2 **Preservative Shop Coating**

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. Transformers and other electrical equipment 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.

8.17.3 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.

8.17.4 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.

8.17.5 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.

8.17.6 Painting for Civil structures shall be done as per relevant part of technical specification.

9.0 CENTRAL DOCUMENTATION FACILITY

Bidder shall provide a Central Documentation Facility in the room identified at TANGEDCO / Headquarters, which shall be designed to store all the technical documents, drawings, manuals, data sheets etc., as given in respective chapters of Technical Specifications. All the documents, data and manuals that are approved by TANGEDCO as well as other documents shall be sent to this facility, from where it is shall be further distributed to all the concerned departments of the project including contractor's authorized personnel. Complete computerized records shall be maintained in this facility for all the incoming and outgoing drawings as per the procedure to be mutually discussed and agreed between the Owner (TANGEDCO) and the contractor at the time of award of EPC contract. This room shall be equipped with adequate facilities for reading as well as duplication of the drawings, data sheets etc. these facilities shall include but not limited to the following for carrying out works related to this project exclusively at **TANGEDCO / HQ**:

i. Three (3) Nos. work stations
ii. Three (3) Nos. Laser Printer A4 Size Coloured
iii. Two (2) Nos. Nos Laser Colour Plotters of A0 Size,
iv. Two (2) Nos of Heavy Duty Photo Copier of A4 Size,
v. Two (2) Nos of Heavy Duty Photo Copier of A4 Size with sorting facility

Specification for above Hardware shall be furnished in line with the specification considered in Control & Instrumentation Volume II Section 2 Part 2.3

Complete consumables for the above, with necessary racks (Min. 06 nos), Special Cabinets (Min. 06 nos made of 18 SWG sheet thickness) for Storage. Modular furniture, tables, chairs etc., shall be provided.

10.0 QUALITY ASSURANCE PROGRAMME

10.1. The Bidder shall adopt suitable quality assurance programme to ensure that the equipment and services under the scope of contract whether manufactured or performed within the Bidder's works or at his sub-Bidder's premises or at the Owner's site or at any other place of work are in accordance with the specifications. Such programs shall be outlined by the Bidder and shall be finally accepted by the Owner/authorized representative after discussions before the award of the contract. The QA programme shall be generally in line with IS/ISO-9001. A quality assurance programme of the Bidder shall generally cover the following:

(a.) His organization structure for the management and implementation of the proposed quality assurance programme
(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.) 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.

10.2. General Requirements - Quality Assurance

10.2.1 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.

10.2.2 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. Compact Disc 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.

10.2.3 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.

10.2.4 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.

10.2.5 No material shall be despatched from the manufacturer's works before the same is accepted, subsequent to pre-dispatch 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).

10.2.6 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.

10.2.7 The Bidder shall submit to the Owner Field Welding Schedule for field welding activities in the enclosed format. 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.

10.2.8 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. All welding/brazing procedures shall be submitted to the Owner or its authorised representative for approval prior to carrying out the welding/brazing.

10.2.9 All brazers, welders and welding operators employed on any part of the contract either in Bidder's/sub-Bidder 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.

10.2.10 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.

10.2.11 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.

10.2.12 Unless otherwise proven and specifically agreed with the Owner, welding of dissimilar materials and high alloy materials shall be carried out at shop only.

10.2.13 No welding shall be carried out on cast iron components for repair.

10.2.14 All the heat treatment results shall be recorded on time temperature charts and verified with recommended regimes.

10.2.15 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.

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.

10.2.16 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.

10.2.17 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.

10.2.18 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.

10.2.19 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.

10.2.20 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.

10.2.21 For all spares and replacement items, the quality requirements as agreed for the main equipment supply shall be applicable.

10.2.22 Repair/rectification procedures to be adopted to make the job acceptable shall be subject to the approval of the Owner/ authorised representative.

10.2.23 Burn in and Elevated Temperature Test Requirement for Electronics Solid State Equipment
All solid state electronic systems/equipment shall be tested as a complete system/equipment with all devices connected for a minimum of 168 hours (7 Days) continuously under energized conditions prior to shipment from manufacturing works, as per the following cycle.

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.

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.

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.

10.3. QA Documentation Package

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.

10.3.1 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.

10.3.2 Typical contents of QA Documentation is 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

10.3.3 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.

10.3.4 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 endeavour 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.

10.3.5 **Transmission of QA Documentation**

On release of QA Documentation by Inspector, one set of quality document shall be forwarded to Corporate Quality Assurance Department 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.

10.4. Project Manager's Supervision

10.4.1 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.

10.4.2 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.

10.5. Inspection, Testing And Inspection Certificates

10.5.1 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.

10.5.2 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.

10.5.3 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.

10.5.4 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.

10.5.5 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.

10.5.6 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.

10.5.7 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.

10.5.8 To facilitate advance planning of inspection in addition to giving inspection notice as specified at clause no 10.5.3- 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.

10.5.9 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.

10.6. Associated document for quality assurance programme:

I. List of items requiring quality plan and sub supplier approval. (Annexure-III).
II. Status of items requiring Quality Plan and sub supplier approval. (Annexure- IV).
III. Field Welding Schedule (Annexure-V).
IV. Manufacturing Quality Plan (Annexure-VI).
V. Field Quality Plan (Annexure-VII).

11.0 PRE-COMMISSIONING AND COMMISSIONING FACILITIES

(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, equipment shall be operated integral with sub-systems and supporting equipment as a complete plant. It will be the responsibility of the Bidder to assess and furnish a list of all commissioning spares 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.

(c.) 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.

(d.) The time consumed in the inspection and checking of the units shall be considered as a part of the erection and installation period.

(e.) 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.

(f.) 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.

(g.) Bidder shall furnish the commissioning organization chart for review & acceptance of Owner at least eighteen months prior to the schedule date of synchronization. The chart should contain :

1. Bio data including experience of the Commissioning Engineers.
2. Role and responsibilities of the Commissioning Organisation members.
3. Expected duration of posting of the above Commissioning Engineers at site.

11.1 Initial Operation

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.

c) The Initial Operation shall be considered successful, provided that each item/ part of the facility can 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.

11.2 Guarantee Tests

a) The final test as to prove the Performance Guarantees shall be conducted at Site by the Bidder in presence of the Owner. The Bidder's Commissioning, Start-up, Purchaser 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. These tests shall be binding on both the parties of the Contract to determine compliance of the equipment with the functional guarantee

b) 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.

c) Any special equipment, tools and tackles required for the successful completion of the Guarantee Tests shall be provided by the Bidder, free of cost.

d) The Guarantee tests and specific tests to be conducted on equipment have been brought out in detail elsewhere in the specification.

12.0 TAKING OVER

Upon successful completion of Initial Operations and all the tests other than guarantee tests conducted to the Owner's satisfaction, the Owner shall issue to the Bidder a Taking over Certificate as a proof of the final acceptance of the equipment. Such certificate shall not unreasonably be withheld nor will the Owner 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 Bidder of any of his obligations which otherwise survive, by the terms and conditions of the Contract after issuance of such certificate.

13.0 TRAINING OF OWNER'S PERSONNEL

13.1 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 Equipment
(b.) Training for TG and related equipment.
(c.) DDCMIS
(d.) Training for Electric Power Supply systems
(e.) Training for HT motor
(f.) Training for power cycle piping/critical piping.

The above training shall be provided taken by the EPC Bidder in one of the reference power plant.

13.2 The scope of services under training shall also necessarily include training of Owner's Engineering personnel covering a training module of upto 52 man months. 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. An indicative module of the training requirement of Owner's Engineering personnel is attached as Annexure-II.

Four (4) man month and two (2) man month training for Purchasers Engineering Personnel on the offered CFD modelling code for SG & ESP including alternative geometry modelling technique to be provided.

13.3 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 (i.e. 35 and 52 man months respectively for O&M and Engineering) is indicative only. Owner reserves the right to

re-appropriate the training period between O&M and engineering depending upon the details of training module proposed by the Bidder.

13.4 Clause 13.2 & 13.3 shall be applicable for domestic bidders. For foreign bidders refer Vol I, Section 2, GCC.

13.5 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.

13.6 In all the above cases, wherever the training of Owner's personnel is arranged at the works of the manufacturer's 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.

13.7 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. All expenses except travelling expenses shall be borne by the contractor.

14.0 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.

15.0 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.

16.0 PACKAGING AND TRANSPORTATION

All the equipment & 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.

17.0 ELECTRICAL ENCLOSURE

All electrical equipment 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.

18.0 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.

18.1 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/cm2). 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 (mm Wcl).
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.

18.2 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.

18.3 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.

19.0 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.

20.0 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.

21.0 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

22.0 ELECTRONIC MODULE/COMPONENT DETAILS

The Bidder shall have to furnish all technical details including circuit diagrams, specifications of components, etc., in respect of each and every electronic card/module as employed on the various solid state as well as microprocessor based systems and equipment including conventional instruments, peripherals etc. It is mandatory for the Bidder to identify clearly the custom built ICs used in the package. The Bidder shall also furnish the details of any equivalents of the same.

23.0 ENVIRONMENTAL MONITORING & CONTROL MEASURES

Bidder to note that MOEF has declared Manali area as critically polluted area and also imposed certain restrictions on consideration of development of projects.

Concerned authorities have been addressed to have self-monitoring system (for Air, Water & Land) so as to ascertain the level of compliance of standards prescribed by MOEF and also to furnish the action plan ie., for the establishment of self-monitoring system. It is also directed to undertake

Environmental Audit (EA) to ascertain the compliance level of standards notified by MOEF. In this context it is to be noted that our proposed project is also located in the said critically polluted cluster. Though environmental clearance for the said project has been obtained the Controlling Authorities will be highly keen and keep a tight vigil on the availability/provision of self monitoring system (for Air, Water & Land) so as to ascertain the level of compliance of standards prescribed by MOEF.

Environmental Clearance:

For Compliance of conditions stipulated by TNPCB under section 21 of the Air (Prevention and control of Pollution) Act 1981 as amended in 1987, the following are included in the specification:

(a.) RCC chimney with designed height of 275mtrs included in the specification.
(b.) High efficiency ESPs (99.9% efficiency) have been proposed to ensure emission of particulate matter within 50 mg/Nm3.
(c.) Equipment for continuous monitoring of Ambient Air Quality has been proposed.
(d.) On line / automatic continuous stack monitor has been proposed.
(e.) Port holes in the chimney and sampling facilities for the stack for the proposed Boiler, as per the Central Pollution Control Board guide lines.
(f.) The unit shall have suitable sufficient acoustic measures for Generator, Turbine, Coal crusher and other sources including special anti-vibration Foundation for which all the heavy rotating equipment / machines shall be erected over the Anti vibration foundations to reduce noise, vibration etc.,
(g.) The unit shall have separate energy meter for the operation of the Electro Static Precipitator, the Air pollution control equipment for the proposed Boiler.
(h.) Alternate power source will come into effect in case of power failure for
(i.) the operation of Air Pollution Control measures laboratory for analysis of gaseous / particulate emissions
(j.) The coal shall be stored in a completely paved area with the provisions for leach ate collection. The coal storage yard shall be provided with wind barriers of sufficient height. The height of the coal piles shall be lower than that of the wind barrier.
(k.) The location of wind barriers shall be based on the predominant wind direction and shall be in consultation with TNPCB so as to avoid fugitive dust emission.
(l.) Closed conveyors for coal transport and Bag filters in all the transfer points to control dust emission have been proposed
(m.) Dust suppression system / water sprinklers to keep the stock pile sufficiently wet all the time to avoid carryover of dust.
(n.) All the internal roads shall be well paved and be provided with water sprinkling arrangement to avoid fugitive dust emission during vehicle movement. The unit shall limit the speed of the vehicle to 10KM/hr. for heavy vehicles within the plant premises to prevent the road dust emission.
(o.) Burners have been designed for low NOx.
(p.) Space provision made for installation of FGD of requisite efficiency of removal of SO2, if required at a later stage for which adequate space is provided near the chimney.
(q.) The unit shall ensure that the velocity of the exit gas from the stack shall be greater than 25 m/sec and the ratio of the exit gas to wind velocity shall not be less than 1.5 to eliminate or reduce pollutant down wash.

(r.) The unit shall have on line/automatic continuous stack monitors with computer recording arrangement for monitoring SPM, Sox and Nox in the boiler emission.
(s.) Sewage Treatment Plant & Effluent Treatment Plant has been proposed.
(t.) Natural draft cooling tower has been included in the specification.
(u.) 100% Dry fly ash collection system and conventional wet bottom ash disposal is included. However ash water recovery system is included in this scope if ash slurry is disposed in the ash pond in emergencies.
(v.) Ash slurry pipe lines and ash water recovery pipe lines of adequate capacity and strength are proposed to be provided. However these pipe lines will be used only during emergency, since 100% dry fly ash collection is proposed.

Hence, it is stated that the implementation of Environmental measures including self-monitoring system (for air, Water and land) as per the EC granted, especially in the following areas have to be ensured by the bidder without any exception:
Continuous Air quality monitoring stations
Online monitoring system
Effluent Treatment plant
Sewage treatment plant
Optimum use of land area
100% Ash collection & utilisation
Green Belt Development.

ANNEXURE-I

S. NO.	DESCRIPTION OF MANUALS	NO OF PRINTS (sets)	NO. OF CD-ROMs (sets)
1	PLANT DEFINITION MANUAL-	-	3 CD-ROMs
2	Drawings "FOR APPROVAL"	10	Soft Copy
3	Drawings "FOR INFORMATION"	10	Soft Copy
4	Drawings "FINAL APPROVED DRAWING"	8	Soft Copy
5	Drawings "AS BUILT "	8	3 CD-ROMs
6	DATASHEETS,DESIGNCALCULATIONS,PURCHASE SPECIFICATIONS, etc. and Other type of documents		
	i) For Approval	10	Soft Copy
	ii) FINAL	8	3 CD-ROMs
	iii) Analysis reports of equipment/ piping/ structures components/ systems employing software packages as detailed in the specifications		
	a) Input	10	Soft Copy
	b) Output	10	Soft Copy
	c) Drawings/ Sketches	10	Soft Copy
7	Erection manual "FINAL"	8	3CD ROMS
8	Operation & Maintenance manual	10	3CD ROMS
9	Plant Hand Book "DRAFT"	6	SOFT COPY
10	Plant Hand Book "FINAL"	15	3CD ROMS
11	Commissioning and Performance Procedure manual	10	3CD ROMS
12	Performance and Functional Guarantees test report	6	3CD ROMS
13	Progress Reports	6	3CD ROMS
14	Project completion report	10	3CD ROMS
15	QA programme including Organization for implementation and QA system manual (with revision-servicing)	1	3CD ROMS
16	Vendor details in respect of proposed vendors including Bidder's evaluation report.		
17	Manufacturing QPs, Field QPs, Field welding schedules and their reference documents like test procedures, WPS, POR etc.		
	i) For review/comment	3	
	ii) For final approval	4	1 set CD ROMS
18	Welding Manual, Heat Treatment Manuals	4	
	Storage & preservation manuals Final Final	4	2 CD ROMS
19	Monthly Vendor Approval and QP approval status	2	1 CD ROM
20	QA Documentation Package for items / equipment manufactured and dispatched to site	2	2 CD ROMS
21	QA Documentation Package for field activities on equipment/systems at site	2	2 CD ROMS

ANNEXURE-II

(Total within 52 man months)

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 Combustion and Air & gas weight calculation Pressure part calculation Pressure part and strength calculation Tube metal temp. calculation and selection. Performance calculation 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 startup system, fuel firing system, draft plant Flow scheme develop- ment of air & flue gas, fuel oil, auxiliary steam, main and reheat steam feed water.	Familiarization with various system and equipment Performance data collection analysis and review O&M feed back Operation history of various equipment and system Failure analysis	Manufacturing processes of pressure parts, and equipment Welding process Testing facilities Product development in process Future plan for technology induction R&D work inprogress	Control philosphy operation, notices, logic & protection schemes, O&M manual familiarization O&M issues Familiarization of special maintenance technique Special tool and tackles familiarization

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
	Layout of over all 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 stretegies, erection procedures			
	Performance and demonstration tests.			
MANDAYS	**120**	**20**	**20**	**20**
CFD model development and validation for Steam Generator	Familarisation of fundamentals and basis for the development of the CFD models.			
	Solving of set of simple problems by Employer'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 & ESPas per the Contract requirement with complete association of the Owner's engineers.			

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
	Validation of the above CFD model for SG & ESPby Bidder in association with the Owner's Engineers.			
MANDAYS	**120 for SG and 60 for ESP**	-	-	-
TURBINE GENERATOR AND IT'S INTEGRAL AUXILIARIES	Turbine cycle optimization and turbine performance in off design condition. Rotor design and strength calculation Rotor dynamic behavior studies wrt natural frequency, critical speed, vibration etc. Blade profile/root design and blade strength design, blade vibration analysis Casing & diaphragm design Labyrinth seal selection & design for different turbine configurations Selection of turbine type (i.e. Tandem vs cross compounding, separate HP/IP vs combined HP/IP, material of construction etc.)	Familiarization of power plants of various makes of turbines for super critical units Collection of data for analysis of availability of turbines Comparative studies for integral systems of turbine O&M history/problems related to turbine Failure analysis	Manufacturing processes of turbine Assembly of turbine Testing of turbines Product development in process Future plan for technology induction R&D work in progress	
	Design principle for Up rating/down rating of existing design/ modules for the specific project.			

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
	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 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 syudies for Selection of BFP Configuration and its drive Criteria for selection of boiler Feed Pump parameters Rotor design, strength calculation and rotor dynamic behavior studies wrt critical speed, vibration etc	Familiarization of power plants of various makes of feed pumps Data collection of BFP parameters and configur ation Collection of data for analysis of availability of BFP	Manufacturing process of various components of BFP Assembly 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	

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
	Role of critical para- meters 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 Guiding factors for selection of BFP seals Computation of axial thrust under various flows Performance calculation Transient analysis in pump suction piping wrt NPSH margin Latest technological trends in BFP design		R&D work in progress	
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 Condenser support selection & design	Collection of data for analysis of availability of Condenser O&M history/problems related to condenser	Testing capability at works Product development in process	

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
	Sizing of condenser w.r.t. super critical units Latest technological trends in condenser arrangement and design Condenser vacuum system design		Future plan for technology induction R&D work in progress	
MANDAYS	**10**	**5**	**5**	
Feed Regenerative Equipment's	Thermal and mechanical design calculation of heaters	Comparative studies of salient features	Manufacturing process of various components of heaters	
	Basis of selecting horizontal/vertical heaters Selection of TTD and DCAs for various heaters, and their effect on turbine heat rate Configuration of HP heaters (2x50% v/s100% capacity	Analysis of data O&M history/problems related to heaters	Assembly Testing capability at works Product development in process	
	Sizing criteria for Deaerator/Heaters Selection of tube & tube sheet material of heaters Latest technological trends in heaters design		Future plan for technology induction R&D work in progress	
MANDAYS	**15**	**10**	**10**	
3-dimensional CFD modeling	CFD model develop ment and validation of design data for steam turbine, BFP, CEP, condenser, heaters etc.			

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
MANDAYS	**20**			
Compressors	Equipment Theory & Maintenance Practice			
MANDAYS	**16**	**-**	**4**	
Condensate Polishing Unit	Equipment Theory & Maintenance Practice			
MANDAYS	**15**	**5**	**5**	
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	**24**	**6**		**16**
DDCMIS-Man Machine Interface System Engineering & Application Software	Specific system customisation	Operation feedback		
	Various system			
	modules & interface with OS			
	Database organization & development			

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
	Development of mimics			
	Other application like calculations, logs historical storage functionalities & use			
MANDAYS	**40**	**6**		**8**
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	**24**	**5**	**10**	
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	**18**	**4**	**4**	
DDCMIS - Control Loop Study Loop Study	General description of closed loop controls of thermal power plant	Specific operational feedback		

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
	Critical analysis of few control loops e.g., TSCS Stress Control boiler startup control etc.			
MANDAYS	**12**	**4**		
DDCMIS-Burner Management System	Hardware logic, NFPA/ VDE requirements other safety standard	Operational feedback	Manufacturing procedure& precautions for handling the system	
	Flame scanner location		System testing facilities	
MANDAYS	**16**	**6**	**6**	**12**
DDCMIS - EHTC, Turbine stress control system, Turbine protection system& ATRS	Basic design concept& features Logics of turbine stress control system Implementation of failsafe philosophy in turbine protection system	Operational feedback	Manufacturing procedure & precautions for handling for handling the system System testing facilities	
MANDAYS	**16**	**6**	**6**	**12**
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				
MANDAYS	**6**	**3**		
VMS				

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
1) Hardware	Equipment Theory & Maintenance Practice			
MANDAYS	**12**	**-**	**6**	
2)Vibration Analysis	Equipment Theory & Maintenance Practice			
MANDAYS	**12**	**-**	**6**	
Analyser				
Water & Gas	Equipment Theory & Maintenance Practice			
MANDAYS	**20**	**-**	**8**	
PADO: System Engineering	Equipment Theory & Maintenance Practice			
MANDAYS	**6**	**3**	**3**	
PADO: Operation & Analysis	Equipment Theory & Maintenance Practice			
MANDAYS	**18**	**6**	**-**	
Actuators	Equipment Theory & Maintenance Practice			
MANDAYS	**18**	**-**	**6**	
Simulator	Equipment Theory & Maintenance Practice			
MANDAYS	**16**	**-**	**4**	
Networking / MIS	Equipment Theory & Maintenance Practice			

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
MANDAYS	12	-	4	
Electric Power Supply System	Theory & design features		Manufacturing/assembly process	
			Testing methodology	
MANDAYS	**5**	**2**		
(ELECTRICAL) GENERATOR	(a) Design aspects of the following areas	Operational feed back Familarisation with different sub-systems	(a) Manufacturing process for	
	Insulation system		Core	
	Cooling medium & arrangement		Winding bars	
	Winding & core support systems		Assembly	
	b) Design aspects of other auxiliary systems		Testing facilities	
MANDAYS	**30**	**15**	**15**	
Generator Excitation System including AVR.	Design features of various sub-systems	Operational feed back Familiarisation with various equipment functioning at reference plants	Manufacturing process& testing facilities for various equipment of excitation system	
	Excitor			
	PMG			
	Controllers & different limiters etc.			
	PSS & associated system studies			
MANDAYS	**30**	**15**	**15**	

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
Boiler Feed pump H.T. Motor	Design Criteria for the Stator core & wdg	Operational feed back	Manufacturing process & test facilities	
	Rotor core & wdg Insulation system Cooling arrangement			
MANDAYS	**20**		**5**	
POWER TRANSFORMER	Equipment Theory & Maintenance Practice			
MANDAYS	**12**	**-**	**4**	**4**
UPS/BATTERY CHARGER	Equipment Theory & Maintenance Practice			
MANDAYS	**8**	**-**	**4**	**4**
CRITICAL PIPING & POWER CYCLE PIPING	Design familiarization for critical piping of supercritical Plant Optimization study for sizing including pressure drop calculation and selection of single or double lead together with Owner's engineers Design and stress analysis of lines with Expansion Joints together with Owner's engineers	Familiarization with feed back (in super critical plant) on failure analysis and vibration analysis of piping. Study of Feed back regarding hanger setting strategies and practice	Cold Setting of spring hanger Cyclic tests carried on spring hangers. Cyclic tests carried on expansion joints	

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 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		Manufacturing process of critical piping components and appreciation of their testing facilities at shop	
MANDAYS	**5**	**2**		

ANNEXURE-III

Project :				**LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB-SUPPLIER APPROVAL**				**DOC. NO.:**		
Stage :								**REV. NO. :**		
Package :								**DATE :**		
Supplier :				**SUB-SYSTEM:**				**PAGE : OF**		
Bidder No :										
Sl. No.	**Item**	**QP/ Insp. Cat.**	**QP No.**	**QP Sub. Schedule**	**QP approval schedule**	**Proposedsub-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

Project :				STATUS OF ITEM REQUIRING QP & SUB-SUPPLIER APPROVAL					DOC. NO.:		
Package :									REV. NO. :		
Bidder :									DATE :		
Bidder No :									PAGE : OF		
Sl. No.	Item/ Service	QP/ Insp. Cat.	QP No.QP Sub. Schedule Approval schedule	Date of submission	Date of commt Appl.	Status Code C/II/I	Proposed Sub-suppliers	Place of manufacturing works	Approval Status	Sub-supplier detail submission schedule	Remarks

ANNEXURE-V

Project :				FIELD WELDING SCHEDULE (To be raised by the Bidder) Welding Code: ……										DOC. NO.:	
Stage :														REV. NO. :	
system:														DATE :	
Bidder :														PAGE : OF	
Bidder No :															
Sl. No.	DRG No. for Weld Location and Identification mark	Description of parts to welded	Dimensions		Process of welding	Type of Weld	WPS. No.	Min. pre-heat	Heat treatment		NDT method/ Quantum	REF		Sub-suppliers approval status/ category	Sub-supplier Details submission schedule	Remarks
									Temp.	Holding time		Spec. No.	ACC Norm Ref.			
Notes:																
SIGNATURE																

ANNEXURE-VI

MFGR.'s LOGO	MANUFACTURER'S NAME AND ADDRESS	MANUFACTURING QUALITY PLAN		PROJECT:
		ITEM :	QP NO.:	
			REV.NO.:	PACKAGE:
		SUB-SYSTEM:	DATE:	CONTRACT NO.:
			PAGE: .... OF....	MAIN-SUPPLIER:

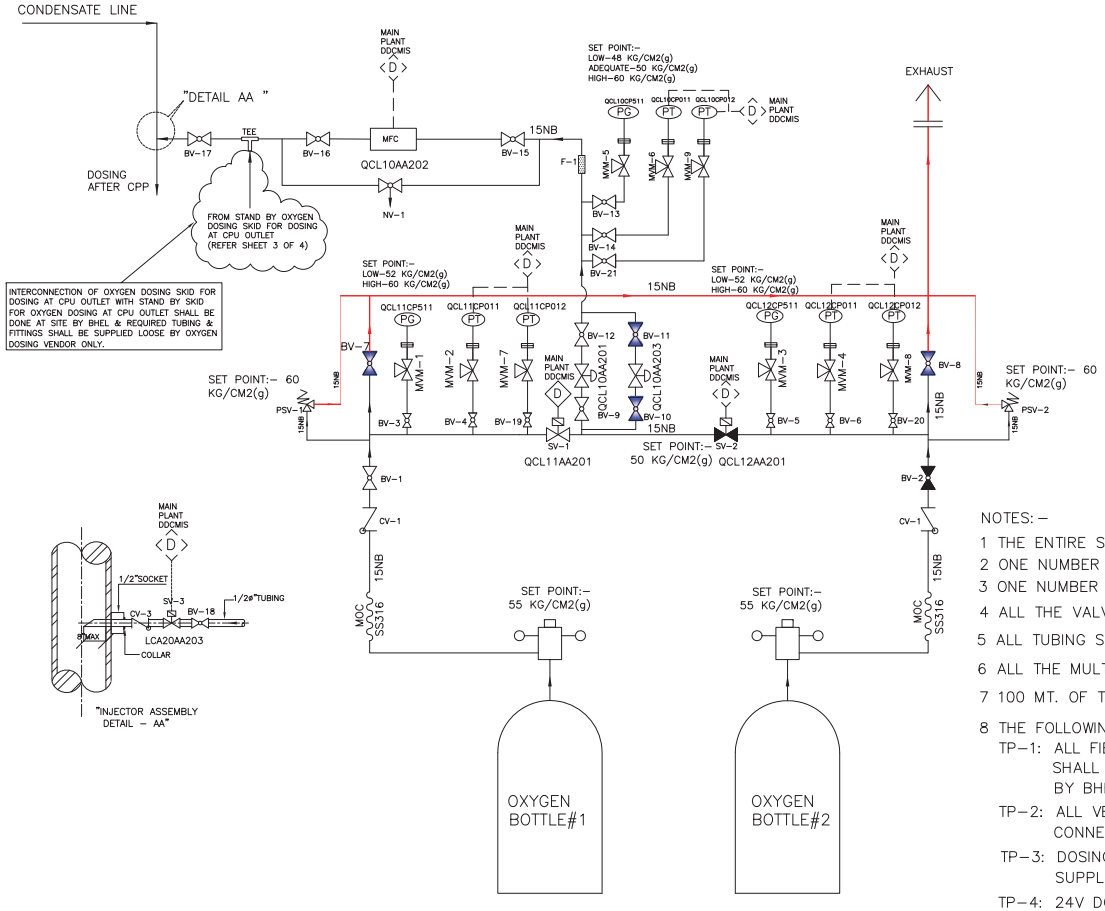
SL. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
										M	C	N	
1	2	3	4	5	6	7	8	9	D*	** 10			11
			LEGEND: * RECORDS, INDENTIFIED WITH "TICK" (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA 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 COLUMN						DOC. NO.: REV..... CAT.....				
MANUFACTURER/ SUB-SUPPLIER		MAIN-SUPPLIER						FOR THE OWNER USE	REVIEWED BY		APPROVED BY		APPROVAL SEAL
SIGNATURE													

ANNEXURE-VII

MFGR.'s LOGO		SUPPLIER'S NAME AND ADDRESS		FIELD QUALITY PLAN				PROJECT:		
				ITEM :		QP NO.:				
						REV.NO.:		PACKAGE:		
				SUB-SYSTEM:		DATE:		CONTRACT NO.:		
						PAGE: …. OF….		MAIN-SUPPLIER:		
SL. NO	ACTIVITY & OPERATIONS	CHARACTERISTICS/ INSTRUMENTS	CLASS# OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		REMARKS
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…… CAT…..	
							FOR THE OWNER USE			
MANUFACTURER/ SUB-SUPPLIER		MAIN-SUPPLIER						REVIEWED BY	APPROVED BY	APPROVAL SEAL
SIGNATURE										

P&IDs FOR OXYGEN DOSING SYSTEM

OXYGEN DOSING SKID 1 AT CPU OUTLET



L E G E N D

	PRESSURE REDUCING CUM REGULATING VALVE
	NEEDLE VALVE
PT	PRESSURE TRANSMITTER
	SOLENOID ACTUATED VALVE
PG	PRESSURE GAUGE
	NON RETURN VALVE/CHECK VALVE
MFC	MASS FLOW CONTROLLER WITH INDICATOR
	BALL VALVE
	BALL VALVE(NORMALLY CLOSED)
	PRESSURE REGULATOR
	PRESSURE SAFETY VALVE
	DISCHARGE TO ATMOSPHERE FOR GAS/SYSTEM
	MULTI-VALVE MANIFOLD(SEE NOTES)
	CHEMICAL SEAL DIAPHRAGM
	GAS FILTER

NOTES:-

1 THE ENTIRE SYSTEM INCLUDING THE JUNCTION BOX SHALL BE SKID MOUNTED.

2 ONE NUMBER SKID FOR ENTIRE STATION SHALL BE PROVIDED FOR DOSING OXYGEN AT CPU OUTLET.

3 ONE NUMBER INJECTION ASSEMBLY (SHOWN IN P&ID) FOR STATION SHALL BE SUPPLIED LOOSE.

4 ALL THE VALVES SHALL BE OF SS 316.

5 ALL TUBING SHALL BE OF SS 316, 15 NB AND 18 BWG.

6 ALL THE MULTI VALVE MANIFOLD SHALL BE 3-WAY VALVE MANIFOLDS (MOC: SS-316).

7 100 MT. OF TUBING OF MOC : SS316, 15NB AND 18BWG FOR STATION SHALL BE SUPPLIED LOOSE WITH THE SKID.

8 THE FOLLOWING SHALL BE TERMINAL POINT DETAILS:

TP-1: ALL FIELD INSTRUMENTS(PRESSURE AND FLOW TRANSMITTERS), AND SOLENOID VALVES(SV1 & 2 ONLY) SHALL BE TERMINATED AT THE JB BY OXYGEN DOSING VENDOR FOR FURTHER CONNECTION TO MAIN PLANT DCS BY BHEL.

TP-2: ALL VENT CONNECTIONS SHALL BE TERMINATED AT ONE POINT BY OXYGEN DOSING VENDOR FOR FURTHER CONNECTION TO ATMOSPHERE, IF REQUIRED BY BHEL.

TP-3: DOSING TERMINAL POINT SHALL BE AFTER MFC & BALL VALVES, TERMINATED BY THE OXYGEN DOSING SUPPLIER FOR FURTHER INTERCONNECTION TILL DOSING LOCATIONS BY BHEL.

TP-4: 24V DC CONNECTION TO SV-3 SHALL BE DIRECTLY CONNECTED BY BHEL .

9 MOC OF FLEXIBLE HOSE SHALL BE SS-316.

CUSTOMER:	TAMILNADU GENERATION & DISTRIBUTION CORPORATION LIMITED 5th Floor, Western Wing, NPKRR Maaligai, 144, Anna Salai, Chennai-600002
CONSULTANT: FICHTNER INDIA	Fichtner Consulting Engineers (India) Private Limited Menon Eternity, 9th Floor, No.165, St. Mary's Road, Alwarpet,Chennai-600018,Tamil Nadu, India
PROJECT	1X800 MW TANGEDCO NORTH CHENNAI TPP STAGE III-BTG
	BHARAT HEAVY ELECTRICALS LTD POWER SECTOR PROJECT ENGINEERING MANAGEMENT NOIDA

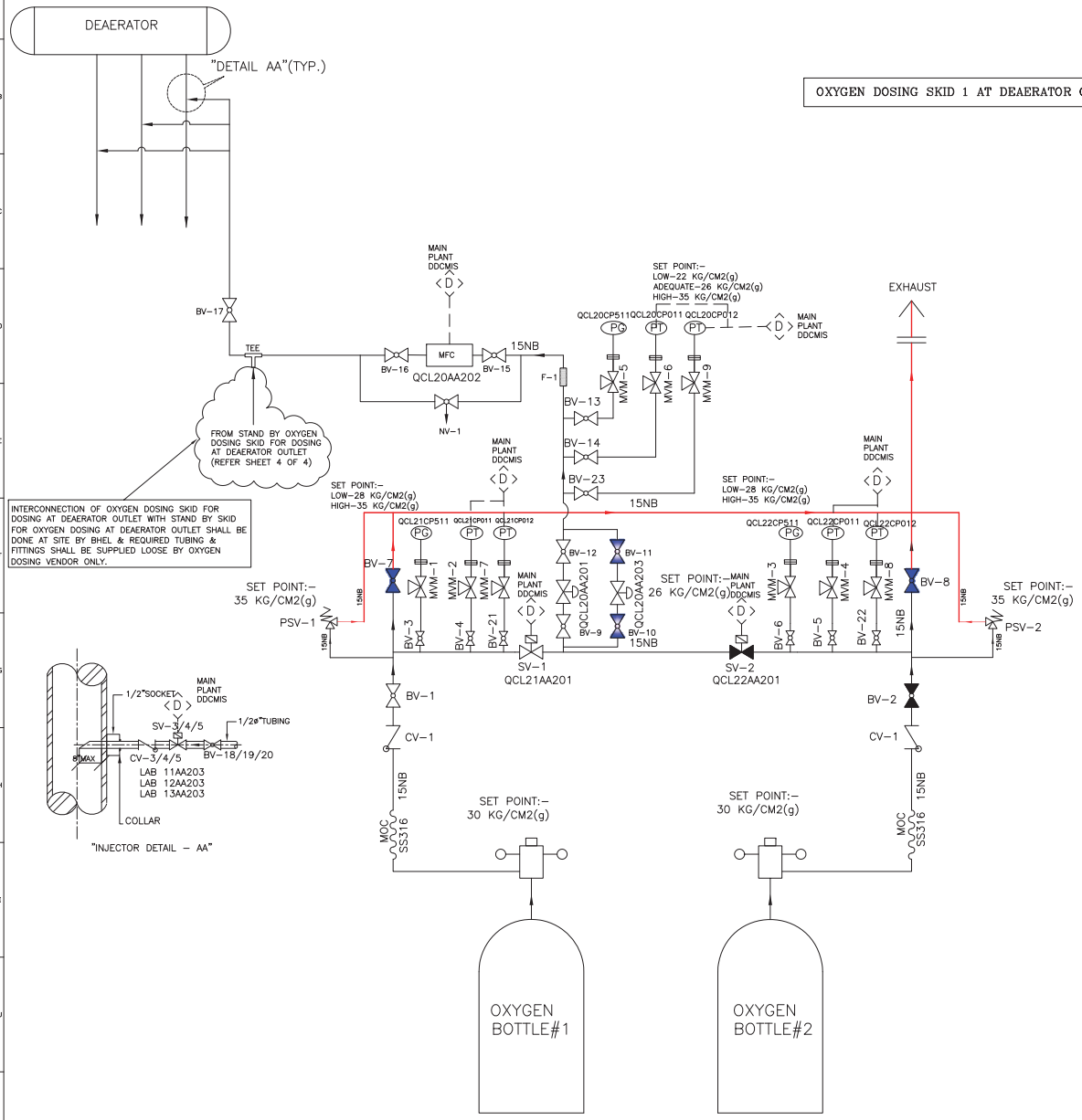
JOB NO.	423
STATUS	CONTRACT
DISTRIBUTION	

REV.	DATE	ALT'D	CHD	APP'D

DEPT CODE	NAME	SIGN	DATE
DRN.	DK		10.06.16
DESN	MKG		10.06.16
CHD	JP		10.06.16
APP'D	PK		10.06.16

TITLE: P&ID FOR OXYGEN DOSING SYSTEM (FOR DOSING AT CPU OUTLET)

DEPT. SIGN | SCALE: NTS | DRAWING NO. PE-TS-423-154A-A002 | SHEET 1 OF 4 | REV. 0 | SIZE-A0



L E G E N D

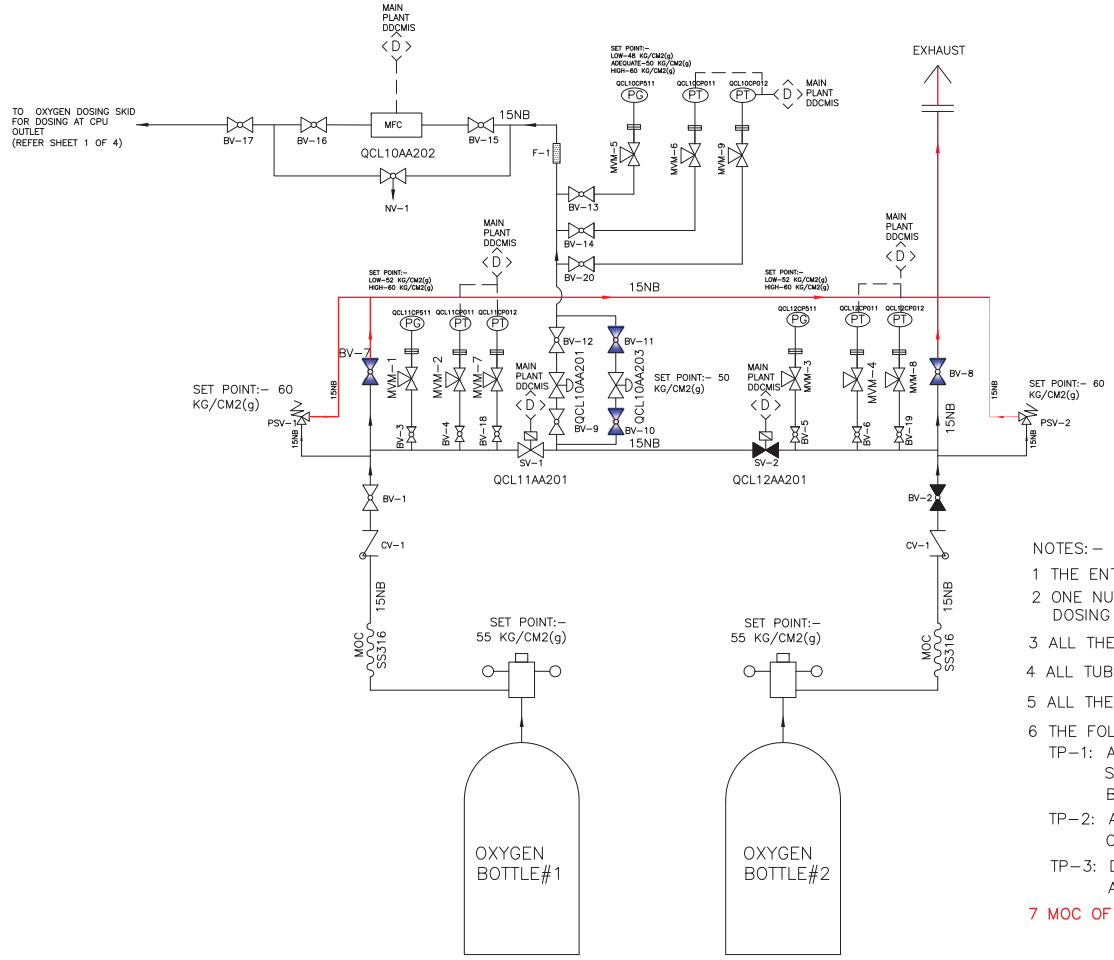
	PRESSURE REDUCING CUM REGULATING VALVE
	NEEDLE VALVE
PT	PRESSURE TRANSMITTER
	SOLENOID ACTUATED VALVE
PG	PRESSURE GAUGE
	NON RETURN VALVE/CHECK VALVE
MFC	MASS FLOW CONTROLLER WITH INDICATOR
	BALL VALVE
	BALL VALVE(NORMALLY CLOSED)
	PRESSURE REGULATOR
	PRESSURE SAFETY VALVE
	DISCHARGE TO ATMOSPHERE FOR GAS/SYSTEM
	MULTI-VALVE MANIFOLD(SEE NOTES)
	CHEMICAL SEAL DIAPHRAGM
	GAS FILTER

NOTES: –

1 THE ENTIRE SYSTEM INCLUDING THE JUNCTION BOX SHALL BE SKID MOUNTED.
2 ONE NUMBER SKID FOR ENTIRE STATION SHALL BE PROVIDED FOR DOSING OXYGEN AT DEAERATOR OUTLET.
3 THREE NUMBER INJECTION ASSEMBLY (SHOWN IN P&ID) FOR STATION SHALL BE SUPPLIED LOOSE.
4 ALL THE VALVES SHALL BE OF SS 316.
5 ALL TUBING SHALL BE OF SS 316, 15 NB AND 18 BWG.
6 ALL THE MULTI VALVE MANIFOLD SHALL BE 3-WAY VALVE MANIFOLDS (MOC: SS-316).
7 100 MT. OF TUBING OF MOC : SS316, 15NB AND 18BWG FOR STATION SHALL BE SUPPLIED LOOSE WITH THE SKID.
8 THE FOLLOWING SHALL BE TERMINAL POINT DETAILS:
TP-1: ALL FIELD INSTRUMENTS(PRESSURE AND FLOW TRANSMITTERS), AND SOLENOID VALVES (SV1 & 2 ONLY) SHALL BE TERMINATED AT THE JB BY OXYGEN DOSING VENDOR FOR FURTHER CONNECTION TO MAIN PLANT DCS BY BHEL.
TP-2: ALL VENT CONNECTIONS SHALL BE TERMINATED AT ONE POINT BY OXYGEN DOSING VENDOR FOR FURTHER CONNECTION TO ATMOSPHERE, IF REQUIRED BY BHEL.
TP-3: DOSING TERMINAL POINT SHALL BE AFTER MFC & BALL VALVES, TERMINATED BY THE OXYGEN DOSING SUPPLIER FOR FURTHER INTERCONNECTION TILL DOSING LOCATIONS BY BHEL.
TP-4: 24V DC CONNECTION TO SV-3,4,5 SHALL BE DIRECTLY CONNECTED BY BHEL .
9 MOC OF FLEXIBLE HOSE SHALL BE SS-316.

CUSTOMER: TAMILNADU GENERATION & DISTRIBUTION CORPORATION LIMITED, 5th Floor, Western Wing, NPKRR Maaligai, 144, Anna Salai, Chennai-600002
CONSULTANT: Fichtner Consulting Engineers (India) Private Limited, Menon Eternity, 9th Floor, No.165, St. Mary's Road, Alwarpet,Chennai-600018,Tamil Nadu, India
PROJECT: 1X800 MW TANGEDCO NORTH CHENNAI TPP STAGE III-BTG
BHARAT HEAVY ELECTRICALS LTD, POWER SECTOR, PROJECT ENGINEERING MANAGEMENT, NOIDA
JOB NO. 423 | STATUS CONTRACT | DISTRIBUTION
TITLE: P&ID FOR OXYGEN DOSING SYSTEM (FOR DOSING AT DEAERATOR OUTLET)
DRAWING NO. PE-TS-423-154A-A002 | SHEET 2 OF 4 | REV. 0 | SIZE-A0

OXYGEN DOSING SKID 2 AT CPU OUTLET



L E G E N D

	PRESSURE REDUCING CUM REGULATING VALVE
	NEEDLE VALVE
PT	PRESSURE TRANSMITTER
	SOLENOID ACTUATED VALVE
PG	PRESSURE GAUGE
	NON RETURN VALVE/CHECK VALVE
MFC	MASS FLOW CONTROLLER WITH INDICATOR
	BALL VALVE
	BALL VALVE(NORMALLY CLOSED)
	PRESSURE REGULATOR
	PRESSURE SAFETY VALVE
	DISCHARGE TO ATMOSPHERE FOR GAS/SYSTEM
	MULTI-VALVE MANIFOLD(SEE NOTES)
	CHEMICAL SEAL DIAPHRAGM
	GAS FILTER

NOTES: –

1 THE ENTIRE SYSTEM INCLUDING THE JUNCTION BOX SHALL BE SKID MOUNTED.

2 ONE NUMBER STAND BY OXYGEN DOSING SKID FOR ENTIRE STATION SHALL BE PROVIDED FOR DOSING OXYGEN AT CPU OUTLET.

3 ALL THE VALVES SHALL BE OF SS 316.

4 ALL TUBING SHALL BE OF SS 316, 15 NB AND 18 BWG.

5 ALL THE MULTI VALVE MANIFOLD SHALL BE 3-WAY VALVE MANIFOLDS (MOC: SS-316).

6 THE FOLLOWING SHALL BE TERMINAL POINT DETAILS:

TP-1: ALL FIELD INSTRUMENTS(PRESSURE AND FLOW TRANSMITTERS), AND SOLENOID VALVES(SV1 & 2 ONLY) SHALL BE TERMINATED AT THE JB BY OXYGEN DOSING VENDOR FOR FURTHER CONNECTION TO MAIN PLANT DCS BY BHEL.

TP-2: ALL VENT CONNECTIONS SHALL BE TERMINATED AT ONE POINT BY OXYGEN DOSING VENDOR FOR FURTHER CONNECTION TO ATMOSPHERE, IF REQUIRED BY BHEL.

TP-3: DOSING TERMINAL POINT SHALL BE AFTER MFC & BALL VALVE SHALL BE BY THE OXYGEN DOSING SUPPLIER AS PER P& ID.

7 MOC OF FLEXIBLE HOSE SHALL BE SS-316.

CUSTOMER:	TAMILNADU GENERATION & DISTRIBUTION CORPORATION LIMITED 5th Floor, Western Wing, NPKRR Maaligai, 144, Anna Salai, Chennai-600002
CONSULTANT: FICHTNER INDIA	Fichtner Consulting Engineers (India) Private Limited Menon Eternity, 9th Floor, No.165, St. Mary's Road, Alwarpet,Chennai-600018,Tamil Nadu, India
PROJECT	1X800 MW TANGEDCO NORTH CHENNAI TPP STAGE III-BTG
	BHARAT HEAVY ELECTRICALS LTD POWER SECTOR PROJECT ENGINEERING MANAGEMENT NOIDA

JOB NO. 423 | STATUS CONTRACT | DISTRIBUTION

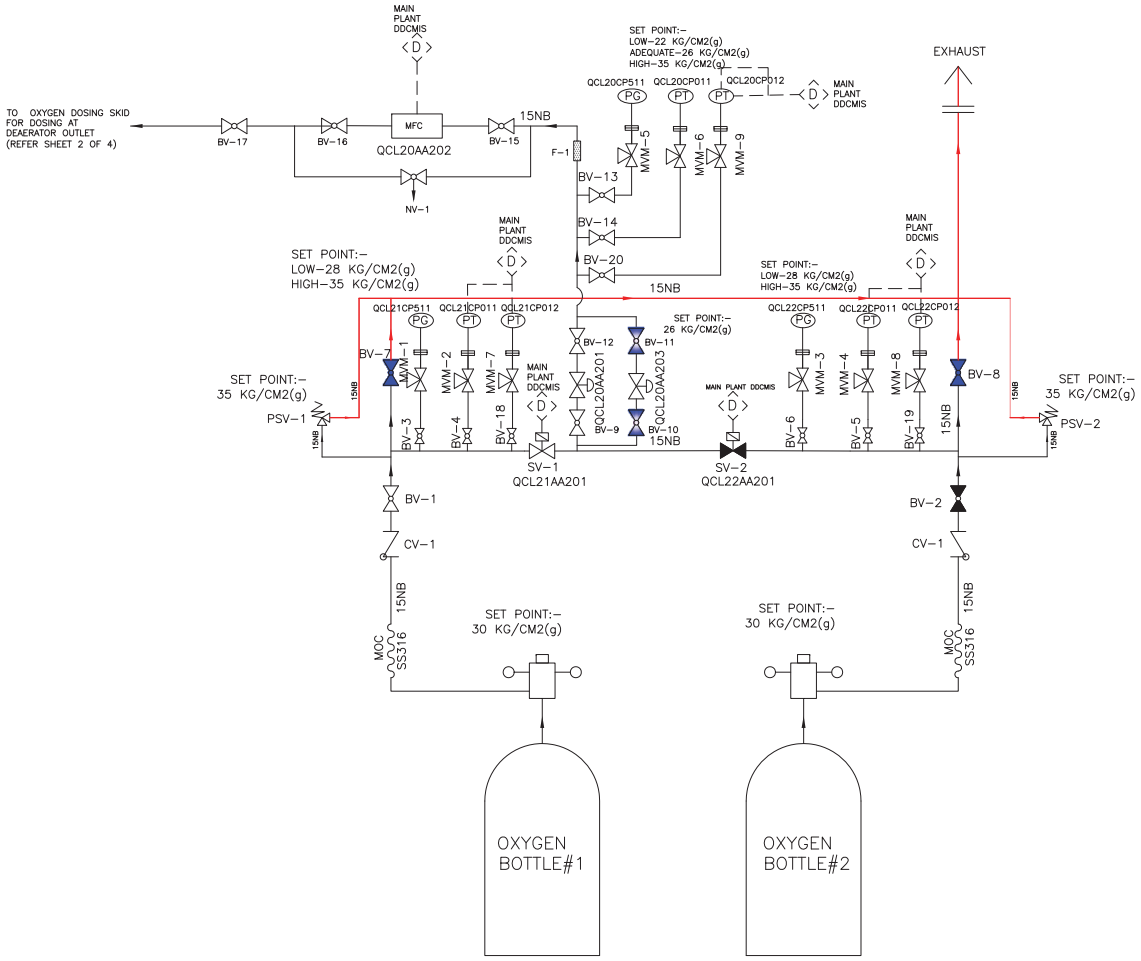
REV.	DATE	ALT'D	CHD	APP'D

DEPT CODE	NAME	SIGN	DATE
DRN.	DK		10.06.16
DES'N	MNG		10.06.16
CHD	JP		10.06.16
APP'D	PK		10.06.16

TITLE: P&ID FOR OXYGEN DOSING SYSTEM (STAND BY SKID FOR DOSING AT CPU OUTLET)

DEPT. SIGN | SCALE: NTS | DRAWING NO. PE-TS-423-154A-A002 | SHEET 3 OF 4 | REV. 0 | SIZE-A0

OXYGEN DOSING SKID 2 AT DEAERATOR OUTLET



LEGEND

	PRESSURE REDUCING CUM REGULATING VALVE
	NEEDLE VALVE
PT	PRESSURE TRANSMITTER
	SOLENOID ACTUATED VALVE
PG	PRESSURE GAUGE
	NON RETURN VALVE/CHECK VALVE
MFC	MASS FLOW CONTROLLER WITH INDICATOR
	BALL VALVE
	BALL VALVE(NORMALLY CLOSED)
	PRESSURE REGULATOR
	PRESSURE SAFETY VALVE
	DISCHARGE TO ATMOSPHERE FOR GAS/SYSTEM
	MULTI–VALVE MANIFOLD(SEE NOTES)
	CHEMICAL SEAL DIAPHRAGM
	GAS FILTER

NOTES: –

1 THE ENTIRE SYSTEM INCLUDING THE JUNCTION BOX SHALL BE SKID MOUNTED.

2 ONE NUMBER STAND BY OXYGEN DOSING SKID FOR ENTIRE STATION SHALL BE PROVIDED FOR DOSING OXYGEN AT DEAERATOR OUTLET.

3 ALL THE VALVES SHALL BE OF SS 316.

4 ALL TUBING SHALL BE OF SS 316, 15 NB AND 18 BWG.

5 ALL THE MULTI VALVE MANIFOLD SHALL BE 3–WAY VALVE MANIFOLDS (MOC: SS–316).

6 THE FOLLOWING SHALL BE TERMINAL POINT DETAILS:

TP–1: ALL FIELD INSTRUMENTS(PRESSURE AND FLOW TRANSMITTERS), AND SOLENOID VALVES (SV1 & 2 ONLY) SHALL BE TERMINATED AT THE JB BY OXYGEN DOSING VENDOR FOR FURTHER CONNECTION TO MAIN PLANT DCS BY BHEL.

TP–2: ALL VENT CONNECTIONS SHALL BE TERMINATED AT ONE POINT BY OXYGEN DOSING VENDOR FOR FURTHER CONNECTION TO ATMOSPHERE, IF REQUIRED BY BHEL.

TP–3: DOSING TERMINAL POINT SHALL BE AFTER MFC & BALL VALVE SHALL BE BY THE OXYGEN DOSING SUPPLIER AS PER P& ID.

7 MOC OF FLEXIBLE HOSE SHALL BE SS–316.

CUSTOMER:	TAMILNADU GENERATION & DISTRIBUTION CORPORATION LIMITED 5th Floor, Western Wing, NPKRR Maaligai, 144, Anna Salai, Chennai–600002
CONSULTANT: FICHTNER INDIA	Fichtner Consulting Engineers (India) Private Limited Menon Eternity, 9th Floor, No.165, St. Mary's Road, Alwarpet,Chennai–600018,Tamil Nadu, India
PROJECT	1X800 MW TANGEDCO NORTH CHENNAI TPP STAGE III–BTG
	BHARAT HEAVY ELECTRICALS LTD POWER SECTOR PROJECT ENGINEERING MANAGEMENT NOIDA

JOB NO.	423
STATUS	CONTRACT
DISTRIBUTION	

REV.	DATE	ALTD	CHD	APPD

DEPT CODE		NAME	SIGN	DATE
DRN.	DK			10.06.16
DESN	MKG			10.06.16
CHD	JP			10.06.16
APPD	PK			10.06.16

TITLE: P&ID FOR OXYGEN DOSING SYSTEM (STAND BY SKID FOR DOSING AT DEAERATOR OUTLET)

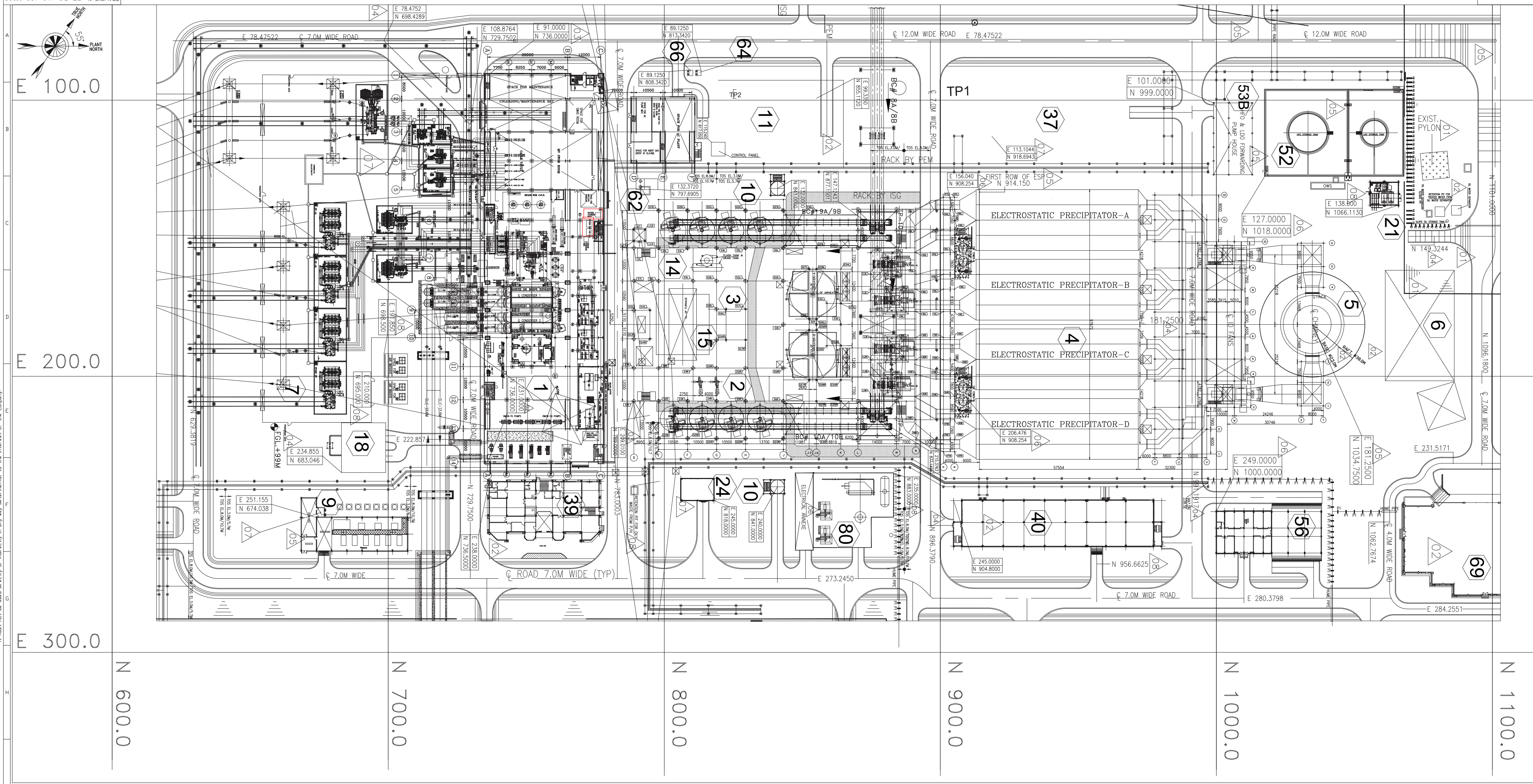
DEPT.	SCALE: NTS	DRAWING NO. PE-TS-423-154-A002(A-A002)
SIGN		SHEET 4 OF 4 REV. 0

DATA SHEET- A

DATA SHEET-A

Sl. No	Description	Parameter
Mechanical Items		
1.0	No. of skid(s)for project	FOUR
2.0	Design pressure of O2 dosing skid	CPU outlet- 60 kg/ cm2 (g) Deaerator outlet -35 kg/ cm2 (g)
3.0	Operating pressure of O2 dosing skid	CPU outlet- 50 kg/ cm2 (g) Deaerator outlet -26 kg/ cm2 (g)
4.0	Operating temperature	Ambient
5.0	Concentration of Oxygen dosed	99%
6.0	Temperature of service fluid	Ambient
2.0	**Cylinders:**	
2.1	Quantity mounted on skid	Two per skid (Total eight)
2.2	Loose supply of filled Oxygen cylinders	30 nos.Loose on one racks (Rack to store 30 oxygen cylinders).
2.3	Design Standard of empty oxygen cylinder	IS-7285 Part 1
2.5	Water Capacity	50 liters
2.6	Gas Capacity	10 m3
2.7	Max Working pressure at 25°C	204 Kgf/cm2
2.8	Painting of oxygen cylinder	As per IS 4379
2.10	Accessories	One (1) number Cylinder storing rack (MS), capacity to hold 30 cylinders
3.0	**All Tubing:**	
3.1	Material	SS 316
3.2	Diameter	15 NB (1/2” OD), 18 BWG
4.0	**Ball valves**	
4.1	Body, Bonnet, stem	SS 316
4.2	Trim Material	SS 316
4.3	Design standard	MSS-99-2010/Equivalent.
4.4	Test standard	MSS-99-2010/Equivalent.
4.5	Size	15 NB
4.6	End Connections	Ferruled
4.7	Rating	2000 PSI
4.8	Valve operation	Manual or pneumatic as per P&ID
5.0	**Check valves/ NRV**	
5.1	Body, cover, disc/piston & seat	SS 316
5.2	Design standard	MSS-99-2010/Equivalent.
5.3	Test standard	MSS-99-2010/Equivalent.
5.4	Size	15 NB
5.5	End Connections	Ferruled
5.6	Rating	2000 PSI
5.7	Valve operation	“Self-actuated” (Manual)
6.0	**Pressure relief valve**	
6.1	Type	Spring loaded, angle type
6.2	Body, bonnet, disc & nozzle	SS 316
6.3	Valve discharges to	Atmosphere (vent)
6.4	Back pressure	Constant
6.5	Set pressure	60 Kg/cm2 (g) for skid 1 and 35 Kg/cm2 (g) for skid 2
6.6	Inlet Connections	Ferruled
6.7	Outlet Connections	Ferruled
6.8	Rating	2000 PSI
7.0	**Fittings**	SS 316
8.0	**Pressure Regulator**	

8.1	Quantity	Two per skid (total 8), each mounted to an oxygen cylinder
8.2	Body & trim	SS 316/Brass
8.3	Inlet connection	1/2 "
8.4	Outlet connection	1/2 "
8.5	Operating pressure	204 Kg/cm2(g)
8.6	Set outlet Pressure	55 Kg/cm2(g) for skid dosing at CPU outlet and 30 Kg/cm2(g) for skid dosing at deaerator outlet
9.0	**Mass Flow Controller/FMCT (along with local Flow indicator)**	----------SS316, ANSI B16.5 CL 400----------
9.1	Expected Flow of O_2 in process	50-400 gm/ hr. (for skids dosing at deaerator outlet); 40-300 gm/ hr. (for skids dosing at CPU outlet)
9.2	MOC-wetted parts	SS 316
9.3	Operating pressure	Pressure reducing valve set pressure (Refer P&IDs)
10.0	**Structural steel**	IS 2062
11.0	**Nuts & bolts**	SS 304



FIRST ANGLE PROJECTION

ALL DIMENSIONS ARE IN MM
THIS IS A PART OF TECHNICAL SPECIFICATION NO. PE-TS-425-154A-A002

NUMBER	DESCRIPTION
1	POWER HOUSE BUILDING INCLUDING ELECTRICAL BAY
2	COAL MILL
3	STEAM GENERATOR
4	ESP
5	CHIMNEY
6	SPACE FOR FGD PLANT
18	DG SET
52	HFO & LDO STORAGE TANK DYKE AREA.
21	FOAM PUMP HOUSE
37	AHP COMPRESSOR HOUSE CUM AHP CONTROL / SWITCHGEAR ROOM
11	ASH WATER CUM SLURRY PUMP HOUSE
64	BOILER WASH WATER SUMP
9	COMPRESSOR HOUSE
39	SERVICE BUILDING
24	BOOSTER PUMP HOUSE
80	AUXILIARY BOILER
40	ESP CONTROL ROOMS
56	FIRE STATION

NUMBER	DESCRIPTION
69	ADMINISTRATIVE BUILDING
65	BOILER BLOW DOWN SUMP
53B	HFO & LDO FORWARDING PUMP HOUSE
66	T.G. WASH WATER SUMP
68	TRANSFORMER YARD WASH WATER SUMP
7	TRANSFORMER YARD
10	MILL REJECTS LOADING HOPPERS
14	BA OVER FLOW SUMP
15	BOTTOM ASH HOPPER
62	PRE OIL WATER SEPARATOR PIT

REFERENCE DWG. :-

1. PLOT PLAN (CUSTOMER) — 13A06-DWG-M-002 RE
2. DG ROOM LAYOUT PLAN — IS-3-DG-694-800-A01
3. GATE COMPLEX — PE-DG-410-641-C024
4. ADMINISTRATIVE BUILDING — PE-DG-410-641-C002
5. TRANSFORMER YARD LAYOUT — PE-DG-410-100-E001
6. TG EQUIPMENT LAYOUT DRAWING AT GROUND FLOOR (AT 0.0M) — PE-DG-410-100-M003
7. GENERAL ARRGT. OF BOILER — 0-00-022-76919
8. GENERAL ARRGT. OF ESP — 0-00-111-27526
9. LAYOUT OF ID SYSTEM — 0-00-020-76876
10. LAYOUT OF TRANSFORMER YARD — PE-DG-410-100-E001
11. YARD PIPING & TRESTLE LAYOUT — PE-DG-410-100-M051

NOTES:-

1. ALL DIMENSIONS AND CO-ORDINATES ARE IN METER UNLESS NOTED OTHERWISE.
2. THE FINISHED FLOOR LEVEL (FFL) OF POWER HOUSE BUILDING GROUND FLOOR IS EL. 0.00M WHICH CORRESPONDS TO 0.5M (RL. 99.5M) ABOVE FGL.
3. THE EXISTING BUILDINGS SHOWN IN SHADED LINE IN THE POWER PLANT AREA, ETC. AND AS REQUIRED FOR THE CONSTRUCTION OF THE FACILITIES FOR UNIT #12 ARE TO BE DISMANTLED.
4. THE PIPE RACK SHOWN IS INDICATIVE ONLY.
5. 400KV OUTGOING LINES ARE TO BE ALIGNED DULY CLEARING THE RE-ROUTED 220KV LINES RUNNING ALONG THE PLANT BOUNDARY.
6. RE-ROUTING OF EXISTING 400KV LINE NEAR PROPOSED SWITCHYARD AND CHP AREA TO BE SUITABLY INCORPORATED IN THIS DRAWING BY TSGENCO.
7. CUST. GRIDS HAVE BEEN CONVERTED TO PLANT GRIDS. REFERENCE POINT HAS BEEN INDICATED.

LEGEND :-

- ROAD
- PIPE/CABLE RACK
- BELT CONVEYOR
- GREEN BELT
- PEDESTAL PIPING

REV.	DATE	ALTD	CHD	APPD	DESCRIPTION
04	25.01.2017	RA	GSF/PKK	JJ	1. CORDINATES OF FIRST ROW OF ESP & CHMINEY CORRECTED AS MARKED UP. 2. GENERALLY UPDATED INLINE WITH PLOT PLAN.
03	23.06.2015	RA	GSF/PKK	JJ	1. REVISED AS PER DCPL/ TSGENCO COMMENTS VIDE LEETR NO 13A06/DCH-4/0304 DTD: 02.06.2015 (RECD ON 09.06.2015).
02	22.05.2015	RA	GSF/PKK	JJ	1. REVISED AS PER DCPL/ TSGENCO COMMENTS DTD: 18.05.2015. 2. GENERALLY UPDATED.
01	30.04.2015	RA	GSF/PKK	JJ	1. REVISED AS PER CUSTOMER COMMENTS DTD: 07.04.2015. 2. GENERALLY UPDATED.

JOB NO. 410
STATUS CONTRACT
DISTRIBUTION

CUSTOMER: TELANGANA STATE POWER GENERATION CORPORATION LTD
TELANGANA, INDIA
1x800 MW KOTHAGUDAM TPS STAGE-VII UNIT#12, PALONCHA

CONSULTANT: DEVELOPMENT CONSULTANTS PVT. LTD.
CONSULTING ENGINEERS
KOLKATA MUMBAI CHENNAI NEW DELHI

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA

DEPT CODE: M

	NAME	SIGN	DATE
DRN			25.03.2015
DESN	RA	-Sd-	25.03.2015
CHD	GSF	-Sd-	25.03.2015
APPD	PKK/SPV	-Sd-	25.03.2015
	JJ	-Sd-	

TITLE: MAIN EQUIPMENT PLAN LAYOUT

SCALE 1:500

DRAWING NO. PE-DG-410-100-M002

SHEET 1 OF 1

SIZE-A0

COMPUTER FILE NAME: PE-DG-410-100-M002_REV03P

DRAWING No. PE-DG-410-100-M002

SUB -SECTION – IB
SPECIFIC TECHNICAL REQUIREMENTS (ELECTRICAL)

Annexure-I
REV: 0 DATE: 17.02.2017

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGE: OXYGEN DOSING SYSTEM
SCOPE OF VENDOR: SUPPLY

PROJECT: 1 X 800 MW NORTH CHENNAI TPP STAGE-III-BTG

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	Power cables, ordinary control cables and screened control cables	Vendor	Vendor*	Within the skid.
2	Junction box for control & instrumentation cable (if applicable)	Vendor	Vendor*	JB shall be mounted on respective skid. Termination of all field instruments, solenoid valves and MFC up to JB shall be done as per BHEL termination drawing by bidder. Connection between JB and DCS shall be in BHEL scope.
3	Any special type of cable like compensating, co-axial, prefab, MICC & fibre optical	Vendor	Vendor*	Within the skid
4	Equipment grounding	Vendor	Vendor*	Within the skid. All equipment metallic enclosures / frames, metal structure etc. shall be grounded at two points each to the nearest grounding points / risers provided by BHEL.
5	Cable glands ,lugs and bimetallic strip for equipment supplied by Vendor	Vendor	Vendor*	1. Double compression Ni-Cr plated brass cable glands 2. Solder less crimping type heavy duty tinned copper lugs for power and control cables.

NOTES:-

*E &C by vendor during factory assembling of the skid.

SUB -SECTION – IC
SPECIFIC TECHNICAL REQUIREMENTS (C&I)

SPECIFIC TECHNICAL REQUIREMENTS (C&I) WITH SCOPE OF SUPPLY:

1.1 **Oxygen Dosing System** shall be operated from DCS through operator work station (OWS) located in common control room (CCR).

1.2 Bidder to supply the field instrumentation, solenoid valve (with limit switches for open close feedback) as required and is shown in the P&ID.
All local gauges as well as transmitters, sensors and switches for parameters like pressure, temperature, level, flow etc. as required for the safe and efficient operation maintenance under the scope of specification shall be provided. The necessary root valves, impulse piping, drain cock, 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. Double root valves shall be provided for all pressure tapping where the pressure exceeds 40 Kg /Cm2.

1.3 All the instruments/drives shall be terminated on JBs in field. JBs shall be in Bidder's scope. The detailed specification of instruments, JB etc. are given in detail as below. JB shall be provided with 20% additional/spare terminals.

1.4 For cable scope, refer to “Electrical Scope between BHEL and Vendor”, elsewhere in the specification.

1.5 Number of pairs to be selected for Screen /Control cable (Size: 0.5 mm2)
a. F-Type: 2P/4P/8P/12P/24P
b. G-Type: 4P/8P/12P

1.6 Diaphragm seal shall be provided with Instruments having contact with corrosive media.

1.7 All field instruments enclosure shall be IP65 local panel/cabinet enclosure shall be IP 55, unless otherwise specified.

1.8 The solenoid valve and mass flow controller with read out shall operate at 24V DC from DCS.

1.9 Instrument installation and accessories required for the same shall be in Bidder's scope and shall be submitted after award of contract. However, any instrument installation not covered in the same shall be subject to customer and BHEL approval during detailed engineering.

1.10 All the transmitters supplied by Bidder shall be rack mounted. The transmitter racks shall be in Bidder's scope of supply. All transmitters shall be HART compatible.

1.11 The make/model of various instruments/items/systems shall be subject to approval of owner/purchaser during detailed engineering stage. No commercial implication shall be acceptable in this regard.

1.12 In case of any conflict and repetition of clauses in the specification, the more stringent requirements as per BHEL’s interpretation shall be complied by the bidder.

1.13 The requirements given are to be read in conjunction with detailed technical specification enclosed in the 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 BHEL’s interpretation shall be complied by the bidder.

1.14 Bidder to delegate /depute their persons/experts (5 working days) as per owner/consultants' requirement without any additional cost to BHEL during commissioning. Schedule of the visit shall be intimated 7 days in advance.

1.15 Drawings/Documents and data to be furnished after award of the contract:

- Field instruments data sheet.
- JB GA drawing & termination details.
- Any other document decided during detailed engineering.

SECTION – II

GENERAL TECHNICAL REQUIREMENTS

SUB-SECTION IIA - GENERAL TECHNICAL REQUIREMENTS (MECH.)
SUB-SECTION IIB - GENERAL TECHNICAL REQUIREMENTS (ELEC.)
SUB-SECTION IIC - GENERAL TECHNICAL REQUIREMENTS (C&I)

SUB -SECTION- IIA

GENERAL TECHNICAL REQUIREMENTS (MECH.)

1.0 SCOPE

This specification is intended to cover design, engineering, manufacturing, fabrication, assembly, inspection & testing at manufacturer's works, supply and dispatch to power station site of skid mounted **Oxygen Dosing Systems** along with start-up commissioning spares and mandatory spares as specified for the **1X800 MW COAL BASED NORTH CHENNAI TPP STAGE –III-BTG**. The above system shall be skid mounted. Two numbers skid for each unit shall be provided for oxygen dosing system (one number for dosing at CPU outlet and one number for dosing at deaerator outlet).

Location of all Oxygen dosing systems inside TG hall 0.0 M. Please refer TG equipment layout drawing at ground floor (at EL 0.0M) BHEL DRG. No. PE-DG-423-100-M003 .Location of oxygen dosing skids shall be b/w B row & C row and b/w column no. 6a & 7a.

Remarks: Redundancy of 100% of oxygen dosing system has to be considered, hence total 4 nos. Oxygen dosing skid shall be supplied for 1X800 MW COAL BASED NORTH CHENNAI TPP STAGE -III. For standby skids please refer the P&ID of oxygen dosing system (Stand by Skid for dosing at CPU Outlet) & P&ID of oxygen dosing system (Stand by Skid for dosing at Deaerator Outlet).

2.0 DESIGN PHILOSOPHY

The objective of providing the dosing systems is to maintain the chemistry of the boiler feed water and also to comply with different modes of operation i.e. "Combined Water Treatment mode" during continuous plant operation and "Ammoniacal mode or AVT (O) mode" during start-up & shutdown conditions.

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The chemical feed for Combined Water Treatment (CWT) involves the feed of only aqueous ammonia and gaseous oxygen. The principles, equipment selection and control philosophy of ammonia feed system has been covered separately in the Design Memorandum and P&ID for Chemical dosing system.
The following philosophy of chemical feed system is considered:-

a) During normal operation:-

- pH is maintained at 8.2-8.5 by dosing aqueous ammonia solution.
- Oxygen dosing rate at economizer inlet, recommended by BHEL is 30-150 ppb. Exact dosing rate shall be decided by the operator based on oxygen level at economizer inlet. For sizing of oxygen dosing system, 150 ppb continuous dosing of 99% pure oxygen has been considered.
- Dosing shall normally be done at CPU outlet. However provision shall be given for dosing at deaerator outlet also. For this purpose two separate skid based oxygen dosing systems shall be supplied for each unit. However, dosing shall be done at one place at a time only.
- Dosing rate shall be controlled from Plant DCS by regulating mass flow controller (MFC) provided on each O2 dosing skid under full load conditions based on dissolved oxygen level at economizer inlet. Oxygen dosing rate can be adjusted in the range of 30-150 ppb from Plant DCS. However, customer may also chose to manually feed a particular set point within this range and operate the oxygen dosing automatically based on this set point.
- The oxygen dosing shall automatically turn off by closing the mass flow controller (MFC) if cation conductivity in the cycle goes above 0.3 us/cm.

b) Startup sequence:-

- Deaerator vent is kept open.
- Ammonia is dosed at CPU outlet to achieve a pH of 9.2.
- Cation conductivity reaches below 0.15 µs/cm (at 25˚C) and the trend is downwards.
- Deaerator vents are closed.
- Oxygen feed is manually started from DCS.

c) Shut down sequence:-

- Oxygen feed needs to be stopped one hour before shut down and deaerator & LP heater vents needs to be opened.
- Ammonia dosing rate needs to be increased to achieve pH in the range of 9.2.

3.0 Equipment for Oxygen Dosing (Two skids per unit, Total 4 Nos. considering redundancy)

As mentioned, four oxygen dosing skids shall be supplied for entire station. Each skid shall be identical unless specifically mentioned otherwise. Since for one unit only one skid out of the two shall be under operation at a time, the cylinder storage for the all the skids shall be common located at the vicinity of the oxygen dosing skids. Each skid shall consist of the following components:-

3.1 Cylinder banks

Each oxygen dosing skid shall consist of a bank of two oxygen cylinders, dosing at downstream of deaerator/CPU outlet. Oxygen cylinder bank is provided to cater daily requirement. The automatic change-over of cylinder takes place on the basis of pressure i.e. the cylinder banks dosing at Condensate Polishing Unit (CPU) outlet will switch over at 52 kg/cm2(g) and the cylinder banks dosing at deaerator outlet at 28 kg/cm2(g). One (1) no. Oxygen cylinder storage rack for storing 30 cylinders shall be supplied to cater 30 days oxygen cylinders requirement.

3.2 Pressure Regulator:

The line pressure regulator is used for reducing a high supply pressure (204 bars cylinder pressure) to 55 kg/cm2(g) pressure in skid dosing at CPU outlet and to 30 kg/cm2(g) pressure in skid dosing at deaerator outlet.

3.3 Valves, tubing, vents and instrumentation shall be as per the attached P&ID (PE-DG-423-154-12000A-A001 sheet 1-4 of 4) and the data sheet. The MOC and specification of the equipments shall be as per the attached data sheet.

4.0 CONTROL AND INSTRUMENTATION

The mode of operation of the oxygen dosing system shall be from main Plant DCS only. All the logics, controls and interlocks shall be implemented in main Plant DCS. Local manual intervention is not envisaged. Both manual/automatic controls shall be implemented in main plant DCS. The provision to select “Auto” or “Manual” mode shall be provided in main Plant DCS-OWS only.

The oxygen gas shall be at high pressure (204 Kgf/cm2) in the cylinders. The same shall be brought to a lower pressure by the Pressure Regulator (set pressure of 55 Kg/cm2 for skid dosing at CPU outlet and set pressure of 30Kg/cm2 for skid dosing at deaerator outlet attached with each cylinder.

Each of the two oxygen cylinders in the skid shall have a dedicated set of solenoid valve, pressure gauge and pressure transmitter. Two cylinders provided on skid are connected and one cylinder will serve at a time based on the pressure at the inlet of solenoid valve. In case the pressure at the inlet of SV1 reaches at the set point, the solenoid valve SV1 will close and solenoid vale SV2 will open and other cylinder shall be taken in to service provided the pressure at the inlet of SV2 is not low and vice versa. Alarm for pressure low at the inlet of solenoid valves shall be provided in main Plant DCS.

A pressure relief valve shall be fitted at the downstream of solenoid valve to relieve system pressure if the system pressure goes above set pressure.

The pressure of the oxygen shall be further reduced by pressure reducing valve in the skid based on the feedback received from pressure transmitter {set point –“ADEQUATE--(Set points– 50 kg/cm2 for skid dosing at CPU outlet & 26 kg/cm2 for skid dosing at deaerator outlet) downstream. The flow and pressure of oxygen can be monitored from Main plant DCS by the signal from mass flow controller (MFC) and from pressure transmitter provided at the downstream of pressure reducing regulating valve. The flow of oxygen dosing will be controlled manually/automatically from Main Plant DCS by adjusting mass flow controller (MFC) provided on skid based on the feedback from the dissolved oxygen analyzer located in the economizer inlet. The MFC shall have a position feedback transmitter that shall transmit the feedback signal to Main plant DCS.

The MFC shall be provided along with flow indicator to check the actual flow rate dosed to the system locally in the field.

All solenoid valves mounted in the oxygen dosing skid shall be 24 V DC powered from main plant DCS and routed through the local skid mounted junction box. All the field instruments, MFC and solenoid valves (SV1 & SV2) shall be terminated at a junction box in the skid by BHEL's oxygen dosing vendor for further connection to Plant DCS. The cabling from JB to main plant DCS shall be in BHEL scope.

At each dosing point, viz. CPU outlet and deaerator outlet, an injection assembly containing 15 NB tubing, fixing collar, solenoid valve, Ball valve and NRV shall be supplied loose by oxygen dosing vendor.

The set points indicated below for operation of pressure reducing valve are tentative. Final value of the same shall be decided based on system requirement.

BIDDER TO NOTE THAT BIDDER HAS TO PROVIDE GAS FILTERS BEFORE MASS FLOW CONTROLLER (MFC) FOR PROPER FUNCTIONING OF THE INSTRUMENT, THE SAME SHALL BE IN BIDDER'S SCOPE.

Bidder to provide a flame arrestor in the vent header of each of oxygen dosing skids.

Following interlocks/alarm annunciation facility shall be provided.

For Skids dosing at CPU Outlet

Source of signal	Tag Number	Set Point (suggested)	Interlock	Alarm in DCS	Remarks
During Normal Operation:-					
Pressure transmitter	PT (QCL11CP011)/ (QCL11CP012)	60 Kg/cm2 (g) (HIGH)	Not applicable	Yes (HIGH pressure at cylinder 1 outlet)	Manual checking of pressure regulator reqd.
Pressure transmitter	PT (QCL11CP011)/ (QCL11CP012)	52 Kg/cm2 (g) (LOW)	Close SV-1(QCL11AA201) & Open SV-2 (QCL12AA201)	Yes (LOW pressure at cylinder 1 outlet)	Auto-changeover of cylinders. Manually replace cylinder 1 with filled cylinder.
Pressure transmitter	PT (QCL12CP011)/ (QCL12CP012)	60 Kg/cm2 (g) (HIGH)	Not applicable	Yes (HIGH pressure at cylinder 2 outlet)	Manual checking of pressure regulator reqd.
Pressure transmitter	PT (QCL12CP011)/ (QCL12CP012)	52 Kg/cm2 (g) (LOW)	Close SV-2(QCL12AA201) & Open SV-1(QCL11AA201)	Yes (LOW pressure at cylinder 2 outlet)	Auto-changeover of cylinders. Manually replace cylinder 2 with filled cylinder.
Pressure transmitter	PT (QCL10CP011)/ (QCL10CP012)	48 Kg/cm2 (g) (LOW)	Close MFC (QCL10AA202)	Yes (Oxygen dosing stopped due to low pressure)	
Pressure transmitter	PT (QCL10CP011)/ (QCL10CP012)	60 Kg/cm2 (g) (HIGH)	Not applicable	Yes (HIGH dosing pressure)	Manual checking of pressure reducing valve reqd.
Pressure transmitter	PT (QCL10CP011)/ (QCL10CP012)	50 Kg/cm2 (g) (Adequate)	Open Permissive pressure of MFC(QCL10AA202),	Not applicable	
Cation Conductivity analyzer **		0.3 µs/cm (at 25˚C), increasing (HIGH)	Close MFC (QCL10AA202)	Yes (Oxygen dosing stopped due to high cation conductivity in feed water cycle)	Increase ammonia pH set point to raise pH to 9.2-9.5 range
Dissolved oxygen analyzer**		30 ppb (LOW), decreasing	Gradually open MFC (QCL10AA202) to increase DO provided signal from PT (QCL10CP001) is "NOT LOW" (i.e < 45 Kg/cm2 (g))	Yes (Low DO level in feed water cycle)	Initial set point may be chosen as 90 ppb. However, provision may be kept to choose exact set point for operation by operator's plant chemist during commissioning within the range of 30-150 ppb.
Dissolved oxygen analyzer**		150 ppb, increasing (HIGH)	Close MFC (QCL10AA202) to decrease DO	Yes (Oxygen dosing stopped due to high DO level in feed water cycle)	
During Start up:-					
Cation Conductivity analyzer **		0.15 µs/cm (at 25˚C), decreasing (ADEQUATE)	Open MFC (QCL10AA202) , provided signal from PT-3 is "NOT LOW" (i.e < 48 Kg/cm2 (g)) & signal from DO analyzer is "NOT HIGH" (i.e > 150 ppb)	Yes (Oxygen dosing started)	

For Skids dosing at deaerator Outlet

Source of signal	Tag Number	Set Point (suggested)	Interlock	Alarm in DCS	Remarks
During Normal Operation:-					
Pressure transmitter	PT (QCL21CP011) / (QCL21CP012)	35 Kg/cm2 (g) (HIGH)	Not applicable	Yes (HIGH pressure at cylinder 1 outlet)	Manual checking of pressure regulator reqd.
Pressure transmitter	PT (QCL21CP011) / (QCL21CP012)	28 Kg/cm2 (g) (LOW)	Close SV-1(QCL21AA201) & Open SV-2 (QCL22AA201)	Yes (LOW pressure at cylinder 1 outlet)	Auto-changeover of cylinders. Manually replace cylinder 1 with filled cylinder.
Pressure transmitter	PT (QCL22CP011) / (QCL22CP012)	35 Kg/cm2 (g) (HIGH)	Not applicable	Yes (HIGH pressure at cylinder 2 outlet)	Manual checking of pressure regulator reqd.
Pressure transmitter	PT (QCL22CP011) / (QCL22CP012)	28 Kg/cm2 (g) (LOW)	Close SV-2 (QCL22AA201) & Open SV-1 (QCL21AA201)	Yes (LOW pressure at cylinder 2 outlet)	Auto-changeover of cylinders. Manually replace cylinder 2 with filled cylinder.
Pressure transmitter	PT (QCL20CP011) / (QCL20CP012)	22 Kg/cm2 (g) (LOW)	Close FCV (QCL20AA202)	Yes (Oxygen dosing stopped due to low pressure)	
Pressure transmitter	PT (QCL20CP011) / (QCL20CP012)	35 Kg/cm2 (g) (HIGH)	Not applicable	Yes (HIGH dosing pressure)	Manual checking of pressure reducing regulating valve reqd.
Pressure transmitter	PT (QCL20CP011) / (QCL20CP012)	26 Kg/cm2 (g) (Adequate)	Open Permissive pressure of MFC (QCL20AA202).	Not applicable	
Cation Conductivity analyzer **		0.3 µs/cm (at 25˚C), increasing (HIGH)	Close MFC (QCL20AA202)	Yes (Oxygen dosing stopped due to high cation conductivity in feed water cycle)	Increase ammonia pH set point to raise pH to 9.2-9.5 range
Dissolved oxygen analyzer**		30 ppb (LOW), decreasing	Gradually open MFC (QCL20AA202) to increase DO provided signal from PT(QCL20CP001) is "NOT LOW" (i.e < 18 Kg/cm2 (g))	Yes (Low DO level in feed water cycle)	Initial set point may be chosen as 90 ppb. However, provision may be kept to choose exact set point for operation by operator's plant chemist during commissioning within the range of 30-150 ppb.
Dissolved oxygen analyzer**		150 ppb, increasing (HIGH)	Close MFC (QCL20AA202) to decrease DO	Yes (Oxygen dosing stopped due to high DO level in feed water cycle)	
During Start up:-					
Cation Conductivity analyzer **		0.15 µs/cm (at 25˚C), decreasing (ADEQUATE)	Open MFC (QCL20AA202), provided signal from PT-3 is "NOT LOW" (i.e < 22 Kg/cm2 (g)) & signal from DO analyzer is "NOT HIGH" (i.e > 150 ppb)	Yes (Oxygen dosing started)	

**** shall be part of SWAS scope.**

SECTION- IIB

GENERAL TECHNICAL REQUIREMENTS (ELECTRICAL)

LV Cables

2.2.16 LV CABLES

2.2.16.1 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 the cables shall conform to the requirements of the following standards and codes:

IS : 3961	:	Recommended current ratings for cables.
IS : 3975	:	Low carbon galvanised steel wires, formed wires and tapes for armouring of cables.
IS : 4905	:	Methods for random sampling.
IS : 5831	:	PVC insulation and sheath of electrical cables.
IS:7098 (Part -I)	:	Cross linked polyethylene insulated PVC sheathed cables for working voltages up to and including 1100V.
IS : 8130	:	Conductors for insulated electrical cables and flexible cords.
IS : 10418	:	Specification for drums for electric cables.
IS : 10810	:	Methods of tests for cables.
ASTM-D -2843	:	Standard test method for density of smoke from the burning or decomposition of plastics.
ASTM-D-2863	:	Standard method for measuring the minimum oxygen concentration to support candle like combustion of plastics.
IEC-60754 (Part-I)	:	Test on gases evolved during combustion of electric cables.
IEEE-383	:	Standard for type test of Class IE Electric Cables.
IEC -60332	:	Tests on Electric cables under fire conditions.
IS:6380	:	Specification of elastomeric insulation and sheath of electric cables
IS:5608	:	Specification for low frequency wires and cables with PVC insulation and PVC Sheath.

IEC:502	:	Extruded solid dielectric insulated power cables for rated voltages from 1.00 kV upto 30 kV
IEC:287	:	Calculations of the continuous current rating of cables (100% load factor)
IEC:228	:	Conductors for insulated cables
IEC: 60	:	High voltage test techniques
IEC: 230	:	Impulse tests on cables and their accessories
IEC-331	:	Fire resisting characteristics of electric cables
NEMA-WC-5	:	Thermoplastic insulated wires and cables for transmission and distribution of electrical energy.
IEC: 540	:	Test methods for insulations and sheaths of electric cables and cords (elastomeric and thermoplastic compounds)
SS-4241475 classF3	:	Cables - Testing of fire characteristics
NES-715-1	:	Temperature index

2.2.16.2 Tecnical Requirements

1. The cables shall be suitable for laying on racks, in ducts, trenches, conduits and under ground buried installation with chances of flooding by water.

2. Cables shall be flame retardant, low smoke (FRLS) type designed to withstand all mechanical, electrical and thermal stresses develop under steady state and transient operating conditions as specified elsewhere in this specification.

3. Aluminium conductor used in power cables shall have tensile strength of more than 100 N/ sq.mm. Conductors shall be multi stranded.

4. XLPE insulation shall be suitable for a continuous conductor temperature of 90 deg. C and short circuit conductor temperature of 250°C.

5. The cable cores shall be laid up with fillers between the cores wherever necessary. It shall not stick to insulation and inner sheath. All the cables, other than single core

unarmoured cables, shall have distinct extruded PVC inner sheath of black colour as per IS: 5831.

6. For single core armoured cables, armouring shall be of aluminium wires/ formed wires. For multicore armoured cables armouring shall be of galvanised steel as follows :

   Calculated nominal dia Size and Type of armour of cable under armour

   i. Up to 13 mm 1.4mm dia GS wire
   ii. Above 13 & upto 25mm 0.8 mm thick GS formed wire / 1.6 mm dia GS wire
   iii. Above 25 & upto 40 mm 0.8mm thick GS formed wire / 2.0mm dia GS wire
   iv. Above 40 & upto 55mm 1.4 mm thick GS formed wire /2.5mm dia GS wire
   v. Above 55 & upto 70 mm 1.4mm thick GS formed wire / 3.15mm dia GS wire
   vi. Above 70mm 1.4 mm thick GS formed wire / 4.0 mm dia GS wire

7. The aluminium used for armouring shall be of H4 grade as per IS:8130 with maximum resistivity of 0.028264 ohm mm2 per meter at 20 deg C. Aluminium armouring shall be same as indicated above for galvanized steel.

8. The gap between armour wires / formed wires shall not exceed one armour wire / formed wire space and there shall be no cross over / over-riding of armour wire / formed wire. The minimum area of coverage of armouring shall be 90%. The breaking load of armour joint shall not be less than 95% of that of armour wire / formed wire. Zinc rich paint shall be applied on armour joint surface of G.S.wire/ formed wire.

9. Cable Identification

   1. Outer sheath shall be of PVC (of suitable grade) & black in colour. In addition to meeting all the requirements of Indian standards referred to, outer sheath of all the cables shall have the following FRLS properties.

      a. Oxygen index of min. 21 (As per NES-715-1).
      b. Acid gas emission of max. 20% (As per IEC-60754-I).
      c. Smoke density rating shall not be more than 60% during Smoke Density Test as per ASTMD-2843.

2. Cores of the cables shall be identified by colouring of insulation. Following colour scheme shall be adopted:

    a. 1 core - Red, Black, Yellow or Blue
    b. 2 core - Red & Black
    c. 3 core - Red, Yellow & Blue
    d. 4 core - Red, Yellow, Blue and Black

3. For reduced neutral conductors the core shall be black.

4. In addition to manufacturer's identification on cables as per IS, following marking shall also be provided over outer sheath.

    a. Cable size and voltage grade - To be embossed.
    b. Word 'FRLS' at every 5 metre - To be embossed.
    c. Sequential marking of length of the cable in metres at every one metre-To be embossed / printed.

    The embossing shall be progressive, automatic, in line and marking shall be legible and indelible.

5. Cores of the cables of upto 5 cores shall be identified by colouring of insulation. Following colour scheme shall be adopted.

    a. 1core - Red, Black, Yellow, Blue
    b. 2 core - Red & Black
    c. 3 core - Red, Yellow & Blue

10. All cables shall meet the fire resistance requirement of IEEE - 383 with cable installations made in accordance with clause “Flammability test” and as per Category-B of IEC 60332 Part -3.

11. Allowable tolerances on the overall diameter of the cables shall be +\-2 mm maximum over the declared value in the technical data sheets.

12. In plant repairs to the cables shall not be accepted. Pimples, fish eye, blow holes etc, are not acceptable.

2.2.16.3 Cable selection & sizing

1. Cables shall be sized based on the following considerations:

   i) Rated current of equipment.

   ii) Maximum voltage drop limits under steady state and during starting for motor being fed from 415V switchgear restricted to 5% and 10% respectively.

   iii) Maximum voltage drop limits under steady state for feeder (i.e. Outgoing feeders being fed from 415V switchgear) restricted to 3%.

   iv) For cables to motors and feeders protected by MCCBs the cross section will be chosen according to the tripping time of MCCBs.

2. Derating Factors

   Derating factors for various conditions of installations including the following shall be considered while selecting the cable sizes:

   a. Variation in ambient temperature for cables laid in air.

   b. Grouping of cables.

   c. Variation In ground temperature and soil resistivity for buried cables.

3. Cable lengths shall be considered in such ways that straight through cable joints are avoided.

4. Cables shall be armoured type if laid in switchyard area, coal handling area or directly buried. All LV power cables except trailing cables shall be XLPE insulated FRLS.

5. All control cables shall be 2.5 Sq mm copper cable.

6. Multicore control cables will generally have spare conductor (s) in accordance with the following chart and cores of a single cable will not be split for different auxiliary/ equipment:

Conductors		Required Cables
1 or 2	:	1-3/C
3 or 4	:	1-5/C
5 or 6	:	1-7/C
7 or 8	:	1-10/C
9 or 10	:	1-12/C
11 or 12	:	1-16/C
13 or 14	:	1-18/C
Above 14 core	:	Two or more of above cables

2.2.16.4 Constructional Features

i) 1.1 kV grade Power Cables

1. 1.1 kV grade XLPE power cables shall have compacted aluminium conductor for cables including 10 sq. mm and above and copper conductor for cables below 10 sq.mm, XLPE insulated, PVC inner-sheathed (as applicable), armoured, FRLS PVC outer-sheathed conforming to IS: 7098. (Part-I).

2. 1.1 kV grade Trailing cables shall have tinned copper (class 5) conductor, insulated with heat resistant elastomeric compound based on Ethylene Propylene Rubber (EPR) suitable for withstanding 90°C continuous conductor temperature and 250 deg C during short circuit, inner-sheathed with heat resistant elastomeric compound, nylon cord reinforced, outer-sheathed with heat resistant, oil resistant and flame retardant heavy duty elastomeric compound conforming to IS 9968.

ii) 1.1 kV Grade Copper Conductor Fire Survival Power Cables

1. 1100 volt grade, 90 Deg.C rating, power cables with stranded Copper conductor, heat resistance elastomeric insulation generally conforming to Type IE-2 of IS: 6380-1984, extruded Halogen free or very low Halogen elastomeric inner sheath, generally conforming to Type SE-3 of IS-6380-1984, round wire/strip armour and extruded outer sheath of elastomeric material generally conforming to Type SE-3 of IS: 6380-1984.

2. The cables shall be generally manufactured in conformity to IS-9968 Part-1/1988.

3. The cables shall be rated for 3 hours fire rating.

4. Conductor shall be of stranded construction, consisting of high conductivity annealed plain copper wires conforming to Class-II of IS 8130. A suitable heat barrier tape, preferably glass mica tape shall be provided over the Conductor.

5. The insulation shall consist of heat resisting elastomeric material EPR (Ethylene Propylene rubber) and shall conform to Type IE-2 of IS:6380/1984 amended up to Date.

6. The suitable fire retardant material fillers shall be used for filling in the interstices.Two layers of plain glass fiber binder tape shall be applied over the laid up cores.

7. Fire Survival Power & Control cables shall be provided for the following services:

    a. DC emergency lube oil pump.

    b. Turbine lube oil pump/barring gear.

    c. Jacking oil pump.

    d. Scanner air fan.

    e. Incoming & outgoing cables for DC lighting distribution board.

    f. Fire /smoke detection system.

    g. DC seal oil pump.

    h. DC emergency lighting cables for Main Plant Building.

    i. Incomer cables for DG board, emergency board, DC lighting board

    j. Batteries to charger and DC distribution board.

    k. Emergency turbine trip by push button in control room.

    l. Boiler turbine: Generator inter-trip which includes the interconnecting cables between

        1. Boiler master fuel trip and turbine trip relays
        2. Generator trip relays and turbine trip relays
        3. Generator trip relays and 765kV kV circuit breaker
        4. Generator trip relays and generator field breaker.
        5. Generator trip relays and UAT breaker.

iii) 1.1 KV Grade Control Cable

1. Control cable shall be multi core, minimum 2.5 sq.mm cross section, stranded copper conductor, PVC insulated, inner PVC sheathed / galvanized steel wire armored and outer sheath made of FRLS PVC compound. In situation where accuracy of measurement or voltage drop in control circuit, warrant, higher cross sections as required shall be used. 4 sq.mm copper conductors shall be used for CT circuits, all other specification remaining same. In 4 sq.mm conductor impose unacceptable high burden on CTs, higher cross section of conductor shall be used.

2. Voltage Transformer leads shall be checked for voltage drop, which shall be limited to within 1 % for all cases other than tariff metering, for which the voltage drop shall be limited to 0.2 %. In case the voltage drop with 4 sq.mm Cu conductors exceeds this value, higher conductor sizes shall be used.

iv) 1.1kV Copper Conductor Fire Survival Control Cables

1. Conductor shall be of stranded construction, consisting of high conductivity annealed tinned copper conductors conforming to IS 8130/1984 amended up to date.

2. A suitable heat barrier tape, preferably glass mica tape shall be provided over the conductor.

3. The conductor insulation shall consist of heat resisting elastomeric material EPR (Ethylene Propylene rubber) and shall conform to Type IE-2 of IS:6380/1984 amended up to date.

4. An inner sheath of extruded special low smoke and very low halogen content (acid gas generation shall be less than 2% by weight) elastomeric (HOFR) compound of black colour or any other natural colour with prior approval from Owner conforming to Type SE-3 of IS-6380/1984, amended up to date, shall be provided over the laid up cores.

5. The armouring over inner sheath shall consist of single layer of wire/round galvanized steel wire as per IS 3975 amended up to date.

6. The outer sheath shall be of special low smoke and very low Halogen content (Acid gas generation shall be less than 2% by weight) elastomeric HOFR compound comprising of synthetic rubber and shall generally conform to the type SE-3 of IS: 6380 latest revision.

7. The colour of outer sheath shall be black or any other natural colour agreed mutually between Owner and Contractor.

8. The minimum sizes of L.T. cable to be chosen are as below:
   a. Al – 16 Sq.mm (3 core)
   b. Cu – 2.5 Sq.mm (3 core)

9. In power cables maximum conductor size to be used will be 300 sq. mm & 630 sq.mm for multi core and single core cables. In case of multi core cables not more than 3 runs to be used or otherwise single core cable to be used.

v) Cable Drums

Cables shall be supplied in non returnable wooden or steel drums of heavy construction. The surface of the drum and the outer most cable layer shall be covered with water proof cover. Both the ends of the cables shall be properly sealed with heat shrinkable PVC/ rubber caps secured by 'U' nails so as to eliminate ingress of water during transportation, storage and erection. Wood preservative anti-termite treatment shall be applied to the entire drum. Wooden drums shall comply with IS: 10418.

2.2.16.5 DRAWINGS, DATA AND MANUALS TO BE FURNISHED FOR APPROVAL

i) Cable datasheets
ii) Cable sizing
iii) QAPs & Test Reports.
iv) Relevant catalogues

2.2.16.6 Tests

i) Type Tests

a. For Conductor

i. Annealing test - For copper conductor only.

ii. Tensile test - For aluminium conductor only.

iii. Wrapping test - For aluminium conductor only.

iv. Resistance test.

b. For Armour Wires/ Formed Wires

i. Measurement of Dimensions.

ii. Tensile Test - For aluminium wires only

iii. Elongation test - For aluminium wires only

iv. Torsion test - For round wires only.

v. Winding test - For Formed wires only.

vi. Resistance test.

vii. Zinc Coating test - For G.S. Formed wires /wires only.

viii. Wrapping test - For Al. Formed wires /wires

c. For XLPE insulation & PVC Sheath

i. Test for thickness.

ii. Tensile strength & elongation tests before ageing and after ageing.

iii. Ageing in air oven.

iv. Loss of mass test - For PVC sheath only.

v. Hot deformation test - For PVC sheath only.

vi. Heat shock test - For PVC sheath only.

vii. Shrinkage test .

viii. Thermal stability test - For PVC sheath only.

ix. Hot set test - For XLPE insulation only.

x. Water absorption test - For XLPE insulation only.

xi. Oxygen index test – For outer sheath only.

xii. Smoke density test - For outer sheath only.

xiii. Acid gas generation test - For outer sheath only.

d. For completed cables

i. Insulation resistance test (Volume resistivity method)

ii. High voltage test

iii. Flammability test as per clause " Flammability test" of IEEE - 383 .

iv. Flammability test as per IEC - 332 Part-3 (Category -B).

v. Test for rodent & termite repulsion property.

ii) Flammaability Test

1. This test shall generally be carried out as per IEEE 383. The cable installation to be tested shall consist of as many cables as are necessary to give atleast 10 kg of organic material per metre run.

2. The following cable installation shall be tested :
Installation with single / multi core cables in touching formation.

3. Size of cables, number of cables, number of layers and laying arrangements for each installation shall be subject to Owner's approval.

4. The size of the cables selected (measured by total cross sectional area of the conductor) shall have maximum organic material per sq. mm of total cross sectional area of all the conductors.

iii) Acceptance Tests

Acceptance tests shall be carried out on each type and size of the cables on the cable drums selected at random as per following sampling plan:

Sl.no	No. of drums in the lot	No. of drums to be taken as sample
	Upto 100	10% (Subject to minimum of 1 drum)
	101 to 300	13
	301 to 500	20
	Above 500	32

The following shall constitute acceptance tests:

1. Item No. 1 to 14, 16, 19, 20, 22, 23, 24, 25 of list of type tests specified in cluase 2.2.15.5.1.

2. Fire resistance test as per SS 4241475 (F3 category).

3. One length per size / lot for surface finish and length measurement.

4. Lay length / sequence of cores, armour coverage, Gap between two consecutive armour wires / formed wires, Band marking.

iv) Routine Tests

Routine tests shall be carried out as per relevant standard for each drum of cables of all types and sizes.

Cabling System

2.2.17 CABLING SYSTEM

2.2.17.1 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:

i) TG Building & Transformer Yard
ii) Boiler Area, ESP
iii) All auxiliary buildings (including electrical rooms of respective buildings) and structures as per details in the general electrical specification/ plot plan & related drawings.
iv) Service Building
v) CPU Regeneration
vi) DG House
vii) Pipe cum cable rack (within the battery limits).
viii) Air Washer Units
ix) All electrical equipment as described in different sections.
x) 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.

2.2.17.2 SCOPE OF SUPPLY

1 The scope of work shall include complete supply, installation, testing, commissioning and putting into successful commercial operation of the cabling system for the entire plant covering all indoor & outdoor areas of BTG area.

2 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):
Supply and installation of cable and cable trays/raceways, supports, conduits, duce bank, cable accessories such as jointing/termination kits, cable glands, lugs, ferrules, etc. as required for all the systems & equipments.

ii. Supply and installation (including laying & termination) of control cables, special cables, instrumentation cables for all equipments and systems.

iii. 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.

iv. Cable routing has to be planned such that it shall not cross the steam lines, oil lines.

v. Fire Sealing Arrangement: All cable entries into the panel (HV & MV & LV SWGR panels) should be provided with fire sealing arrangements.

vi. 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 seated 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

vii. 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.

viii. All necessary erection materials, consumables and sundry items including arc welding rods to complete the installation for satisfactory and trouble free operation.

ix. 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 Bidder without any extra charge to the purchaser.

2.2.17.3 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.
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.

2.2.17.4 DESIGN AND CONSTRUCTIONAL FEATURES

1 **Inter Plant Cabling**

Interplant cabling for main routes shall be laid along overhead trestles/duct banks. However, from tap-offs, same can be through shallow trenches with sand filling. All the switchgear room shall be provided with cable spreader room at ground floor. The cable trenches are allowed between switchyard control room and transformer yard only. In case of Duct banks, pull-pits shall be filled with sand and provided with a PCC covering.

2 **Transformer yard**

In transformer yard cables shall be laid in RCC concrete trenches with RCC covers. The main cable routes coming out from Main plant building and crossing the Transformer yard shall be laid in overhead trestles/duct banks. Minimum clear height of trestle shall be 3 m and for Rail/road crossing, it shall be as per rail/road crossing norms. False floors are not to be provided for cabling purpose.

3 **Cable entry**

Cable entry from outdoor underground/cable routes to the buildings, if any, shall be above the finished floor level of the building.

All Buildings shall have suitable cable spreader rooms /cable vaults.

4 Trenches

PCC flooring of built up trenches shall be sloped for effective drainage with sump pits and sump pumps.

No sub-zero level cable vault/trenches shall be provided below control building/switchgear rooms in main plant areas.

All field switches for equipments corresponding to a stream located within a radius of4-5 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.

Cable trenches shall be provided in Transformer Yard and Switchgear/MCC rooms. In other areas local cable trenches with length not exceeding 5 metres are allowed just near the equipment.

Cables for one set of auxiliaries such as ID,FD & PA fans & half of the coal mils shall be routed in one route & for through other set of auxiliaries through other route.

Bidder shall provide two independent routes for cables between Switchyard Control Room & Main Plant Control Room. Bidder shall provide the cable trays along with its supporting structure arrangement on the trestle.

5 Cable Vault:

i) Cable vault of not less than 3.5 metres clear height shall be provided.
ii) 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.
iii) Cable vaults shall be provided with adequate drainage facility for drainage of fire water.
iv) Each cable vault should have two fire proof doors.
v) Exit signs shall be provided near doors for personnel escape in case of emergency.

6 Major routes in Turbine area (STG Package area) shall be on overhead cable trays either supported from available structures, building structure. Only in specific areas as shall be approved by purchaser/consultant where number of cables are too small compared to the route length and in transformer yard, cable shall be routed in cable trenches.

2.2.17.5 EQUIPMENT DESCRIPTION

Cable trays, Fittings & Accessories

1 Cable trays shall be ladder 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.

2 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.

3 Cable trays shall have standard width of 150 mm, 300 mm & 600 mm 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.

4 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 Prefabricated hot dip galvanized sheet steel cable trays shall be used for maximum support span of 2000 mm 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.

6 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.

7 Separate coloured paint strips 2 inch width each numbers equally spaced at 5 metres interval shall be applied for identification of different type of trays depending upon types of usage/applications/area as below:

High/ medium voltage cables:

11kV/6.6kV :red strips

1.1kv power cables : yellow strips

1.1kv control cables : blue strips

Instrumentation cables : green strips

8 **Support System for Cable Trays**

Cable tray support system shall be pre-fabricated similar or equivalent to "Unistrut make".

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.

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.

9 FRP CABLE TRAYS

FRP Cable trays shall be used for areas like intake raw water pump house, Desalination plant, CHP, Battery room, NDCT and chemical house.

Cable trays shall be of ladder / perforated type complete with all necessary coupler plates, elbows, tees, bends, reducers, stiffeners and other accessories. Cable trays of ladder and perforated types and the associated accessories such as coupler plates, tees, elbows, etc. shall be of FRP.

The FRP cable tray shall be ultra violet resistant. FRP cable trays shall be manufactured in accordance with NEMA FG-1-1984-1993 and Standards IS-6746 and ASTM E 84. Manufacturing process shall be pultrusion using automated pultrusion machines. Resin to be used shall be ultraviolet resistant polyester resin.

All cable trays and accessories shall be corrosion / chemical resistant, weather resistant, easy to drill and cut. Lightweight, high strength and flame retardant in accordance with ASTM E-84-Class 1 Rating and as per IS-6746-Very Low Flammability. An additive material shall be mixed with the FRP to make them resistant to ultraviolet light. The oxygen index shall be minimum 30 as per ASTM-D-2863.

The minimum glass content in the FR material shall be 55%.

The Ladder type trays shall have side rails and horizontal rungs. Both of these shall be of same material i.e. the FRP with additive material. The rungs shall be placed 300 mm apart from each other. The side runner of the Ladder type FRP cable trays shall be pultruded FRP channel of 100 x 35 mm height. The minimum thickness of the tray will remain 4mm. The rungs to side member are connected to the Larger portion of the side rail by using pin made of fiberglass reinforced thermoplastic, and should have both mechanical and adhesive lock.

Minimum thickness of perforated type FRP cable tray shall be 4mm.Minimum thickness of coupler plates shall be 4mm.

HV, MV and LV power single core cable shall be laid in trefoil formation with 2D gap where 'D' is the diameter of cable.

HV & MV cables and LV power cables (95 sq. mm & above) multicore cables shall be laid in touching formation in single layer. 1100V multicore cables below 95 sq. mm shall be laid in two layers. Control and instrumentation cables shall be laid in 3 layers.

i) Individual tray systems shall be established for the following services: -
   a) 6.6 kV and higher voltage power cables.
   b) 415 Volt power cables.
   c) Special noise-sensitive circuits or instrumentation cables.
   d) Control cables. (Control cables shall be laid along with LV power cables and instrumentation cables if required for short length near the eaquipment with GI seperators).
   e) Further subdivision of tray systems shall be provided if required to meet special segregation/separation requirements.

ii) In areas having coal dust, cable trays shall be run in vertical formation while horizontal trays shall be provided in other areas. Cable depth not to exceed two cables for vertical trays.

iii) The minimum design vertical spacing for trays shall be 300 mm measured from the bottom of the upper tray to the top of the lower tray. At least a 250 mm clearance shall be maintained between the top of a tray and beams, piping, or

other obstacles to facilitate installation of cables in the tray. A working space of not less than 600 mm shall be maintained on at least one side of each tray. Tray covers shall be provided on the top most tray of each tier of cable trays.

10 **Pipes, Fittings & Accessories**

Pipes offered shall be complete with fittings and accessories (like tees, elbows, bends, check nuts, bushings, reducers, enlargers, coupling caps, nipples etc.) 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

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.

11 **Junction Boxes**

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.
Glass Fibre Reinforced Junction Boxes No. of Ways: 12/24/36/48 with 20% spares terminals.

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^{O}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 RAL7032). Earth connection (studs size shall be M 6) shall be provided on the cover as well as door.

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).

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.

General

1. JBs shall have small canopy at the top.
2. 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.
3. Cable entry shall be from bottom side only.
4. Ensure gland plate sealing perfect. It shall be of the same quality and arrangement as that of door to cover arrangement.

   Steel Junction Boxes
   No. of Ways12/24/36/48 with 20% spares terminals.
   Junction boxes shall be designed in accordance with NEC, article 370, paragraph 18,19& 20 or equivalent standards.

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.

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 and 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.

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.

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.

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.

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.

12 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, look 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.20% spare terminals shall be provided
.

13 **Terminations & Straight through Joints**

Termination and jointing kits for 11/6.6 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. 11/6.6 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.

Straight through joint and termination shall be capable of withstanding the fault level for 33kV, 11 kV and 6.6 kV systems.

1.1 KV grade straight through joints shall be of proven design.

14 **Cable glands**

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.

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.

15 **Cable lugs/ferrules**

The cables lugs shall be conforming to IS: 8309.

Machine ferruling shall be adopted.
Cable lugs for power cables shall be Aluminium solder less crimping type suitable for aluminium compacted conductor cables.

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 pan
iii) Pin type lugs shall not 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.

16 **Cable Clamps & Straps**

The cable clamps required to clamp multicore cables on vertical runs shall be made up of Aluminium strip of 25x3 mm size. For clamping the multicore cables on horizontal trays, 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.

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.

17 **Galvanizing**

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

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.

18 **Welding**

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

2.2.17.6 INSTALLATION

1 **Cable tray and Support System Installation**

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 & ESP areas.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 1000mm. 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.

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.

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.

2 **Conduits/Pipes/Ducts Installation**

(a) 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.

(b) 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.

(c) 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.

(d) 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.

(e) 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

(f) 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.

(g) All G.I. pipes shall be laid as per approved layout drawings and site requirements.

1 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

2 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.

3 **Junction Boxes Installation**

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.

4 **Cable Laying and Installation**

1) 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.

2) Cable installation shall be carried out as per IS: 1255 and other applicable standards.

3) 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.

4) Laying of cables directly buried in ground is not acceptable.

5) For coal handling plant the cables shall not be routed along conveyor galleries. The cables shall be routed on independent cable trestles.
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 or other available building steel surfaces. 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.

6) 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.

7) 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.

8) 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.

5 **Laying of cables in cable trays**

1) 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.

2) 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.

3) 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

4) 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.

Bending radii for cables shall be as per manufacturer's recommendations and IS1255.

5) 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.

6) 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.

7) Where cables cross roads/rail tracks, the cables shall be laid in Hume pipe/PVC pipe.

8) 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.

9) 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.

10) Joints for less than 250 Meters run of cable shall not be permitted.

11) 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) Wherever few cables are branching out from main trunk route troughs shall be used.

13) Cables shall be neatly arranged in the trenches/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 trenches/trays shall be the responsibility of the contractor.

14) 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.

15) 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.

16) Minimum number of spare cores required to be left for interconnection in control cables shall be as cl.3.07.00, chapter 16.
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.

17) 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.

18) 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.

a) Separation

b) Sufficient spacing not less than 300 mm shall be provided between different tiers of trays and the same shall be maintained to permit adequate access for installation and maintenance of cables.

c) At least 300mm clearance shall be provided between HV power & LV power cables, LV power & LV control/instrumentation cables,

d) Segregation

e) Segregation means physical isolation to prevent fire jumping.

f) Cables from two different services viz. supply from Station Board and Unit Board shall be segregated.

g) 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.

h) 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.

6 **Cable fire sealing**

i) 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 seated 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.

ii) Wherever the cables/cable trays pass through walls/floors, fire proof cable penetration seals rated for one hour 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.

iii) 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.

7 **Cable laying in trenches between switchyard and Transformer yard**

1 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.

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.

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 tilt such times the final termination to the equipment is completed.

2 Prior to laying of cables inside trenches, the contractor shall properly clean inside of those trenches.

3 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.

4 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.

5 All wall openings/pipe sleeves shall be effectively sealed after installation of cables to avoid seepage of water inside building/lined trench.

6 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.

7 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:

1. 1 Cable in pipe - 53% full
2. 2 cables in pipe - 51% full
3. 3 or more cables - 43% full
4. 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.

8 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.

2.2.17.7 CABLE IDENTIFICATION

1. 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.

2. If laying of underground cable is specifically agreed by Owner as a special case then the underground cables 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.

3. Drum number of each cable from which it is taken shall be recorded against the cable number in the cable schedule.

2.2.17.8 CABLE TERMINATIONS & CONNECTIONS

1. 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.

2. 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 Engineer in charge of TANGEDCO.

3. Responsibility of proper termination shall lie on the contractor. Guarantee for termination shall also have to be given by the contractor.

4. 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.

5. 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.

6. 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.

7. 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.

8. All cable terminations shall be appropriately tightened to ensure secure and reliable connections.

9. 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.

10. 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.

11. All cable entries shall be through bottom only and top entry terminations are made only after getting approval of Site Engineer.

12. 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.

13. 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.

14. Where threaded cable gland is screwed into threaded opening of different size, suitable brass threaded reducing bushing shall be used provided.

15. 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. 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 the terminals.

17. 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 three hours.

18. **Cable accessories for H.V. Systems**

1. The H.V. cables terminations/joints shall be done by skilled, certified and experienced jointers duly approved by the Site Engineer.

2. 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 kid.

3. 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.

4. 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.

2.2.17.9 QUALITY ASSURANCE PROGRAMME

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.

2.2.17.10 LIST OF TESTS TO BE CONDUCTED

1 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:

a) Working load
b) Working load + point load
c) Off load
d) Proof load + point load
e) 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

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.

c) Test 3: Tests on Channel Fixed on Beam/Floor
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.

c) Test 3A A length of steel structure shall be rigdly 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.

d) 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.

e) 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.

d) 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 6 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 6.6kV and 11kV class. Fire proof Cable Penetration system should have been tested for the following tests:

a) Accelerated Ageing test
b) Water absorption test
c) Fire rating test
d) Hose Stream test
e) Vibration test followed by fire rating test

2 Routine/ Acceptance Tests

Following routine/acceptance tests shall be carried out on all the equipments, devices & materials supplied:

a) 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.

3 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. ll 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:

        1) Physical and Dimensional checks
        2) Check/measurement of thickness for Nickel chrome plating for cable glands and tinning for cable lugs.
        3) Check chemical composition of brass parts for cable glands.
        4) Hardness check on gaskets.
        5) Test for uniformity of galvanization.

4 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

Earthing and Lightning Protection System

2.2.18 EARTHING AND LIGHTNING PROTECTION SYSTEM

2.2.18.1 Earthing System

2.2.18.2 Scope

ii. The Contractor shall provide all required material and carry out main earth grid, treated earth pits, raisers and inter connections, equipment earthing, interconnection to the existing, BOP area earth mats etc. for the following areas and all areas/buildings/structures including but not limited to:

a) Main Plant Building (TG Building)
b) Boiler Area, ESP area, Circulating water system, DG room & other electrical systems.
c) Service building
d) Air washer room
e) Transformer yard
f) All other miscellaneous building not mentioned herein but in BTG supplier scope.

iii. Earthing system shall consist of earth grids and electrodes buried in soil in the plant area, embedded in concrete inside the buildings to which all the electrical equipment, metallic structures are connected to have earth continuity for safety reasons. The earthing system shall conform to IS 3043 and Indian Electricity Act/rules.

iv. The Contractor shall furnish the detailed design, layout and calculations for Owner's approval. Contractor shall obtain all necessary statutory approvals for the system.

2.2.18.3 Codes and Standards

i. 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.

ii. 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 below. 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.

1.	IS:513	-	Cold rolled low carbon steel sheets and strips
2.	IS:802	-	Code of practice for the use of Structural Steel in Overhead Transmission Line Towers
3.	IS:1079	-	Hot Rolled carbon steel sheet & strips
4.	IS:1239	-	Mild steel tubes, tubular and other wrought steel fittings
5.	IS:1367 Part-13	-	Technical supply conditions for threaded Steel fasteners. (Hot dip galvanized coatings on threaded fasteners)
6.	IS:2309	-	Code of Practice for the protection of building and allied structures against lightning
7.	IS:2629	-	Recommended practice for hot dip galvanising of iron & steel
8.	IS:2633	-	Method for testing uniformity of coating on zinc coated articles
9.	IS:3043	-	Code of practice for Earthing
10.	IS:6745	-	Methods for determination of mass of zinc coating on zinc coated iron & steel articles
11.	IS:9595	-	Metal – arc welding of carbon and carbon manganese steels – recommendations
12.	IEEE:80	-	IEEE guide for safety in AC substation grounding
13.	IEEE:142	-	Grounding of Industrial & commercial power systems
14.	Indian Electricity Act.		
15.	Indian Electricity Rules.		

2.2.18.4 Design Criteria

1. Fault Current & Duration

Earthing system network/earth mat shall be interconnected mesh of mild steel rods buried in ground in the plant. For earth mat design, the size of earthing conductor shall be calculated considering maximum fault current 50 kA for duration of 1 second and corrosion factor. The maximum permissible step and touch potentials shall be calculated in accordance with the formula, given in IEEE-80.

2. Conductor Material

i. The earthing system conductors and accessories as proposed are to be as:
   (a) Conductors above ground level and in trenches : Galvanized steel
   (b) Conductors buried in ground or embedded in concrete : Mild Steel
   (c) Electrodes : GS Pipe / Rod

ii. The contractor shall undertake the soil resistivity measurements at site and shall select suitable type of conductors.

iii. The earth conductors shall be free from pitting, laminations, rust, scale and other electrical, mechanical defects.

3. Size of Conductors

The minimum sizes of earthing conductors for various electrical equipments shall be as below:

Sl.No	Equipment	Earth Conductor buried in earth	Earth conductor above griund level & in built up trenches
1.	Main earth Grid	40 mm dia. MS Rod	---
2.	Transformeryard	40 mm dia. MS Rod	---
3.	Switchyard	40 mm dia. MS Rod	---
4.	Power Transformer		75 x 10 mm GS Flat
5.	11kV / 6.6 kV / 415 V Switchgear / Equipment	---	75 x 10 mm GS Flat
6.	415 V MCC / Distribution Boards/ Distribuiton Transformers	---	75 x 10 mm GS flat
7.	LV motors		
	Above 100 to 200 kW	---	75x10 mm GS flat
	Above 55 KW to 100 KW	---	50x6 mm GS flat

	Above 22 KW to 55 KW	---	50x6 mm GS flat
	Above 5.5 KW to 22 KW	---	25x6 mm GS flat
	Fractional HP LV Motors	---	8 SWG GS Wire
8.	Control panel & Control Desk	---	50x6 mm GS flat
9.	Push Button Station / Junction Boxes	---	8 SWG GI Wire
10.	Column, Structures, Cable tray, fence , gate and busduct enclosures	---	50x6 mm GS flat
11.	Crane, Rail, Rail tracks & other non-current carrying metal parts	---	50x6 mm GS flat

4. Soil Treatment to lower Resistivity

The soil resistivity study shall be carried out by the contractor. In order to reduce the resistivity of the soil the earth pits shall be treated with high purity electrically conductive material having ultra-low resistance value (typically, 0.001 ohm-m). The properties of the material shall be such that it does not require periodic re-watering or recharge of salt or earth enhancing compound during the life of the power plant. The material should be such that it does not reach chemicals into the adjacent soil or underground water channels and should be PH neutral. Earth enhancing material should permanently protect the encased metal components of the earthing systems. Earthing electrodes encased in high strength concrete mixed with the conductive material shall be preferred instead of electrode buried directly in the earth.

5. Rod Electrodes

Galvanized steel pipe/rod electrodes of suitable diameter and length shall be used as per the recommendation of IS-3043. For test pits electrodes shall be heavy duty type (Class – C) GI pipe of suitable diameter with perforations. For treated earth pits, GI pipe shall be provided as per IS 3043 including charcoal, salt etc. Necessary number of treated earth pits shall be provided for UTs, UATs in the transformer yard and other UATs in the main power house building and for all LT transformer Neutral & body earthing. Electrodes installed in the test pits will have disconnecting facilities.

6. Earthing of Electrical equipment on cranes and travelling machines

i. Every electrical equipment shall have double earthing. A ring earthing system shall be provided within the crane/machine to which electrical equipment shall be connected at least at two places.

ii. The earth ring on the crane/machine shall be connected to the plant earthing system through gantry rails. Two sets of earth collector brushes shall be provided on each side of crane/machine to connect its earth ring to the gantry rails. Each end of each gantry rail shall be bonded to the plant earthing system.

iii. In addition, intermediate earthing bond shall also be provided on the rails at every 60 m in case of longer tracks. Flexible copper bonds shall be provided across any gap in the running gantry rails. For mobile equipment with flexible cables, one separate copper conductor of adequate size shall be provided for earthing.

7. Equipment Earthing Leads

The size of the earthing leads shall be decided based on the type of equipment and structure to be earthed and shall be provided generally as per IS-3043.

2.2.18.5 Earthing System Layout

1. General

i. Metallic frames of all current carrying equipment, supporting structures adjacent to current carrying conductors, structures in contact with switchyard earth, lightning protection system conductors and neutral points of various systems shall be connected to a single earthing system.

ii. All the offsite areas shall be interconnected together by minimum two parallel conductors.

iii. Crane rails, tracks, metal pipes and conduits shall be effectively earthed at two points. Steel RCC columns, metallic stairs, and rails etc. of the building housing electrical equipment shall be connected to the nearby earthing grid conductor by one earthing lead ensured by bonding the different sections of hand rails and metallic stairs.

iv. For all other equipments, two earthing leads shall be used if rated voltage of equipment is above 250V. In case the rated voltage is 250 V or below, one earth lead can be used. Metallic structures adjacent to electrical equipment shall be earthed by one earthing lead.

v. Earthing conductors in outdoor areas shall be installed at a minimum depth of 600 mm.

vi. Each continuous laid lengths of cable tray shall be earthed at minimum two places by G.S. flats to earthing system, the distance between earthing points shall not exceed 30 metre. Wherever earth mat is not available Contractor shall do the necessary connections by driving an earth electrode in the ground.

vii. Portable tools, appliances and welding equipment shall be earthed by flexible insulated cable .

viii. The cable sheaths, screens armour shall be earthed at both ends for multi-core cables. For single core cables the same shall be done at one end (switchgear end) only.

ix. Electronic earthing shall be provided as per relevant international standard for all control systems (such as DDCMIS,PLC,SAS,EDMS,etc.,). Fo electronic equipment chemical earthing pit shall be provided. The earth pit shall be tested and type proven and shall be guaranteed for service life of 40 years. The chemical earth pit shall comprise pipe electrode,crystalline conductive mixture, bentonite, etc., constructed in a pit of not less than 4000mm depth. The pit shall be effective in all weather conditions and offer medium resistance. For electronic earthing system, earthing conductor shall be copper.

x. Neutral of Service transformers shall be earthed through minimum of 400 sq.mm single core cable through two numbers treated earth pit and inturn shall be connected to station earth grid.

xi. LV Neutral points of the following transformers shall be connected to Neutral Grounding Resistors(NGR). NGR shall be connected to earth through two numbers treated earth pit.

a) Unit transformers
b) Station Transformer
c) Unit , station and other Auxiliary transformers

xii. Steel to copper connections shall be brazed type and shall be treated to prevent moisture ingression.

xiii. Metallic sheaths and armour of all multi-core power cables shall be earthed at both equipment and switchgear end, Sheath and armour of single core power cables shall be earthed at switchgear end only.

xiv. Earthing conductors alond their run on cable trench, ladder, walls etc., shall be supported by suitable welding/cleating at intervals of 1000mm. Wherever it passes through walls, floors etc., pipe sleeves shall be provided for the passage of the conductor and both ends of the sleeve shall be sealed to prevent the passage of water through the sleeves.

xv. Railway tracks within the plant area shall be bonded across fish plates and connected to earthing grid at several locations.

xvi. Electronic panels and equipments shall be grounded utilizing an insulated copper ground wire terminated at separate earth electrodes.

2. Earthing Conductor layout

i. Main earthing conductors shall be laid in the form of a grid. Spacing between conductors, number of parallel conductors, etc., shall be decided such that step and touch potential are within safe limits.

ii. The maximum permissible step and touch potentials shall be calculated in accordance with the formula, given in IEEE-80.

iii. Earthing conductors shall be provided around the outside edge of fence at a distance of approximately 6000 mm. This shall be connected to the main earthing grid.

iv. Grounding conductor around the building shall be buried in earth at a minimum distance of 1200 mm from the outer boundary of the building.

i. Every alternate post of the fence shall be connected to earthing grid by one GS flat and gates by flexible lead to the earthed post.

ii. Each of the earth leads of transformer neutral, lightning arrester shall be directly connected to two separate electrodes. Neutral points of HV transformer shall be earthed through NG resistors. The Contractor shall connect the NGR earthing point to earth electrodes by suitable earth conductors Lightning protection down conductor shall be directly connected to a separate earth electrode.

iii. All earth electrodes in turn shall be connected to main earthing system. The earth grids of different areas of the plant shall be interconnected through, test pits to enable measurement of earth resistance for each area separately.

iv. Earthing grid design shall be done in such a manner that the grid resistance is less than one ohm.

v. Earth pit shall be constructed as per IS: 3043. Electrodes shall be embedded below permanent moisture level. Minimum spacing between electrodes shall be atleast equivalent to twice the length of the electrode.

3. Earthing Conductors inside the building

i. Main earthing conductors shall be buried in earth around the building. Minimum two taps-off from this earthing loop shall be taken inside the building and connected to the earthing grid embedded in the floor slab with approximately 50 mm concrete cover. The requirement of electrodes around the building shall be specified.

ii. In case the building has more than one floor, each floor shall be provided with separate earth grid. These floor earthing grids shall be interconnected.

iii. Each RCC / Steel column of the building shall be interconnected to the floor earthing grid in the ground floor.

iv. Instrumentation system and computer system shall be provided with a dedicated earthing system suitable for the equipment. Separate electronic earthing for the PLC equipments, SAS panels and all other equipments wherever necessary shall also be provided.

v. Earthing grids of all the buildings, outdoor yards shall be interconnected to form a single grid for the plant.

vi. Earthing grid design shall be done in such a manner that the grid resistance is less than one ohm.

vii. Suitable earth risers as approved by Owner shall be provided above finished floor/ground level, if the equipment is not available at the time of laying of main earth conductor.

viii. A minimum earth coverage of 300 mm shall be provided between the ground grid conductor and the bottom of trenches, tunnels, underground pipes, foundations, railway tracks etc. The ground grid conductor shall be re-routed in case it fouls with equipment foundations.

2.2.18.6 Earthing System Installation

i. The spacing between two electrodes shall be at least equivalent to twice the length of the electrode.

ii. Earthing conductors along their run on columns, walls, etc. shall be supported by suitable welding / cleating at interval of 1000mm and 750mm respectively. 8 SWG earth wire should be run along with lighting conduits and shall be earthed at both ends. The wire should be suitable clamped with conduit at equal interval at not more than 500 mm.

iii. The earthing conductor crossing the road / track shall be laid in hume pipe or laid at a greater depth to avoid damage.

iv. When earth conductor passes through floors, walls, etc., suitable pipe sleeves shall be provided and the same shall be sealed after installation.

v. The connection between earthing pads / terminal to the earth grid shall be made short and direct and shall be free from kinks & splices.

vi. Cable trays, metal pipes / conduits, steel columns, etc., shall not be used as earth continuity conductors.

vii. Street lighting poles, flood light poles & towers, their junction boxes shall be connected to the earthing conductor to be run along with supply cable. This earth conductor shall be in turn connected to earth grid at two extreme points.

viii. Flexible earth conductors shall be provided at expansion joints for earthing the gates, operating handles, etc.

ix. Equipment bolted connection after being checked and tested shall be painted with anti-corrosive paint / compound be welded. For rust protection, the welds shall be treated with zinc chromate primer and coated with zinc rich paint.

x. Proper earth connections for cable glands, cable boxes, cable armour, screens, etc. to be provided.

xi. All bimetallic connections shall be treated with suitable compound to prevent moisture ingression.

xii. The contractor shall demonstrate the effectiveness of earthing system by measurement of earth resistance, step and touch potential at different locations. Earth resistance at earth terminations shall be measured in presence of Owner's representatives. All equipment required for testing shall be furnished by contractor.

xiii. Connections between earth leads and equipment shall normally be of bolted type. Contact surfaces shall be thoroughly cleaned before connections. Equipment bolted connections after being tested and checked shall be painted with anti-corrosive paint/compound.

xiv. Connections between equipment earthing leads and between main earthing conductors shall be of welded type. For rust protection the welds should be treated with red lead compound and afterwards thickly coated with bitumen compound. All welded connections shall be made by electric arc welding. The overlapping of earthing conductor in welded joints should be 6 times diameter. Cleats should be

provided at both sides to increase contact area. Angles/ cleats should be welded at the point of crossing of longitudinal and transverse earthing conductors.

xv. Resistance of the joint shall not be more than the resistance of the equivalent length of conductors.

xvi. Back filling material to be placed over buried conductors shall be free from stones and harmful mixtures. Back filling shall be placed in layers of 150 mm. Trenches after laying earth rods should be closed with approved filling materials in layers and not with debris.

2.2.18.7 Other Requirements of Earthing System

Life expectancy	40 years
System Fault level	50kA for one second
Minimum Steel corrosion	0.3mm/year (on dia. of conductor)
Depth of burial of main earth conductor	600mm below grade level; where it crosses trenches, pipes, ducts, tunnels, rail tracks, etc., it shall be at least 300mm below them.
Conductor joints	By electric arc welding, with resistance of joint not more than that of the conductor.

2.2.18.8 Lightning Protection System

i. The main purpose of lightning protection system are to :
- Provide protection to structures from lightning strokes.
- Provide a low resistance-conductive path to lightning discharge.

ii. Lightning protection system shall be in strict accordance with IS: 2309 for the stuctures, equipments and buildings within the battery limits.

2.2.18.9 Conductor material

For Lightning protection, material & minimum sizes shall be as follows:

a. Vertical air termination : 20 mm dia MS rod
b. Horizontal air termination : 25X6 mm Galvanised steel flats
c. Down conductor : 25X6 mm Galvanised steel flats
d. Test link : 150x50x6 mm Galvanised steel Strip with Box
e. Earth Electrodes : Treated earth pit with pipe electrode as per IS:3043

The above sizes are indicative only. Actual size shall be arrived at as per design by the Bidder.

2.2.18.10Lightning Syatem Layout

i. Lightning system shall comprise of air terminations, down conductors, test links, earth electrode etc.

ii. Air termination network consisting of vertical or horizontal conductors or combination of both shall be provided for the building. Down conductors shall follow the most direct path possible between the air terminal network and the earth termination network. Each down conductor shall be provided with a test link for testing. An earth electrode shall be connected to each down conductor.

iii. Suitable lightning protection shall be provided to protect

a) Main Power House building as per IS requirement
b) Boiler Area, ESP area,DG room, Service building & other electrical systems.
c) All other miscellaneous building & electrical systems not mentioned herein but in scope of main plant (BTG) supplier.

iv. Installation of lightning conductors on the roofs of buildings shall include construction of support, laying, anchoring, fastening and cleating of horizontal conductors, grouting of vertical rods wherever necessary, laying, fastening / cleating / welding of the down comers on the walls / columns of the building and connection to the test links to be provided above ground level.

2.2.18.11Air Terminations

i. The vertical air terminal rods shall be installed at the roof of buildings for MCC/Switchgear rooms, ESP Control rooms etc to protect these objects from lightning strokes.

ii. ii) The projected length of the Air termination rod shall be as required to protect the object (on which the rod is fixed) from lightning stroke.

iii. The air terminal rod shall be properly fixed on the top of the building/structure to withstand very high wind pressure. In case the air terminal rod is embedded at the top of roof of building, the portion embedded inside the concrete shall not touch the reinforcement bars and shall be duly insulated from them.

iv. All the vertical air terminal rods shall be electrically connected together by means of horizontal conductors of size 25 x 6 mm galvanized steel flats. Horizontal air

termination (i.e. G.S. Flat conductor) shall be so laid that no part of the rod shall be more than nine (9) metres from the nearest roof conductor.

2.2.18.12Shielding Masts

v. The shielding mast for lightning protection shall be installed at the top of steel columns cap plates of the associated building.

vi. The shielding mast shall be made of galvanized steel rod and the height of the same shall be decided considering the zones to be protected.

vii. Each shielding mast shall be connected to grounding grid by a down conductor 50 x 6 mm minimum. Galvanised steel flat run along the building column. In addition all building columns joints shall be electrically bonded.

2.2.18.13Down conductors

i. Down conductors shall be as short and straight as practicable and shall follow a direct path to earth electrode.

ii. Each down conductor shall be provided with a test link at 1000 mm above ground level for testing but it shall be in accessible to interference. No connections other than the one direct to an earth electrode shall be made below a test point.

iii. All joints in the down conductors shall be welded type.

iv. Down conductors shall be cleated on outer side of building wall, at 750 mm interval or welded to outside building columns at 1000 mm interval.

v. Lightning conductor on roof shall not be directly cleated on surface of roof. Supporting blocks of PCC/insulating compound shall be used for conductor fixing at an interval of 1500 mm.

vi. All metallic structures within a vicinity of two meters of the conductors shall be bonded to conductors of lightning protection system.

vii. Lightning conductors shall not pass through or run inside GI Conduits.

viii. Testing link shall be made of galvanized steel of size 25x 6mm.

ix. Pulser system for lightning shall not be accepted.

x. Hazardous areas handling inflammable/explosive materials and associated storage areas shall be protected by a system of aerial earths.

xi. Lightning protection conductors/ air termination rods and circumferential band provided at the top position of chimney stack shall be lead coated in order to avoid melting by exposure to hot flue gases.

xii. For tall buildings and structures, early streamer emission (ESE) type, air terminal system is preferred.

xiii. Horizontal air termination flats provided on top of boilers, main plant building & other buildings shall be laid such that no part of the roof shall be more than 9 metres.

xiv. Conductors of lightning protection system shall not be connected with conductors of earthing system above ground level.

xv. Lightning protection shall have as few joint as possible and avoid sharp bends. Down conductors shall have as far as possible, no joint except at test point and end termination.

xvi. Termination at the metallic equipments on roof should be made by suitable nuts, bolts, pressure washer and bitumen washers with good electrical conductivity.

xvii. All lightning protection conductors shall be exposed to atmosphere unless specifically mentioned.The lightning protection in the transformeryard shall cover the following equipments in the protection zone.

a) Generator Transformer
b) Station Transformer
c) Unit Transformers
d) Auxiliary Transformers

xviii. All areas of the power station shall be provided with lightning protection. Thelightning protection system for buildings shall consist of Air termination network, Down conductors, Test link and earth electrodes.

xix. Air termination network consisting of vertical or horizontal conductors or combination of both shall be provided ofr the building. Down conductors shall follow the most direct path possible between the air terminal network and the earth termination network. Each down conductor shall be provided with a test link for testing. An earth electrode shall be connected to each down conductor.

xx. For lightning protection , material thickness of galvanizing shall be atleast 610 gm / sq.mm for all galvanised steel conductor.

xxi. The lighting protection system shall not come in direct contact with other equipment / systems such as cables, conduits, electrical equipment, under ground metallic ducts etc., All metallic structures within vicinity shall be bonded to the lightining protection system.

xxii. All welded / brazed joints shall be coated with anti-corrossive paints for rust protection.

xxiii. Lightning conductor when used above ground level and shall be connected through test link with erth electrode / earthing system.Down conductors shall be as short and straight as practical and shall follow a direct path to earth.Down conductor shall not be connected to other earthing conductors above ground level.

xxiv. Each down conductor shall be provided with attest link at 1500 mm above ground level for testing. But it shall be in accessible to interference. No connections other than the one direct to an earth electrode shall be made below a test point.All joints in the down conductors shall be welded type.

xxv. Down conductors shall be cleated on outer side of the building wall / welded to out side building columns at 750 mm interval.

xxvi. Lightningconductor on the roof shall be cleated on surface of roof using insulated clamps / saddles for conductor fixing at an interval of 1000 mm for horizontal run and 750 mm for vertical run.

xxvii. Conductor of the lightning protection system shall not be connected with the conductors of the safty earthing system above ground level.

xxviii. Installation of lighting conductors on the roofs of the buildings shall include construction of supports, laying , anchoring, fastening and cleating of horizontal conductors, grounding of vertical rods wherever necessary, laying , fastening / cleating / welding of the down comers on the walls / columns of the buildings and the connections to the test links to be provided above ground level.

2.2.18.14Electrodes (for Lightning Protection)

i. The electrodes shall be 40 mm diameter 3000 mm long mild steel rod.These shall be driven into the ground.

ii. All the electrodes shall be interconnected by means of one (1) 40 mm dia mild steel rod which shall be laid under ground at a minimum depth of 1000 mm below finished grade level unless stated otherwise. This ground mats/electrode in turn shall be connected to main grounding grid.

2.2.18.15Riser (for Lightning Protection)

All risers connected to grounding mat shall be 40 mm mild steel rods and shall be projected 300 mm above grade level unless stated otherwise.

2.2.18.16Jointing & Connection

i. All ground conductor connections below ground level shall be done by electric are welding with low hydrogen content electrode.

ii. The projected portion of riser above ground shall be coated with two (2) coats of bitumen paints (anti-corrosive paints) with a minimum thickness of 1 mm after connection.

iii. The joints in the lightning conductors shall be kept to a minimum and there shall be no joint in the underground portions of conductors.

iv. All the joints shall be done by arc welding process overlapping of the conductors at straight joints shall not be less than 150 mm. The contact surfaces shall be cleaned properly before jointing.

v. The portion of galvanized steel flats, which undergoes welding at site, shall be coated with two (2) coats of cold galvanizing anti-corrosive paint after welding.

vi. The bolted joint of the test link shall be covered with thick coating of bitumen paint after successful testing.

vii. The air terminal rods and shielding mast shall be coated with weather resistant anti-corrosive paint (zinc chromate followed by two coats of aluminium paint).

viii. The steel to copper connection shall be brazed type.

ix. The lightning protection of inflammable liquid storage tanks wherever required, shall be provided with horizontal conductors strung between tall poles covering the entire zones or with air terminal rods mounted on top of poles/structure. These horizontal conductors/vertical air terminal rods shall be connected to rod electrodes, which in turn shall be connected to station ground mat.

2.2.18.17Quality Assurance Program

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. 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.

2.2.18.18Inspection and Testing

1. Earth Continuity Checks.

2. Earth resistance of the complete system as well as sub system

3. The earthing and lightning conductors should be type tested as per IS 2669. Following minimum tests shall be conducted.

   a) Freedom form defects
   b) Uniformity in thickness
   c) Mass pf coating
   d) Adhesion tests
   e) Any other applicable tests not mentioned in the specification but required.

2.2.18.19Drawing and Documents

The following drawings and documents shall be submitted for approval durind detail engineering stage.

1. Soil resitivity report
2. Design basis report for earthing and lightning protection system
3. Earthing design calculation
4. Typical installation drawings for earthing and lightning protection system
5. Electronic earthing layout and details
6. Earthing layot for Transformer yard
7. Earthing layot for power house building, boiler and ESP.
8. Earthing layot for all auxiliary plant buildings
9. Earthing layot for all non-plant buildings
10. Lightning Protection design calculation and layout

SECTION- IIC

GENERAL TECHNICAL REQUIREMENTS (C&I)

CHAPTER-3

FIELD AND MEASURING INSTRUMENTS

2.3.3 Field & Measuring Instruments (Primary & Secondary Instruments)

2.3.3.1 General requirements

Instruments, control devices and other equipment accessories covered under this specification shall be furnished in accordance with I&C specification sheets and drawings enclosed herewith and the requirements of all applicable clauses of this specification.

The instrumentation and control equipment shall conform to all applicable codes and standards including those referred in Cl. no. 2.3.1.6 in this Volume. All equipment and systems shall also fully comply with the design criteria stated in chapter-2 of this part.

The instrumentation/control equipment and accessories shall be from the latest proven design for which the performance and high availability have been demonstrated by a considerable record of successful operation in power station service for similar applications. The bidder shall furnish sufficient evidence to fully satisfy the Owner in this regard.

For plug in type instruments, 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/Electrical connection shall be screwed connection with double compression type Nickel-plated brass cable glands for Explosion proof area, Flame proof area and high vibration prone area.

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

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, Division 1 area & flame proof) and an anticorrosive paint shall be applied to the field mounted enclosures / instruments. All the field instruments shall also be provided with SS tag nameplate and double compression type Nickel-plated brass cable gland. Gaskets, Fasteners, Counter and mating flange shall also be included wherever required with the field instruments.

Following minimum requirement of field instruments shall be fulfilled by Bidder (In addition, Redundancy criteria for field instruments shall be as specified elsewhere in specification): -

a. Level switches / pressure switches / flow switches/any other process switches etc. for OLCS / Alarms / Interlocks / Protection. Pressure switches at inlet, outlet of individual pumps and discharge header of pumps for protection and auto start / stop & alarms.

b. Level switches (Type as per Owner approval) for sump/tank level high/normal/ low/very low interlocks.

c. Level Transmitters (Type as per Owner approval) for open sump/ tank/bunker/vessel/heaters.

d. Stand pipes on both side of tank for all level instruments (LT, LS & LG).

e. Flow elements (Type as per Owner approval) with flow transmitter & Flow meter for flow measurement of process medium like Steam, Water, Air, Flue Gas, Fuel oil, open channel liquid, solid fuel, ash flow, DM water, Raw water, Instrument and Service air etc. as decided by owner.

f. Pressure gauges and temp. Gauges at inlet and outlet of each heat exchanger and cooler.

g. DPG, DPT & DPS across the filters/strainers.

h. Tapping points/test points shall be provided.

i. All primary Instruments, hardwares & JBs etc. used for measurement for HFO, LDO & Turbine Lube Oil system shall be flame proof (IEC-79.1, Part I). All primary Instruments, hardwares & JBs etc. used for measurement for Hydrogen shall be intrinsically safe and explosion proof as per NEC article 500, class 1, Division 1 area I.

j. All Thermocouples & RTDs (Type as per Owner approval) shall be Duplex. Thermocouples shall be provided for Services with Temperature > 200 deg C.

k. All Field Instruments used in acid or alkaline atmosphere shall be with standard Anti corrosion coating i.e. the combination of Polyurethane and epoxy resin baked coating (ANSI/ISA-71.04).

l. All primary instruments installed at “Minus level or Floor” shall be with protection class of IP 68.

m. Transmitters (all type) for monitoring & controls purpose.

n. Bidder shall provide electronics weighing in motion system as per IS-11547, hermitically sealed load cell of precision strain gauge type,100% over load protection of cell and 250% overload protection for the construction; one calibrator attachment with two Weigher.

o. All field mounted push button, selector switch etc. shall be as per IEC or NEMA 4X protection.

p. All limit switch shall be conform to IEC-60947-5-1 and shall have minimum 2SPDT/DPDT contacts.

q. At APH, temperature measuring device of different lengths forming grid shall be provided to have average temperature for variable flow of flue gas, secondary air and primary air. These temperatures may be connected to nearest remote I/O panel.

r. On both left and right sides of furnace, separate lines shall be laid and provided with furnace pressure transmitters having wide range than the furnace pressure transmitters used for modulating control.

s. Temp. Transmitters are envisaged with RTD & Thermocouples for monitoring services / application only. However any RTD & Thermocouples are used for control, interlock & protection application, same shall be directly wired to DDCMIS/DCS using instrumentation & Extension cables respectively.

t. As for the water flow/ steam flow measurements, necessary flow elements/ transmitters are chosen in the process line and supplied such that their algebraic summation shall be mass balanced for calculating the system efficiency.

u. Non-contact type electronic 2-wire position transmitters shall be provided for all inching type motorised valves and dampers.

v. For CW sump level, Turbine oil tank, Ash Silo, LDO/HFO tank, DM water tanks, CS tank, Acid and alkali applications, only noncontact type level transmitters like Acoustic, Ultrasonic, and Radar based (Type as per Owner approval) shall be provided by bidders as specified in Tender Specification and as approved by owner.

w. For Turbine oil, HFO/LDO applications & H2 Gas application, Zener protection on power supplies shall be included.

x. 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. For HFO, LFO Applications, SS capillary with thin wafer element with ANSI RF flanged ends are to be provided. For hazardous area, explosions proof enclosure as described in NEC article 500 shall be provided.

y. Considering the type of application, wireless technology to bring signals to DDCMIS may be adopted by interfacing with OPC gateway to avoid cabling for smart level transmitters specified above at sr. no. xxi, in case used for monitoring only. However Wireless technology as adopted by Bidder shall be reliable and field proven in power plants and same shall be approved by Owner. Wirelss transmitters shall have the same minimum specification/ parameters as mentioned for wired transmitters.

z. Gauges (all type) for local monitoring in field.

aa. Each switching element including the limit and torque switches of valve actuators shall be provided with minimum two contacts i.e. 2SPDT OR DPDT.

bb. All instruments should be supplied with valid calibration and test certificates provided by OEM.

cc. Canopy/Enclosure shall be provided for field instruments like transmitters, switches & flow meters, etc and any other equipment to protect from direct sun light, lightning & rain.

Field instruments shall be supplied & offered as per data sheets specified below:

2.3.3.2 Transmitters, Switches, Gauges and Panel Mounted Instruments

i) Pressure, Differential Pressure, DP type Level and Flow Transmitters (PT, DPT, LT & FT)

Smart Transmitters of the electronic type shall be furnished. All Transmitter shall be installed in closed LIE in the boiler area. Similarly transmitter for TG shall also be in LIE except the transmitters located in covered area on TG floor and these shall be mounted in LIR. Transmitters shall be equipped with mounting brackets suitable for a mounting in transmitter enclosures.

In general, Transmitters are envisaged to be grouped at several places as to be decided during detailed engg. Stage. For this purpose, suitable enclosures complete with all tubing, fittings, purge meters, loop cable trays etc. shall be provided.

S.No	Features	Essential / Minimum Requirements
1	Type/Construction	Sealed capacitance/ Inductance/ Silicon resonance type
2	**Material**	
	Body	Die cast Aluminium with epoxy coating for air & flue gas, SS316 for other services
	Diaphragm	SS316 With Teflon seal for process requirement/process media for other services
	Measurement element	316 SS (Suitable material/coating for Hydrogen pressure transmitters/Differential pressure transmitters) the suitable material/coating shall be chosen as per the suggestion of transmitter manufacturer.
	Valves	Carbon steel for non-corrosive applications & SS316 for corrosive applications
3	Output Signal	4 to 20 m Amp. DC (Two wires) HART Compatible
4	Local Indicator	LCD indicator (5 digit) with scale of Engg. unit
5	Overall Accuracy	± 0.04% or better of Span for BTG package ± 0.065% or better of Span for BOP packages ± 0.2% or better of span for remote seal type transmitter.
6	Turn down ratio	100:1 in general

S.No	Features	Essential / Minimum Requirements
		10:1 for vacuum/very low pressure applications. 10:1 for very high pressure application. 30:1 for other applications.
7	Stability	+ 0.15% of URL for 5 years.
8	Response time	150 msec.
9	Power supply	24V DC nominal
10	Load Impedance	500 Ohms (min.)
11	Drive capability	600 Ohms nominal
12	Enclosure Class	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
13	Span and Zero	Locally adjustable, non-interacting
14	Zero suppression / elevation	At least 100% of Span
15	**Connection**	
	Process	Half (1/2) inch NPT (F) Quarter (1/4) inch NPT with / without oval flanges
	Electrical	Suitable for Plug in type connection (Both side of transmitter), unused entry with blind plug.
16	**Accessories**	
	For Absolute Pressure Transmitters	Two (2) valve SS316 manifold
	For Gauge & Vacuum pressure transmitter	Three (3) valve SS316 manifold
	For DP, level & flow transmitter	Five (5) valve SS316 manifold
	For oil and corrosive liquids	Separator diaphragm seals
	For all transmitters	Mounting bracket
	Steam Service	Syphon
	Pumps Discharge service	Snubbers
17	Adjustment / calibration From hand held calibrator / centralized OWS based system / maintenance (as applicable).	From hand held calibrator/centralized OWS based system
18	IBR Requirement	For high pressure service, Process tapping and root valves are as per IBR rules and regulations

Manifold should not be mounted on the transmitter, Manifold shall be non integral and standalone type. Snubbers/Pulsation dampners shall be used where the process media is unstable for measurement such as the discharge of a pump. Over range protection shall be used where necessary. The coil syphons & condensate pots shall be used for steam services. Transmitters shall be provided with suitable drain & vent points.

Transmitters, smart positioner & other HART based instruments shall be supplied along with 4 Nos. of universal type hand held/portable calibrators. Temperature transmitters shall be supplied along with 4 Nos. of hand held/portable mV source generators/signal reader.

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.

Following minimum accessories shall be provided with each set:-

a) Soft carrying case with adjustable shoulder straps & lead compartments.
b) HART lead set.
c) Rechargeable batteries.
d) Battery charger.
e) Power adaptor.
f) Universal plug kit for power adaptor.
g) Load resistor.
h) Interfacing cables of each type as per requirements.
i) Protective boot.
j) Standard banana jack.
k) Operation manual & software CD.
l) Analysis & Diagnostic Software.

For flanged remote seal diaphragm:

a) Maximum pressure rating : To meet 200 percent of process pressure
b) Availability of seals : for both high and low pressure sides with capillary connection in case of differential pressure transmitters and
c) Single Capillary connection for pressure transmitters.
d) Capillary length : 6.0 m
e) Fill fluid : Suitable oil
f) Process connection size : 1 inch
g) Flange size and Accessories : As per process requirement. Flange pressure rating : Required Class (ANSI)
h) Process liquid : Sea water, Ash water, chemical, hydrogen gas, sealoil etc.,
i) Process fluid temperature : 25°C to 60°C
j) Diaphragm and wetted part material : Suitable for sea water, ash water and chemical applications.(offered material to be specified)
k) Flushing option : To be made available with 1/4 inch (necessary drain and gasket suitable for sea water application to be provided)

ii) Pressure Switches (PS) & Differential Pressure Switches (DPS)

S.No	Features	Essential / Minimum Requirements
1	Applicable Standards	IS3624 - 1966/ISA-RP-8.1 except as modified in spec.
2	**Materials**	
	Bellows	316SS
	Bourdon tube	316SS
	Movement	316SS
	Enclosure	Die-cast aluminium with stoved enamel black finish. Epoxy coating shall be provided for corrosive atmosphere.
3	Type/Construction	Bourdon/Sealed Diaphragm Piston Actuated preferable. Indicators with contacts are not acceptable.
4	Protective Diaphragm	Teflon
5	Accuracy	± One (1) percent or better of full range

S.No	Features	Essential / Minimum Requirements
6	Repeatability	± 0.5(half) percent or better of full range
7	Setting & Differential	Adjustable
8	**Contact**	
	Number	DPDT /2 SPDT
	Type	Auto reset with internal Adjustable snap action micro switch
9	Rating	5 Amp, 240V AC / 0.2 Amp, 220V DC
10	End connection	½" NPT (F) / Manufactures Standards
11	Connection - instrument	Half (1/2) inch NPT Male Process
12	Electrical	Suitable for Plug in type connection. All the switches are internally connected and brought to the surface with Amphenol male/female connection. Cabling need not terminated inside the switch. Cable ends are to be soldiered in connector and to be inserted for easy maintenance.
13	Over range protection	One Fifty (150) percent of full scale
14	Enclosure Class	IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area)
15	Dead band adjustment	Adjustment up to 10% at set points.
16	**Accessories**	
	3 / 5 valve manifold	As applicable for all switches
	Self cleaning type pulsation dampners / Snubbers (Material SS316)	Pump and compressor
	Syphon	For all steam lines
	Protective separating diaphragm	For fuel oil & corrosive liquid lines.
	Mounting	Local (in LIE/LIR for BTG package)
17	IBR Requirement	For high pressure service, Process tapping and root valves are as per IBR rules and regulations

iii) Pressure & Differential Pressure Gauges (PG & DPG)

S.No	Features	Essential / Minimum Requirements
1	Applicable Standards	IS:3602-1966, IS/3624, ASME B 40.1
2	**Type / construction**	
	760 mm to 1.0Kg/cm2	Bellows/Diaphragm
	Above1.0Kg/cm2	Bourdon Tube
	Suction side of pumps	Compound gauge
3	**Materials**	
	Bellows	316SS
	Bourdon tube	316SS
	Movement	316SS
	Case Enclosure	SS 316 / Die-cast aluminium with stoved enamel black finish. Epoxy coating shall be provided for corrosive atmosphere.
4	End connection	½" NPT (M)
5	Protective Diaphragm	Teflon
6	Dial Size	150mm with shatter proof glass

S.No	Features	Essential / Minimum Requirements
7	Scale Details	Graduations in black lines on white dial, on white dial, 270 Deg. pointer deflection scale provided with glass cover. Smallest scale division shall be one (1) percent of full scale value or smaller. Pointer stop for all gauges.
8	Range Selection	Cover 125% of max. of scale
9	Accuracy	± One (1) percent or better
10	Instrument process connection	½" NPT Male (Back Entry)
11	Mounting Type	Local / 1/2 inch NPT Male (Back entry) mounted on local gauge board.
12	Protection Class	IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area)
13	**Accessories**	
	3 way needle valve / manifolds	For all gauges
	Self cleaning type	Pump and compressor discharge (Pulsation dampener / Snubbers (S316) lines
	Syphon	For all steam lines
	Protective separating	For fuel oil and corrosive liquid lines
14	**Other Particulars**	
	External Zero adjustment / Safety device	For all gauges
	Ranges 5 to 20 Kg/cm2	Rubber blow out disc with open front construction.
	Ranges above 20 Kg/cm2	Neoprene safety diaphragm at the back with solid front construction.
16	Over range protection	One Fifty (150) percent of full scale
17	Over Range Test	Test pr. For the assembly shall be 1.5 to the max. Design pr. At 38°C
18	**Other Requirements**	Movement mechanism shall be glycerine filled for oil services & vibration prone area.
		For Fuel oil & corrosive liquid lines diaphragm type sensors required. Armoured capillary of 10 M for Fuel oil & Corrosive liquid service.
		Contact type pressure gauges are not acceptable for interlock & protection.
		For condensate storage tank the pressure gauge in terms of0-10000 mmwcl or suitable range having **dial size of 300mm or bigger size** shall be provided.
19	IBR Requirement	For high pressure service, Process tapping and root valves are as per IBR rules and regulations

2.3.3.3 Temperature Related Instruments

a) Temperature Transmitters (TT)

S.No	Features	Essential / Minimum Requirements
1	Type	SMART type configurable from control room through HART protocol (HMS System).
2	Display type	Indicating type (5 digit LCD Display),
3	Accuracy	±0.10%,

2.3.3.9 Solenoid Valves

Solenoid valves shall be provided with control valves / pneumatic control valves hooked up with process interlock requirements and where direct tripping is involved. The number of ways for solenoid valve shall be provided as indicated below:

a. Two (2) way solenoid valves shall be provided, where process line of less than 50 mm with low pressure and temperature application.

b. Three (3) way solenoid valve shall be provided commonly, where the pressure is admitted or exhausted from a diaphragm valve or single acting cylinder, e.g., Pneumatic operated spray water block valve.

c. Four (4) way solenoid valve shall be provided for operating double acting cylinders, e.g., pneumatically operated on-off type dampers.

d. For operation of the fuel oil corner nozzle valves, fuel oil trip valves etc., double coil solenoid valve (latch coil & relatch coil) shall be adopted. Single coil usage requires always power and loss of power leads to closure of above valves resulting the unit trip or loss of generation.

e. Solenoid Valve coils shall be Class-H high-temperature or Class-F construction as applicable and shall be designed for continuous duty. Three-way solenoid valves shall be designed for universal operation so that the supply air may be connected to any port. Solenoid enclosures shall be NEMA-4)/ (Explosion proof for NEC Class-1, Division 1 area)/ flame proof (IEC-79.1, Part I) as applicable). Body material of solenoid valve shall be Brass or SS316 with epoxy paint as decided during engineering by owner. Material of wetted parts shall be SS316 only. Leakage class shall be class VI (Bubble tight)..

f. All solenoid shall be with Varistors, LED indication, surge suppress diode and circuits.

g. Solenoid valve shall operate on 24V DC, UPS 240V AC or 220V DC as per system requirements.

2.3.3.10 Power Cylinders (Pneumatic)

S.No	Features	Essential / Minimum Requirements
1	Mounting Type	a) Fixed position mounting (End mounting). b) Trunnion mounting
2	Control Signal	a) 0.2 to 1 Kg/Sq. cm. from I/P converter for modulating purposes. 24V/48VDC operated solenoid valve operating on pneumatic line. b) The Pilot solenoid will have separate coils for open closing purpose.
3	Supply Air	0-7 Kg / Cm2.
4	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

S.No	Features	Essential / Minimum Requirements
		operation.
5	Casing	IP-65.
6	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).
7	Fail-safe operation	Stay put, open or close position on pneumatic / electrical power supply failure as per process safety criteria.
8	Repeatability	Better than 0.5% of full travel.
9	Hysteresis	Less than 1% of full travel.
10	Material	Internal part's material and material of accessories shall be SS316 only.
	In case of loss of mA signal. Manual adjustment shall be made through available manual knob and locked at required position for sufficient required process fluid flow.	

2.3.3.11 Non - Nucleonic (Vibration) type Density Meter (For DM Plant)

S.No	Features	Essential / Minimum Requirements
1	Type	Non - Nuclear type radiation
2	Application	Liquid Density measurement
	Detector	
3	Orientation	As per requirement
4	Case Material	SS 316/ Cast Aluminium alloy
5	Wetted part material	SS 316
6	Operating Principle	Vibration Density measurement
	Convertor	
7	Output	4-20 mA DC isolated.
8	Electrical Connection	½" NPT
9	Enclosure Class	IP 65
10	Local Display	Digital 5 digit, density display with temp. Compensation.
11	Accuracy	+/- 1%
12	Response time	< 1 minute
13	Power Supply	240 V AC, +/- 10%, 50 Hz. From UPS

2.3.3.12 Junction Box

S.No.	Features	Essential/Minimum Requirements
1	Type of Enclosure	Dust tight, Flame Proof / Weatherproof and Waterproof, generally conforming to IP 65.

S.No.	Features	Essential/Minimum Requirements
2	Material	16 SWG sheet steel hot-dip galvanized / Cast aluminium LM6.
3	Type of Cover	Solid unhinged with retention chain
4	Mounting	Indoor / Outdoor
5	Cable Entry	Downwards
6	Cable Glands	Double compression type – Nickel plated brass with PVC hoods.
7	Terminals	Phoenix / Wago (screw less cage clamp type spring loaded)
8	Gasket	Neoprene
9	Grounding	Two terminals for body and shield ground
10	Number of Drain Holes	Two at bottom capped.
11	Door	Hinged, lockable type
12	Color	In General same as provided for control panels, and for special services, To be decided during detailed engineering & subject to owner's approval.
13	Note: i. Suitable mounting clamps and other accessories shall be in scope of bidder. ii. The brackets, bolts, nuts, screws, glands, lugs required for erection shall be of brass, included in bidder scope of supply. High voltage & insulation resistance test shall also be conducted. iii. M6 Ni plated Brass earthing stud shall be provided (external 2 nos. internal 1 no.) iv. Gasket (Normal)- Neoprene thickness 6.0 mm	

2.3.3.13 Interposing Relays (IPR)

Electromagnetic type IPRs with modular design, plug-in type connections, suitable for channel/DIN rail mounting in cabinets; coil rating 24V D.C; 2 set of silver plated change over contacts rated for 0.5A 220 V DC/8 A 240 V AC. Freewheeling diode across relay copper coil and self reset type status LED indicator flag (electronic) shall be provided. Manual forcing/override facility is required. The test voltage for relay shall not be less than 4 KV with operating temperature from as per ambient temperature condition at site. The relay shall have the necessary approvals like V0 inflammability class in accordance with UL94", IEC60664/IEC60664A/DIN VDE 0110. Facility to stimulate IPR manually shall be provided. The VA burden of relays shall be suitable to match the capacity of output modules. Interposing relay & sockets for mounting the interposing relay shall be of same make only.

The operating temperature of the Relay & Sockets shall be from –20 deg. C to 60 deg. C. The operating/release time of the relay shall not be more than 10/5 ms respectively.

The relay and DIN Rail sockets shall have the necessary approvals like UL/VDE and V0/V2 inflammability class in accordance with UL94", IEC60664/IEC60664A/ DINVDE0110.

Facility to stimulate IPR manually shall be provided. The VA burden of relays shall be suitable to match the capacity of output modules. Interposing relay & sockets for mounting the interposing

thermal Power project of minimum 500 MW or higher size unit, which are in successful commercial operation for minimum 2 years at the date of bid opening. Bidder to furnish the necessary proof for the same in the bid offer.

Similarly, all other C&I equipments/ C&I system/instruments/PLC/SWAS/ UPS/ Charger system/Control systems/Sub systems and accessories etc, whose guaranteed and trouble free performance has been proven at least for three years, in not less than two nos. different reheat type pulverized coal fired units of unit size not less than 500 MW except some specific requirements indicated elsewhere.

Bidder shall furnish the required information/details/PTR to fully satisfy the owner regarding successful operation and high reliability of products/systems offered/furnished.

The bidder shall obtain & furnish the certification from his tieup partners (as consortium or other wise) that their design, engineering, procurement, manufacturing, erection, commissioning and shop test facility are adequate to meet the specified technical & performance/quality requirements for execution & commissioning of the package offered to the satisfaction of owner.

Standardization and Uniformity of Hardware

To ensure & provide smooth and optimal maintenance easy interchangeability and efficient spare parts management of various C&I instruments/equipment like vibration monitoring systems, all 4-20mA electronic transmitters/ transducers, control hardware, control valves, actuators and other instruments/ local devices etc. being furnished by the Bidder for main plant areas (eg. boiler/turbine etc.) and other plant and station auxiliaries for similar applications, the Bidder shall ensure that they are of the same make, series and family of hardware.

To ensure smooth and optimal maintenance easy interchangeability and efficient spare parts management of various C&I instruments/equipment like vibration monitoring systems, all 4-20mA electronic transmitters/ transducers, control hardware, control valves, actuators and other instruments/ local devices etc. being furnished by the Bidder for main plant areas (eg. boiler/turbine etc.) and the Bidder shall ensure that they are of the same make, series and family of hardware.

The bidder shall obtain & furnish the certification from his tie-up partners (as consortium or otherwise) that their design, engineering, procurement, manufacturing, erection, commissioning and shop test facility are adequate to meet the specified technical & performance/quality requirements for execution & commissioning of the package offered to the satisfaction of owner.

2.3.2.8 Redundancy Criteria for Sensors and Signals from MCC/SWGR

Redundancy of components and systems shall be dictated by availability criteria described under DDCMIS/DCS/PLC to ensure the system availability target as well as safety considerations in critical applications are fully met.

Bidder shall also introduce redundant control equipments or instruments wherever it is felt by owner that the introduction of the same shall lead to reduction of downtime of plant and equipments, in addition to the case/criteria clearly defined/identified in the specification.

Triple redundancy or dual redundancy for signals from MCC/SWGR, sensors and transmitters will be used for critical control /Protection application, critical monitoring application & other control/interlock applications. Where correction/ compensation for the measured signal are involved, the computed signal shall be the one transferred for control purposes. The measured value indicated shall be the duly corrected/ compensated signal.

Sensor/signals/measurements redundancy required (2 out of 3 or 1 out of 2) requirement have been specified in respective control system specifications and as specified elsewhere in the technical specification. However, sensor/signals/measurements utilization will be decided during detailed engineering. It is mandatory to use sensors/signals/measurements with 2 out of 3 logic for critical control & protection (Analog & Binary) application/service and sensors with 1 out of 2 logic for all other control & interlock (Analog & Binary) application/service as explained below.

2.3.2.9 Triple measurement scheme

Triple measurement scheme for analog inputs employing three independent transmitters connected to separate tapping points shall be employed for the most critical measurements. The same shall be used in analog control functions including, the following but not limited to, furnace draft, feed water flow, Feed Water Temperature, feed water pressure before Economiser, Discharge Flow of each BFP, BFP discharge Temperature, Boiler Separator level control, Steam Pressure, Main steam, CRH & HRH, steam temp. control, SH spray Flow, RH spray Flow, throttle pressure, PA/SA Air Flow, PA/SA Air Temperature, PA header pressure, Mill Air Flow, Mill outlet Temperature, Coal Feeder Speed Control, Spray water flow, SH, RH & Aux. Steam Desuperheater inlet & outlet Temp at each stage, SH Platen Steam Temperature before Desuperheater, SH Platen Steam Temperature after all super heaters, RH steam Temperature at Turbine end, Main steam Temperature at turbine end, turbine first stage pressure, Deaerator level, Deaerator Flow after Last LPH, Hot well level, GS steam Pressure, condensate flow before recirculation line, turbine speed, Turbine Control Valve position, Power measuring device, HP/LP Heater level, SCAPH temp. Control, HP Bypass controls, LP Bypass controls, Light Oil Pressure, Heavy Oil Pressure, Atomising Steam Pressure, Heavy Oil Temperature, Hydrogen gas pressure of generator, Atomising air pressure, TDBFP steam pressure, TDBFP steam temperature, TDBFP controls, BFP speed control, Turbine lube oil temperature, Turbine main oil tank level and all other trip & protection logics etc.

For MFT/FSSS/BMS/Turbine protection/ Generator/Unit tripping, triple sensors shall be provided. For Binary and analog inputs required in major equipment (Furnace, Turbine, tripping/protection of any HT drive etc.) protection triple-sensing devices shall be provided. Binary and analog inputs, which are, required for protection of more than one equipment as well as protection signals for HT Drives (fed by a supply feeder of ratings 6.6 kV onwards)/MDBFP/TDBFP etc., triple sensing devices shall be provided.

Triple sensors shall be provided for Instruments required for auto starting of HT driven pumps or pump tripping due to very low level of water/discharge pressure very low and Trip of any auxiliary which will lead to substantial (50%) loss of unit availability. 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. Left and right side shall be treated as individual path / individual parameter, and each side/path shall have own triple redundancy accordingly.

2.3.2.10 Dual measurement scheme

For binary and analog inputs required for other modulating control, protection and interlock purpose of other equipment and other critical monitoring application etc., minimum dual sensors shall be provided. Dual sensors shall be provided 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. Dual sensors shall be provided for instruments required for Heat rate measurements & PADO calculations.

Dual measurement scheme for analog inputs employing two independent transmitters/ temperature element, connected to separate tapping points shall be employed for the remaining measurements used for analog control functions.

Dual duplex Temperature Elements shall be provided before and after of each LP Heater and HP Heater on water lines.

Dual redundant position transmitters shall be provided for Steam Admission Valves i.e. (Main steam Stop & Control Valves, Reheat steam Stop Valves & Control valves and TDBFP steam stop valves & control valves), Extraction steam QCNRV, CRH NRV.

Dual analysers shall be provided for chemical dosing controls and O2 dosing controls.

For binary and analog inputs used for alarm and monitoring only, single sensor criteria shall be applicable.

All the instruments/sensors/transmitters/switches meant for redundant applications shall have completely separate and independent impulse pipes/ root valves etc. No redundant instrument shall share a single process tapping. There will be separate and independent tapping for every individual instrument.

2.3.2.11 Back-Up Instrumentation

a) No full backup discrete hardwired based control or hardwired manual operation is envisaged in the 800 MW Unit control room for main plant. Bidder shall however perform a failure analysis to establish that the plant can be safely shutdown or can be brought to a safe operating condition without any damage to equipment and / or personnel during the unlikely event of catastrophic failure of DDCMIS/DCS.

CHAPTER-8

ERECTION HARDWARE

2.3.8 Erection Hardware - Process Connection and Piping

2.3.8.1 General Requirements

This section covers the material requirement for instrument connection to process, instrument process, piping, tubing, supports, Instrumentation cables, control cables and compensating cables/Extension cables, transmitter racks and main accessories to be furnished under this specification and the requirements of installation and routing. Impulse lines, fittings and other accessories required for the erection of complete Instrumentation and Control System supplied under various packages of this specification shall be supplied on "as required' basis. Bidder shall offer all necessary items for this section based on his experience on similar plants, plant layout diagrams, installation drawings and other applicable sections of this specification. Based on the good engineering practices Bidder shall furnish installation drawings during the engineering of the system for Owner's review and approval .The installation of the drawings shall be suitable for his installation of his range of instrumentation.

The Bidder shall furnish and test all required erection hardware, which is necessary for proper installation and interconnection of the equipment/systems furnished by the Bidder and their integration with main equipment/systems as per the enclosed installation drawings and other applicable clause. The Bidder shall furnish all hardware and accessories to ensure that the equipment/systems furnished form a complete and operational system meeting the intent and requirement of this specification.

All materials, furnished shall conform to the latest editions of America National Standard Code for Pressure piping, Power piping, ANSI B311.1, ANSI B16.11, ASME Boiler and Pressure Vessel Codes, IBR and other applicable ASME, ANSI and Indian Standards. Schedule numbers, sizes and dimensions of all carbon steel, stainless steel and alloy seamless steel pipe shall confirm to ANSI B.36.10 and of stainless steel pipe shall confirm to ANSI B 36.19 unless otherwise specified.

All materials supplied under this section shall be suitable for intended service; process operating conditions and type of instruments used and shall fully conform to the requirements of this specification.

The Bidder is responsible for the performance of the equipment furnished on system basis any shortfall in erection material observed during erection stage shall be compensated by the Bidder at no extra cost. (~~Installation drawings # LII-GEOE15066-I-45786-001 to 29 shall also be referred by bidder~~).

5) Fittings:-

Forged cast steel A234 Gr. WPM galvanized inside and outside; screwed as per ASA B2.1 dimensions as per ASA B16.11, rating 2000 pounds, elbows and soft seats. The size of the fittings shall be ½ inch through 2 inch.

6) Air Filter Regulator Set:-

An instrument Air Filter Regulator Set with mounting assembles shall be provided for each pneumatic device requiring air supply.

7) Instrument Air Piping System:-

Instrument Air shall be made available by the bidder at 3.5 to 7.0 Kg/cm² pressure. The instrument air may be arranged as under:-

i) For the control valves and power cylinders in owner's scope but controlled by bidder's control system, the instrument air requirement for E/P converter shall be tapped from the nearby instrument air header laid by bidder / already laid existing piping with accessories available near the control valves or damper. Complete hardware required for interfacing with Owner system shall be in bidder scope.
ii) Air supply piping shall be installed at site always with a slope of over 1/100 to prevent accumulation of condensed water within the pipe.
iii) All joints in the instrument air sub-header shall be of screwed type.
iv) Instrument airline shall be separate for each individual instrument, equipment & drive with own isolation valve and other required hardware. Tee off of instrument line for two or more same/similar services instrument, equipment & drive are not acceptable.
v) Instrument air flushing/purging lines shall be provided for Bowl Mill DP, secondary air flow measurement instrument and other all flue gas services instruments etc.

8) **Signal / Control Air Tubing System**:-

Necessary tubes with fittings and accessories for output signal from pneumatic instruments mounted in the field and control signals to final control elements shall be covered under this tubing system.

2.3.8.3 Specification for Erection Hardware

The erection hardware shall meet the following specifications:-

a) Impulse piping

S.No	Item	Specification
1	High pressure and high temperature services (Medium: Steam & Water and furnace region)	Seamless Alloy Steel piping to ASTM A335 GR.P91 / 22 (schedule XXS / 160 for high pressure & high temperature)
2	Low pressure and low temperature services (Medium: Steam & Water)	Seamless carbon steel piping to ASTM A106, Gr. C
3	Low pressure and low temperature services (Air, Flue gas)	ERW carbon steel piping to IS 1239:1973 Heavy class System)
4	Steam and water analysis system	Seamless stainless steel piping to ASTM A312 GR. TP-321
5	Seamless copper tubing	ASTM B-75

b) Fittings Double compression type

S.No	Item	Specification
1	Material for socket weld fittings	ASTM A105,ASTM A182, Gr. F22 6000/3000 lbs
2	Dimensions of fittings	ANSI B16.11
3	Fittings for steam and water analysis.	Gr. F-321

c) Valves

S.No	Item	Specification
1	3 – way valves	SS body/forged CS body stellited internals and SW ends as per requirement for 2500 lb/800 lb ASA ratings.
2	5- valve manifolds	FAS body/FCS body 316SS stellited internals with NPT (F) SCRD ends for 3000/2500 lb/1500 lb/800 lb ASA ratings. Construction – Single block (Bar stock)
3	3-valve manifolds	FAS body/FCS body 316SS stellited internals with NPT (F) SCRD ends for 3000/2500 lb/1500 lb/800 lb ASA ratings. Construction – Single block (Bar stock)
4	2-valve manifolds	FCS body, 316SS stellited internals, NPT (F) SCRD ends. Construction – Single block (Bar stock)
5	Isolation and drain valves	Globe valves with FAS body/FCS body, 316SS stellited internals SW ends for 3000/2500 lb/1500 lb/800 ASA ratings.

d) Other Fittings items

S.No	Item	Specification
1	Condensation vessels	FAS/FCS body with NPT (F) SCRD connection and vent plugs for 3000/2500/1500/800 lb ASA ratings.

S.No	Item	Specification
2	Racks and Associated Equipment	ANSI C83.9-1972
3	Code for pressure piping, welding and Hydrostatic testing	ANSI B-31.1
4	Flexible conduits with fittings	Lead coated, paper insulated, heat resistant flexible metallic conduits with necessary fittings.
5	3 Valve manifold shall be used, wherever Diff Pressure transmitter / switch have been used for pressure measurement.	
6	5 Valve manifold shall be used for Diff. Pressure & Flow measurement Transmitters / Switches.	
7	In addition to above, table # 8.1 shall also be followed for selection of specific erection hard ware as per process requirements.	

2.3.8.4 Transmitter & Switches Enclosures

In general, BTG process transmitters & switches installed at outdoor location and in areas where they are subjected to splashing oil, water, steam etc., shall be mounted in closed type transmitter rack. For other areas (indoor), open type racks may be used for installation of transmitters and process switches. However the actual requirement shall be finalized during detailed Engineering considering following:-

a. Transmitter/Switches enclosures shall be free standing, enclosed type offering protection against dust, moisture and vermin. Enclosures shall be suitable for outdoor installations, in thermal power plants.

b. The enclosures shall comprise of Galvanized Sheet mounting plate internally. Also external-mounting brackets in Polyamide or Stainless Steel shall be available. Alternatively transmitter enclosures can be glass Fiber Reinforced Polyester (GRP) compression moulded and shall be weather proof.

c. Instrument piping inside the enclosure shall conform to the specification and in line with typical installation drawings enclosed with the specification.

d. Blow down header shall be provided inside the enclosure as called for.

e. Bulk head connection shall be provided to receive and terminate the impulse pipes from root valves.

f. Instrument tubing, fittings and isolation, drain valves shall be to ANSI code for pressure piping. Piping/tubing shall be subject to hydrostatic tests at 1.5 times maximum system pressure.

g. Support angles shall be provided for valve manifolds, wiring trays etc. Enclosures shall be complete with necessary bulk head fittings, junction boxes, drain header and other accessories as needed on the basis of approved hook up drawings.

h. Sufficient spacing among adjacent transmitters shall be maintained to offer easy accessibility and operational convenience. The enclosure shall be designed with sizes to suit the grouping and to completely include all the hardware for hooking up the transmitters to the process on the basis of approved installation diagrams. A maximum of five (5) transmitters are envisaged to be grouped in one enclosure.

i. A minimum of twenty (20) percent spare terminals shall be provided. Only one wire per terminal shall be used on the outgoing side of these blocks (for cable panel). Any common connections required shall be provided on the panel side of the block. All incoming power terminals are to be clearly identified in a manner distinctly different from all other terminals and grouped in a logical pattern.

j. Chapter no. 6 of this volume shall also be referred for designing of Transmitter / Switches enclosures.

2.3.8.5 Local Instruments, Local Boards and Tapping Points

a. All local gauges as well as sensors, Transmitters and switches any other instruments for parameters like pressure, temperature, level, flow etc. for safe and efficient operation of equipment under the scope of specification, shall be provided by bidder as approved by Owner. Such equipment shall be listed by the Bidder detailing the items with the respective functions in service. All field mounted instruments shall be mounted in such a way as not to be affected by vibration & environmental conditions. Racks to mount these instruments shall be furnished by bidder complete with requisite erection hardware, tubings and junction boxes with all terminals of the instruments duly wired complete with cable glands. Groupings of instruments, actual number of racks for instruments and its construction shall be to Owners approval.

b. Transmitters & Switches provided shall be mounted in transmitter/Switches enclosures to owner's approval. The junction box for electrical connections shall be outside the transmitter enclosures.

c. All erection hardware required for complete installation/ implementation of entire instrumentation specified is included in bidders scope. Any change in size, type, rating or in quantity deemed necessary during engineering shall be supplied within package price with no additional financial implication to owner.

d. Bidders scope includes providing counter flanges on pipe lines/ vessels to suit owner arranged flanged devices. Counter flanges shall be complete with gaskets, nuts, bolts and other requisite accessories for proper installation.

l) At CW & ACW pump discharge headers flow transmitters shall be provided (Non Contact ultrasonic Type are preferable). In addition flow measurement shall also be provided for CW water used anywhere except condenser service.

m) Flow transmitters for general applications shall be of the differential pressure type

n) Flow switches for OLCS / Alarms / Interlocks / Protection.

o) Lubricating oil Flow transmitter/meter with switch shall be provided for Bearing systems of APH, FD, PA, etc.,

p) Sight glasses flapper indication type shall be provided on lube oil cooling water piping as required to ensure indication of fluid flow.

q) On line Fuel flow & velocity measurement facility in each Pulverized Fuel (PF) pipe for each coal pulveriser shall be provided by bidder for accurate, absolute and simultaneous measurement of coal velocity, coal density, coal mass flow rate and air-to-fuel ratio. The equipments shall compromise of sensors working on micro wave technology.

r) In addition to the conventional triple DP measurement techniques involving venturi/Aerofoil for secondary air flow measurement, One number Flow measurement system each on Left side and Right side shall be provided as redundant/checking measurement for secondary air flow which could be used in the optimization package.

s) On line secondary air flow & velocity measurement facility in each on left side & right side shall be provided by bidder for accurate, absolute and simultaneous measurement of air velocity & flow rate. The equipments shall compromise of sensors working on tribo-electric (Correlation technique) technology.

t) Any other flow element/meter required for system shall be finalised as per system requirement and as per approved drawings/documents by owner.

5. Process Connections

a) The type of instrument source connection shall depend upon the process parameters and the tapping size. The source connection drawings shall be finalised during the engineering stage.

b) Size of tapping point stub, number and size of root valves for different types of measurements are as follows:

S.No.	Quantity of root valves	Size of stub and root valve	Service Condition
Pressure and Differential Pressure Measurement			
(i)	2	25NB	≥ 40 bar (g) OR 425^{0}C
(ii)	1	15NB	< 40 bar (g) AND 425^{0}C.
Level Measurement			
(a)	**Level Gauge & Switch**		
(i)	2	25NB	≥ 40 bar(g) OR 425^{0}C
(ii)	1	25NB	< 40 bar(g) AND 425^{0}C
(b)	**Level transmitter (displacement type)**		
(i)	2	40NB	>40 bar(g) OR 425^{0}C
(ii)	1	40NB	<40 bar(g) AND 425^{0}C
(c)	**Stand pipe for level measuring instrument**		
(i)	2	80 NB	≥40 bar(g) OR 425^{0}C
(ii)	1	80 NB	< 40 bar(g) AND 425^{0}C
Flow Measurement			
(i)	2	25NB	≥ 40bar(g) OR 425^{0}C
(ii)	1	25NB	< 40 bar(g) AND 425^{0}C
Sampling system measurement (Steam and Water Service)			
(i)	2	25 NB	≥40 bar(g) OR 425^{0}C
(ii)	1	25 NB	< 40 bar(g) AND 425^{0}C

FORM NO. PEM-6666-0

BHEL PEM	DATA SHEET FOR MASS FLOW CONTROLLER FOR OXYGEN DOSING	SPECIFICATION NO.:
		VOLUME
		SECTION
		REV. NO. / DATE :
		SHEET 1 OF 1

DATA SHEET – A & B

	DATA SHEET – A FOR MASS FLOW CONTROLLER (TO BE FILLED BY PURCHASER)		DATA SHEET – B (TO BE FILLED UP BY BIDDER)
GENERAL	PROJECT	TANGEDCO NORTH CHENNAI TPP (1X800 MW)	……
	MAKE/MODEL NUMBER	BIDDER TO SPECIFY	……
	TYPE	BIDDER TO SPECIFY	……
	SERVICE	99% PURE OXYGEN	……
TECHNICAL	PRINCIPLE	□ CORIOLIS □ THERMAL MASS FLOW □ OTHER	……
	MATERIAL OF CONSTRUCTION		……
	a) BODY	□ DIE CAST AL (MINIMUM) □ __ __ __	……
	b) WETTED PARTS	■ SS 316 □ __ __ __	……
	POWER SUPPLY	■ 24V DC □ 230V AC	……
	INPUT SIGNAL	4-20 mA	……
	OUTPUT SIGNAL	4-20 mA for Mass Flow Rate (HART compatible) (Selectable for other measured quantities)	……
	ACCURACY (on FSD)	■ ±1% □ __ __ __	……
	LINEARITY	■ ±1% □ __ __ __	……
	HYSTERESIS	■ ±1% □ __ __ __	……
	REPEATABILITY	■ ±0.2% □ __ __ __	……
	TURN DOWN RATIO	■ 50:1 □ __ __ __	……
	RESPONSE TIME	■ 100 mSec □ __ __ __	……
	PROCESS CONNECTION	■ ½" NPT (M) □ ½" FLANGED	……
	MOUNTING/ INSTALLATION DETAIL	BIDDER TO SPECIFY	……
	ENCLOSURE	■ IP-65 □ __ __ __	……
	REVERSE POLARITY PROTECTION	□ PROVIDED □ __ __ __	……
	MEASURED SIGNAL (AS MINIMUM)	■ MASS FLOW RATE □TOTAL MASS FLOW □ TEMPERATURE □ DENSITY	……
	TAG PLATE MATERIAL	■ STAINLESS STEEL □ __ __ __	……
	ACCESSORIES	BIDDER TO SPECIFY	……
	CABLE ENTRY DETAILS/QTY.	BIDDER TO SPECIFY	……

	SL. No.	DOSING LOCATION	OPERATING PRESSURE	DESIGN PRESSURE	OPERATING TEMP	DESIGN TEMP	FLOW RANGE	FLOW RATE	MAX OPERATING TEMP
SERVICE CONDITION	1.	AT DEA O/L AT CPU O/L	VENDOR TO SELECT AS PER PROCESS CONDITIONS						

FORM NO. PEM-6666-0

BHEL PEM	DATA SHEET FOR MASS FLOW CONTROLLER FOR OXYGEN DOSING	SPECIFICATION NO.:
		VOLUME
		SECTION
		REV. NO. / DATE :
		SHEET 1 OF 1

Tag No. : ……..….. Qty.: ……

Date Sheet No. PE-DS-999-145-I012

DATA SHEET – C

DATA SHEET – C FOR MASS FLOW CONTROLLER
(TO BE FILLED BY BIDDER)

GENERAL	PROJECT	———————————
	MAKE/MODEL NUMBER	———————————
	TYPE	———————————
	SERVICE	———————————
TECHNICAL	PRINCIPLE	———————————
	MATERIAL OF CONSTRUCTION	
	a) BODY	———————————
	b) INTERNAL	———————————
	POWER SUPPLY	———————————
	INPUT SIGNAL	———————————
	OUTPUT SIGNAL	———————————
	ACCURACY (on FSD)	———————————
	LINEARITY	———————————
	HYSTERESIS	———————————
	REPEATABILITY	———————————
	TURN DOWN RATIO	———————————
	RESPONSE TIME	———————————
	PROCESS CONNECTION	———————————
	MOUNTING/ INSTALLATION DETAIL	———————————
	ENCLOSURE	———————————
	REVERSE POLARITY PROTECTION	———————————
	MEASURED SIGNAL (AS MINIMUM)	———————————
	TAG PLATE MATERIAL	———————————
	ACCESSORIES	———————————
	CABLE ENTRY DETAILS/QTY.	———————————

	SL. No.	DOSING LOCATION	OPERATING PRESSURE	DESIGN PRESSURE	OPERATING TEMP	DESIGN TEMP	FLOW RANGE	FLOW RATE	MAX OPERATING TEMP
SERVICE CONDITION	1.	AT DEA O/L AT CPU O/L							

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR TRANSMITTER

(APPLICABLE FOR PRESSURE 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 :

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. When material corelation are not available manufacturer's compliance to be provided.
4. 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 SOLENOID VALVES

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	TYPE						
	MAKE						
	MODEL No.						
2	MATERIAL (BODY. PLUNGER/TRIM)			P	W	V	
3	PORT SIZE			P	W	V	
4	CABLE CONNECTION SIZE			P	W	V	
5	ENCLOSURE CLASS			P	W	V	TYPE TEST CERTIFICATE TO BE FURNISHED BY VENDOR
6	No. OF COILS & INSULATION CLASS			P	W	V	TEST CERTIFICATE TO BE FURNISHED FOR INSULATION CLASS BY VENDOR
7	POWER SUPPLY CHECK			P	W	V	
8	IR / HV TEST			P	W	V	
9	FUCTIONAL TEST			P	W	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

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. 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 :

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. When material corelation is not available, MFR's compliance to be provided
5. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

2.5.3.6 Calibration of Instruments

The Bidder shall carry out the calibration of instruments as indicated below by submitting the test procedure and quality assurance plan for the Owner's approval. Bidder shall also prepare detailed checklist/calibration sheets for each of the systems/equipment clearly indicating the step-by-step procedures to be carried out for calibration pre commissioning, loop checking, powering and commissioning.

The calibration of all instruments shall be checked and calibration records prepared for the Owner's use. If the instruments require recalibration, Bidder shall recalibrate the instruments and revise the calibration records and submit to the Owner.

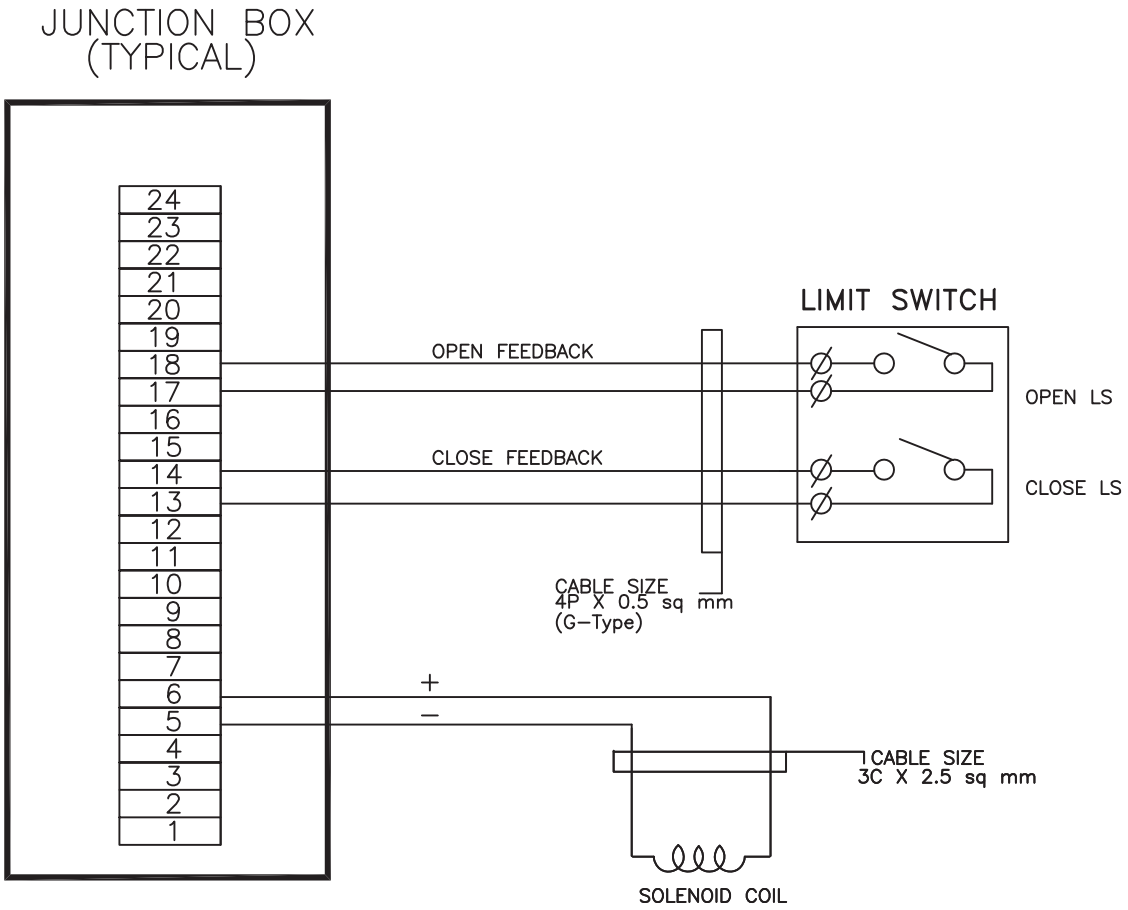
2.5.3.7 Tests to be performed for Field Instruments

S.No	Tests to be performed
1.	**Pressure Gauges**
	Calibration Hydro test (1.5 times max. pr.)
2.	**Pressure switches**
	Calibration test / Hydro test / Contact rating test / Accuracy test / Repeatability
3.	**Differential Pressure Gauges**
	Calibration test / Hydro test / Leak test / Over range test / Accuracy test / Repeatability test.
4.	**Differential Pressure Switches**
	Calibration test / Hydro test / Contact rating test / Leak test / Accuracy test / Repeatability test.
5.	**Thermometers**
	Calibration / Material test / Accuracy test / Bore concentricity : $\pm$ 5% of wall thickness / Hydrostatic test for TW (1.5 times max. pr.)
6.	**Temperature switch**
	Calibration / Material test / Accuracy test / Bore concentricity: 1.5% of wall thickness / Hydrostatic test for TW (1.5 times max. pr.) / Contact rating test.
7.	**Resistance temperature detector assembly.**
	Calibration / Material test / Bore concentricity test / Insulation test ($\leq$ 500 MΩ at 500V DC) As per ISA, Hydro test for TW. Bore concentricity: $\pm$ 5% of wall thickness, Accuracy test.
8.	**Thermocouple assembly**
	Calibration / Material test, Insulation test ($\geq$ 500 Ω at 500 V, DC) as per ISA, Hydro static test (1.5 times max. pr.), Bore concentricity: $\pm$ 5% of wall thickness.
9.	**Thermo wells**
	Material test / Bore concentricity: $\pm$ 5% of wall thickness / Hydrostatic test for TW (1.5 times max. pr.)
10.	**Level Gauges**

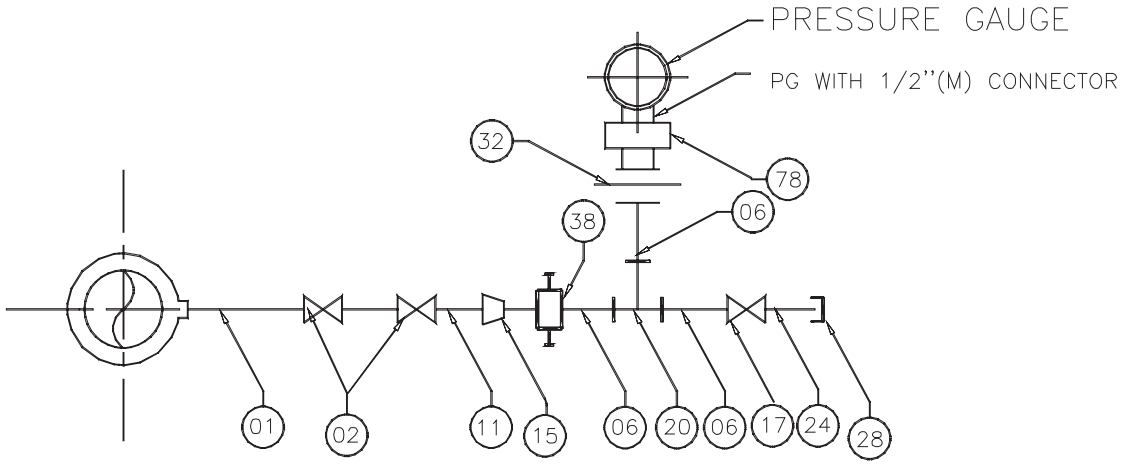
S.No	Tests to be performed
	Hydrostatic test / Material test / Seat leakage test / Ball check test.
11.	**Level switches (Magnetic)**
	Material test / Contact rating test / Hydro test / Calibration test.
12.	**Flow Switch**
	Material test / Hydro static test (1.5 times max. pr.) / function test.
13.	**Flow glasses**
	Material test / Hydrostatic test (1.5 times max. pr.) / function test.
14.	**Variable area flow meters**
	Calibration test / Material test / Hydrostatic test (1.5 times max. pr.)
15.	**Flow element**
	100% Radiography test / Hydro test / Calibration test, IBR Certificate.
	Calibration test for flow element shall be witnessed by Owner.
16.	**Control valves / Pneumatic block valve / Pressure regulating valve – Refer chapter 10.**
17.	**Position transmitters**
	Calibration / hysteresis and Accuracy test
18.	**Electro Pneumatic Convertors**
	Calibration test / Accuracy test
19.	**Solenoid valves**
	Hydro test / Seat leakage test / CV test / Coil insulation test
20.	**Air filter regulators**
	Calibration test / Accuracy test
21.	**Junction Boxes**
	Test for degree of protection / Material test
22.	**Tests for terminal blocks**
	Test for moulding for flame resistant, Non-hygroscopic and Decarbonised / Insulation test between terminals / Insulation between terminal block and frame.
23.	**Thermocouple extension cable**
	Thermo-e.m.f characteristic / Continuity test / Measurement on capacitance, inductance and loop resistance / Insulation resistance / High voltage test as per latest IS / Tensile and elongation test / Oxygen index test / Any other test applicable.
24.	**Mass flow meter**
	Performance test / Calibration test / Hydrostatic test.
25.	**Boiler Level Gauge**
	Hydrostatic test / Material test / Seat leakage test / IBR Certificate
26.	**pH / Conductivity measurement / Silica / Dissolved oxygen analysers**:
	Calibration test, Accuracy test
27.	**Sample cooler :**

S.No	Tests to be performed
	Hydro test, IBR Certificate
28.	**Sampling racks :**
	Hydro test, IBR Certificate for tubes and fittings.
29.	**SO2 / NOx analyser / SPM analyser:**
	Calibration test, accuracy test
30.	**Interposing relay**
	Functional test, temperature rise test, H.V test, Insulation test
31.	**Transmitter Racks** :
	Hydro test, air leak test for piping / tubing and fittings. IBR certification as required for tubing / piping and fittings.
32.	**Pressure Transmitter**
	Calibration test / Hydro test / Leak test / Over range test / Accuracy test / Repeatability test.
33.	**Differential pressure transmitter**
	Calibration test / Hydro test / Leak test / Over range test / Accuracy test / Repeatability test.
34.	**Temperature Transmitter**
	Calibration test / Accuracy test / Ambient temperature error test
35	**Pneumatic Block Valves**
	a) IBR certificate form III C b) Hydrostatic test : ANSI B 16.34 c) Seat leakage test : As per ANSI B 16-104 d) CV test: As per ISA procedure e) Magnetic particle test ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 Deg.C) f) Liquid penetration test: ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 Deg.C) g) Radiography test: ANSI B 16.34 special class h) Calibration and Hysteresis test i) Actuator leakage test
36.	**Pressure Regulating Valve**
	a) IBR certificate form III C b) Hydrostatic test : ANSI B 16.34 c) Seat leakage test : As per ANSI B 16-104 d) CV test: As per ISA procedure e) Magnetic particle test ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 Deg.C) f) Liquid penetration test: ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 Deg.C) g) Radiography test: ANSI B 16.34 special class h) Calibration and Hysteresis test i) Actuator leakage test
37.	**Local Panels :**
	Visual inspection, wiring & continuity check, H.V. and I.R. tests on panels, checking of bill of materials, functional tests.
38	**Wiring Termination & Accessories**

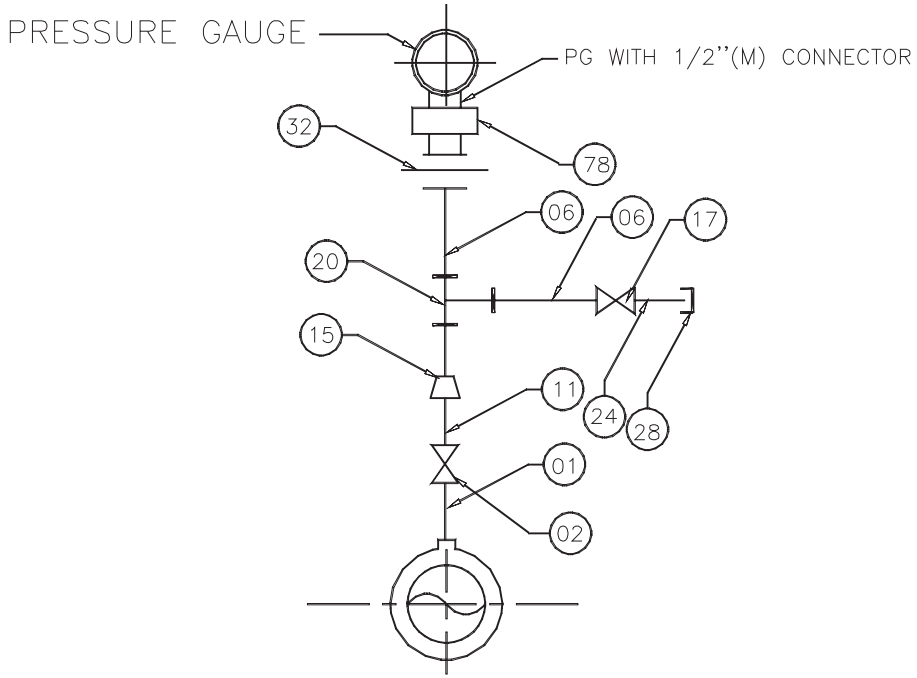
INTERFACE FOR SOLENOID VALVE (24VDC)



BHEL	PROJECT: 1X800MW TANGEDCO NORTH CHENNAI TPS	DRG.NO.	
		DATE	
	TITLE: TYPICAL HOOK-UP DIAGRAM SOLENOID VALVE (24VDC)	REV.NO.	
		SHT 1 OF 1	



FIG–A STEAM/LIQUID SERVICE



FIG–B AIR SERVICE

NOTE

TAG NO.	DESCRIPTION	QTY. A	QTY. B
78	1/2''NPT(F)X1/2"NPT(M) SNUBBER/ PULSATION DAMPER	1	1
38	3–WAY GAUGE VALVE WITH 1/2" NB SW	1	–
32	1/2"NPS, 3 PIECE PIPE UNION WITH 1/2"NPT(F) SCREWED	1	1
28	1/2"NPT (f) CS CAP	1	1
24	1/2"NPS, SCH–80/160 X 1/2"NPT(MO CS/AS NIPPLE	1	1
20	1/2"SW EQUAL TEE, CS/AS	2	1
17	1/2"SW CS/AS GLOBE VALVE	1	1
1	1/2"/ 3/4"/ CS/AS NIPPLE OF MTL. SAME AS THAT OF MAIN PIPE(AS PRE PROCESS REQ.)	AS REQ.	
15	1"TO 1/2"SW REDUCER	1	1
11	1"NPS SCH–80/160 CS/AS PIPE	1	1
6	1/2"NPS. SCH–80/160 CS/AS PIPE	AS REQ.	
2	1/2"/3/4"/1"ROOT VALVE – SW GLOBE VALVE	2	1

REV. No.	DATE	MECH.	CIVIL	ELEC.	C&I	DESCRIPTION
X	XX.XX.2015	XXX	XXX	XXX	XXX	PRELIMINARY ISSUE

CHECKED

TAMIL NADU GENERATION AND DISTRIBUTION CORPORATION LIMITED

LAHMEYER INDIA

LAHMEYER INTERNATIONAL (INDIA) PVT. LTD.
CONSULTING ENGINEERS, GURGAON, INDIA

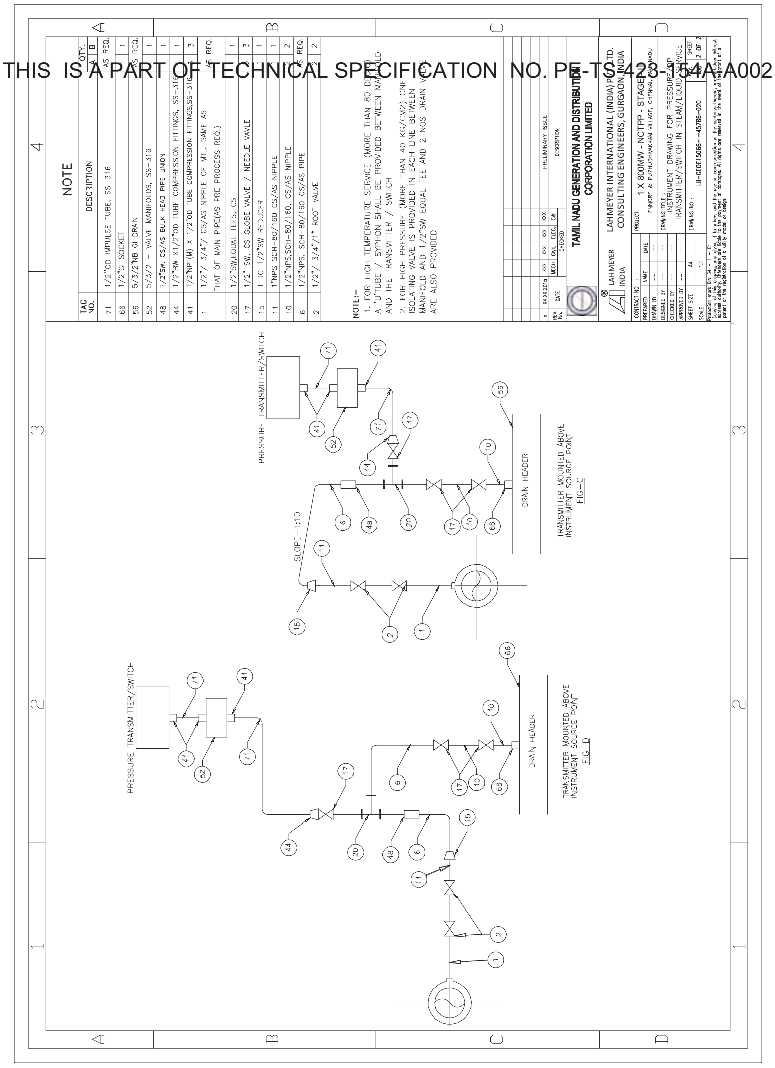
CONTRACT NO :		
PREPARED	NAME	DATE
DRAWN BY	--	--
DESIGNED BY	--	--
CHECKED BY	--	--
APPROVED BY	--	--
SHEET SIZE	A4	
SCALE	1:1	

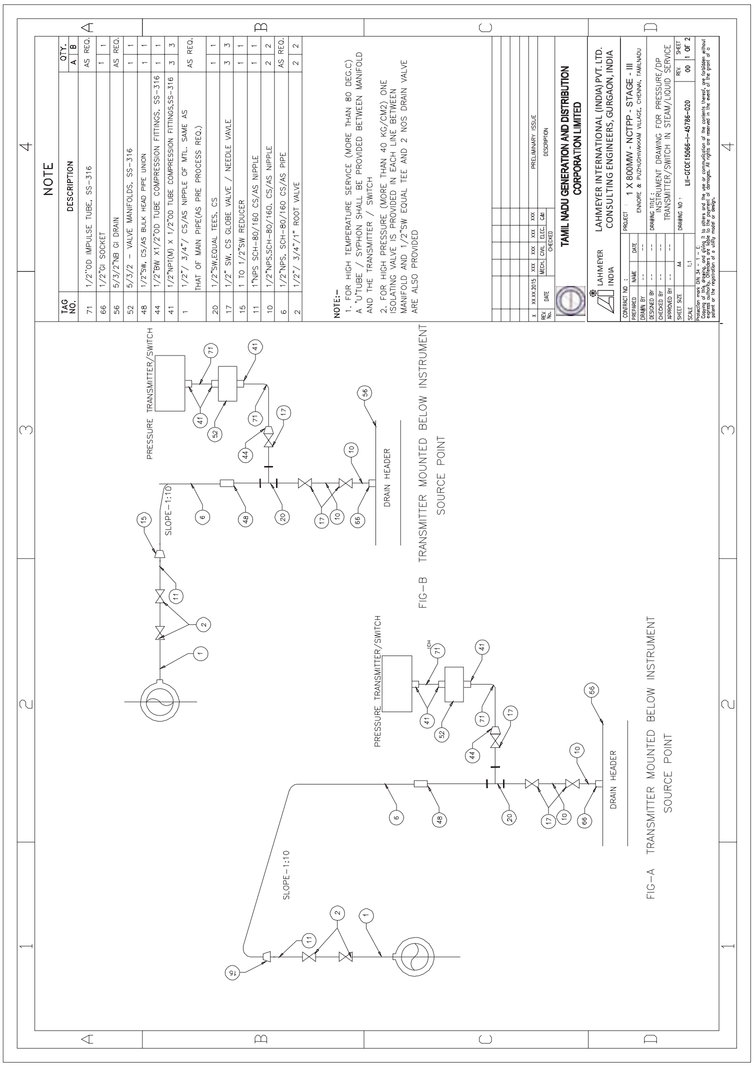
PROJECT : 1 X 800MW - NCTPP - STAGE - III
ENNORE & PUZHUDHIVAKKAM VILLAGE, CHENNAI, TAMILNADU

DRAWING TITLE : INSTRUMENT DRAWING FOR PRESSURE GAUGE FOR STEAM/LIQUID/AIR SERVICE

DRAWING NO : LII–GEOE15066–I–45786–004 | REV. 00 | SHEET 1 OF 1

THIS IS A PART OF TECHNICAL SPECIFICATION NO. PE-TS-423-154A-A002


PRESSURE TRANSMITTER/SWITCH
SLOPE-1:10
DRAIN HEADER
TRANSMITTER MOUNTED ABOVE INSTRUMENT SOURCE POINT
FIG-D
FIG-C
NOTE
TAG NO. | DESCRIPTION | QTY. A B
71 1/2"OD IMPULSE TUBE, SS-316 AS REQ.
66 1/2"GI SOCKET 1 1
56 5/3/2"NB GI DRAIN AS REQ.
52 5/3/2 - VALVE MANIFOLDS, SS-316 1 1
48 1/2"SW, CS/AS BULK HEAD PIPE UNION 1 1
44 1/2"BW X1/2"OD TUBE COMPRESSION FITTINGS, SS-316 1 1
41 1/2"NPT(M) X 1/2"OD TUBE COMPRESSION FITTINGS,SS-316 3 3
1 1/2"/ 3/4"/ CS/AS NIPPLE OF MTL. SAME AS THAT OF MAIN PIPE(AS PRE PROCESS REQ.) AS REQ.
20 1/2"SW,EQUAL TEES, CS 1 1
17 1/2" SW, CS GLOBE VALVE / NEEDLE VAVLE 3 3
15 1 TO 1/2"SW REDUCER 1 1
11 1"NPS SCH-80/160 CS/AS NIPPLE 1 1
10 1/2"NPS,SCH-80/160, CS/AS NIPPLE 2 2
6 1/2"NPS, SCH-80/160 CS/AS PIPE AS REQ.
2 1/2"/ 3/4"/1" ROOT VALVE 2 2
NOTE:-
1. FOR HIGH TEMPERATURE SERVICE (MORE THAN 80 DEG.C) A 'U'TUBE / SYPHON SHALL BE PROVIDED BETWEEN MANIFOLD AND THE TRANSMITTER / SWITCH
2. FOR HIGH PRESSURE (MORE THAN 40 KG/CM2) ONE ISOLATING VALVE IS PROVIDED IN EACH LINE BETWEEN MANIFOLD AND 1/2"SW EQUAL TEE AND 2 NOS DRAIN VALVE ARE ALSO PROVIDED
PRELIMINARY ISSUE
TAMIL NADU GENERATION AND DISTRIBUTION CORPORATION LIMITED
LAHMEYER INTERNATIONAL (INDIA) PVT. LTD.
CONSULTING ENGINEERS, GURGAON, INDIA
1 X 800MW - NCTPP - STAGE - III
ENNORE & PUZHUDHIVAKKAM VILLAGE, CHENNAI, TAMILNADU
INSTRUMENT DRAWING FOR PRESSURE/DP TRANSMITTER/SWITCH IN STEAM/LIQUID SERVICE
LII-GEOE15066-I-45786-020
2 OF 2


PRESSURE TRANSMITTER/SWITCH
SLOPE-1:10
DRAIN HEADER
FIG-A TRANSMITTER MOUNTED BELOW INSTRUMENT SOURCE POINT
FIG-B TRANSMITTER MOUNTED BELOW INSTRUMENT SOURCE POINT
NOTE
TAG NO. | DESCRIPTION | QTY. A B
71 1/2"OD IMPULSE TUBE, SS-316 AS REQ.
66 1/2"GI SOCKET 1 1
56 5/3/2"NB GI DRAIN AS REQ.
52 5/3/2 - VALVE MANIFOLDS, SS-316 1 1
48 1/2"SW, CS/AS BULK HEAD PIPE UNION 1 1
44 1/2"BW X1/2"OD TUBE COMPRESSION FITTINGS, SS-316 1 1
41 1/2"NPT(M) X 1/2"OD TUBE COMPRESSION FITTINGS,SS-316 3 3
1 1/2"/ 3/4"/ CS/AS NIPPLE OF MTL. SAME AS THAT OF MAIN PIPE(AS PRE PROCESS REQ.) AS REQ.
20 1/2"SW,EQUAL TEES, CS 1 1
17 1/2" SW, CS GLOBE VALVE / NEEDLE VAVLE 3 3
15 1 TO 1/2"SW REDUCER 1 1
11 1"NPS SCH-80/160 CS/AS NIPPLE 1 1
10 1/2"NPS,SCH-80/160, CS/AS NIPPLE 2 2
6 1/2"NPS, SCH-80/160 CS/AS PIPE AS REQ.
2 1/2"/ 3/4"/1" ROOT VALVE 2 2
NOTE:-
1. FOR HIGH TEMPERATURE SERVICE (MORE THAN 80 DEG.C) A 'U'TUBE / SYPHON SHALL BE PROVIDED BETWEEN MANIFOLD AND THE TRANSMITTER / SWITCH
2. FOR HIGH PRESSURE (MORE THAN 40 KG/CM2) ONE ISOLATING VALVE IS PROVIDED IN EACH LINE BETWEEN MANIFOLD AND 1/2"SW EQUAL TEE AND 2 NOS DRAIN VALVE ARE ALSO PROVIDED
PRELIMINARY ISSUE
TAMIL NADU GENERATION AND DISTRIBUTION CORPORATION LIMITED
LAHMEYER INTERNATIONAL (INDIA) PVT. LTD.
CONSULTING ENGINEERS, GURGAON, INDIA
1 X 800MW - NCTPP - STAGE - III
ENNORE & PUZHUDHIVAKKAM VILLAGE, CHENNAI, TAMILNADU
INSTRUMENT DRAWING FOR PRESSURE/DP TRANSMITTER/SWITCH IN STEAM/LIQUID SERVICE
LII-GEOE15066-I-45786-020
1 OF 2

SECTION III

DOCUMENTS TO BE SUBMITTED BY BIDDER

SCHEDULE OF PRE-BID CLARIFICATION

All clarification from the Technical Specification shall be filled in by the BIDDER clause by clause in this format only.

VOLUME	SECTION	CLAUSE NO.	PAGE NO.	SPECIFICATION REQUIREMENT	CLARIFICATION	REASONS FOR CLARIFICATION

Note: Bidder to furnish all the pre bid in the above indicated pre bid clarification format only. General Pre bid clarification will not be considered.

COMPLIANCE CUM CONFIRMATION SCHEDULE

The bidder shall confirm compliance with following by signing/ stamping this compliance certificate and furnishing 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/ deviations with regard to same.

b.) QP/ test procedures shall be submitted in the event of order based on the guidelines given in the specification & QP enclosed therein. QP will be subject to BHEL/Customer approval in the event of order & 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.The charges for 3rd party inspection (Lloyds, TUV or equivalent) for imported components shall be included in the base price of the equipment by the bidder.

c.) All drawings/data – sheets etc. to be submitted during contract shall be subject to BHEL/Customer review/ approval. GA drawings, as submitted with offer at tender stage are for reference purpose only and shall be subject to approval during contract stage.

d.) There are no other deviations with respect to specification other than those furnished in the 'Schedule of Deviations'.

e.) The offered materials shall be either equivalent or superior to those specified. Also for components where material is not specified it shall be suitable for intended duty, materials shall be subject to approval in the event of order.

f.) The commissioning spares (if any) are supplied on 'As Required Basis' & prices for same included in the base price (If bidders reply to this is "No commissioning spares are required" and if some spares are actually required during commissioning same shall be supplied by bidder without any cost to BHEL).

g.) All sub vendors shall be subject to BHEL/CUSTOMER approval.

h.) Any special tools & tackles, if required, shall be in bidder's scope.

i.) Demonstration parameters shall stand valid till the satisfactory completion of demonstration test and its acceptance by BHEL/Customer.

DECLARATIONS

I ……..……certify that all the technical data and information pertaining to this specification are correct and are true representation of the equipment/system covered by our format proposal number Dated …….. and there is no deviation to the specification.

I hereby certify that I am duly authorized representative of the Bidder's company whose name appears above my signature.

Bidders Company Name …….

Authorized representative's
Signature ……..

Name …….

Bidder's Name

The bidder hereby agrees to fully comply with the requirements and intent of this specification for the price indicated

DEVIATION SHEET (COST OF WITHDRAWL)

1X800 MW COAL BASED NORTH CHENNAI TPP STAGE –III-BTG

TECHNICAL SPECIFICATION FOR OXYGEN DOSING SYSTEM

TECH SPEC NO: PE-TS-423-154A-A002

TENDER ENQUIRY REFERENCE:-

NAME OF BIDDER:-

SL NO	VOULME/ SECTION	PAGE NO.	CLAUSE NO.	TECHNICAL SPECIFICATION/ TENDER DOCUMENT	COMPLETE DESCRIPTION OF DEVIATION	COST OF WITHDRAWL OF DEVIATION	REFERENCE OF PRICE SCHEDULE ON WHICH COST OF WITHDRAWL OF DEVIATION IS APPLICABLE	NATURE OF COST OF WITHDRAWL OF DEVIATION (POSITIVE/ NEGATIVE)	REASON FOR QUOTING DEVIATION
TECHNICAL DEVIATIONS									
COMMERCIAL DEVIATIONS									

PARTICULARS OF BIDDERS/ AUTHORISED REPRESENTATIVE

NAME	**DESIGNATIONS**	**SIGN & DATE**	

NOTES:

1. For self manufactured items of bidder, cost of withdrawl of deviation will be applicable on the basic price (i.e. excluding taxes, duties & freight) only.
2. For directly dispatchable items, cost of withdrawl of deviation will be applicable on the basic price including taxes, duties & freight.
3. All the bidders have to list out all their Technical & Commercial Deviations (if any) in detail in the above format.
4. Any deviation not mentioned above and shown separately or found hidden in offer, will not be taken cognizance of.
5. Bidder shall submit duly filled unpriced copy of above format indicating "quoted" in "cost of withdrawl of deviation" column of the schedule above along with their Techno-commercial offer, wherever applicable.
6. Bidder shall furnish price copy of above format along with price bid.
7. The final decision of acceptance/ rejection of the deviations quoted by the bidder shall be at discretion of the Purchaser.
8. Bidders to note that any deviation (technical/commercial) not listed in above and asked after Part-I opening shall not be considered.
9. 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 withdrawl 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 withdrawl of deviation shall be taken as NIL.
10. Any deviation mentioned in priced copy of this format, but not mentioned in the un-priced copy, shall not be accepted.
11. 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.
12. Cost of withdrawl is to be given seperately for each deviation. In no event bidder should club cost of withdrawl of more than one deviation else cost of withdrawl of such deviations which have been clubbed together shall be considered as NIL.
13. In case nature of cost of withdrawl (positive/negative) is not specified it shall be assumed as positive.
14. In case of descrepancy in the nature of impact (positive/ negative), positive will be considered for evaluation and negative for ordering.